Cities through Energy Analysis & Planning (C-LEAP): Disaggregating Emissions Inventory Trends

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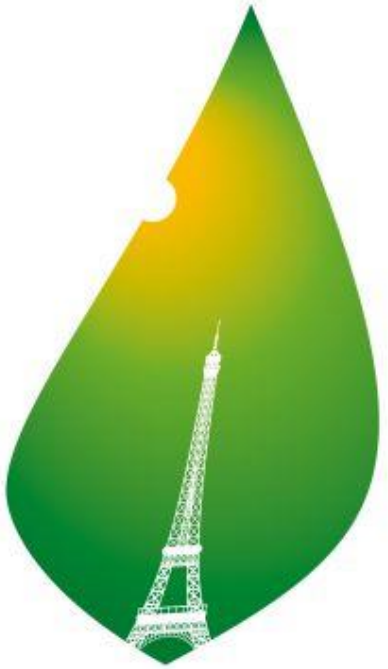
Why do GHG Inventories?

- Internal Stakeholders
  - "You can't reduce what you don't measure"
- External Stakeholders
  - Comparative
  - City-Scale Performance
    - Storytelling on what are we accomplishing
  - A datapoint for what is actually emitted by a city.
    - Vertical Integration
    - Data for supporting other kinds of modeling



COP21 · CMP11
PARIS 2015
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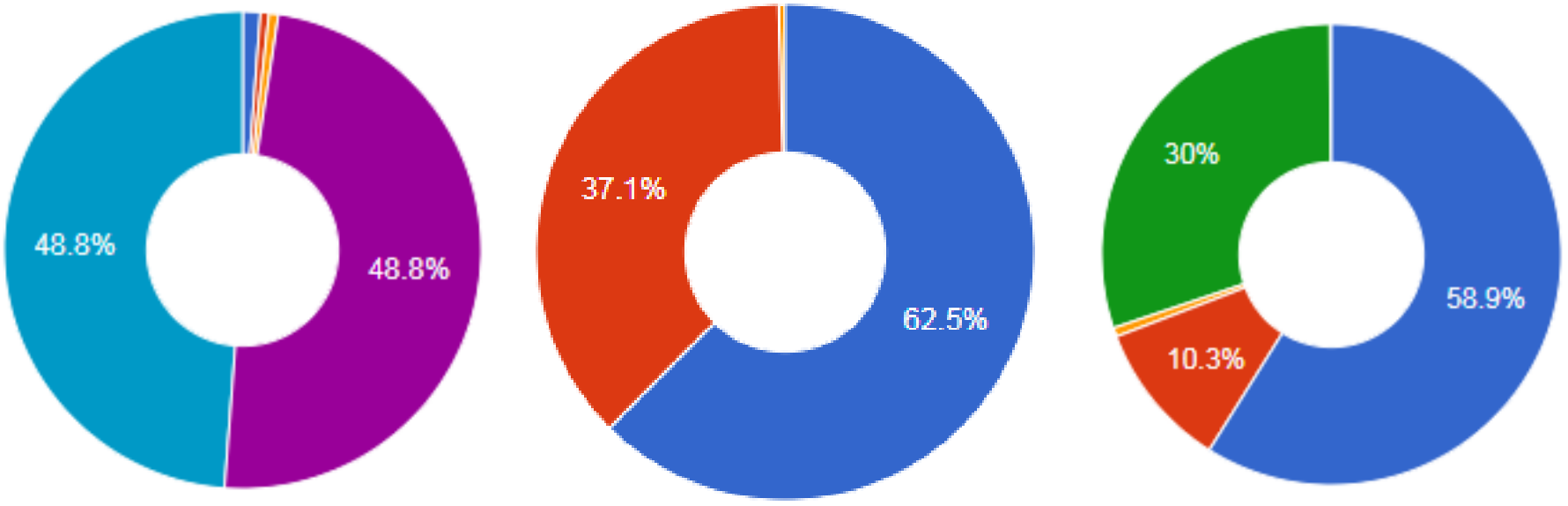
Which GHG inventory goes to which city?

