DEVELOPING A HIGH-LEVEL GREENHOUSE GAS EMISSIONS INVENTORYING PROTOCOL FOR LOCAL GOVERNMENT CLIMATE ACTION MANAGEMENT: CHICO, CA - A CASE STUDY

A Project

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in

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Fletcher Alexander

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DEVELOPING A HIGH-LEVEL GREENHOUSE GAS EMISSIONS INVENTORYING PROTOCOL FOR LOCAL GOVERNMENT CLIMATE ACTION MANAGEMENT: CHICO, CA - A CASE STUDY

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Over the past 10-12 years thousands of cities and counties across the United States have developed local Climate Action Plans to mitigate some degree of greenhouse gas emissions generated within their jurisdictions; hundreds of these cities are located in the state of California. The process of developing a Climate Action Plan usually involves the completion of a greenhouse gas emissions inventory in order to establish a baseline estimate of greenhouse gas emissions generated by those activities the local government plans to begin tracking and managing. Climate Action Plans generally have 10, 20 or 30-year horizons and a series of interim targets tiered off of an ultimate reduction target. Tracking progress of implementation over time requires regular accounting of emissions generated by activities within the plan's scope. Completing city- or county-wide greenhouse gas emissions inventories can be a time- and resource-consumptive

process, one that the planning departments often tasked with managing implementation aren't necessarily equipped to conduct on an annual or biennial basis.

This project aims to develop a high-level community-wide greenhouse gas emissions inventorying protocol that can be utilized by these agencies and their staff on a regular basis to track progress on and guide resource allocation in Climate Action Plan implementation. The protocol focuses on the largest emissions generating activities within a jurisdiction, tracking data related to these activities at a high-level of aggregation. The protocol was developed to produce results that are relevant, accurate, complete, measurable, consistent and transparent. As a case study, the project quantifies an estimate of 11 years' worth of community-wide greenhouse gas emissions for the City of Chico, CA. The City of Chico was an early signatory to the U.S. Conference of Mayors' Climate Protection Agreement in 2006 and adopted a community-wide Climate Action Plan in 2012.

CHAPTER I

INTRODUCTION

Purpose

This project aims to develop a community-wide greenhouse gas (GHG) emissions inventorying protocol that can be utilized by local government agencies on an annual basis in order to provide frequent and timely metrics to guide Climate Action Plan (CAP) implementation.

As a case study, the project quantifies 11 years' worth of community-wide GHG emissions for the City of Chico, CA: from the City's CAP base year of 2005 to the interim target year of 2015.

Scope

Local government agencies that have developed and adopted a Climate Action Plan require accurate data on progress towards goals to guide implementation. Often, upon adoption of a CAP, a local government agency has completed only one GHG emissions inventory to establish a baseline; this analysis may consist of a single or multiple years. The results of this baseline inventory are used to establish "Business as Usual" (BAU) emissions projection scenarios and to set targets for emissions mitigation. Completing a GHG emissions inventory can be a substantial undertaking; it is a highly detailed and technical exercise that requires significant investment of time, resources and expertise (Boswell et al., 2012). For a local government agency implementing a region-wide CAP the standard protocol guidelines are the U.S. Community Protocol for Accounting & Reporting GHG Emissions (Community Protocol), developed by the International Council for Local Environmental Initiatives (ICLEI).

The GHG emissions inventorying process involves the establishment of inventory scope - both temporal and spatial, the identification of primary form data sources and the collection and organization of a wide range of data, the conversion of the primary form data into estimates of GHG emissions using emission factors (EFs), and the aggregation and analysis of results. This is a process that can be cost- and time-prohibitive to conduct on an annual or biennial basis for a local government agency. The scoping decisions in particular can make a significant difference in the amount of time and resources required to complete the inventory.

The Community Protocol identifies five Basic Emissions Generating Activities (BEGAs): electricity consumption by the community; residential and commercial stationary combustion equipment fuel consumption; on-road motor vehicle travel; use of energy in water transportation and treatment; and solid waste generated by the community (ICLEI, 2013). The Community Protocol also identifies additional reporting frameworks for a more detailed and/or broad inventory. These include isolating emissions from government operations, isolating emissions from individual industry sectors, considering up-stream emissions associated with manufacturing and transportation of goods, considering life-cycle emissions from business operations and including additional in-boundary sources. Additional in-boundary sources a community can choose to account for within the scope of their inventory include: chemicals and refrigerant used in industrial processes; other transportation sources including passenger and freight rail, marine vessels, air travel and off-road vehicles; process emissions from wastewater treatment; and agricultural emissions generated by livestock production and manure / fertilizer decomposition.

The protocol designed for this project focuses on the five Basic Emissions Generating Activities outlined by the Community Protocol and it identifies primary form input data sources that collect and report relevant data only at the highest levels of aggregation for a community. The protocol was developed in a manner that satisfies the six GHG Accounting & Reporting Principles outlined in the Community Protocol: Relevance and Utility for Users; Accuracy; Completeness; Measurability; Consistency and Comparability; and Transparency (ICLEI, 2013).

The inventory results for the City of Chico that are included here were developed as an output of the protocol calculator in the form of a series of tables and charts. These figures summarize primary form input data, emission factors, GHG emissions estimates by sector and an estimated total Metric Tons of CO2-equivalent (MTCO2e) emissions on an annual basis from 2005-2015. Annual emissions numbers are contextualized in terms of population growth and sales tax revenue data as an indicator of local economic activity.

Significance

The protocol can be a valuable tool for local government agencies implementing Climate Action Plans to track community-wide emissions levels on an annual basis. It is designed to meet the scope requirements of the Community Protocol, at a high level of aggregation, in a manner that is consistent with the GHG Accounting & Reporting Principles. It is organized into a Microsoft Excel spreadsheet that is formatted to include necessary formulas and coefficients and that identifies primary form input data sources. Implementing the protocol on an annual basis will allow a local government agency to produce a high-level estimate of community-wide GHG emissions with a relatively low degree of time and resources required.

In the case of Chico, the results will inform the near-term actions of the Sustainability Task Force, which is charged with advising the City Council on CAP implementation. The results will also inform the longer-term efforts of the Planning Department in implementing the 2030 General Plan and will serve as an important high-level sustainability indicator for the community.

The inventory, and subsequent annual results, will be included in the Planning Department's annual Sustainability Indicators Report to City Council.

The inventory results included in the study quantify annual community-wide GHG emissions estimates from the City of Chico CAP's base year of 2005 (from which the reduction targets are based) to the interim target year of 2015. The only other GHG emissions inventory data the City of Chico has had to inform CAP implementation has been an initial study of calendar year 2005, completed in 2008 (Stemen and Salazar, 2008) and a preliminary results summary of this study, completed in 2015 (Alexander, 2015). The results included here represent the most current estimates of community-wide GHG emissions calculated for the first time through the interim target year of 2015.

A preliminary study for the City of Chico was undertaken, by the author, in the Summer of 2015. This effort established early boundaries for the protocol and involved the collection and analysis of relevant data for the years 2005-2012. A report summarizing the study parameters and findings was delivered to the Planning Department and Sustainability Task Force. Results from this study were included in the Planning Department's 2015 Sustainability Indicators Report to City Council, a report that summarizes a series of quantitative and qualitative indicators associated with the Sustainability Element of the City's General Plan (Wolfe et al., 2015). This case study, including the preliminary study, was funded by the City of Chico Planning Department.

Limitations

ICLEI's Community Protocol identifies and discusses the strengths and weaknesses of two different approaches to estimating GHG emissions from on-road motor-vehicle travel. The preferred method outlined in ICLEI's protocol is to use estimates of Vehicle Miles Travelled

(VMT) as the primary form input for emissions from this sector. The quality and accuracy of this data, however, can vary greatly depending on how it is estimated. Some communities have developed complicated transportation management models that estimate VMT; those that have not, including Chico, can use estimates provided by the State Department of Transportation (DOT).

The Community Protocol also discusses a methodology utilizing fuel sales data, which it suggests can be useful in communities with a relatively low proportion of trans-boundary travel (ICLEI, 2013). Chico is a rural town with no other municipalities directly bordering it; relative to many communities in California and elsewhere the community and its activities are isolated from overlap with those of nearby or neighboring urban areas. For this reason, along with the potential inaccuracies of State DOT estimates of VMT, the decision was made to utilize transportation fuel sales data as the primary form input for the transportation sector in this protocol.

