A nighttime photograph of a city street. On the left is a large, ornate brick building with many windows, some of which are lit. In the center and right are modern skyscrapers. One prominent skyscraper has a glowing blue, teardrop-shaped light fixture on its top. The sky is dark, and there are some light flares from streetlights or camera effects.

Quick Start Guide

# GREENHOUSE GAS EMISSIONS INVENTORY CONTRIBUTION ANALYSIS TOOLKIT

A Guide to Understanding Drivers of Change in  
GHG Emissions Inventories

**ICLEI USA**  
July 2018

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## INTRODUCTION

This quick start guide is a companion to the Contribution Analysis Toolkit, which is intended to help local government staff complete an analysis of the drivers of change of local greenhouse gas (GHG) emissions. This version of the guide gives more direct guidance on use of the spreadsheet tool; however, it is highly recommended that users read the full user guide thoroughly and take advantage of other training material available.

The guide is intended for local governments that have completed at least two greenhouse gas emissions inventories and want to better understand the factors driving the changes between the two inventory years, such as weather or population growth. The guide explains the methodology for performing a contribution analysis, provides guidance on using the Contribution Analysis Excel tool, and includes examples of how local governments can use the tool to communicate about trends in their GHG emissions over time.

Although useful in many respects, community GHG inventories provide only a wide-angle view of emissions trends with little insight into the drivers of those trends, resulting in a missed opportunity to better understand policy efficacy. Drivers of change can include external factor—such as weather or economic conditions, changes in utility operations or grid resource mix. A contribution analysis can separate the effects of these drivers, providing greater understanding of why emissions are changing. This information in turn can allow more informed targeting of emissions reduction policies and more accurate evaluation of policy effectiveness.

Understanding the drivers of change between two inventories has become increasingly critical as cities shift from establishing inventory baselines to using multiple inventories for carrying out long term emissions management commitments.

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“Seeing what factors impact your emissions is powerful. This project opens up the ‘black box’ of GHG inventories. It helps agencies to focus on the areas they can affect the most.”

-Garrett Wong, City of Santa Monica

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## WHY DEVELOP A CONTRIBUTION ANALYSIS?

- Be able to tell a more nuanced and accurate story about how and why emissions are changing in your community.
- Learn whether underlying trends in energy use per household or per square foot are increasing or decreasing, after taking out the effects of weather.
- Understand how drivers like electricity emissions factors and vehicle fuel efficiency effect your inventory.
- Get an indication of the emissions impact that local programs may be having.
- Learn how vulnerable energy use is to changes in weather, and be able to predict how climate change may impact future energy use.
- Plan for climate action from a more detailed understanding of what is driving emissions changes.
- Make a more effective case to state-level regulators of the importance of supportive state policies, such as renewable portfolio standards.

## OVERALL FRAMEWORK

The GHG Contribution Analysis tool analyzes emissions changes in six categories:

1. Residential electricity
2. Commercial electricity
3. Residential natural gas
4. Commercial natural gas
5. On-road transportation (passenger)
6. Solid waste

The analysis is conducted separately for each sector, and then the results are combined to understand overall drivers and trends. To gain a comprehensive picture of emissions changes between two years, users may also users may input emissions in up to five additional categories (e.g., industrial electricity, non-road transportation). These other categories are not analyzed for underlying drivers, but are integrated into the overall emissions change results.

## THE TOOL ACCOUNTS FOR CHANGES IN THE FOLLOWING KEY DRIVERS:

- Population
- Size of the built environment (e.g., building square footage)
- Emissions factors
- Per capita GDP
- Weather

The tool produces visuals of the results in the form of ‘waterfall’ charts, which show the change between the starting and ending inventories as a series of up and down steps.

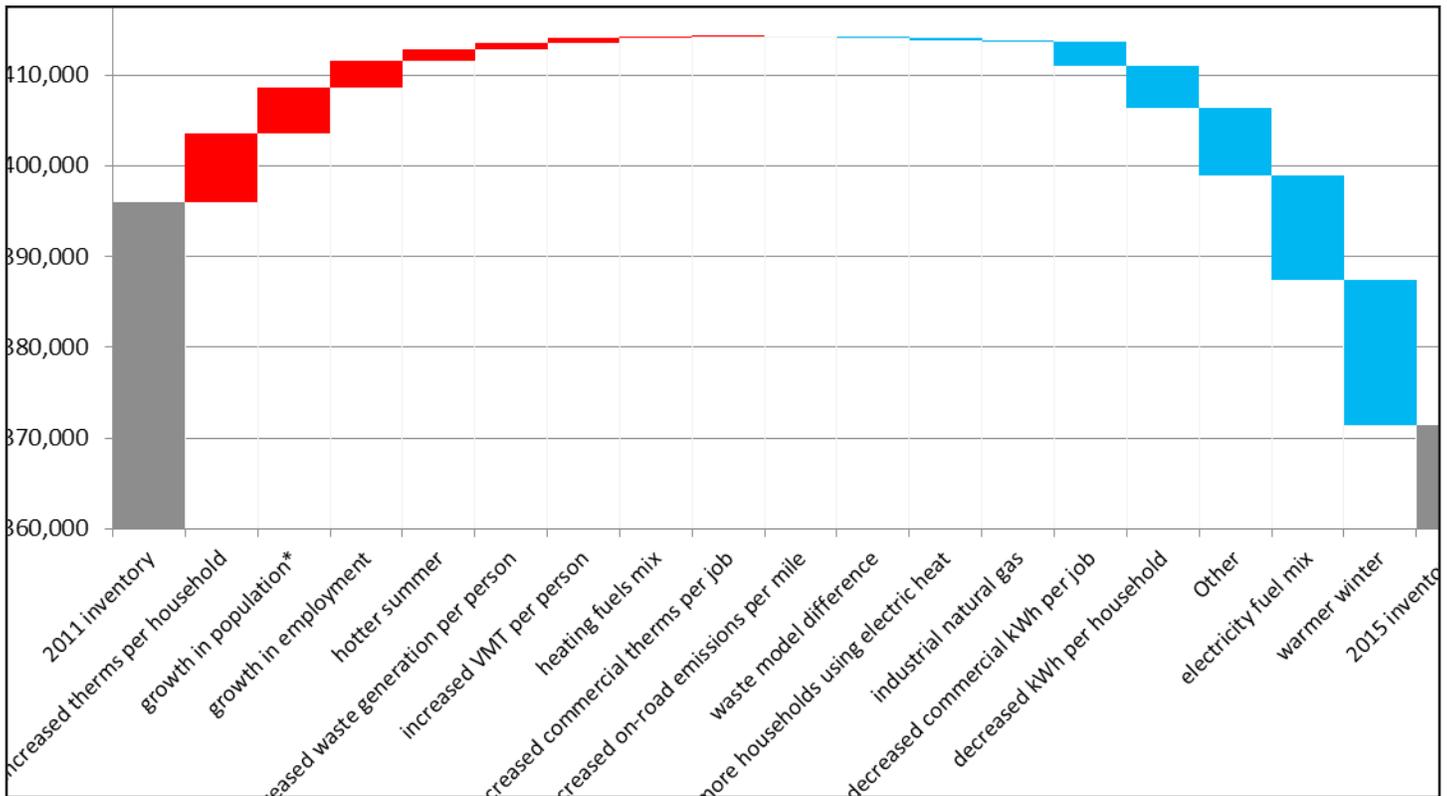


Figure 1 Example of a waterfall chart for a city's drivers of change analysis

## USING THE CONTRIBUTION ANALYSIS TOOL: DATA COLLECTION

### INTRODUCTION

For all inventory inputs, it is recommended that inventories for both years follow an established standard for community level GHG inventories: either the US Community Protocol or Global Protocol for Community Scale Emissions (GPC). However, the most important consideration is that the two inventories are consistent in the methods and data sources used for each sector.