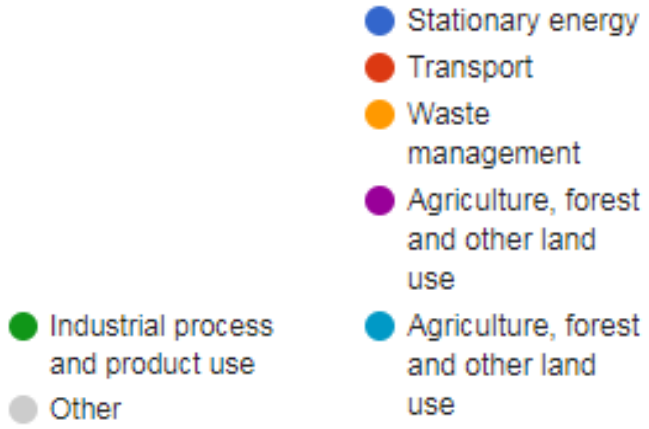
Guadalajara Metro

Kaohsiung

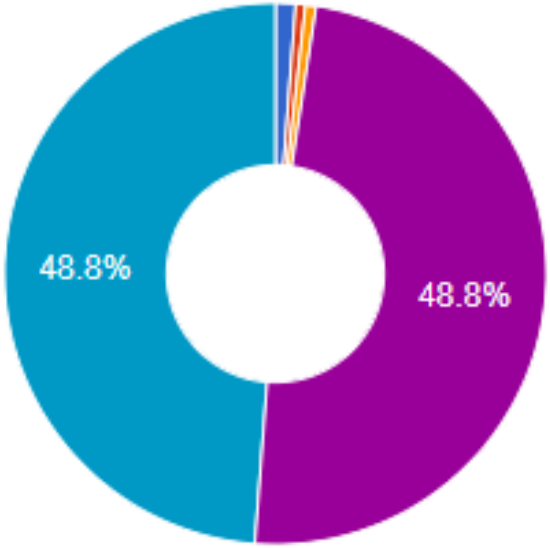
Portland



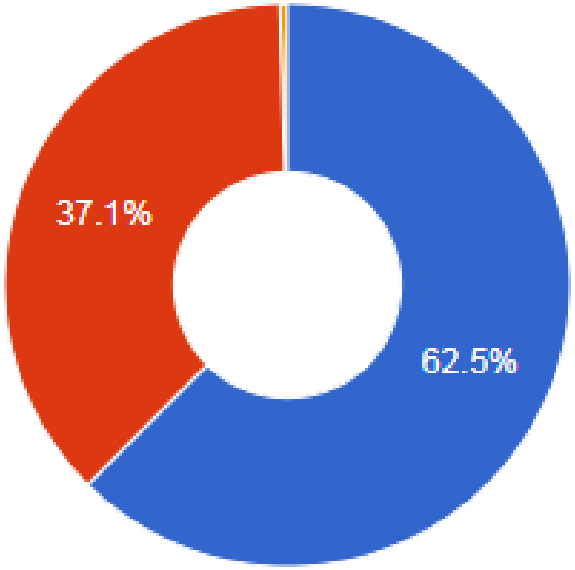
Activity 1



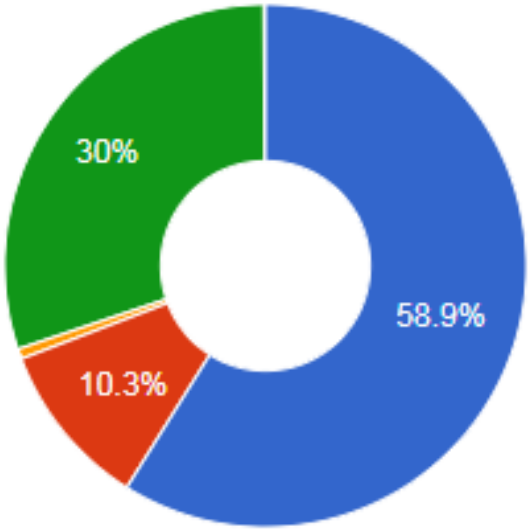
Guadalajara Metro

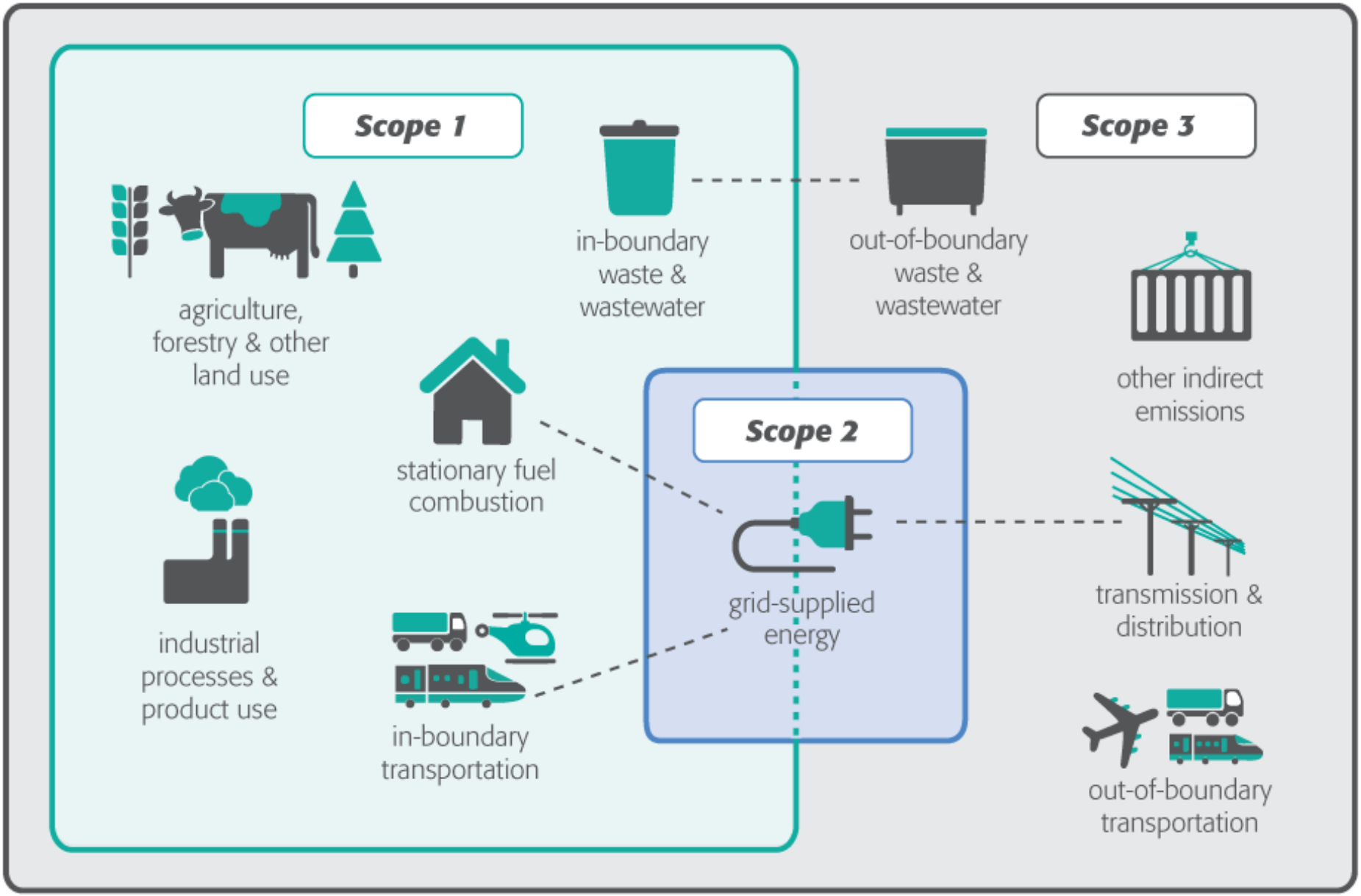


Portland



Kaohsiung





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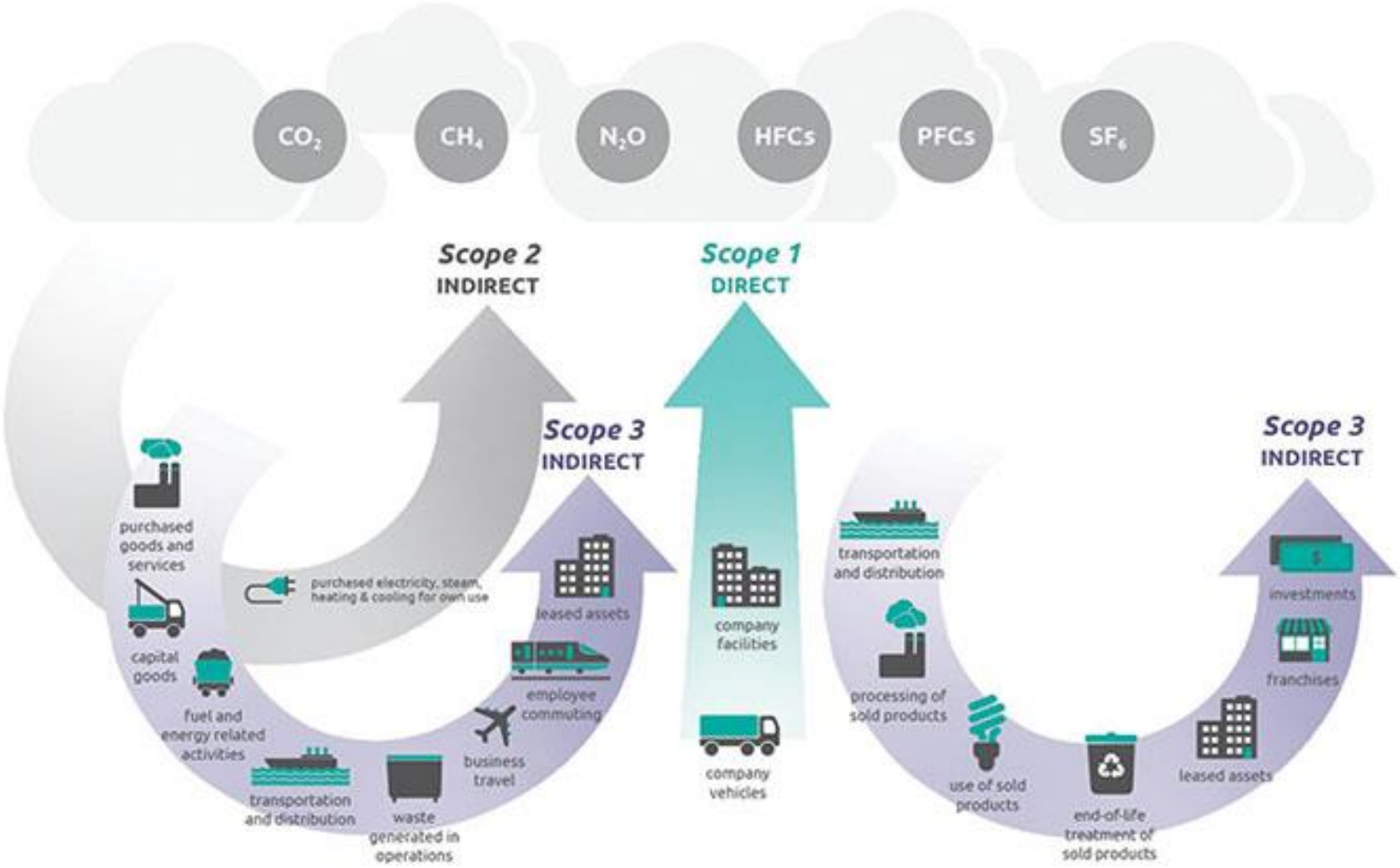

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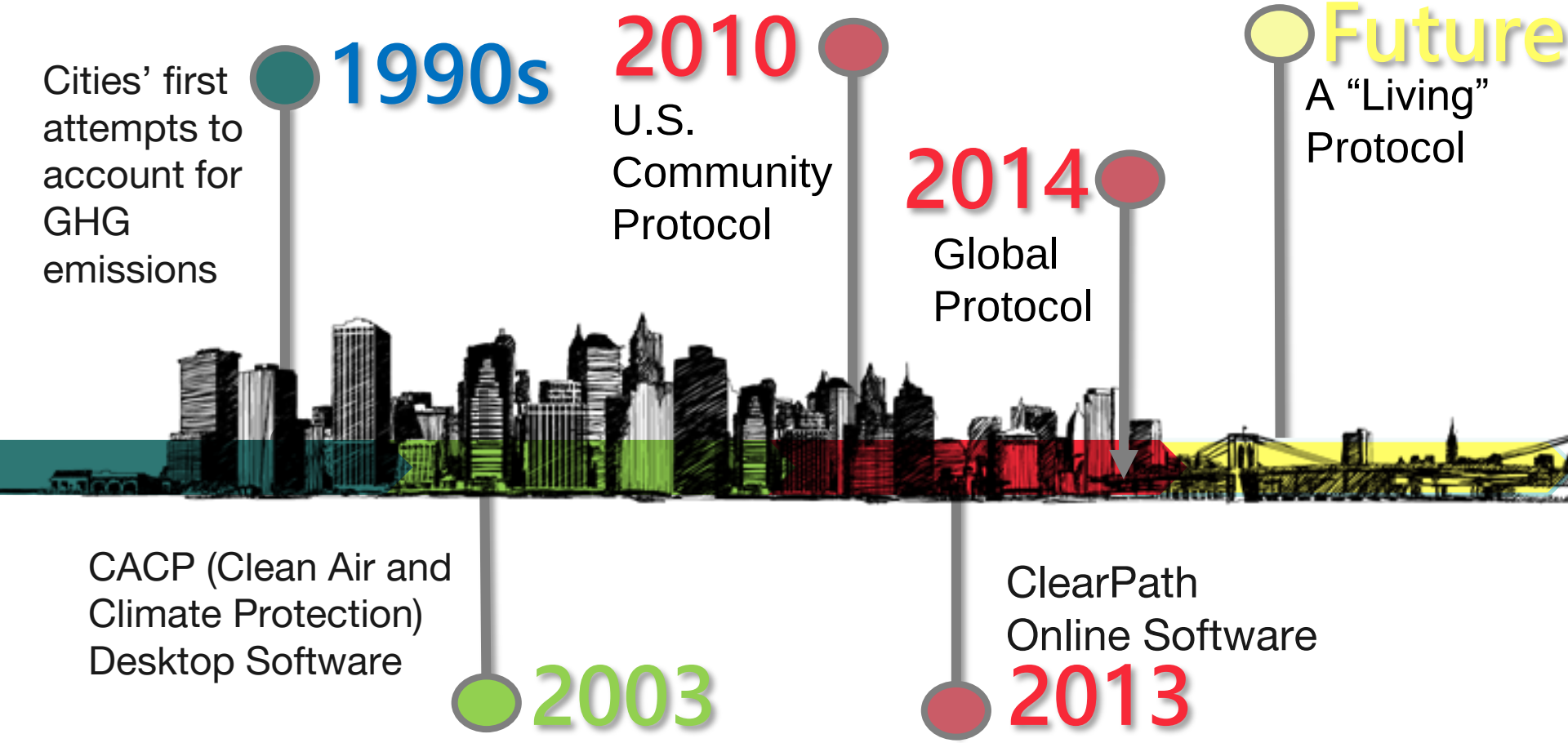
History of City Emissions Management