A potential limitation to the completeness of local transportation fuel sales data was suggested by the data source, the State of California Board of Equalization (BOE). The BOE indicated that, because of the way in which fuel sales are tracked - through associated fuel tax revenue - it was likely that sales at fueling stations owned out-of-area were not being accounted for in the revenue and consumption data for the Chico Urban Area (CUA). It was decided to run an alternate transportation analysis utilizing VMT as the primary form input, to cross-check inventory results and trends.

There is a second limitation to the study in the energy sector, having to do with the completeness of the energy consumption data provided by Pacific Gas & Electric (PG&E) - the primary energy utility in the Chico Urban Area. This data represents all electricity and natural gas sold by PG&E to their customers, but does not include Direct Access (DA) energy purchases by some commercial customers. Direct Access is a service that allows customers to purchase electricity from a competitive provider, not a regulated utility, that is delivered through the utility's grid infrastructure.

A final limitation has to do with accounting of the volume of waste generated in the Chico Urban Area and sent to the local landfill. This data is captured by weights of waste hauling trucks coming from Chico to dump at the landfill; it does not include the weights of loads hauled in personal vehicles.

List of Abbreviations

GHG	Greenhouse Gas
CAP	Climate Action Plan
BAU	Business as Usual
ICLEI	International Council for Local Environmental Initiatives
EFs	Emission Factors
BEGA	Basic Emissions Generating Activity
MTCO2e	Metric Tons of Carbon Dioxide-Equivalent Emissions
VMT	Vehicle Miles Travelled
DOT	Department of Transportation
BOE	Board of Equalization
CUA	Chico Urban Area
PG&E	Pacific Gas and Electric
DA	Direct Access
IPCC	Intergovernmental Panel on Climate Change
WMO	World Meteorological Organization

UNEP	United Nations Environment Program
FAR	First Assessment Report
USCMCPA	United States Conference of Mayors' Climate Protection Agreement
UNFCCC	United Nations Framework Convention on Climate Change
EPA	Environmental Protection Agency
CBA	Cost-Benefit Analysis
NPV	Net Present Value
AB-32	Assembly Bill-32 (California, 2006)
NCA	National Climate Assessment (2014)
kWh	Kilowatt Hour
USBTS	United States Bureau of Transportation Statistics

CHAPTER II

LITERATURE REVIEW

The Intergovernmental Panel on Climate Change (IPCC) is an international organization tasked with assessing the scientific basis of climate change, associated impacts and risks, and providing policy-makers around the world with the scientific basis for options for GHG emissions-mitigation and climate adaptation. The IPCC was established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Program (UNEP) and released its first report, the "IPCC First Assessment Report" (FAR) in 1990 (IPCC, 2013).

As of their most recent report, the "IPCC Fifth Assessment Report" (2014), the IPCC states, among the key findings in their "Synthesis Report - Summary for Policymakers," that both warming of our climate system and the link to human activity are clear. Recent anthropogenic GHG emissions are higher than at any point in history and changes in our climate system are unprecedented over hundreds to thousands of years (IPCC, 2014).

The charts below (Figure 1) summarize trends in anthropogenic carbon dioxide emission levels from 1850 to present, as well as globally averaged GHG concentrations, combined land and ocean surface temperatures and sea level change over the same period.

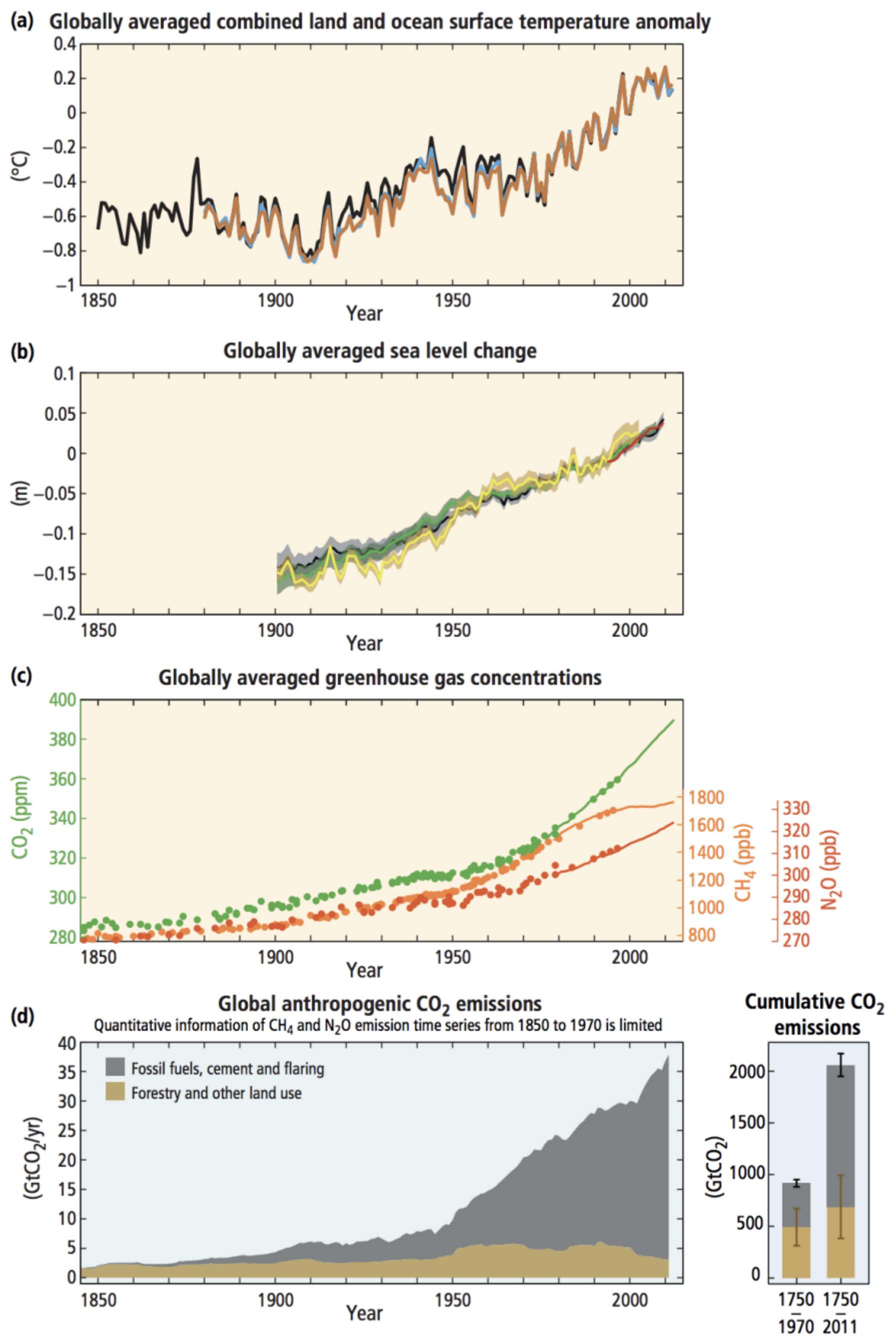

Figure SPM.1 | The complex relationship between the observations (panels a, b, c, yellow background) and the emissions (panel d, light blue background) is addressed in Section 1.2 and Topic 1. Observations and other indicators of a changing global climate system. Observations: **(a)** Annually and globally averaged combined land and ocean surface temperature anomalies relative to the average over the period 1986 to 2005. Colours indicate different data sets. **(b)** Annually and globally averaged sea level change relative to the average over the period 1986 to 2005 in the longest-running dataset. Colours indicate different data sets. All datasets are aligned to have the same value in 1993, the first year of satellite altimetry data (red). Where assessed, uncertainties are indicated by coloured shading. **(c)** Atmospheric concentrations of the greenhouse gases carbon dioxide (CO_2, green), methane (CH_4, orange) and nitrous oxide (N_2O, red) determined from ice core data (dots) and from direct atmospheric measurements (lines). Indicators: **(d)** Global anthropogenic CO_2 emissions from forestry and other land use as well as from burning of fossil fuel, cement production and flaring. Cumulative emissions of CO_2 from these sources and their uncertainties are shown as bars and whiskers, respectively, on the right hand side. The global effects of the accumulation of CH_4 and N_2O emissions are shown in panel c. Greenhouse gas emission data from 1970 to 2010 are shown in Figure SPM.2. *{Figures 1.1, 1.3, 1.5}*

Figure 1: Summary of Anthropogenic CO2 Emissions and Correlated Environmental Impacts, 1850 to Present, From the IPCC Fifth Assessment Report (IPCC, 2014).