In cases where the method for a particular source or sector is different between the two inventories, updates must be made to apply a consistent approach—usually by applying the method used in the newer inventory to the earlier inventory year.

### GENERAL DATA SOURCES

#### POPULATION

Total population by city is provided by the American Community Survey data through the US Census: American Factfinder.

#### NUMBER OF HOUSEHOLDS

Total housing units by city is provided by the American Community Survey data through the US Census: American Factfinder. One-year (i.e. yearly) estimates are produced for cities over 65,000 in population, 3-year estimates are produced for the period 2011-2013 and earlier for cities from 20,000-65,000 in population, and 5-year estimates are available for remaining communities. 5-year estimates are intended to represent the average number of households over a 5-year period.

#### COMMERCIAL BUILDING SQUARE FOOTAGE (FT<sup>2</sup>)

The square footage of commercial building space is typically collected from local sources such as tax records. If these data are not available, the service sector employment data can serve as a proxy (see below).

#### SERVICE SECTOR EMPLOYMENT

Service sector employment data may be obtained from the OnTheMap census tool at the city level for years 2002-2014. Select 'Area Profile,' 'All Workers,' and 'Primary Jobs', as shown in Figure 2.

<sup>1</sup> <https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml>

<sup>2</sup> <https://onthemap.ces.census.gov/>

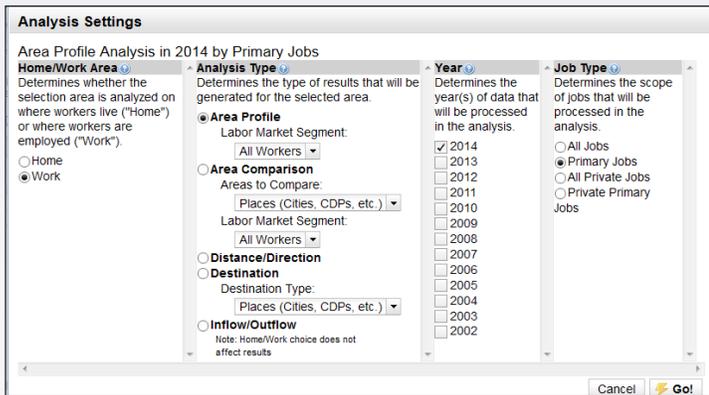


Figure 2 Obtaining service sector employment from the OnTheMap census tool.

Annual GDP is available at the metropolitan region level from the Bureau of Economic Analysis under 'Gross Domestic Product (GDP) by Metropolitan Area' as 'Per capita real GDP'. For communities not in a metropolitan statistical area or where the geography does not match exactly, state level or local data should be used. Select the 'all industry total' for the output.

#### DAILY WEATHER INPUTS

Daily min, max, and average temperatures can be gathered from the Climate Data Online service from the National Center for Environmental Information by National Oceanic and Atmospheric Administration (Figure 3). Average temperatures are optional as not all stations have this data. The temperature dataset is found under "Daily Summaries" for the meteorological station closest to the jurisdiction being assessed and all the inventory years involved. Once the station is selected in the cart, choose "Custom GHCN-Daily CSV" and "Air Temperature" on the next page. Not all meteorological stations track air temperature, but airport stations tend to have this data.

Select a date range that includes both your inventory years, as well as the time period of any monthly energy data. For example, if your inventory years were 2010 and 2015, and your monthly energy data was for 2016 and 2017, you would need weather data for 2010 through 2017.