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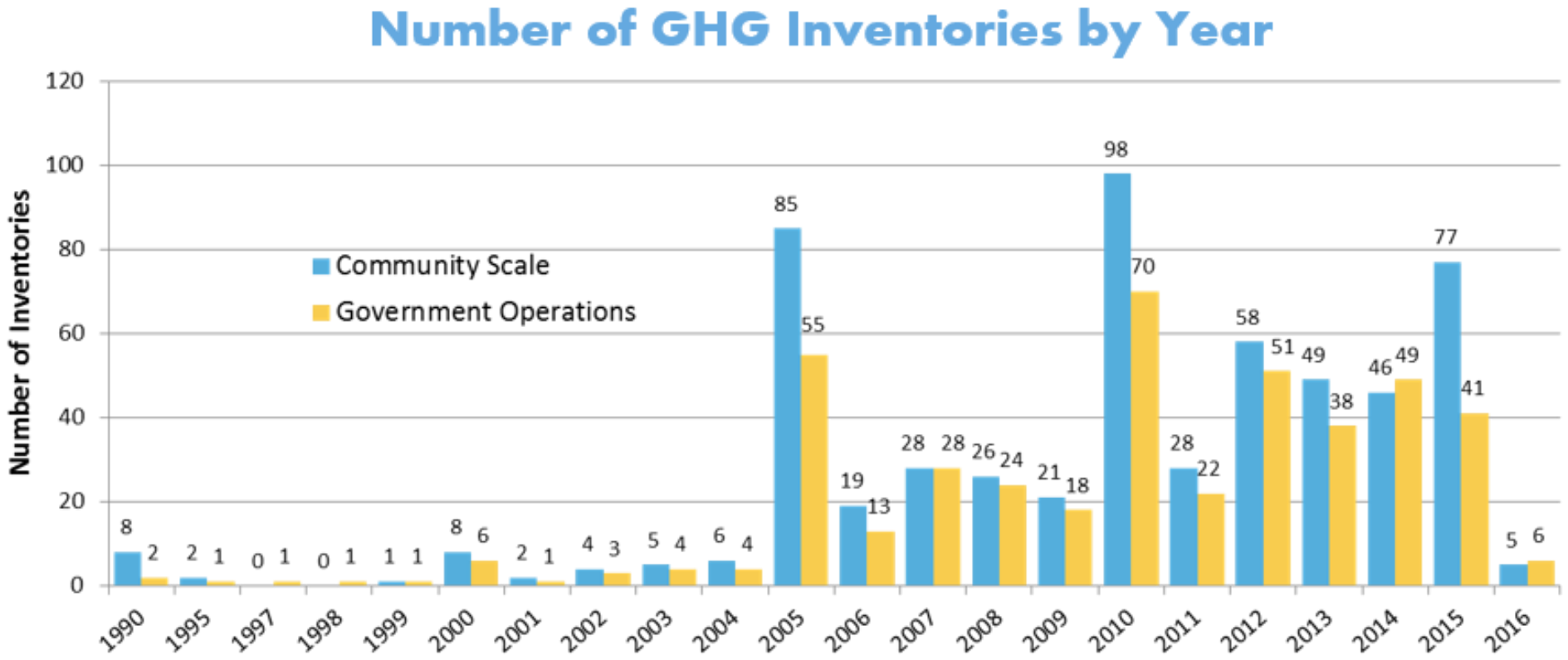
Many Inventories Performed



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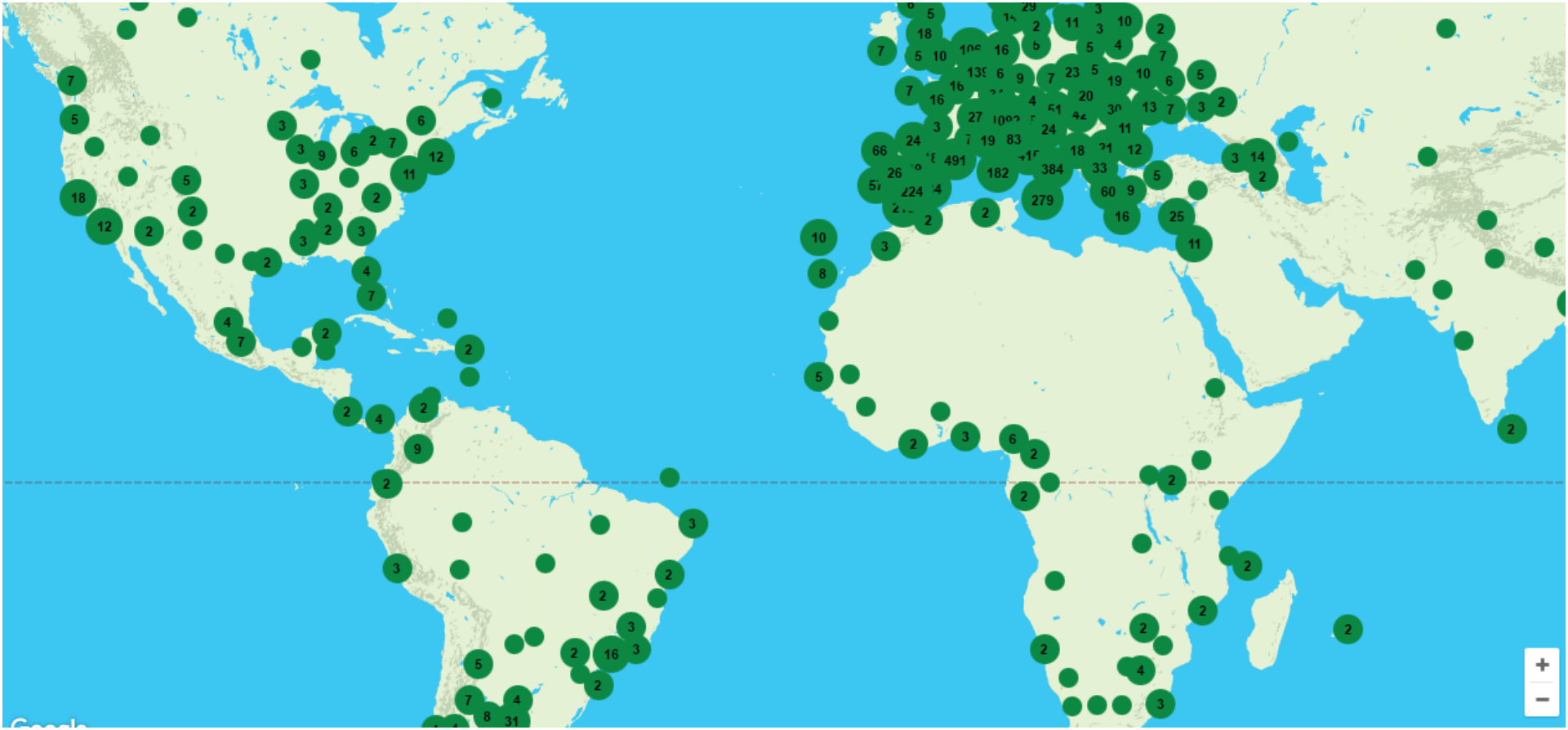
GLOBAL COVENANT of MAYORS for CLIMATE & ENERGY



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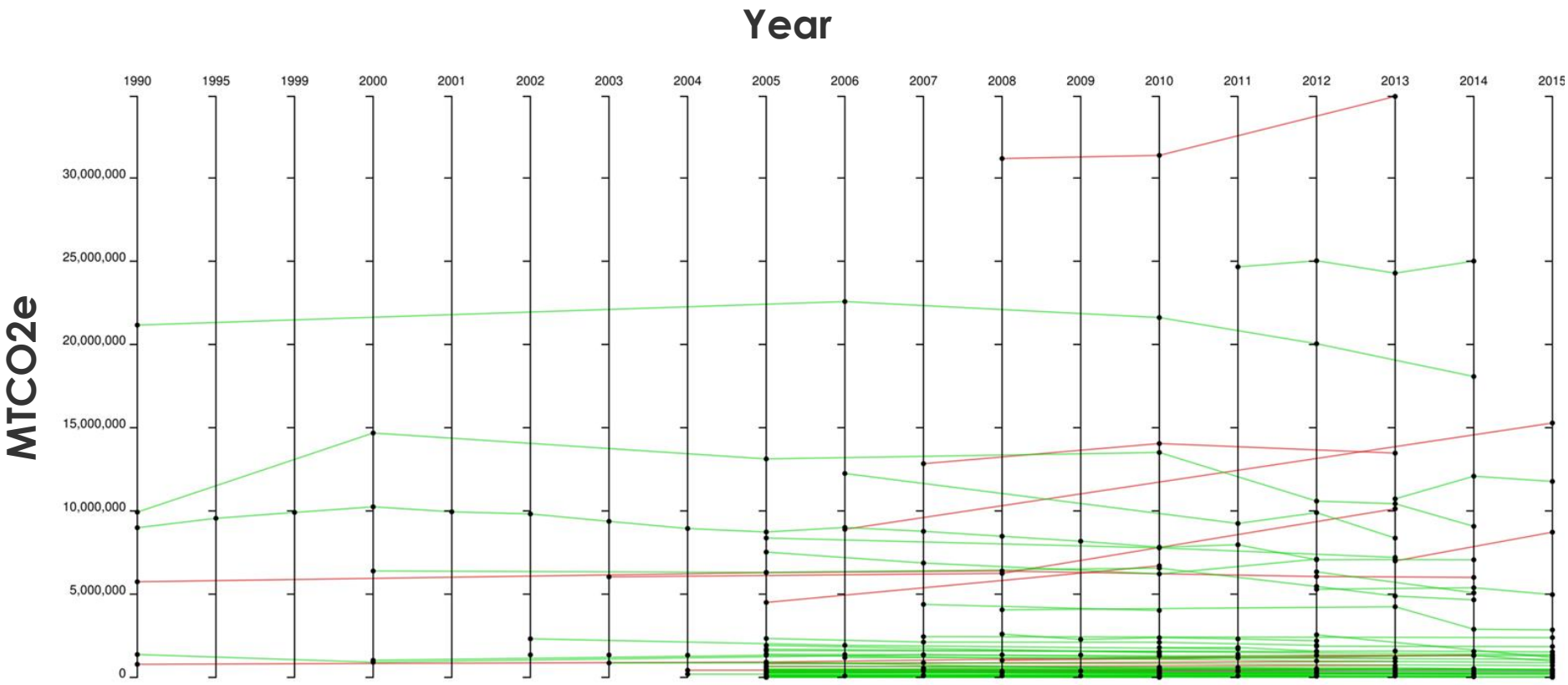
Encouraging Trends