The United State Conference of Mayors' Climate Protection Agreement (USCMCPA) was launched by Seattle Mayor Greg Nichols on the same day in 2005 that the Kyoto Protocol was ratified by 141 countries around the world. The USCMCPA is a voluntary commitment for cities to reduce their greenhouse gas emissions to targets that are roughly in line with the 2005 Kyoto Protocol target for the United States, which was a 7% reduction from 1990 levels by 2012 (USCM, 2017). The Kyoto Protocol was the first international agreement committing signatory nations to binding GHG emissions reductions targets. Linked to the United Nations Convention on Climate Change (UNFCCC), the Kyoto Protocol was adopted in Kyoto Japan on December 11th, 1997 and entered into force on February 16th, 2005 (UNFCCC, 2014). An amendment, including new emissions reduction commitments from signatory parties, was adopted in 2012 in Doha, Qatar. Most recently, in 2016, the Paris Agreement was adopted to build on the framework of the UNFCCC. The Paris Agreement not only refines the goals outlined in the Kyoto Protocol, it includes a new focus on adaptation to the impacts of climate change and establishes financial mechanisms to assist developing nations, many of which are disproportionately impacted (UNFCCC, 2016). The USCMCPA was established to advance progress towards the goals of the Kyoto Protocol through local leadership and innovation across the United States, utilizing the framework of the U.S. Conference of Mayors as a support structure. By May of 2007 the USCMCPA had 500 signatories; as of November 2017, it has 1,060.

The scale to which city government leaders across the country committed their communities to local climate action was a reflection of two important drivers. The first of these was a recognition that at the national level in the United States there was a lack of meaningful commitment to action. In 2003 the Environmental Protection Agency (EPA) had decided that because carbon dioxide was not an air pollutant under the Clean Air Act it lacked the authority to regulate emissions; the EPA also concluded that even if it had the authority to regulate emissions, it had the discretion not to in weighing impacts to industry (Wood, 2014). This decision was appealed to the Supreme Court by the State of Massachusetts and finally, in Spring of 2007, the Court ruled against the EPA's decision. By this time the USCMCPA had over 500 signatory cities.

The second of these was a recognition of the important role local government agencies have to play in effective and urgent climate action, regardless of the degree of commitment on the part of the federal government. Government, at any level, has a responsibility to protect shared public resources - the "commons" (Heinberg and Kaufmann, 2010). Local government in the United States, primarily municipal and county-level agencies, control the majority of transportation planning, construction and land use decisions. The majority of GHG emissions being emitted in communities are generated in the transportation sector and by built environment energy consumption. Reducing transportation impacts in particular, by reducing vehicle miles travelled, is primarily a function of planning decisions and availability of legitimate alternatives to single-occupant-vehicle trips - both of which are controlled at the local government level (Boswell et al., 2012).

One of the biggest challenges to incentivizing local climate action has to do with a lack of full accounting in cost-benefit analysis of environmental externalities, and a disconnect between where the costs are borne and the benefits realized. Externalities, in economic analysis, are costs or benefits that are not carried or realized by the parties involved in a market transaction and therefore not taken into account (Harris, 2006). Externalities may exist because there isn't a market mechanism to capture them or because they are difficult to account for. Many types of industrial pollution are external costs, to the environment and society, that firms don't take into account unless they are mandated to, through taxes, fines or other measures. In the case of GHG emissions, quantifying the cost of a unit of emissions, or the value of its mitigation, is especially difficult. No U.S. state, nor the federal government, has established a carbon tax.

Despite this challenge, well-designed climate action efforts can also have positive economic impacts - benefits more conventionally accounted for and locally realized than reductions in GHG emissions levels. Indeed, in the energy sector, there have been and continue to be great opportunities to reduce emissions and save money in the near- and long-term through efficiency, conservation and renewable generation. In fact, a significant number of efficiency measures and many renewable generation alternatives are currently cost-competitive with a “Business as Usual” scenario without accounting for any dollar value in mitigated emissions (Lovins and RMI, 2011).

The City of Chico’s 2020 Climate Action Plan, adopted by City Council in 2012, includes a cost-benefit analysis (CBA) of 67 energy and transportation sector actions. The analysis considered community-wide costs and benefits to each potential emissions-mitigating action over its lifetime, discounting future costs and benefits to account for the opportunity cost of investment, risk and inflation, to determine a net-present-value (NPV). This net present value was divided by the emissions-mitigating potential of each action to determine a net cost per unit of emissions mitigated. All but 11 of the 67 actions had a net positive value per unit, meaning they would, over their lifetimes, both save money and reduce emissions (Alexander and Herman, 2012). The City of Chico 2020 CAP also includes a CBA of included actions to be implemented specifically by the municipal government and found a NPV of over $4,000,000 for these actions.

The State of California became the first state in the nation to pass binding climate legislation, Assembly Bill 32 (AB-32) - the California Global Warming Solutions Act, in 2006. The overarching target outlined in AB-32 is a reduction of state-wide GHG emissions to 1990 levels by 2020 (CARB, 2014). When AB-32 was signed into law, in 2006, California was the eighth largest economy in the world, directly behind Italy and ahead of Spain; as of 2016 it was the sixth largest economy in the world, directly behind the United Kingdom and ahead of France (CLAO, 2006/2016). Given its relative size, influence and focus on innovation, California can play a key role on the frontiers of climate action - it already has been doing so for some time. From the capacity of installed renewable energy generation, including wind and solar, to the significant number of cities incorporating climate action and sustainability strategies into their General Planning processes, to the cutting-edge alternative transportation and resource conservation technologies being developed by the private sector, California is setting trends in this space on a global scale. The state has compelling reasons to act, including significant vulnerabilities to the impacts of climate change. By some estimates, climate change impacts in California threaten trillions of dollars of public and private investment in the state over the coming decades (Kahrl and Roland-Holst, 2012).

These threats come primarily in the form of increases in wildfire activity, sea-level rise and more frequent and severe storms. The 2014 National Climate Assessment (NCA) identified five key impacts to the Southwest region, of which California is a part: reduced snowpack and stream flows; threats to agriculture, in particular high-value specialty crops; increased wildfire; sea level rise and attendant coastal damage; and threats to health, especially resulting from increases in average regional temperatures (USGCRP, 2014). The Central Valley faces challenges unique within the state. The Central Valley is growing at a rate roughly fifty percent faster than the rest of California and this growth will require innovative approaches to energy conservation and reducing VMT in order to protect the quality of life experienced today, especially for at-risk and low-to-moderate-income families (Moffat and Lovins, 2010).

In Fall of 2006 the City of Chico, CA became an early signatory to the U.S. Conference of Mayor's Climate Protection Agreement. A number of steps were taken to begin work on complying with the commitment. These included: establishing a Sustainability Task Force to coordinate efforts and advise the City Council in 2007; completing an initial one-year community-wide GHG emissions inventory of the year 2005 in 2008; establishing a "Business as Usual" emissions scenario based off the base year GHG estimates; establishing interim and ultimate reduction goals for a Climate Action Plan that were roughly in-line with State of California mandated reduction goals outlined in AB-32 (Figure 2); and developing a 2020 CAP outlining strategies to mitigate community-wide GHG emissions from the transportation, energy and waste sectors. The CAP also identifies potential climate change impacts to Chico's region and outlines a strategy for the City to refine that assessment over time and begin developing adaptation strategies. The CAP was developed between 2009-2011 and adopted by City Council in November of 2012.