<sup>3</sup> <https://www.bea.gov/regional/>

<sup>4</sup> <https://www.ncdc.noaa.gov/cdo-web/datasets>

<sup>5</sup> <https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml>

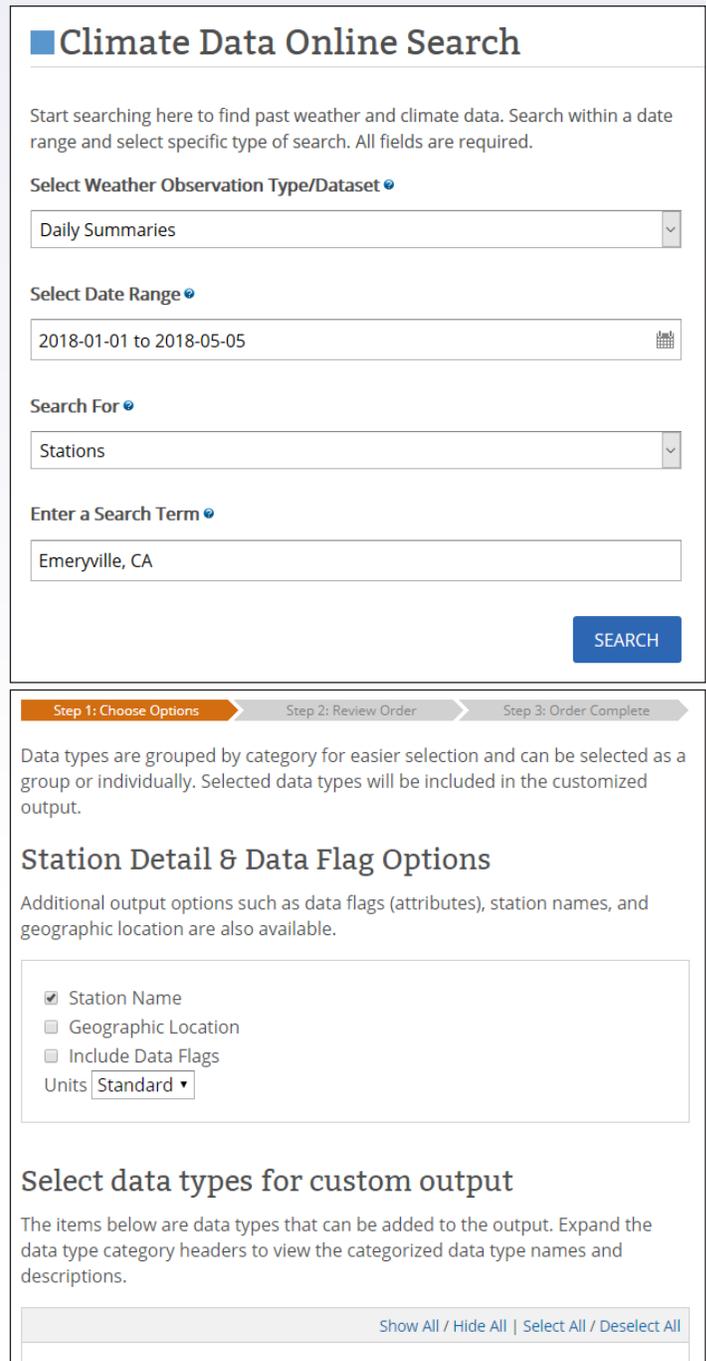


Figure 3 Obtaining daily air temperature data from NOAA's Climate Data Online

## INVENTORY DATA REQUIREMENTS

### ANNUAL ENERGY USAGE AND NUMBER OF CUSTOMERS

Total kWh and therms usage and total emissions broken down by the residential and commercial sectors are needed for analysis for both electricity and natural gas. Municipal sector data, if provided separately by the utility, can be combined with the commercial sector unless your jurisdiction operates a large facility such as a wastewater treatment plant that uses more energy than other facilities. If municipal data does include such facilities, they are considered industrial data. Industrial data and agricultural data should be omitted if possible from the commercial dataset.

For both electricity and natural gas, the energy usage and emissions data must match the inventory years that you are conducting the contribution analysis on. For example, if you are analyzing inventory years 2010 and 2015, you will need inventory data from those years.

The number of natural gas customers for each inventory year is also required. If your utility is unable to provide this data, you can estimate it using census data from the American Community Survey (Figure 4)<sup>5</sup>. Enter the name of your city, and click go. Then select 'Housing' on the sidebar, and then 'Physical Housing Characteristics.' Select each inventory year, and scroll down to the data on 'House Heating Fuel.' This will provide the percent of households using natural gas (utility gas), which you will need to multiply by the total number of households.

The screenshot shows the American Community Survey data viewer for Atlanta city, Georgia. The sidebar on the left lists various demographic categories, with 'Housing' selected. The main content area displays 'Total housing units' as 231,432, sourced from the 2012-2016 American Community Survey 5-Year Estimates. Below this, there are links to popular tables for this geography, including '2016 American Community Survey' (with sub-links for Selected Housing Characteristics, Financial Characteristics, Occupancy Characteristics, and Physical Housing Characteristics), '2010 Census' (with sub-links for General Housing Characteristics and Tenure, Household Size, and Age of Householder), '2016 Population Estimates Program' (with a link for Annual Estimates of Housing Units), and 'Census 2000' (with sub-links for General Housing Characteristics and Tenure, Household Size, and Age of Householder). A link for 'Want more? Need help? Use Guided Search or visit Census.gov's Quick Facts.' is also present.

Subject	Atlanta city, Georgia					
	Occupied housing units		Owner-occupied housing units		Renter-occupied housing units	
	Estimate	Margin of Error	Estimate	Margin of Error	Estimate	Margin of Error
<b>HOUSE HEATING FUEL</b>						
Utility gas	48.8%	+/-0.8	65.4%	+/-0.9	36.3%	+/-1.1
Bottled, tank, or LP gas	0.7%	+/-0.1	0.7%	+/-0.2	0.6%	+/-0.1
Electricity	49.8%	+/-0.8	33.3%	+/-0.9	62.3%	+/-1.2
Fuel oil, kerosene, etc.	0.1%	+/-0.1	0.1%	+/-0.1	0.1%	+/-0.1
Coal or coke	0.0%	+/-0.1	0.0%	+/-0.1	0.0%	+/-0.1
All other fuels	0.1%	+/-0.1	0.2%	+/-0.1	0.1%	+/-0.1
No fuel used	0.5%	+/-0.1	0.2%	+/-0.1	0.6%	+/-0.2

Figure 4 Obtaining census data on percent of customers using utility gas for heating.

## MONTHLY ENERGY USAGE DATA AND NUMBER OF CUSTOMERS

Monthly electricity and natural gas usage data broken down by the residential and commercial sectors is needed to normalize for weather. For each sector, the number of customers served during those months is also required. This data is collected locally from the utilities supplying the energy to the jurisdiction. Data collection email templates are provided to help facilitate the process. You may find it more effective to set up a meeting or call with their utility representatives, as additional discussion may clarify that monthly data aggregated by customer class is needed. ***For jurisdictions that are served by multiple utilities, only one set of monthly data and customer account total is needed for the analysis.***

**For jurisdictions that are served by multiple utilities, only one set of monthly data and customer account total is needed for the analysis.**

In some parts of the country, monthly data may be available directly for download. For example, San Diego Gas and Electric makes monthly usage data by zip code available for download [here](#) and Southern California Edison makes similar data available . For local governments in Minnesota, monthly data by utility territory is available [here](#) .

If your utility is unable to provide you the monthly electricity or natural gas data for a sector, the tool can still generate an output. However, the contribution analysis will not be able to break out the weather impact for that particular fuel.

If your utility can provide the monthly electricity or natural gas data, but not the number of customer accounts, there are several options. Census data for households using that energy source could be used. Alternatively, if utility data is available from a different year, this can be used as a baseline to extrapolate from. The total number of households in the jurisdiction could be used as a last resort. The customer count is used to calculate the per capita energy usage, so it is ideal to match the count to how many are using the energy.

## UTILITY DATA AND CUSTOMER AGGREGATION

Utilities may be required to aggregate their customers' data for privacy reasons when providing monthly energy data. When making the data request, be sure that a description of the customer types is included, as sometimes the commercial sector includes agricultural or industrial data. For example, in California, if the minimum number of customers and usage proportions are not met for privacy purposes, then the public utilities are required by the California Public Utilities Commission to aggregate industrial, agricultural, and commercial users first by sector and then across sectors before sharing any data.

Since the purpose of the contribution analysis is to single out sector-specific drivers, it is ideal to omit agricultural and industrial energy data from the commercial energy dataset. Agricultural and industrial energy are not components that can be analyzed in the model and will merely add to the noise in the data interpretation. Having an overall sense of what is in the energy dataset will help with data interpretation.

## TRANSPORTATION DATA

The tool analysis is most effective when total VMT is known, allowing a more informative decomposition that separates effects of fuel economy and changes to VMT per person. Either data for passenger vehicles only or for all on-road vehicles may be entered. However, the analysis is most accurate for passenger vehicles.

If VMT data is unavailable, total gallons of fuel for on-road transportation is acceptable for the analysis. However, this data will not allow the tool to separate the effect of changes to vehicle fuel economy from changes in VMT per person.