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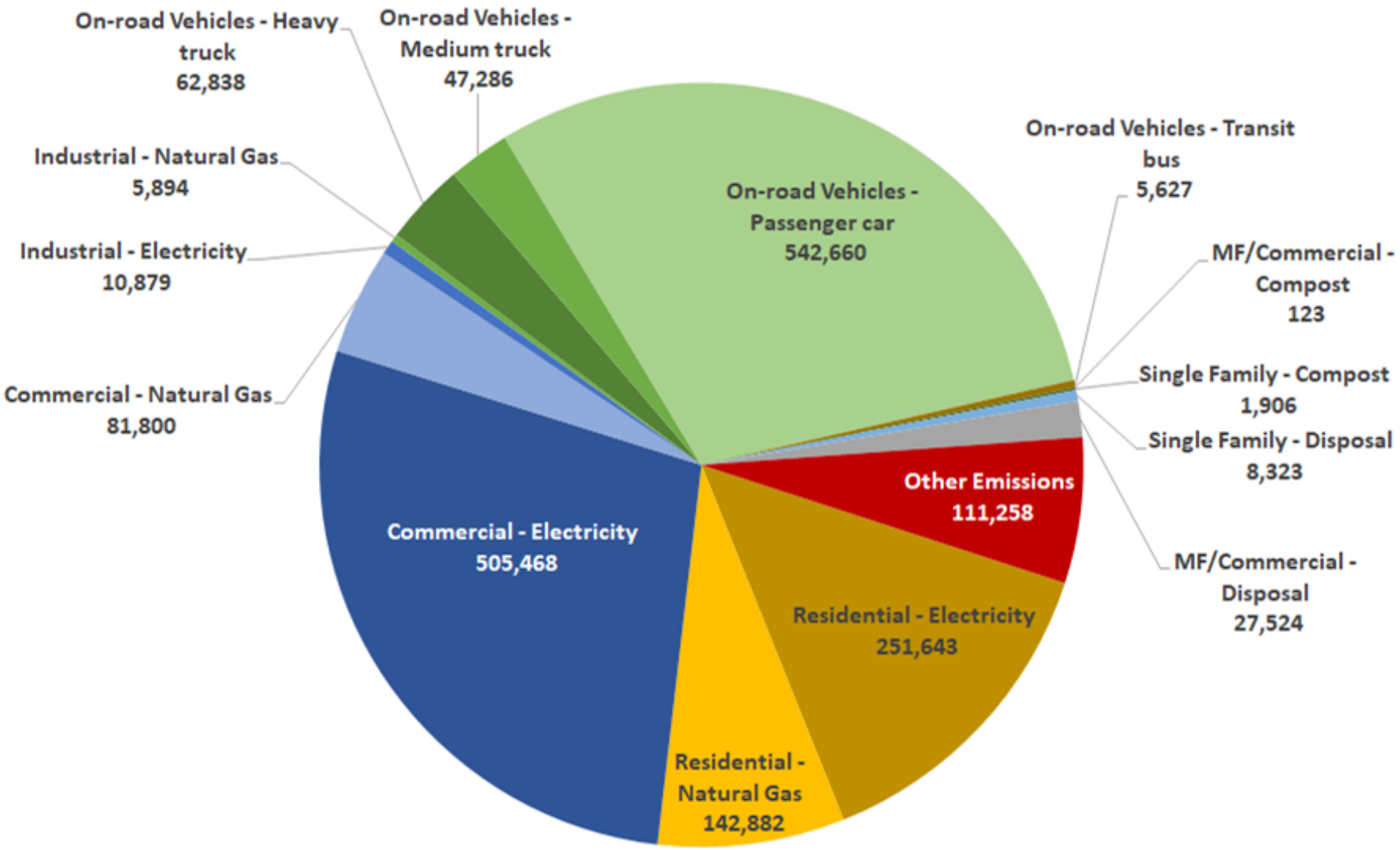
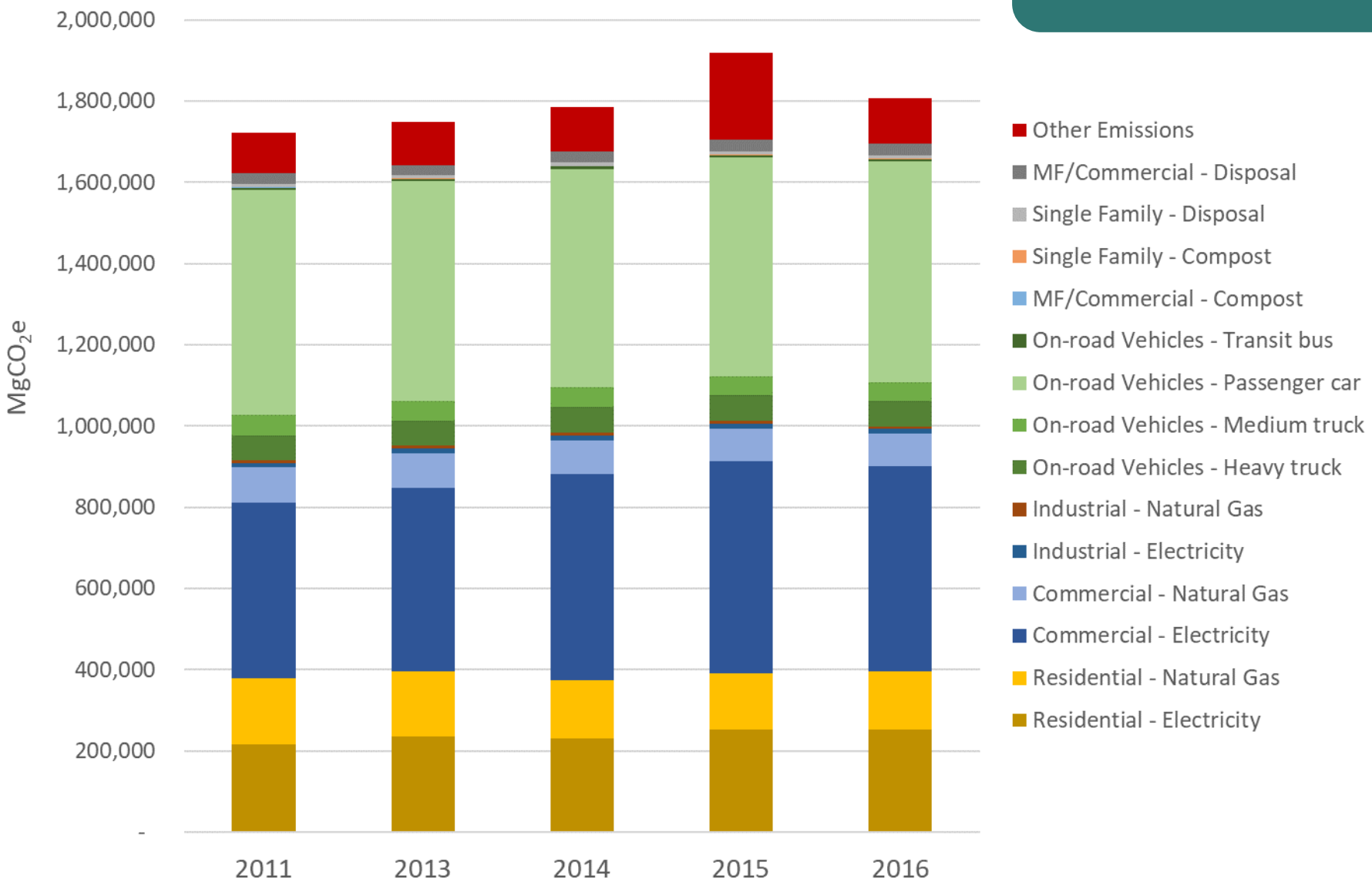
Emissions Detective

Emissions Detective



Emissions Detective

What's the emissions story?



Measurement of emissions is great, but…

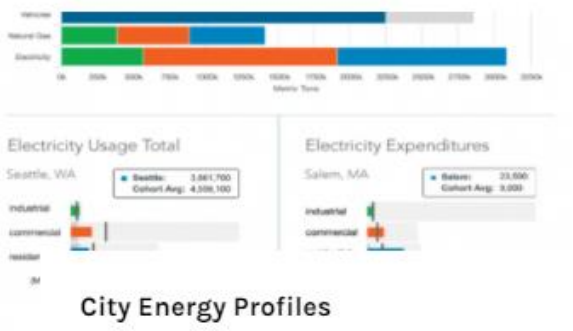
- What is driving the total emission changes?
  - Cleaner Grid?
  - More Efficient Vehicles?
  - Local Action?