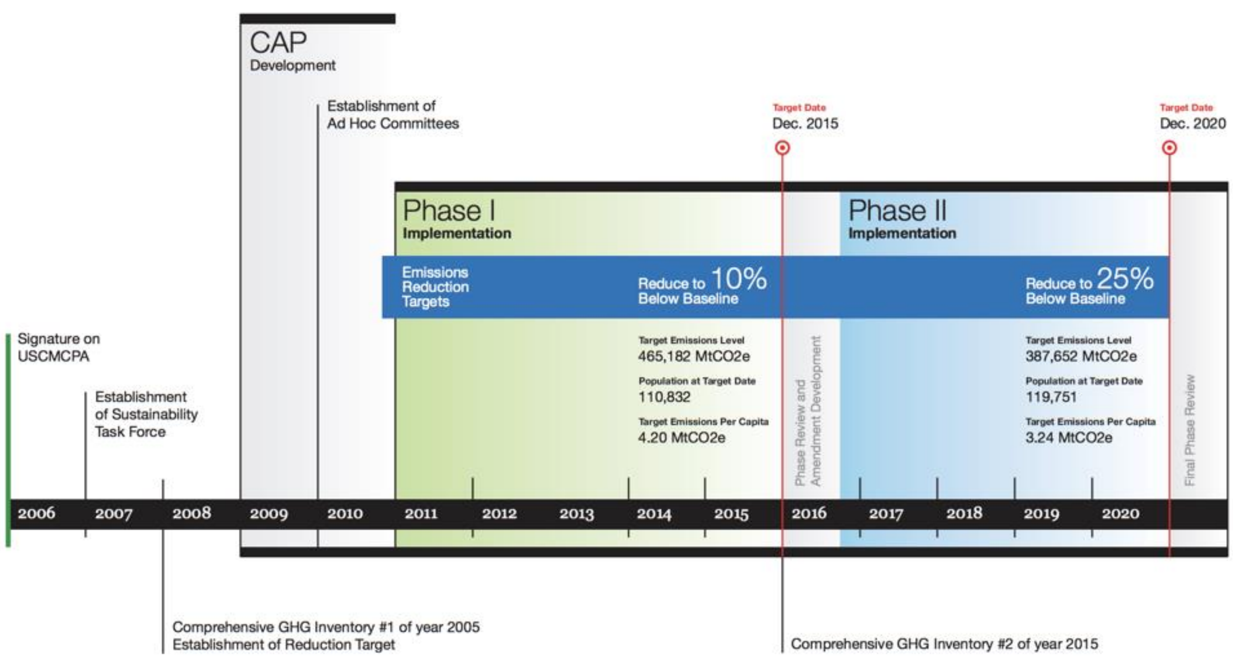

Figure 2: City of Chico 2020 Climate Action Plan Timeline and Targets (Alexander and Herman, 2012).

CHAPTER III

METHODOLOGY

The first step in the project was to develop a protocol scope that met the needs outlined in the introduction and to customize its parameters to the City of Chico, CA specifically. The protocol was organized to be consistent with the City of Chico's Climate Action Plan in terms of scope sectors so its results are consistent with the organization of the CAP. Emissions sources identified by the protocol include the energy sector - commercial and residential electricity and natural gas consumption; the transportation sector - community transportation fuels sales consumption; and the waste sector - tonnage of waste sent to landfill.

The protocol's spatial scope was established as the incorporated City of Chico - the urban area within city limits. The City's CAP addresses emissions generated throughout the Greater Chico Urban Area, a geographic area that includes some outlying development and pockets of county land adjacent to or surrounded by city limits. The spatial boundary of the incorporated City for this study was established to focus on activities within the City's jurisdiction and to enable greater consistency with input data, which is tracked and reported based on those boundaries in most cases. The temporal boundary for the protocol was set on an annual basis because most of the required data is tracked and reported on a calendar year basis, and the CAP's targets are aligned with calendar years.

The protocol identifies four sources for the input data required to complete an annual GHG emissions inventory update; the alternate transportation analysis included two additional sources. These sources are representatives or publications of the government agencies and utilities that provide the commodities and services being utilized and are mandated to accurately track and publicly report data related to their usage. The emission factors employed by the calculator to convert these primary form inputs {kilowatt-hours (kWh) of electricity, therms of natural gas, gallons of transportation fuels / vehicle miles travelled and tons of waste sent to landfill} into an estimate of GHG emissions, in the form of Metric Tons of CO2-equivalent emissions, were established by the U.S. Environmental Protection Agency, the International Council for Local Environmental Initiatives and Pacific Gas & Electric. PG&E is mandated by AB-32 to publicly report annual grid mix and an associated emission factor for electricity provided by the utility.

Once the scope was established for the protocol, the next step was to develop an excel-based calculator that could be used to convert primary form input data into estimates of GHG in the form of MTCO2e. The calculator consists of a main spreadsheet that includes tables for inputting primary form data, updating emission factors, and displaying summary results. It also includes additional spreadsheets identifying data sources and including a series of tables and charts that organize and contextualize the summary results for inclusion in the Sustainability Indicators Report and other publications.

Implementing the protocol to produce an inventory of community-wide GHG emissions for the years 2005-2015 involved a number of steps. The first of these was to reach out to the primary form data sources and collect required input data to conduct an initial analysis. As mentioned above, these sources had been identified as part of the preliminary study in 2015, and contact information for their positions was included in the calculator. The Excel workbook that the protocol calculator is organized within (Figure 3) has been designed so that a city staff member, without necessarily having previous involvement in GHG inventorying processes, can use it to complete an annual inventory without needing to conduct additional research.

City of Chico Greenhouse Gas Emissions Calculator 2005 - 2020

Inventory Input Data Sources

Data	Source
Population	City of Chico Community Development Department
Sales Tax Revenue	City of Chico Community Development Department
Gasoline Sales (Gallons)	State of CA Board of Equalization Data Analysis Section; Courtney Kassis, Business Tax Specialist, (916) 319-9522, courtney.kassis@boe.ca.gov
Diesel Sales (Gallons)	State of CA Board of Equalization Data Analysis Section; Courtney Kassis, Business Tax Specialist, (916) 319-9522, courtney.kassis@boe.ca.gov
Commercial Electricity (kWh)	Incorporated City of Chico PG&E Energy Overview, Green Communities Online Portal; Armando Navarro, Community Energy Manager, (707) 815-9955, ARN2@pge.com
Residential Electricity (kWh)	Incorporated City of Chico PG&E Energy Overview, Green Communities Online Portal; Armando Navarro, Community Energy Manager, (707) 815-9955, ARN2@pge.com
Commercial Gas (Therms)	Incorporated City of Chico PG&E Energy Overview, Green Communities Online Portal; Armando Navarro, Community Energy Manager, (707) 815-9955, ARN2@pge.com
Residential Gas (Therms)	Incorporated City of Chico PG&E Energy Overview, Green Communities Online Portal; Armando Navarro, Community Energy Manager, (707) 815-9955, ARN2@pge.com
Waste to Landfill (Tons)	City of Chico Public Works Department / Butte County Recycling; Steve Rodowick, Recycling Coordinator, (530) 879-2352, srodowick@buttecounty.net
PG&E Electricty Emissions Factors	City of Chico Community Energy Use and GHG Data Report; Armando Navarro, Community Energy Manager, (707) 815-9955, ARN2@pge.com

Calculator Key

PRIMARY FORM DATA - INPUT HERE	NOTES ON UPDATING CHARTS
FORMATTED CELLS - DO NOT EDIT	MANUALLY UPDATED CELLS

Inventory Input Data - Primary Form

Year	Population	Sales Tax Revenue	Transportation Sector		Energy Sector				Waste Sector
			Gasoline Sales (Gallons)	Diesel Sales (Gallons)	Commercial Electricity (kWh)	Residential Electricity (kWh)	Commercial Gas (Therms)	Residential Gas (Therms)	Waste to Landfill (Tons)
2005									
2006									
2007									
2008									
2009									
2010									
2011									
2012									
2013									
2014									
2015									
2016									
2017									
2018									
2019									
2020									

A-2a Inventory Emissions Factors

Inventory Sector	Unit of Measurement	Emissions Factor	
Gasoline	Gallons		MT CO2e / Gallon
Diesel Fuel	Gallons		MT CO2e / Gallon
Electricity	Kilowatt Hours	(See Table A-2b)	
Natural Gas	Therms		MT CO2e / Therm
WTLF	Tonnage		MT CO2e / Wet Short Ton w/ Methane Capture