## OPTIONAL INVENTORY DATA

You can enter in whatever sector or category that you have data for in the optional inventory section. Some suggested sectors are listed below.

## WASTE

Total landfill and/or incineration disposal in short tons and total waste emissions is needed for analysis. If there is local data on the waste composition in each inventory year, this can be used to understand how changes in disposal of specific waste types affect emissions. This data can be collected through an audit of the waste collected for disposal.

<sup>6</sup> <https://energydata.sdge.com/>

<sup>7</sup> [https://www.sce.com/wps/portal/home/regulatory/energy%20data%20-%20reports%20and%20compliances!/ut/p/b0/04\\_Sj9CPykssy0xPLMnMz0vMAfGjzOK9PF0cDd1NjDzdzb1cDBwDXMxdQoPMDE28DfULsh0VAZwLqm0!/](https://www.sce.com/wps/portal/home/regulatory/energy%20data%20-%20reports%20and%20compliances!/ut/p/b0/04_Sj9CPykssy0xPLMnMz0vMAfGjzOK9PF0cDd1NjDzdzb1cDBwDXMxdQoPMDE28DfULsh0VAZwLqm0!/)

<sup>8</sup> <https://mn.gov/commerce/industries/energy/utilities/annual-reporting/>

## INDUSTRIAL ENERGY

Total industrial sector emissions can be inputted to the analysis under “All Other Emissions”. Some utilities may aggregate industrial energy into commercial energy—in this case, leave the aggregated data in the main contribution analysis under commercial energy and do not make a separate entry in “All Other Emissions”.

## OFF-ROAD TRANSPORTATION

Total sector emissions can be inputted to the analysis under “All Other Emissions”. This can be further broken down into airport, water fleet, or other off-road if desired.

## OTHER SECTORS

Total sector emissions that aren’t mentioned above, such as wastewater treatment, process and fugitive emissions, and water transportation can be inputted to the analysis under “All Other Emissions”.

## USING THE CONTRIBUTION ANALYSIS TOOL: PROGRAM EVALUATIONS

The contribution analysis is designed to reveal the impact of all factors that contribute to a change in performance between two years. Many of those drivers are largely outside of a city’s control. After accounting for those items, the remaining change is an indicator of the overall impact of actions taken within the city, either by government or private actors to reduce activity levels and emissions. It may be desirable to showcase the impact of specific actions that the community has undertaken alongside broader changes. Thus, the toolkit was designed to allow for results of specific actions to be incorporated into the framework. Results of stand-alone program evaluations can be applied to the overall analysis, and the toolkit incorporates those reductions by allocating the “remaining change” in activity or emissions to the specific action as appropriate and away from the remaining increase or decrease in activity.

Actions may take the form of a project, which is focused, for example, on a particular building or a few buildings; or a program, which seeks to accomplish a large number of projects or behavior change by many individuals. Program and project evaluation is a well-established practice and beyond the scope of this guidance document. Well-executed evaluations require significant effort on their own. Therefore, the toolkit does not directly support quantification of individual city projects or programs, but this section does introduce minimum standards for approaching that quantification.

Evaluations are difficult because they require the development of an alternative scenario of what the outcomes would have been in the absence of the project or program, otherwise known as a counterfactual. Developing a retrospective counterfactual is dependent on the availability of data to represent a business-as-usual scenario. The difference between the counterfactual and the actual performance can be said to be the impact of the project or program. Depending on the nature of the project, fully describing a counterfactual often depends on the degree of control you have over the target of the intervention, so that other influences can be controlled for. Specific efficiency projects within a building are among the most straightforward since sources of data are readily available in the form of meter readings and past usage can be used to construct a counterfactual from which to compare. On the other end of the spectrum are programs to encourage behavior change and other matters of choice like transportation modes. A counterfactual in those cases would have to describe the behaviors of individuals in absence of the program. How many individuals participated? Would some number of them have changed behavior without the program?

Short of performing a custom evaluation in support of a larger contribution analysis, there are a number of alternative sources of data that can be utilized where available. Often utility regulations require utility administered efficiency programs to include evaluations. These may be a useful source of ready to use data, assuming (1) data is available to show that the impact between the two inventory years being analyzed and (2) evaluation was conducted at a geographic scope that is completely inside that of the inventories.

When applying bottom up estimates of program impacts to the contribution analysis, it is important to consider how those impacts are balanced with the overall change. Within the model, there is always a change that is the net increase or decrease in energy use, VMT, or waste generated that is not attributed to the major external factors that the model accounts for. Applying program evaluations in the model simply allocates a portion of that unattributed change to the specific program, ideally leaving a smaller unattributed change. However, that is not the only possible outcome. Because the remaining change is a net increase or decrease, there is no way to tell the number or magnitude of counteracting forces that create that final result. For example, an individual program that has a significant reduction attributable to it could be larger than the unattributed

change that exists before it is included in the analysis. By allocating the unattributed change to a specific action, the net effect of all other unattributed factors may change direction revealing some degree of shift towards more energy, transport, or waste generating activities due to factors not included in the analysis. It is expected that there will always be some amount of unattributed changes and no way to tell the mix of positive and negative forces working to produce the net result that is observed as a toolkit output.

Many communities have relied upon some type of market-based approach to addressing the carbon intensity of the electricity they consume, including RECs, community choice aggregation, utility-specific emissions factors and others. While there are important rules governing how those things are accounted for in official inventory reporting contexts, the goal of the contribution analysis in showcasing the impact of local actions as well as external drivers, it is important to incorporate those here. The spreadsheet tool accompanying this document is designed to allow users to showcase the impact of these actions. Guidance on how to do this is provided in the tool instructions below. In this case, change attributable to these types of actions will be reflected in computed changes to the emissions factor, rather than an allocation of the remaining net change in energy use as describe earlier in this section.

# USING THE CONTRIBUTION ANALYSIS TOOL: THE EXCEL FILE

The GHG Contribution Analysis Tool is built as a Microsoft Excel workbook. You will need to enable macros in order for the tool to fully function. Usually when you open the workbook a security warning will show. Click 'Enable Content' on this bar, as shown in Figure 5.