- Can we better understand inventories to help us develop more effective and efficient climate policies?

- Can we show we are making progress even if total emissions are increasing?

Cities Leading on Energy Analysis and Planning (C-LEAP)

- Demonstration Cities
- Actions, Goals, and Metrics Mapping
- City Energy Profile Tool
- Identify Possible Futures



City Energy Profiles

Local Energy Action Toolbox

City Energy: From Data to Decisions

- US Department of Energy Program Spearheaded by NREL
  - –Research
  - –National Dataset improvement
  - –Potential of local action analysis

Demonstration Cities

Steering Committee:

- Bellevue, WA
- King County, WA
- Santa Monica, CA
- Aspen, CO
- Metro Washington Council of Governments
- Delaware Valley Regional Planning Council

Second Round Cities

- Hayward, CA
- Nashville TN
- Cleveland, OH
- Denver, CO
- Miami-Dade County, FL
- Durham, NC
- Olympia, WA
- Shoreline, WA
- Ashland, OR

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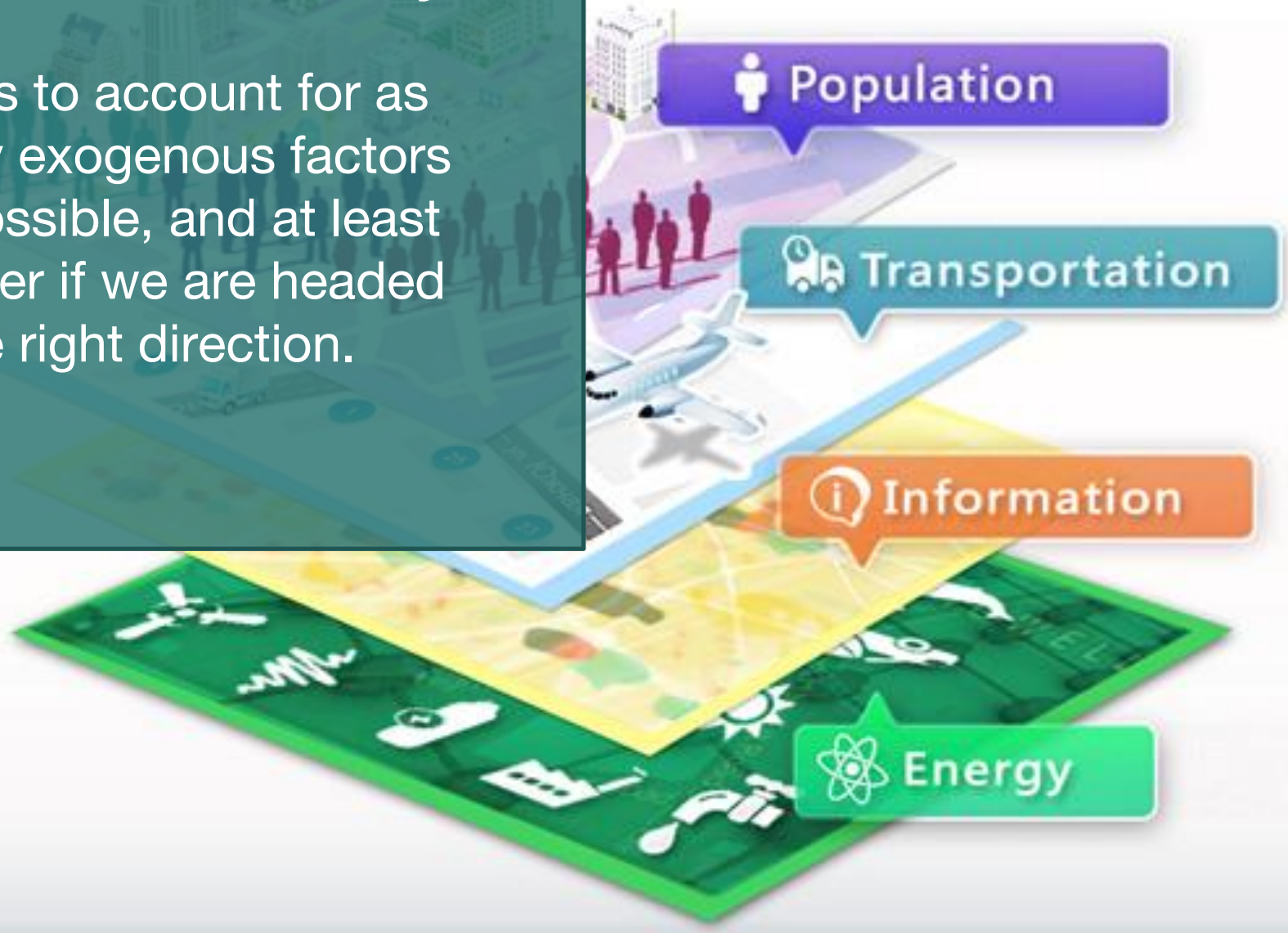
Contribution Analysis

Seeks to account for as many exogenous factors as possible, and at least answer if we are headed in the right direction.



Project Overview

Create and disseminate a framework for performing a “contribution analysis” of community-scale GHG emissions trends over time.

Contribution analysis identifies how various factors contribute to changes in emissions seen between two GHG inventories. These factors may include:

- External factors such as weather and population growth
- Changes in emissions factors
- Impact of state or federal policy and programs
- **Impact of local policy and programs**

By isolating external factors, the framework should support more informed target-setting, policy-making, and communications

Project Approach

- Develop a draft contribution analysis model
- Upgrade existing GHG inventories to protocol compliance and/or analyze program-level emissions reductions in each Steering Committee jurisdiction to feed into model
- Pilot the model with Steering Committee jurisdictions
- Finalize the model
- Create a replication toolkit to enable others to utilize

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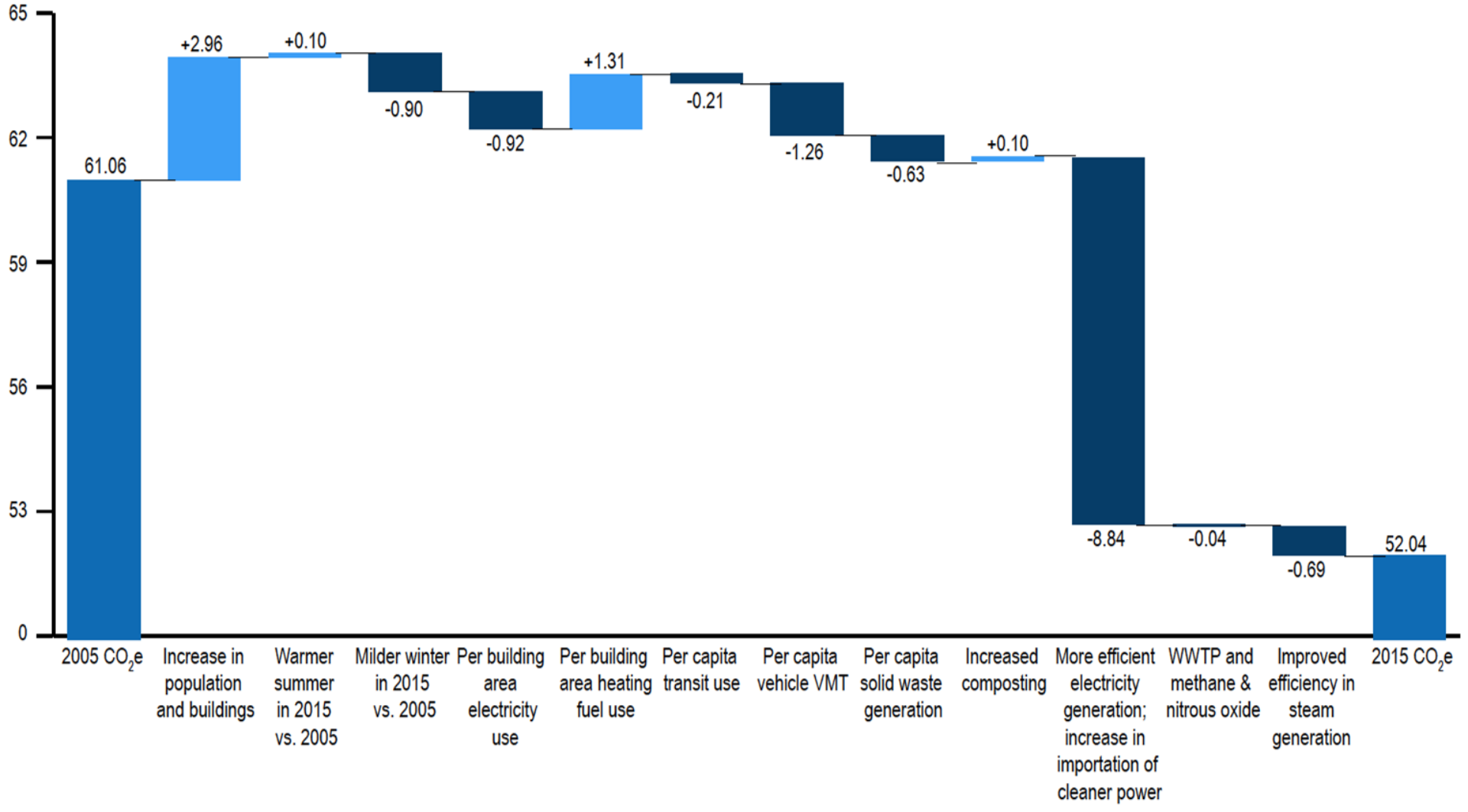
Model Development