A-2b PG&E Electricity Emissions Factors by Year

Year	MT CO2e / kWh	Year	MT CO2e / kWh	PG&E INPUT - lbs GHG Emissions Per kWh
2005	0.000000	2013	0.000000	
2006	0.000000	2014	0.000000	
2007	0.000000	2015	0.000000	
2008	0.000000	2016	0.000000	
2009	0.000000	2017	0.000000	
2010	0.000000	2018	0.000000	
2011	0.000000	2019	0.000000	
2012	0.000000	2020	0.000000	

Inventory Results by Sector & Sub-Sector - MT CO2e

Year	Transportation Sector		Energy Sector				Waste Sector	Total	Per Capita	Per $ Sales Tax Revenue
	Gasoline Sales	Diesel Sales	Commercial Electricity	Residential Electricity	Commercial Gas	Residential Gas	Waste to Landfill			
2005	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!	#DIV/0!
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!	#DIV/0!
2007	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!	#DIV/0!
2008	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!	#DIV/0!
2009	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!	#DIV/0!
2010	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!	#DIV/0!
2011	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!	#DIV/0!
2012	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!	#DIV/0!
2013	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!	#DIV/0!
2014	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!	#DIV/0!
2015	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!	#DIV/0!
2016	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!	#DIV/0!
2017	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!	#DIV/0!
2018	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!	#DIV/0!
2019	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!	#DIV/0!
2020	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!	#DIV/0!
% Change '05-'X:	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

Figure 3: Microsoft Excel-Based Greenhouse Gas Emissions Inventorying Protocol Calculator, Customized for the City of Chico for the Years 2005-2020.

For the transportation data, the source was the State of California Board of Equalization Department of Tax and Fee Administration in Sacramento. The BOE provided fuel sales data for the City of Chico in the form of annual totals of gasoline and diesel fuel sold in gallons. For the energy data, the source was Pacific Gas & Electric's Local Customer Relations Manager for the North Valley / Sacramento Division. PG&E provided energy consumption data for the City of Chico in the form of annual totals of kilowatt hours consumed by the residential and commercial sectors and of therms of natural gas consumed by the residential and commercial sectors. For the waste data, the source was the City of Chico Administrative Manager for General Services. The City of Chico provided waste-to-landfill data in the form of annual tons of waste tipped at the Neal Road Landfill that was collected within City of Chico limits.

Other primary form data collected included annual population estimates and local sales tax revenue data, used to contextualize emissions inventory results. Both of these data sets were provided by the City of Chico Planning Department in the form of annual totals.

Once all of the primary form input data had been collected the next step in the project was to input the data into the calculator (Figure 4). Besides the primary form input data, emissions factor for the various emissions sources had to be collected or calculated and inputted as well. Emission factors for transportation fuels were sourced from the Environmental Protection Agency's "Emission Factors for Greenhouse Gas Inventories" (EPA, 2014). Emissions Factors for natural gas and electricity were sourced from PG&E's "Incorporated City of Chico Energy Overview," an energy consumption summary spreadsheet provided by the utility to local government planning agencies on an annual basis. Emission factors for waste-to-landfill were calculated utilizing a protocol outlined in ICLEI's "Community Protocol V1-1, Appendix E - Solid Waste Emissions Activities & Sources" (ICLEI, 2013).

Inventory Input Data - Primary Form

Year	Population	Sales Tax Revenue	Transportation Sector		Energy Sector				Waste Sector
			Gasoline Sales (Gallons)	Diesel Sales (Gallons)	Commercial Electricity (kWh)	Residential Electricity (kWh)	Commercial Gas (Therms)	Residential Gas (Therms)	Waste to Landfill (Tons)
2005	79,091.0	$ 15,826,241.00	30,167,879.0	15,604,197.0	253,549,926.0	201,846,075.0	8,133,681.0	11,007,290.0	88,307.0
2006	84,491.0	$ 17,425,145.00	29,086,753.0	16,017,892.0	258,271,030.0	225,498,202.0	8,604,247.0	12,255,141.0	87,413.4
2007	86,949.0	$ 17,122,084.00	32,014,382.0	16,237,030.0	265,462,971.0	236,116,144.0	8,208,145.0	12,692,043.0	94,758.5
2008	87,673.0	$ 16,355,572.00	28,750,856.0	16,393,090.0	262,254,185.0	241,132,537.0	8,309,927.0	12,847,934.0	90,747.1
2009	86,103.0	$ 14,394,525.00	26,776,961.0	12,213,811.0	272,931,694.0	242,710,409.0	8,411,096.0	13,040,424.0	75,536.6
2010	86,900.0	$ 14,166,974.00	26,806,872.0	12,094,927.0	274,409,744.0	235,293,204.0	8,679,168.0	13,235,049.0	75,295.3
2011	86,819.0	$ 14,802,745.00	25,755,939.0	12,647,934.0	257,969,630.0	240,599,993.0	9,007,071.0	14,143,971.0	74,983.6
2012	88,179.0	$ 16,502,121.00	24,834,712.0	11,969,633.0	262,885,148.0	246,152,139.0	8,622,453.0	13,202,811.0	74,889.9
2013	89,752.0	$ 17,043,519.00	25,684,590.0	12,129,518.0	261,174,969.0	241,700,606.0	9,080,771.0	13,177,876.0	74,107.0
2014	90,711.0	$ 18,389,852.00	25,424,269.0	12,350,114.0	257,592,115.0	239,074,944.0	5,353,650.0	11,103,645.0	69,594.8
2015	91,795.0	$ 19,246,775.00	23,021,357.0	10,495,648.0	257,774,809.0	231,445,253.0	5,322,271.0	11,073,709.0	74,105.2
2016									
2017									
2018									
2019									
2020									

A-2a Inventory Emissions Factors

Inventory Sector	Unit of Measurement	Emissions Factor	
Gasoline	Gallons	0.008789	MT CO2e / Gallon
Diesel Fuel	Gallons	0.010221	MT CO2e / Gallon
Electricity	Kilowatt Hours	(See Table A-2b)	
Natural Gas	Therms	0.005307	MT CO2e / Therm
WTLF	Tonnage	0.283500	MT CO2e / Wet Short Ton w/ Methane Capture

A-2b PG&E Electricity Emissions Factors by Year

Year	MT CO2e / kWh	Year	MT CO2e / kWh	PG&E INPUT - lbs GHG Emissions Per kWh
2005	0.0002218	2013	0.000194	0.427
2006	0.0002068	2014	0.000197	0.435
2007	0.0002884	2015	0.000184	0.405
2008	0.0002908	2016	0.000000	
2009	0.0002608	2017	0.000000	
2010	0.0002019	2018	0.000000	
2011	0.0001783	2019	0.000000	
2012	0.0002014	2020	0.000000	

Figure 4: Protocol Calculator with Primary Form Data and Emission Factors Inputted.

Once all of the primary form data had been inputted into the calculator, along with updated emission factors, the summary charts and tables were updated and the inventory results summarized. The methodology for the alternate transportation analysis was the same as the initial analysis for all sectors except transportation. The protocol calculator was revised to accommodate the alternate input and emission factor data. The primary form data input became vehicle miles travelled and new emission factors were calculated for each year. While emission factors for combusting a given amount of gasoline or diesel fuel are consistent year-to-year, the emission factors for vehicle miles travelled depend on a variable that changes year-to-year - the average vehicle fuel efficiency of automobiles on the road. Emission factors for VMT were calculated utilizing a protocol outlined in ICLEI's "Community Protocol V1-1, Appendix D - Transportation and Other Mobile Emissions Activities and Sources" (ICLEI, 2013). Estimates of average vehicle fuel efficiency were sourced from the U.S. Bureau of Transportation Statistic's (USBTS) National Transportation Statistics "Average Vehicle Fuel Efficiency of U.S. Light Duty Vehicles" (USBTS, 2017). Vehicle miles travelled data was sourced from the California Department of

Transportation's "CA Public Road Data Highway Performance Monitoring Annual Report" (CDOT, 2017).