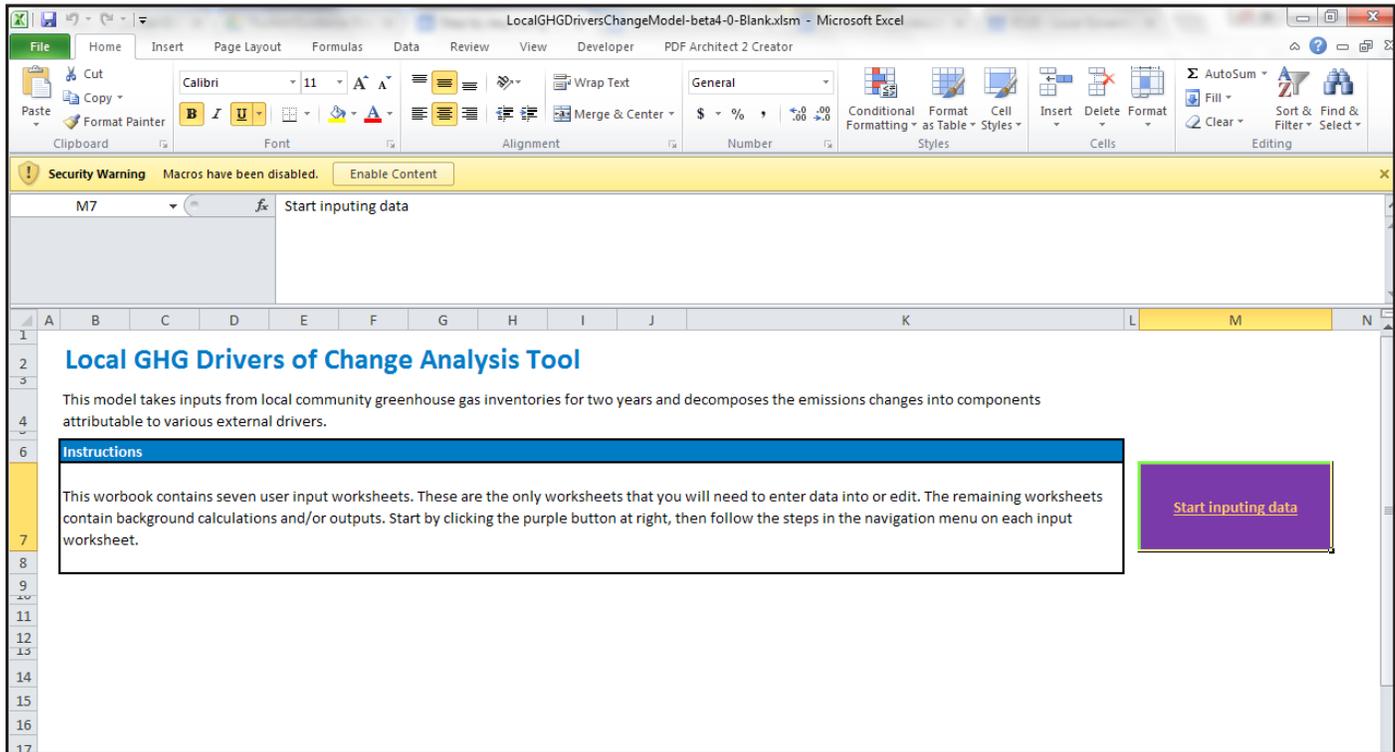


Figure 5 Enabling Macros

If the option to enable macros does not appear, you probably need to change Excel's macro security settings. Go to the Developer menu, then macro security. In the dialog box, select 'Disable all macros with notification' and Save. Then close and re-open the Contribution Analysis workbook. This time it should give you the option to enable macros.

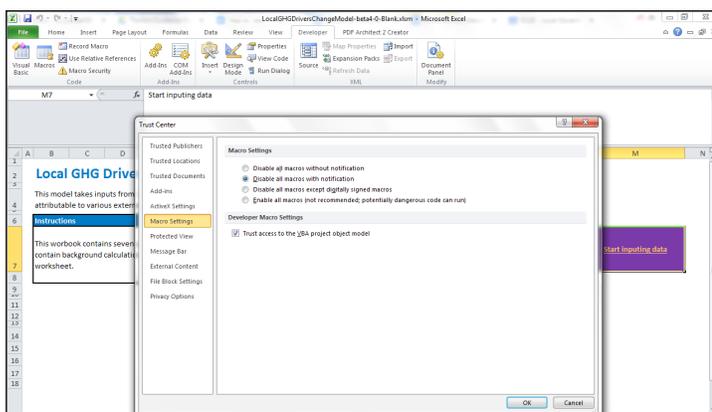


Figure 5 Enabling Macros

## WORKBOOK STRUCTURE

There are seven data input tabs. All data that needs to be entered or edited by users is on these seven tabs. Additional tabs contain outputs and calculations. You can move through the data input tabs using links on the navigation sidebar, which appears at the right of each input tab. Required inputs for each tab are indicated by peach-colored cells. Optional inputs are indicated by white cells. All other cells are locked and not user editable.

## BASIC INPUTS

The first input tab is for basic inputs. Enter the jurisdiction name, contact information and the date in the top box.

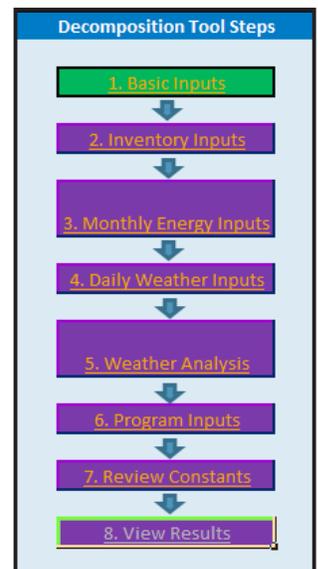


Figure 7 Navigation Sidebar

Contact information	
Jurisdiction Name	Yourtown, USA
Person Completing	Susan Supergreen
Email	<a href="mailto:ssupergreen@yourtown.gov">ssupergreen@yourtown.gov</a>
Date Completed	1-Jan-18

Figure 8

Next, enter the years you are analyzing, population, and number of households in the lower box. Optional fields are provided to enter notes about the data source.

Years and demographic information				Use dropdown to select commercial indicator:	
	Inventory years	Population	Number of Households	employment	\$GDP/person
Year 1					
Year 2					
Data Source					

Figure 9

Click on cell F10 to choose whether you are using data on commercial square footage or employment (see section on data collection), then enter the appropriate data. Finally, enter GDP per person (optional).

Years and demographic information				Use dropdown to select commercial indicator:	
	Inventory years	Population	Number of Households	employment	DP/person
Year 1				employment	
Year 2				commercial Ft^2	
Data Source					

Figure 10

## INVENTORY INPUTS

The next tab is where you will enter the required information from your community GHG inventories.

### ELECTRICITY

Enter residential and commercial electricity emissions and usage for each year. It is a good idea to enter notes about the data source as well. The name of the data source, such as Bureau of Economic Activity or the ICLEI ClearPath inventory output file, is at minimum recommended; more detail is encouraged if available.

Inventory Inputs					Greener City				
Electricity inputs									
Year	Residential electricity emissions (MTCO2e)	Residential usage (kWh)	Commercial electricity emissions (MTCO2e)	Commercial usage (kWh)					
2011	54,723	81,676,086	81,691	126,304,904					
Data Source									
2014	73,774	117,839,486	54,168	104,810,721					
Data Source									

Figure 11

## STATIONARY FUEL COMBUSTION

Enter usage and number of households for natural gas. If fuel oil or propane are included in your inventory, enter usage and households for those fields as well; otherwise you may leave those fields blank. If you do enter residential fuel oil and/or propane, then the “fuel emissions” field should include emissions from those fuels as well as from natural gas.