- Key Challenge in differentiating the impact of changing two variables simultaneously.
  - –Electricity Use and Emissions Factor
- Solution: Logarithmic Mean Divisiva Index (LMDI)
- LMDI Benefits
  - –Easy Inputs
  - –“Perfect Decomposition” for completeness and time reversal

NYC: Analysis 2005-2015



Santa Monica 15x15 Climate Action Plan - Highlights

Building Energy Efficiency: Over 18 MWh and 40,000 therms saved

Local Renewable Energy: Locally installed solar surpasses 5 MW

Mobility Matters: Successful launch of Breeze Bike Share

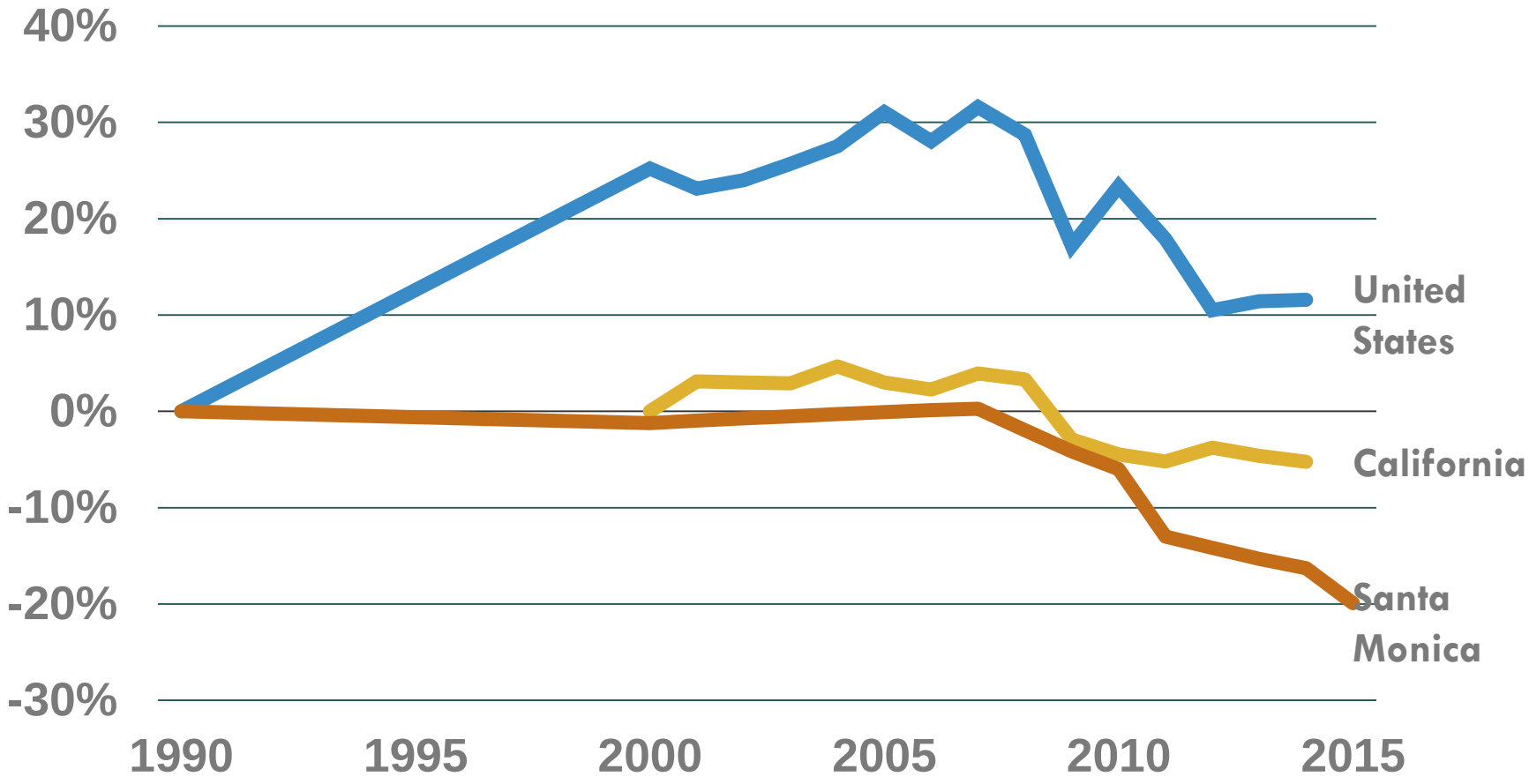
Better Biking: 105 miles of bike routes, lanes & sharrows

Water Efficiency: Saved 2.8 MGD (20 gal/person/day)

Municipal Operations: 1.4 MWh and 36,641 therms saved

Renewable Fuels: Big Blue Bus reduces emissions 62% with landfill gas

Santa Monica Greenhouse Gas Emissions Trend



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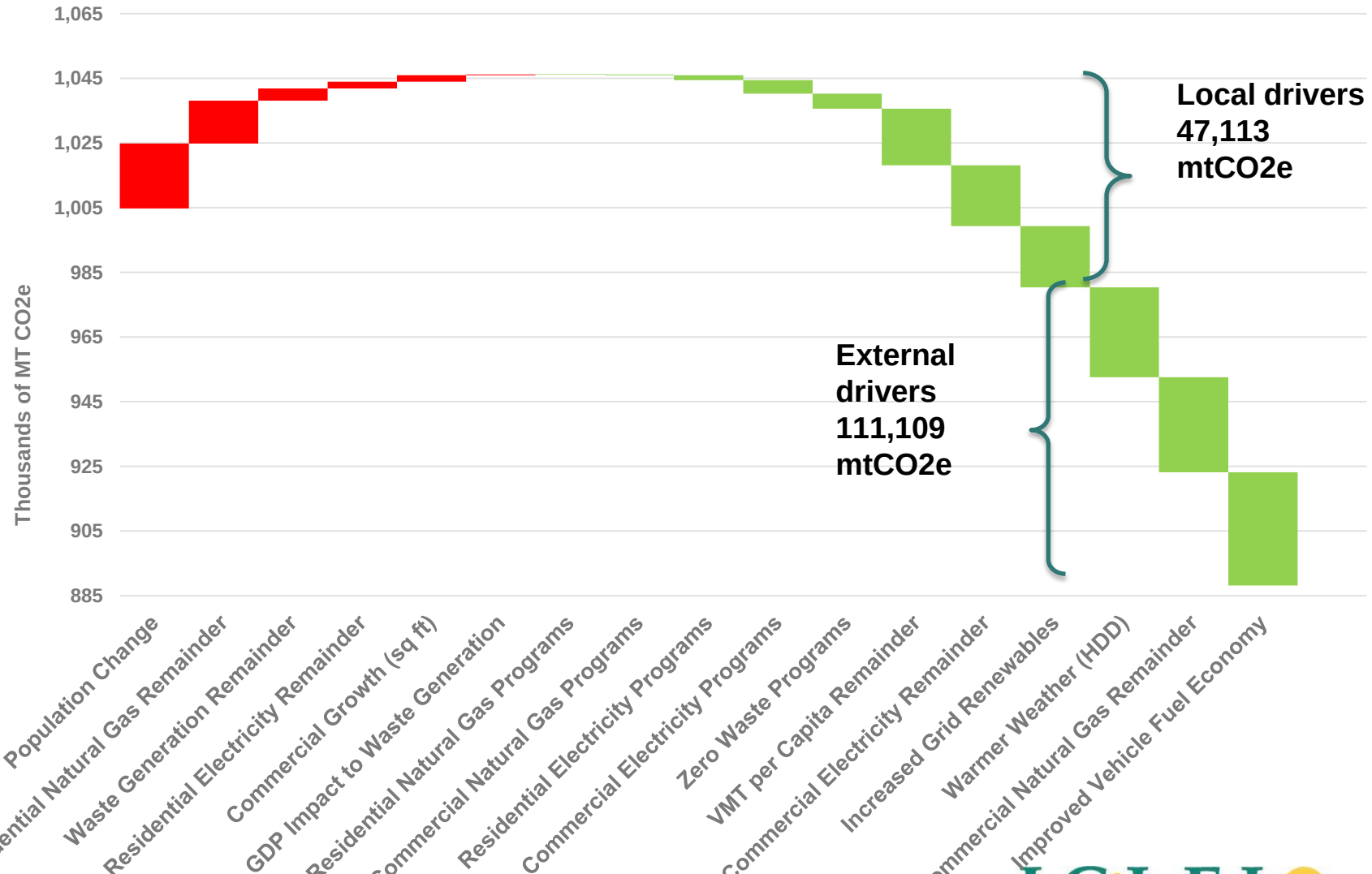
Santa Monica: Analysis 2011-2015



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Aspen: Visualizing Data in CAP