The final step in completing the alternate transportation analysis was to input the VMT data and the associated emission factors into the revised calculator (Figure 5) and rerun the analysis. The summary charts and tables for the entire community-wide inventory were updated and a second inventory results summary document developed.

Inventory Input Data - Primary Form

			Transportation Sector		Energy Sector				Waste Sector
Year	Population	Sales Tax Revenue	Vehicle Miles Travelled - Passenger Vehicle	Vehicle Miles Travelled - Light Truck	Commercial Electricity (kWh)	Residential Electricity (kWh)	Commercial Gas (Therms)	Residential Gas (Therms)	Waste to Landfill (Tons)
2005	79,091.0	$ 15,826,241.00	175,731,031.2	108,454,464.8	253,549,926.0	201,846,075.0	8,133,681.0	11,007,290.0	88,307.0
2006	84,491.0	$ 17,425,145.00	173,795,618.7	107,260,002.3	258,271,030.0	225,498,202.0	8,604,247.0	12,255,141.0	87,413.4
2007	86,949.0	$ 17,122,084.00	175,682,369.4	108,424,432.6	265,462,971.0	236,116,144.0	8,208,145.0	12,692,043.0	94,758.5
2008	87,673.0	$ 16,355,572.00	175,682,369.4	108,424,432.6	262,254,185.0	241,132,537.0	8,309,927.0	12,847,934.0	90,747.1
2009	86,103.0	$ 14,394,525.00	174,978,985.2	107,990,330.8	272,931,694.0	242,710,409.0	8,411,096.0	13,040,424.0	75,536.6
2010	86,900.0	$ 14,166,974.00	174,978,985.2	107,990,330.8	274,409,744.0	235,293,204.0	8,679,168.0	13,235,049.0	75,295.3
2011	86,819.0	$ 14,802,745.00	166,511,832.0	102,764,728.0	257,969,630.0	240,599,993.0	9,007,071.0	14,143,971.0	74,983.6
2012	88,179.0	$ 16,502,121.00	174,978,985.2	107,990,330.8	262,885,148.0	246,152,139.0	8,622,453.0	13,202,811.0	74,889.9
2013	89,752.0	$ 17,043,519.00	174,978,985.2	107,990,330.8	261,174,969.0	241,700,606.0	9,080,771.0	13,177,876.0	74,107.0
2014	90,711.0	$ 18,389,852.00	178,022,559.6	109,868,708.4	257,592,115.0	239,074,944.0	5,353,650.0	11,103,645.0	69,594.8
2015	91,795.0	$ 19,246,775.00	154,720,193.1	95,487,379.9	257,774,809.0	231,445,253.0	5,322,271.0	11,073,709.0	74,105.2

A-1 Inventory Emissions Factors

Inventory Sector	Unit of Measurement	Emissions Factor	
VMT	Miles	(See Tables A-3, A-4)	
Electricity	Kilowatt Hours	(See Table A-2)	
Natural Gas	Therms	0.005307	MT CO2e / Therm
WTLF	Tonnage	0.283500	MT CO2e / Ton

A-2 PG&E Electricity Emissions Factors by Year

Year	MT CO2e / kWh	Year	MT CO2e / kWh
2005	0.0002218	2011	0.0001783
2006	0.0002068	2012	0.0002014
2007	0.0002884	2013	0.000194
2008	0.0002908	2014	0.000197
2009	0.0002608	2015	0.000184
2010	0.0002019		

A-3 Vehicle Miles Travelled - Light Truck - Emissions

Year	MT CO2e / Mile	Year	MT CO2e / Mile
2005	0.000505	2011	0.000477
2006	0.000500	2012	0.000475
2007	0.000479	2013	0.000473
2008	0.000468	2014	0.000477
2009	0.000471	2015	0.000464
2010	0.000475		

A-4 Vehicle Miles Travelled - Passenger Vehicle -

Year	MT CO2e / Mile	Year	MT CO2e / Mile
2005	0.000290	2011	0.000265
2006	0.000292	2012	0.000248
2007	0.000281	2013	0.000243
2008	0.000279	2014	0.000241
2009	0.000267	2015	0.000237
2010	0.000259		

Figure 5: Protocol Calculator with Alternate Transportation Analysis Primary Form Data and Emission Factors Inputted.

CHAPTER IV

RESULTS

The two sets of results, from the initial analysis and the alternate transportation analysis, show a significant degree of variance in the magnitude of emissions estimates specifically for the transportation sector and for the community-wide results as a whole (Figures 6-7). The initial analysis results in estimate of emissions for 2015 of 309,619 MTCO2e from the transportation sector and 507,515 MTCO2e community-wide. The alternate transportation analysis results in an estimate of emissions for 2015 of 81,029 MTCO2e from the transportation sector and 278,926 MTCO2e community wide. The trends demonstrated by both analyses, specifically for the transportation sector and for the community-wide results as a whole, are consistent. The discussion of inventory results that follows will focus on trends and percentage changes year-over-year.

Inventory Results by Sector & Sub-Sector - MT CO2e											
Year	Transportation Sector		Energy Sector				Waste Sector	Total	Per Capita	Per $ Sales Tax Revenue
	Gasoline Sales	Diesel Sales	Commercial Electricity	Residential Electricity	Commercial Gas	Residential Gas	Waste to Landfill			
2005	265,157.4	159,489.3	56,239.6	44,771.3	43,166.1	58,416.6	25,035.0	652,275.4	8.2	0.0412
2006	255,654.9	163,717.7	53,420.8	46,642.1	45,663.5	65,039.1	24,781.7	654,919.8	7.8	0.0376
2007	281,387.0	165,957.5	76,546.7	68,084.5	43,561.3	67,357.8	26,864.0	729,758.8	8.4	0.0426
2008	252,702.6	167,552.5	76,251.9	70,110.7	44,101.5	68,185.1	25,726.8	704,631.1	8.0	0.0431
2009	235,353.3	124,836.4	71,185.6	63,303.3	44,638.4	69,206.6	21,414.6	629,938.3	7.3	0.0438
2010	235,616.2	123,621.3	55,389.8	47,494.1	46,061.1	70,239.5	21,346.2	599,768.2	6.9	0.0423
2011	226,379.1	129,273.6	45,986.6	42,890.2	47,801.3	75,063.3	21,257.9	588,651.9	6.8	0.0398
2012	218,282.1	122,340.7	52,944.3	49,574.3	45,760.1	70,068.4	21,231.3	580,201.3	6.6	0.0352
2013	225,752.0	123,974.9	50,585.9	46,814.0	48,192.4	69,936.1	21,009.3	586,264.7	6.5	0.0344
2014	223,463.9	126,229.6	50,826.7	47,173.0	28,412.3	58,928.0	19,730.1	554,763.6	6.1	0.0302
2015	202,343.8	107,275.2	47,355.0	42,518.1	28,245.7	58,769.1	21,008.8	507,515.8	5.5	0.0264
% Change '05-'16:	-23.7%	-32.7%	-15.8%	-5.0%	-34.6%	0.6%	-16.1%	-22.2%	-33.0%	-36.0%

Figure 6: City of Chico 2005-2015 Greenhouse Gas Emissions Inventory Results Summary Chart.