Stationary fuel combustion inputs						
Year	Residential fuel emissions (MTCO <sub>2</sub> e)	Residential natural gas usage (therms)	Residential households using natural gas	Commercial fuel emissions (MTCO <sub>2</sub> e)	Commercial natural gas usage (therms)	
2011	51,397	9,225,104	6,339	45,776	8,608,601	
Data Source						
2014	48,988	9,092,153	6,039	45,739	8,509,544	
Data Source						
	Residential heating oil usage (gallons)	Residential propane usage (gallons)	Residential households using heating oil	Residential households using propane	Commercial fuel oil usage (gallons)	Commercial propane usage (gallons)
2011		414,879			310	
Data Source						
2014		299,044			305	
Data Source						

Figure 12

## ON-ROAD TRANSPORTATION

Enter the on-road transportation emissions for each year. If you have VMT data, then you should use that; otherwise you may enter the amount of fuel use in either gallons or MMBtu. Click on cell D23 to change the unit. The analysis used for on-road transportation is most applicable to passenger travel. If your inventory separates on-road passenger and freight VMT or fuel use, you should enter only the passenger portion here. Enter the freight portion under ‘All other emissions’ (see below). If your inventory does not separate passenger and freight emissions, then it is fine to enter the total here.

On-road transportation inputs		Choose unit*:
Year	On-road transportation emissions (MTCO <sub>2</sub> e)	Total VMT
2011	55,562	140,684,770
Data Source		
2014	57,303	146,556,433
Data Source		

Figure 13

## SOLID WASTE

Enter the amount of waste sent to landfill and/or incinerator, and the associated emissions. If waste is sent to landfill, you must enter waste composition. The default is to use waste composition categories consistent with the EPA WARM model and ICLEI’s ClearPath tool. You may change to using IPCC/GPC categories by clicking on cell F29. If your inventory did not use a waste breakdown or assigned all waste as 100% mixed MSW, you may enter 100% mixed MSW here as well (choose the ClearPath/EPA WARM categories). Otherwise, enter the percent for each waste type.

Solid waste inputs			Waste categories:	
Year	Total waste landfilled (short tons)	Landfilled waste emissions (MTCO2e)	Waste incinerated (short tons)	Incinerated waste emissions (MTCO2e)
2011	3,068	37,171		
Data Source				
2014	2,628	37,312		

Figure 14

Note that the tool assumes the inventory has been completed using the methane commitment approach, in which the quantity of emissions is directly relatable to the amount of waste disposed and the mix of materials. Changes to directly measured landfill emissions cannot be disaggregated with this tool.

Landfilled waste composition (needed only for landfilled waste; enter 100% Mixed MSW if unknown):								
% Mixed MSW	% Corrugated Containers	% Magazines/ Third-Class Mail	% Newspaper /phonebooks	% Office Paper /textbooks	% Food Waste	% Grass	% Leaves	% Branches
	7.00%		2.40%	22.60%	22.10%		1.95%	1.95%
	7.00%		2.40%	22.60%	22.10%		1.95%	1.95%

Figure 15

#### ALL OTHER EMISSIONS

Use this optional space to enter any other emissions from your inventory that were not included above. These can include sectors such as wastewater treatment, industrial energy, and off-road transportation. These sectors will not be deconstructed through the Contribution Analysis Tool to reveal impact of weather and other factors, but will be included in the visualization of total emissions changes. You may enter up to five categories for other emissions. If you have more categories than this in your inventory, you will need to combine some categories to equal five. For each category, enter the category name in the top row and the emissions two rows below.

All other emissions (MTCO2e)					
Sector Name	Residential other	Commercial other	Industrial	Transport other	Water & Wastewa
Year					
2011	6,081	11,270	1,469,938	1,787,246	13,351
Data Source					
2016	2,267	2,617	1,195,240	1,653,627	18,314
Data Source					

Figure 16

## EXTERNAL WEATHER NORMALIZATION FACTORS

The “Weather Normalization” section provides an option for the user to enter externally calculated weather normalization factors. In some cases, your electric and/or natural gas utilities may calculate their own weather normalization factors for each year, and may prefer to provide those rather than providing monthly energy use data. A weather normalization factor is the ratio between the estimate of what energy use would have been with ‘normal’ weather (usually defined as average over the past 30 years) and the actual energy in a year. For example, if predicted normal usage in 2015 was 1,100,000 kWh and actual usage was 1,000,000 kWh, the normalization factor would be 1.1.

Utilities derive the predicted usage with normal weather using regression models similar to what is used in the Contribution Analysis Tool. However, their models are usually more complex: they may start with daily or even hourly energy use; incorporate humidity, wind, and prior day temperatures; and use more complicated mathematical functions to fit the data.

These differences may allow the utility model to more accurately predict the response of energy use to weather. On the other hand, the utility model will usually be for the utility’s entire service territory rather than specific to your community, and using the normalization factors from a utility model will not give you information about the amount of energy used for heating and for cooling. For these reasons, we recommend using monthly energy use data in the Contribution Analysis Tool when possible.

If you are using external weather normalization factors, select ‘Yes’ in cell G43, and enter the factors for electricity and gas for each year.

Weather Normalization			
Are you using externally calculated weather normalization factors?			Yes
Year	Electricity normalization factor	Gas normalization factor	If yes, enter factors at left. If no, complete Monthly Energy Inputs, Daily Weather Input and Weather Analysis tabs.
2011	1.000	1.000	
2014	1.000	1.000	

Figure 17

## TOTAL INVENTORY EMISSIONS

The “Total Inventory” section serves as a check for your data entry. If you have entered all data correctly, the total from your inventory should be equal to the sum of sectors calculated in cells D50 and 51.

Inventory Total		
Year	Emissions (MTCO <sub>2</sub> e)	Sum of Sectors
2011		326,320
2014		317,284

Figure 18

## MONTHLY ENERGY INPUTS

On the next tab, you will enter monthly energy use. This will be used to estimate the response of energy use to weather. If you are using externally calculated weather normalization factors, or if you are not estimating weather impacts, you can skip to the “Program Inputs” tab.

Start by entering the first year for which you have monthly energy data, as well the number of months of electricity and natural gas data you have.

Monthly Energy Inputs		Greener City	
First year with energy data	Months of electricity data	Months of natural gas data	
2011	12	12	

Figure 19

Values for years and months will automatically populate in columns B and C. Find the appropriate starting month for electricity data, and paste in the monthly residential usage, number of residential customers, and commercial usage. The months of data must be consecutive, with no gaps. Next find the starting month for natural gas data and paste in the residential usage, residential customers, and commercial usage.