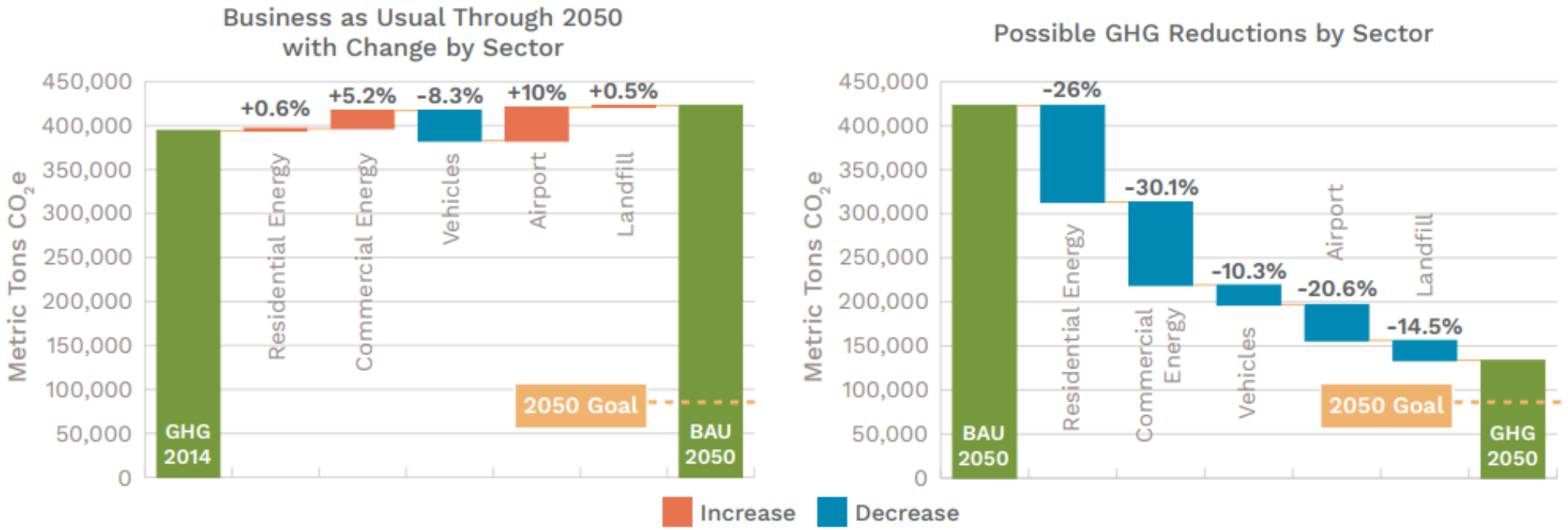

Figure 2. Community-wide GHGs are likely to grow between now and 2050 if the current level of climate action in Aspen continues. On the other hand, if efforts increase dramatically and all objectives in the GHG Reduction Toolkit are achieved, Aspen could get very close to reaching its 2050 goal.

- Wedges are net changes by sector and do not go deeper into contribution analysis
- Aligned with GHG Reduction Toolkit for CAP implementation

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Importance of State/Federal Policies

- State and federal policies like vehicle fuel economy and renewable energy portfolio are **huge contributors to emissions reduction**
- Important to **advocate** for their continued implementation

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Testimonials

"Staff were able to identify that the utility fuel mix is a big driver of emissions, which requires state action to change. **The findings supported our existing work and efforts to redouble our advocacy for change at the state level**."

- City of Bellevue, WA

"The contribution analysis toolkit allows for **quick and easy analysis** of the multiple factors driving changes to greenhouse gas emissions from one period to another. Furthermore, the toolkit boils down the varying impacts of all these factors into **one easy-to-understand graphic**."

- Delaware Valley Regional Planning Commission

"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**."

- City of Santa Monica, CA

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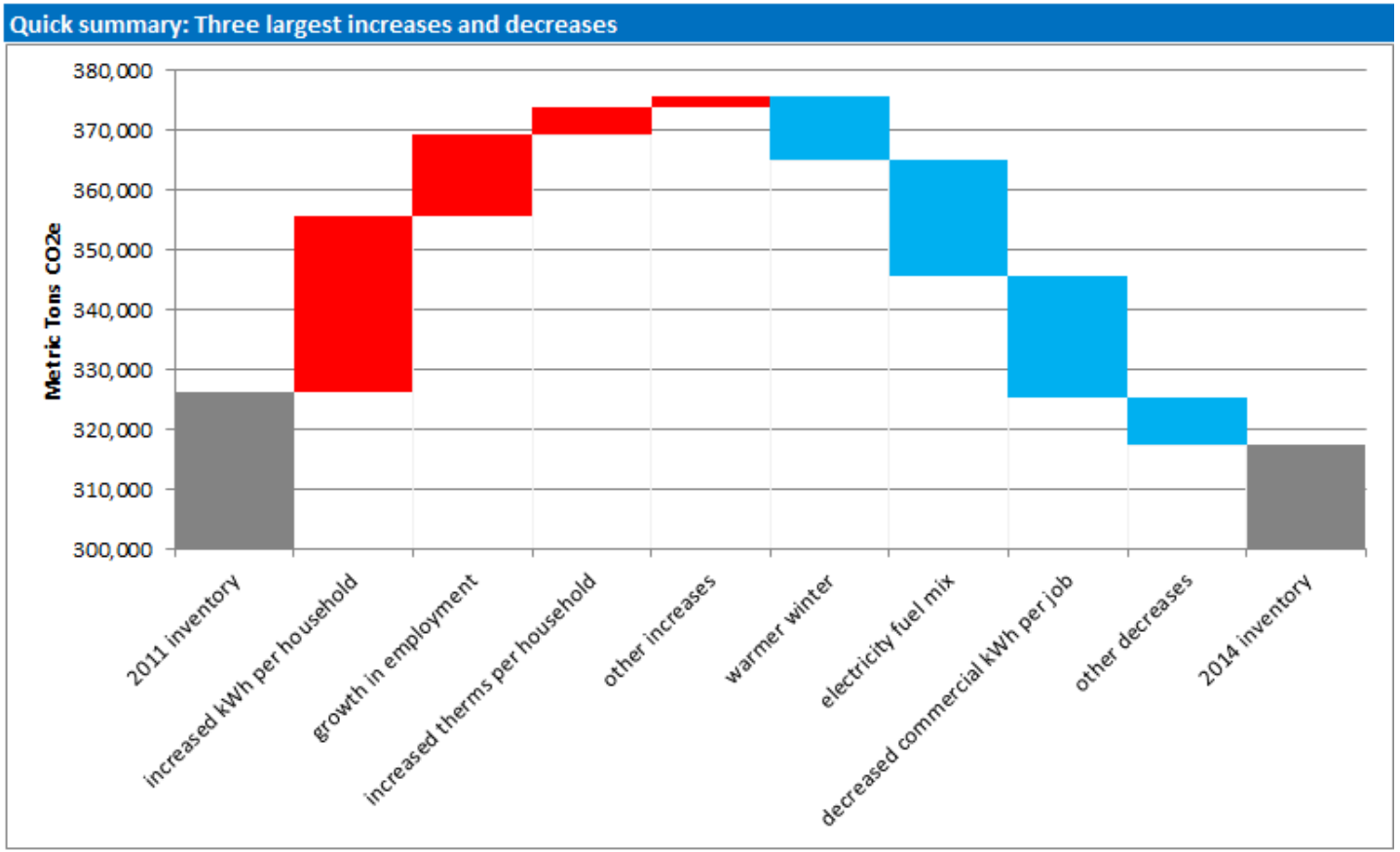

Navigating the Drivers of Change Analysis Tool

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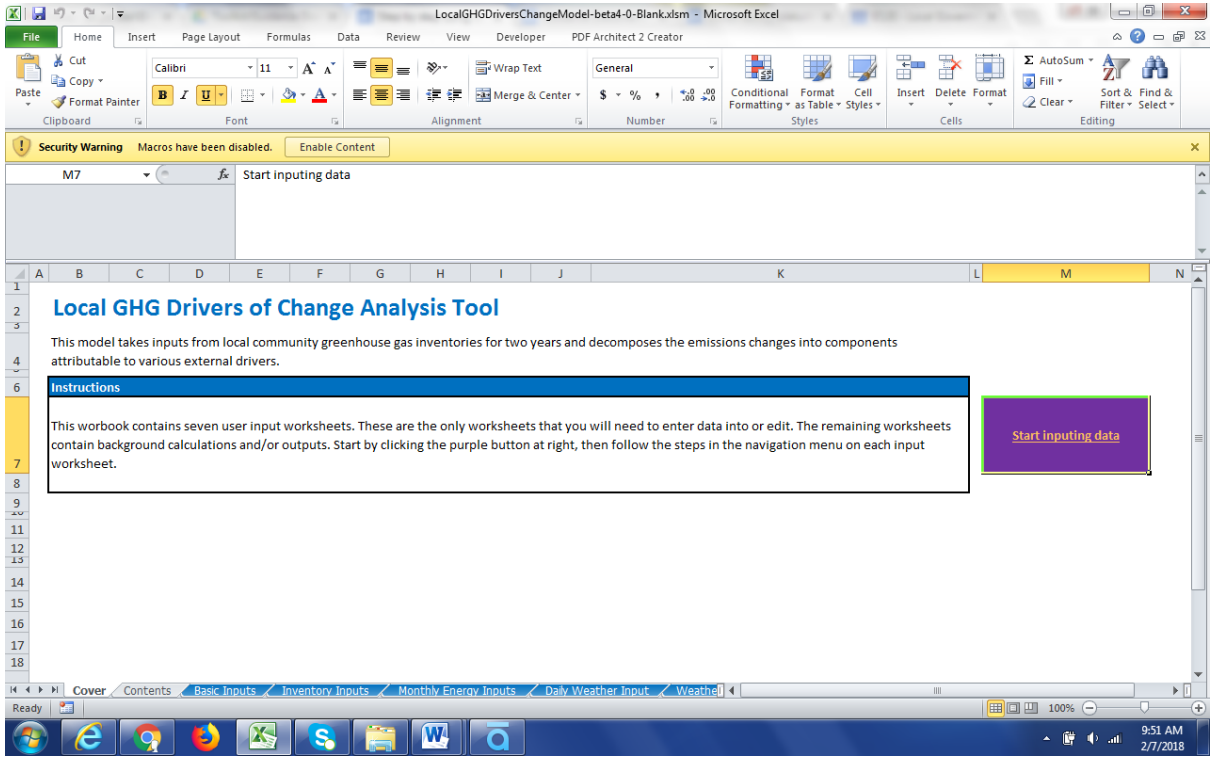
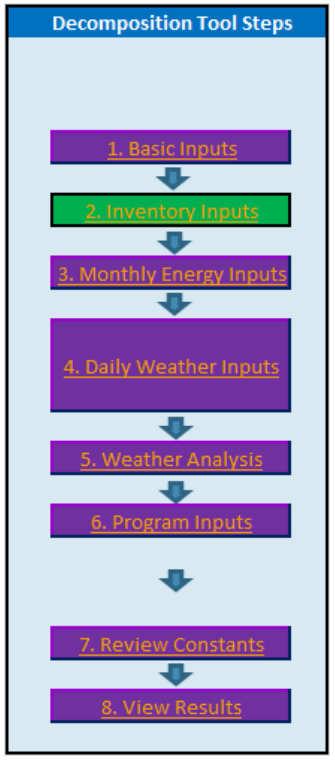
Drivers of Change Analysis Tool