Inventory Results by Sector & Sub-Sector - MT CO2e											
Year	Transportation Sector		Energy Sector				Waste Sector	Total	Per Capita	Per $ Sales Tax Revenue
	Passenger Vehicle Miles	Light Truck Miles	Commercial Electricity	Residential Electricity	Commercial Gas	Residential Gas	Waste to Landfill			
2005	50,921.4	54,817.8	56,239.6	44,771.3	43,166.1	58,416.6	25,035.0	333,367.9	4.2	0.0211
2006	50,695.2	53,682.6	53,420.8	46,642.1	45,663.5	65,039.1	24,781.7	339,925.0	4.0	0.0195
2007	49,438.8	51,972.5	76,546.7	68,084.5	43,561.3	67,357.8	26,864.0	383,825.5	4.4	0.0224
2008	48,968.0	50,780.4	76,251.9	70,110.7	44,101.5	68,185.1	25,726.8	384,124.3	4.4	0.0235
2009	46,696.5	50,810.2	71,185.6	63,303.3	44,638.4	69,206.6	21,414.6	367,255.3	4.3	0.0255
2010	45,319.0	51,282.9	55,389.8	47,494.1	46,061.1	70,239.5	21,346.2	337,132.6	3.9	0.0238
2011	44,168.4	49,029.3	45,986.6	42,890.2	47,801.3	75,063.3	21,257.9	326,197.0	3.8	0.0220
2012	43,398.7	51,282.9	52,944.3	49,574.3	45,760.1	70,068.4	21,231.3	334,260.0	3.8	0.0203
2013	42,439.7	51,045.4	50,585.9	46,814.0	48,192.4	69,936.1	21,009.3	330,022.9	3.7	0.0194
2014	42,940.6	52,418.7	50,826.7	47,173.0	28,412.3	58,928.0	19,730.1	300,429.4	3.3	0.0163
2015	36,714.7	44,314.8	47,355.0	42,518.1	28,245.7	58,769.1	21,008.8	278,926.3	3.0	0.0145
% Change '05-'15:	-27.9%	-19.2%	-15.8%	-5.0%	-34.6%	0.6%	-16.1%	-16.3%	-27.9%	-31.2%

Figure 7: City of Chico 2005-2015 Alternate Transportation Analysis Greenhouse Gas Emissions Inventory Results Summary Chart.

The results of the initial analysis show an overall downward trend in community-wide GHG emissions from the CAP's base year of 2005 to the interim CAP target year of 2015. The initial analysis shows an overall reduction of 23.6% over this time period, while the alternate transportation analysis shows an overall reduction of 16.3%. Both analyses show reductions from 2005-2015 from every sector within the scope with the exception of residential natural gas consumption. The relative contribution of the transportation sector, and consequently all other sectors, varies significantly across the two methodologies. In the initial analysis emissions from the transportation sector represent roughly two thirds of total community-wide emissions; in the alternate transportation analysis, they represent roughly one third.

The two bar charts below (Figures 8-9) display both the aggregate trends of community-wide emissions levels and the relative contribution of each sector over time. Data graphics displaying both the form and substance of a set of data provide important depth to the information under consideration (Tufte, 2001). The second layer of information here - which sectors are producing what percentage of overall emissions levels - is an important factor for local government agencies to consider in selecting and prioritizing emissions-mitigating activities in CAP implementation. Along with a cost-benefit analysis that prioritizes cost-effective actions which are locally applicable and feasible, this information is an important determining factor in resource allocation. There is a significant variance between the results of the two methodologies in terms of which sectors are the biggest contributors to emissions levels, as discussed above. This variance underscores the importance of accurate input data and methodological consistency in GHG emissions inventorying.

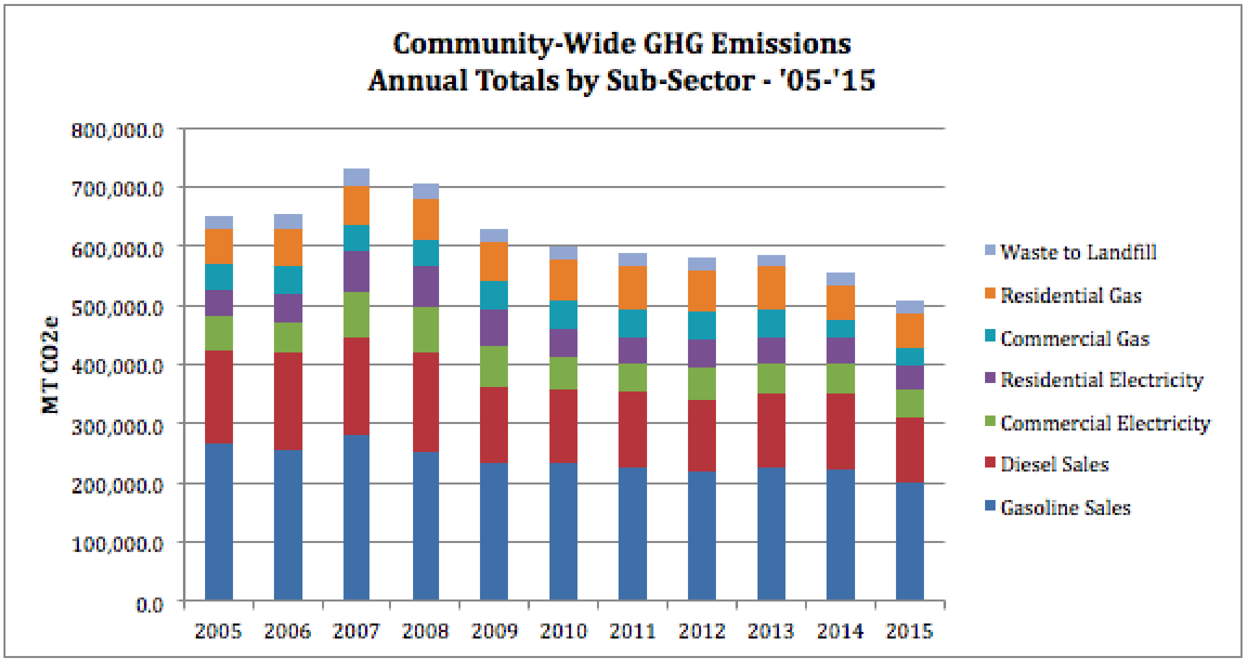

Figure 8: City of Chico 2005-2015 Community-Wide Greenhouse Gas Emissions Annual Totals by Sub-Sector 2005-2015.

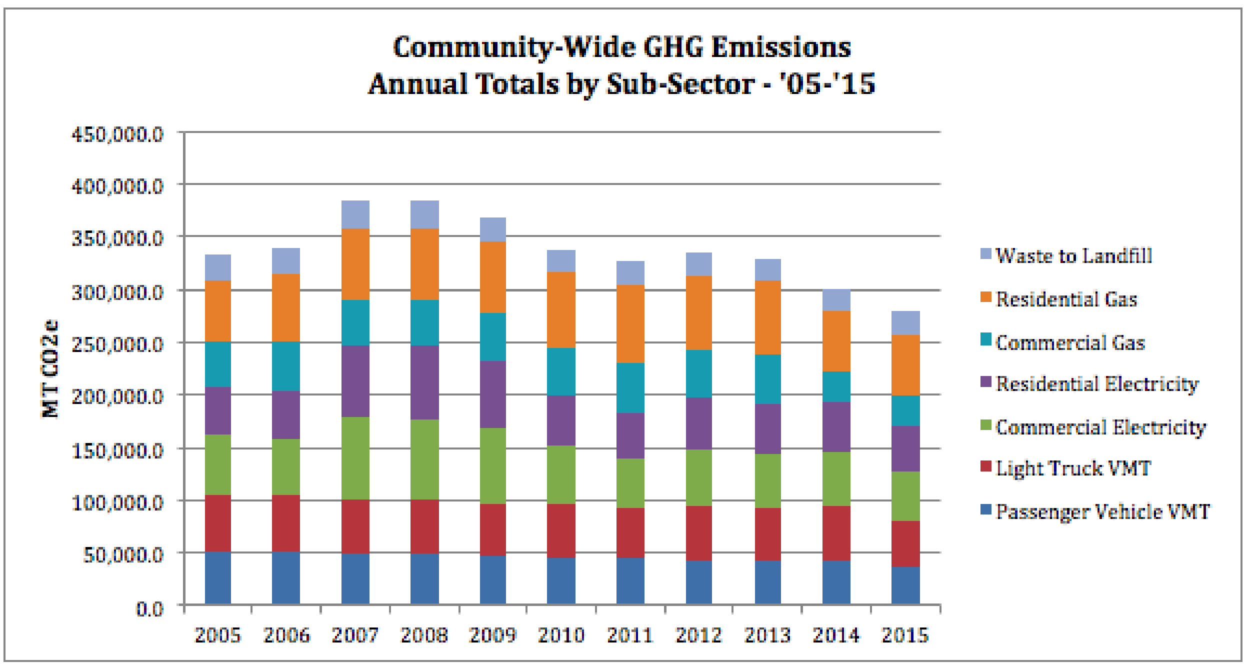

Figure 9: City of Chico 2005-2015 Alternate Transportation Analysis Community-Wide Greenhouse Gas Emissions Annual Totals by Sub-Sector.