Year	Month	Aggregate residential electricity use (kWh)	Number of residential electric customers	Aggregate commercial electricity use (kWh)	Aggregate residential natural gas use (therms)	Number of residential gas customers	Aggregate commercial natural gas use (therms)
2011	1			10,426,645	1,589,883	6,339	1,332,209
2011	2			9,421,999	1,409,453	6,339	1,314,346
2011	3			9,027,444	1,168,706	6,339	1,118,847
2011	4			8,545,308	986,446	6,339	968,685
2011	5			7,321,771	748,268	6,339	676,861
2011	6			7,483,473	431,134	6,339	425,735
2011	7			8,998,100	286,990	6,339	317,685
2011	8			8,402,590	218,984	6,339	259,058
2011	9			8,202,781	268,294	6,339	296,438
2011	10			7,358,132	356,650	6,339	352,007

Figure 20

Note that it is not required to supply monthly detail on the number of customers. The option exists in order to allow users to account for sudden significant changes in the number of customers. It is possible you will only be able to obtain a single number of annual customers. In this case, enter the annual customer value for each month.

### DAILY WEATHER INPUTS

For the “Daily Weather Inputs” tab, you can simply paste in the data from the NOAA file (see ‘Daily Weather Data’ on p.39 of this guide). Be sure that the data starts in row 4 as shown here, and that the date is in column C, and the daily maximum and minimum temperatures are in columns E and F.

Daily Weather Data Input					
Instructions: copy data directly from NOAA national centers for environment and data service					
STATION	NAME	DATE	TAVG	TMAX	TMIN
USW0009	ASPEN PIT	1/1/2011		7	-15
USW0009	ASPEN PIT	1/2/2011		24	-15
USW0009	ASPEN PIT	1/3/2011		28	3
USW0009	ASPEN PIT	1/4/2011		24	2
USW0009	ASPEN PIT	1/5/2011		28	7
USW0009	ASPEN PIT	1/6/2011		36	5

Figure 21

## WEATHER ANALYSIS

Once you have entered monthly energy use and daily weather data, proceed to the “Weather Analysis” tab. This tab controls the macros that will perform the linear regression on the data to find the best parameters for weather response.

The macros will test a range of reference temperatures for heating and cooling degrees to determine the best fit (see the sections on heating and cooling degree days and reference temperatures, within the ‘Contribution Analysis Theory’ part of this guide). The default ranges used by the tool are between 55 and 65 degrees for heating degree days, and between 60 and 70 for cooling degree days. You can adjust these ranges if desired.

Range to test for HDD Reference Temp		Range to test for CDD Reference Temp	
Min	Max	Min	Max
55	65	60	70

Figure 22

You can also adjust the months that are assigned to different seasons. Fall, winter, and spring months are used in the HDD regression, while summer months are used in the CDD regression. ***It is a good idea to adjust the months that are assigned to summer vs to spring or fall, according to your climate. This will help get the most accurate weather response parameters.***

It is a good idea to adjust the months that are assigned to summer vs to spring or fall, according to your climate.

Any month in which air conditioners usually run should be assigned to summer, while months when heat is used should be assigned to fall or spring. Enter a 1 to include a month in a season, and a 0 to not included it. Below is an example for a climate where cooling is only needed during the summer months of June, July and August. For a climate with a longer cooling season you might assign September and May or October to summer as well. It is ok for summer to overlap with spring and fall (1’s placed in both for a month), if there tends to be both heating and cooling during that month. Winter should not overlap with spring or fall however.

Season Dummy Variables. Enter 1 to assign, 0 to not assign.				
Summer may overlap with spring or fall; spring and fall should NOT overlap with winter.				
Month	Winter	Spring	Summer	Fall
January		1	0	0
February		1	0	0
March		0	1	0
April		0	1	0
May		0	1	0
June		0	0	1
July		0	0	1
August		0	0	1
September		0	0	0
October		0	0	0
November		0	0	0
December		1	0	0

Figure 23

After making any adjustments, click on the buttons to run the macro for each sector. It may take a minute or two for the macro to run. You will be shown the regression tab for that sector while the macro is running, and returned to the weather analysis tab when it is complete.

After the macro completes its calculations, a message will be shown. A message in green text indicates that the macro ran successfully. The message may indicate that the macro was unable to determine HDD coefficients or CDD coefficients. This means that the data did not show a statistically significant correlation between that variable and energy use. See Appendix B for more detail on the statistics used. The Contribution Analysis Tool will automatically apply any coefficients that were found, while excluding those that were not statistically significant from the analysis. For example, if a coefficient is found for HDD but not for CDD, the tool will calculate the effect of weather on heating energy use between the two inventories, but not the effect of cooling energy use (in most cases, when a factor is found to be not statistically significant, that effect is also very small).



Figure 24

Regression status	
Residential electric	Weather regression complete; HDD coefficients found; unable to determine CDD coefficients
Residential gas	Weather regression complete; HDD coefficients found
Commercial electric	Weather regression complete; HDD and CDD coefficients found
Commercial gas	Weather regression complete; HDD coefficients found

Figure 25

If a message is displayed in red text, this means that the macro was unable to complete, usually because of bad data, such as a non-numeric value, in either the monthly energy or weather data. The macro will also be unable to complete if there is not weather data for the time period of all monthly energy use data.

## PROGRAM INPUTS

Entering program data is optional. For electricity, fuels, and on-road transportation programs, there are two ways to enter data. You may enter either an activity data reduction (kWh, therms or VMT/gallons/MMBtu), or an already calculated emissions reduction. You may enter up to three programs of each type. Only enter an individual program one way; if you enter a kWh reduction for a program, do not enter the emissions reduction for that same program. This will be calculated automatically.

If you are entering an already calculated emissions reduction for a residential or commercial electricity program, you will need to specify whether the program is an emissions factor change (an emissions factor change would reduce emissions without changing the total kWh value in your inventory). This will ensure that the program reduction is subtracted from the appropriate driver of change. Similarly, for on-road transportation reductions, you will need to specify whether the program is a fuel efficiency change.

Residential Electricity Programs—Emissions reduction already calculated			
Program Name			
Emissions Reduction (MTCO2e)			
Data Source			
Is this an emissions factor change?			
	Yes		
	No		

Figure 26

## ENTERING REC PURCHASES AS A PROGRAM

If you are entering purchases or Renewable Energy Credits or a similar market based renewable energy mechanism as a program, be sure that the total electricity emissions you enter for the affected sector on the “Inventory Inputs” tab is that after the RECs are subtracted. The total kWh you enter for the sector should not have the RECs subtracted.