- Builds on to ICLEI's broader emissions management tools suite
- Built as Excel tool, must enable macros
- Navigation sidebar on right goes through 7 data input tabs. Additional tabs for outputs + calculations

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Model Inputs

Sector		Inputs needed
General Info		Population, number of households, per capita GDP, commercial building ft^2 or total employment within jurisdiction
Inventory	Residential Electricity	Total emissions, total kWh usage, monthly kWh data
	Commercial Electricity	Total emissions, total kWh usage, monthly kWh data
	Residential Natural Gas	Total emissions, total therms usage, monthly therms data
	Commercial Natural Gas	Total emissions, total therms usage, monthly therms data
	On-Road Transportation	Total on-road emissions, total on-road vehicle miles traveled (VMT) or total gallons of fuel
	Solid Waste	Total landfill disposal, waste composition breakdown for each inventory year*
	Other Sectors*	Residential/commercial fuel use (propane, heating oil), industrial electricity/natural gas, off-road transportation, wastewater treatment
Daily weather input		Daily min, max, and average temperatures

* Optional data

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Inventory Inputs

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				

required inputs
optional inputs

Stationary fuel combustion inputs						
Year	Residential fuel emissions (MTCO2e)	Residential natural gas usage (therms)	Residential households using natual gas	Commercial fuel emissions (MTCO2e)	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				
Data Source						
2014		299,044				
Data Source						

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Weather Regression Inputs

First year with energy data	Months of electricity data	Months of natural gas data	Data sources/notes
2011	12	12	

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
2011	11			7,876,245	675,217	6,339	583,810
2011	12			9,656,357	1,085,079	6,339	962,920

Daily Weather Data Input

Instructions: copy data directly from NOAA national centers for envi

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
USW0009:	ASPEN PIT	1/7/2011		37	8
USW0009:	ASPEN PIT	1/8/2011		35	7
USW0009:	ASPEN PIT	1/9/2011		25	9
USW0009:	ASPEN PIT	1/10/2011		10	-13
USW0009:	ASPEN PIT	1/11/2011		13	-18
USW0009:	ASPEN PIT	1/12/2011		28	-7
USW0009:	ASPEN PIT	1/13/2011		35	16
USW0009:	ASPEN PIT	1/14/2011		36	19
USW0009:	ASPEN PIT	1/15/2011		32	10
USW0009:	ASPEN PIT	1/16/2011		33	11
USW0009:	ASPEN PIT	1/17/2011		36	26
USW0009:	ASPEN PIT	1/18/2011		33	18

- Monthly energy data needed for weather regression
- Model can be run without the weather regression if monthly data is unavailable
- Daily weather data available from NOAA

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Weather Regression Analysis

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

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

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	0
February	1	0	0	0
March	0	1	0	0
April	0	1	0	0
May	0	1	0	0
June	0	0	1	0
July	0	0	1	0
August	0	0	1	0
September	0	0	0	1
October	0	0	0	1
November	0	0	0	1
December	1	0	0	0

Run Residential Electric Regression

See details

Run Residential Gas Regression

See Details

Run Commercial Electric Regression

See details

Run Commercial Gas Regression

See details

- Run the macros from this tab
- Regression status line will update when regression is complete
- Purpose is to analyze impact of weather on energy usage

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Program Inputs (Optional)

Program Inputs	Aspen		
This tab is optional. Enter the name for each program, and enter either activity reductions OR emissions reductions, depending on the data			
Reductions should be entered as a positive number.			
Residential Electricity Programs-kWh reduction			
Program Name			
kWh savings in Year 2 compared to Year 1			
Data source			
Residential Electricity Programs--Emissions reduction already calculated			
Program Name			
Emissions Reduction (MTCO2e)			
Data Source			
Commercial Electricity Programs--kWh reduction			
Program Name			
kWh savings in Year 2 compared to Year 1			
Data source			
Commercial Electricity Programs--Emissions reduction already calculated			
Program Name			
Emissions Reduction (MTCO2e)			
Data Source			

- Either emissions data or activity data is acceptable

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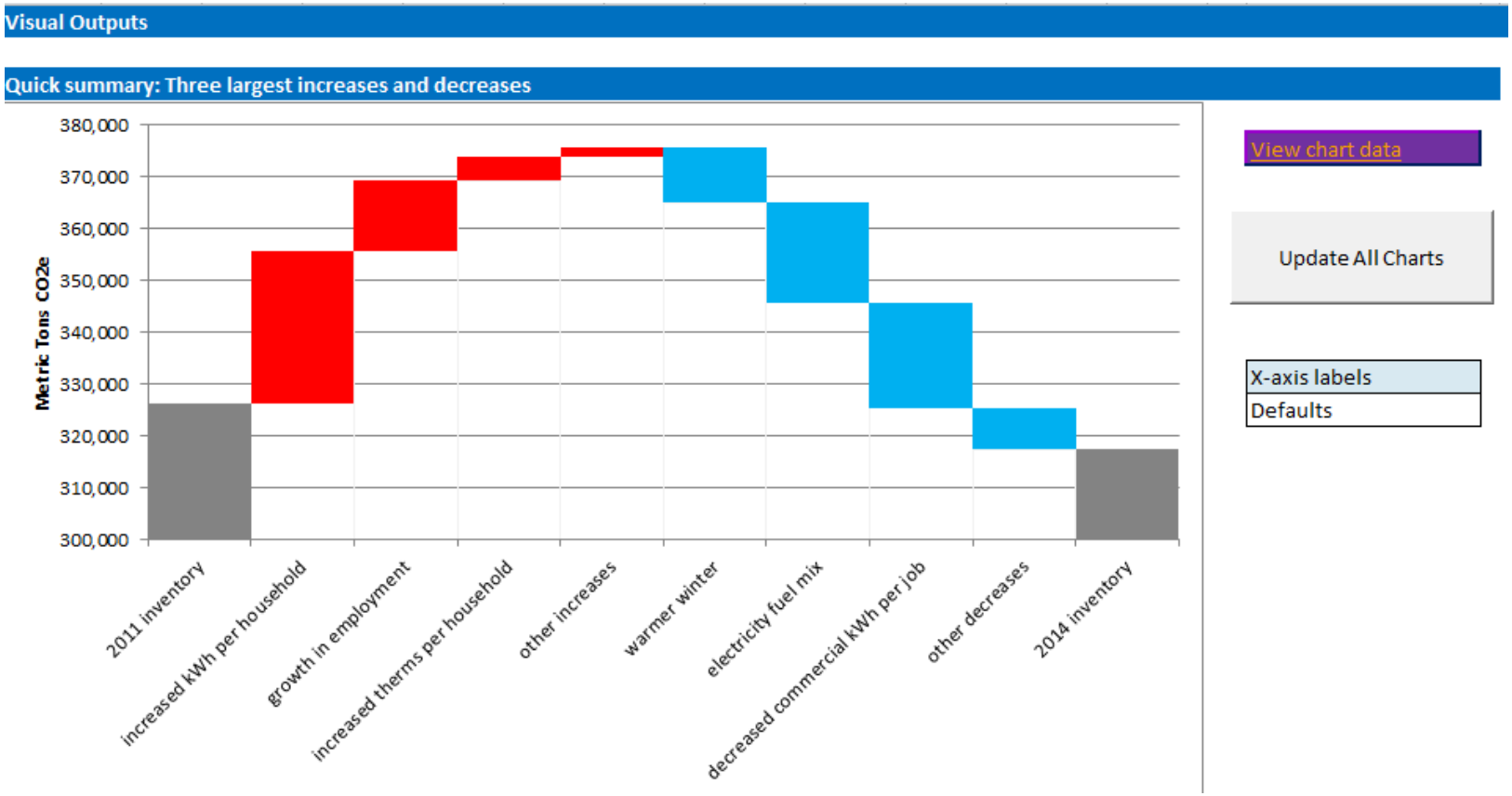
Visuals



- Several different visual options: top drivers, detailed summary, quick summary, sector breakdowns
- Red for emissions increase, blue for emissions decrease

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How to Get Involved

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Using Drivers of Change Toolkit

- The replication toolkit will be **publicly available** on ICLEI's website
- ICLEI staff will be providing **technical assistance** on data analysis/interpretation for members or fee-for-service
- Interested in getting the word out? **Schedule a demo** for a regional workshop

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Thank You

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