### INVENTORY INPUTS FOR RECS (IF ENTERED AS PROGRAM):

Electricity inputs				
	Residential electricity emissions (MTCO <sub>2</sub> e)	Residential usage (kWh)	REC Purchases (MTCO <sub>2</sub> e)	Residential usage (kWh)
2013	7,261,384	13,320,628,859	7,853,042	14,405,993,972
Data Source	7259280	13,320,628,859	7,850,801	14,405,993,972
2015	7,087,935	14,390,688,083	7,383,247	14,990,231,423
Data Source	7,055,369	14,390,688,083	7,349,314	14,990,231,423

Figure 26

Finally, answer ‘Yes’ to ‘Is this an emissions factor change?’ when entering the program.

### PROGRAM INPUTS FOR RECS:

Residential Electricity Programs--Emissions reduction already calculated			
Program Name	REC Purchases		
Emissions Reduction (MTCO <sub>2</sub> e)	1,234		
Data Source			
Is this an emissions factor change?	Yes		

Figure 28

## CONSTANTS

The final input tab is for constants used in the calculations. You should review the solid waste factors and adjust the landfill gas capture and oxidation rates as needed to match those used in your inventory. Make sure you are editing the right waste categories; either WARM or GPC/IPCC, depending on which you selected on the “Inventory Inputs” tab.

Otherwise, you do not need to make any changes to this tab, unless you want to change the value used for one of the constants.

## VISUALS

If you click the link for ‘View Results’ from any of the input tabs, you will be taken to the “Visuals” tab, which shows waterfall charts of the drivers of change between your two inventories at different levels of detail. The first chart is the highest-level summary, showing the three factors that caused the largest increases in emissions and the three factors that caused the largest decreases in emissions. The second chart is a medium-level summary, and the

third chart provides a detailed breakdown of all the change components, including individual programs.

Next to each chart is a button labeled ‘Update All Charts.’

Update All Charts

This button is connected to a macro that creates the high-level summary chart, refreshes the data in the other charts, and adjusts the y-axis of each chart to most clearly show the data.

- The first time you visit the visuals tab, click ‘Update All Charts’ to set up the high-level summary and other charts.
- However, do not click on ‘Update all charts’ before you have entered your inventory data, as this may cause an error.

## SECTOR WATERFALL CHARTS

The tool also produces a waterfall chart with details for each sector. To view these, use the outputs navigation on the Visuals tab. Each chart is on the tab with the calculations for that sector.

# USING THE CONTRIBUTION ANALYSIS TOOL: INTERPRETATION

## INTERPRETATION OF THE SUMMARY CHARTS

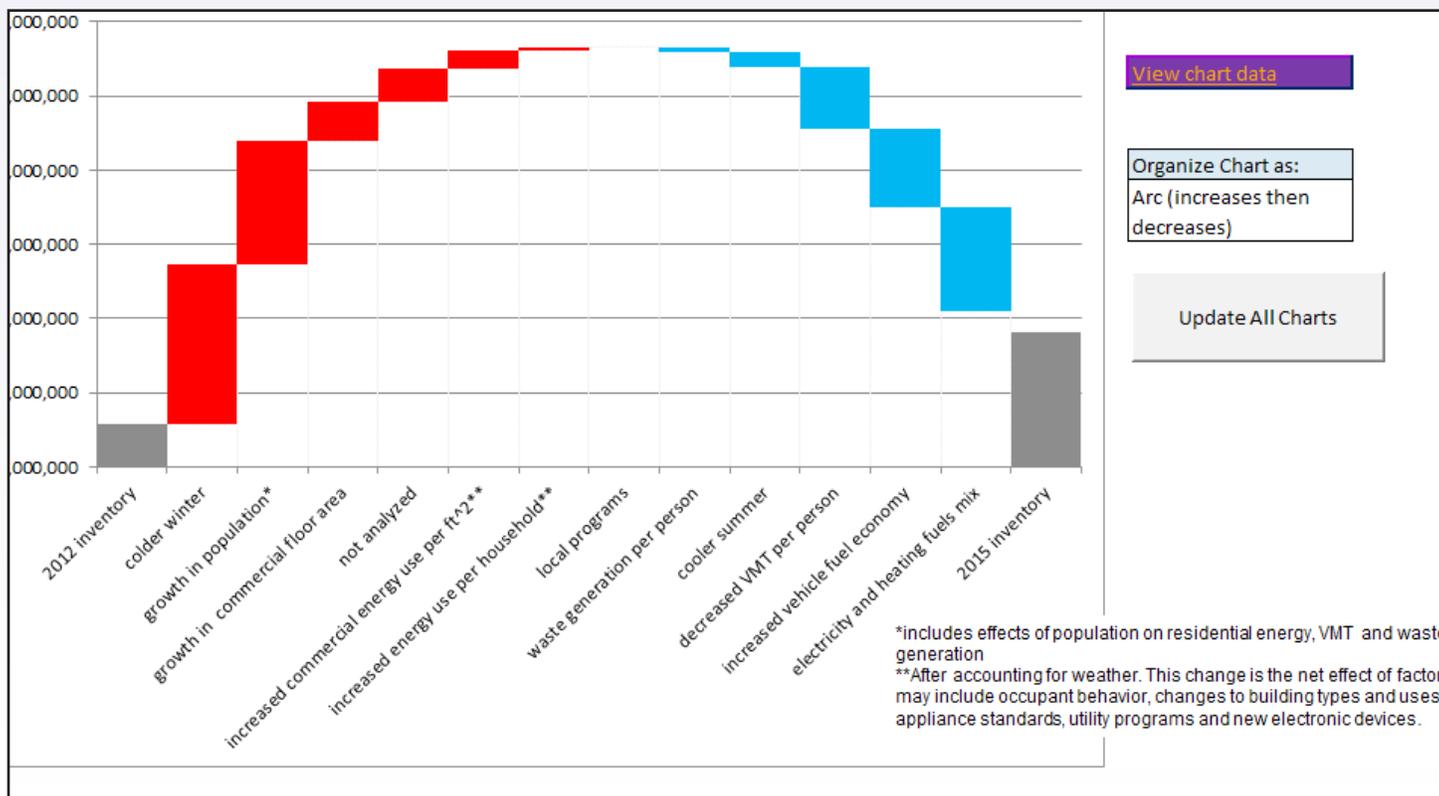


Figure 29 Medium level summary of drivers of change for an example city

The growth in population, local programs, and weather shown in these summary charts are aggregations of the sector-level impacts. For example, growth in population impacts emissions in the residential electricity, fuels, waste, and on-road transportation sectors, but is only shown here as the total population impact. This is shown more explicitly in the population detail chart, described in the next section.

If you entered any optional emissions data such as wastewater treatment, off-road transportation, or fugitive emissions, the total change in these emissions between the initial and final years will appear in the “Not Analyzed” column, without any further decomposition into effects due to weather, economics, or programs.

## CLOSING

For further information on the theory behind the calculations in the tool and a full guide to interpretation of the outputs, please see the full guidance document accompanying this quick start guide in the GHG Contribution Analysis Toolkit.