Comparing the inventory results with population data and local sales tax revenue data allows for consideration of the results in the context of the growth of both the local population and the local economy (Figures 10-11). The emissions reduction targets outlined in the CAP are based on gross emissions levels in absolute terms, but considering the inventory results alongside these other indicators allows for a more informed analysis of progress. Between the years 2005-2015 the population of the City of Chico grew by 16% while local economic activity, as measured by sales tax revenue data, grew by 22%. Total community-wide GHG emissions, as estimated by the initial analysis, decreased by 33% on a per-capita basis and 36% on a per-dollar-sales-tax-revenue basis. As estimated by the alternate transportation analysis, they decreased by 28% on a per-capita basis and 31% on a per-dollar-sales-tax-revenue basis.

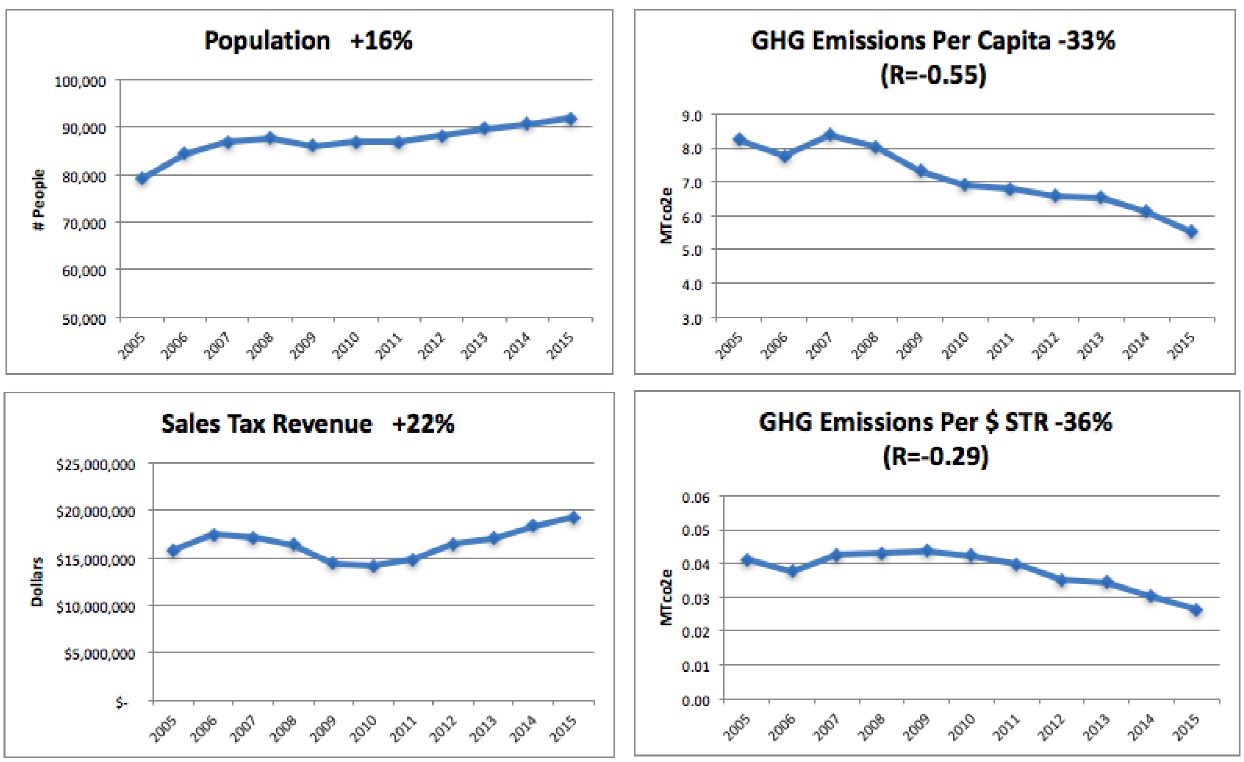

Figure 10: City of Chico 2005-2015 Greenhouse Gas Emissions Inventory Results on a Per-Capita and Per-Dollar of Sales Tax Revenue Basis.

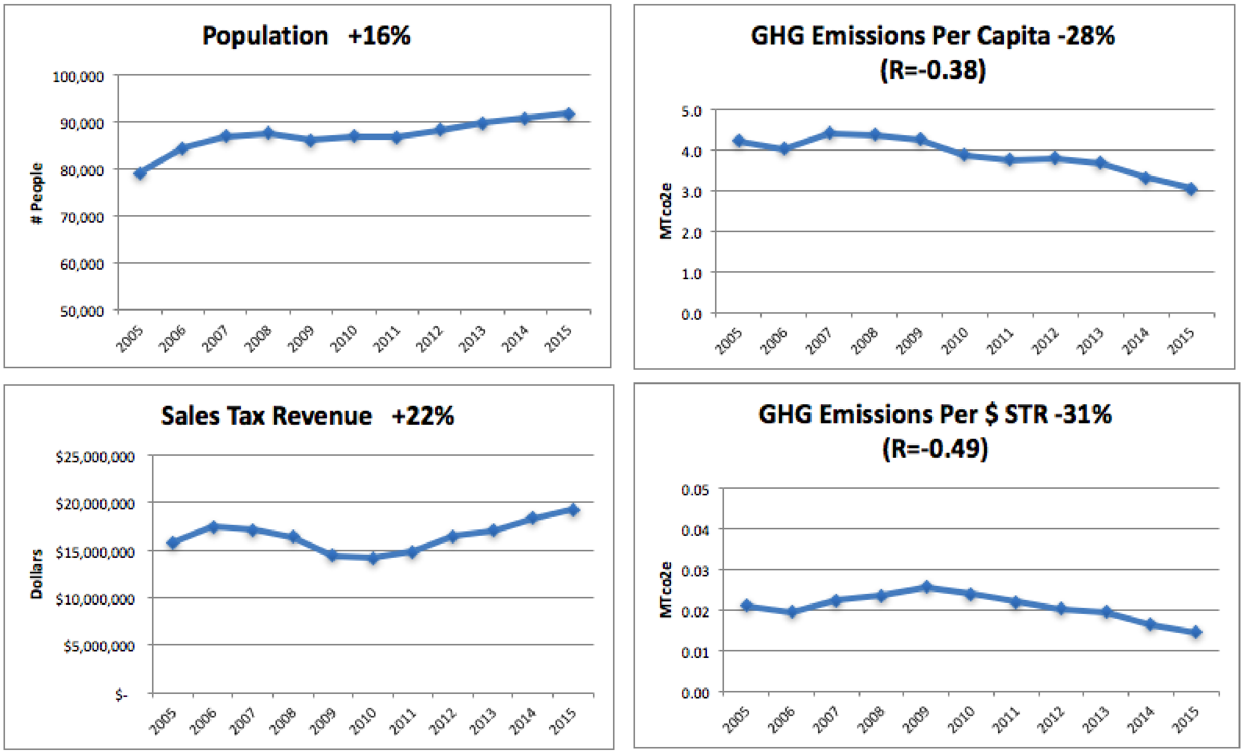

Figure 11: City of Chico 2005-2015 Alternate Transportation Analysis Greenhouse Gas Emissions Inventory Results on a Per-Capita and Per-Dollar of Sales Tax Revenue Basis.

A correlation analysis was run on the population and sales tax revenue data compared to both sets of inventory results in order to determine whether or not increases or decreases in population and local economic activity were correlated, and likely partly responsible for, increases or decreases in emissions levels. As summarized above, results for community-wide emissions levels show a downward trend over time in both analyses; population and sales tax revenue have increased over the same time period.

The correlation analysis confirms what the data seems to show: neither changes in population nor local economic activity are positively correlated with changes in emissions levels. In fact, population and sales tax revenue have increased over the period inventoried while emissions levels have decreased. This demonstrates that local action to mitigate GHG emissions has not only decreased emissions levels associated with the activities present in the CAP's base year, but has offset emissions from increased activities associated with a growing population and economy. The correlation coefficients ("R"-values included in the charts above) show a negative correlation for each variable, population and sales tax revenue, compared with the community-wide GHG emissions results from each of the analyses. It is highly unlikely that a growing population or economy is actually negatively correlated with GHG emissions generation - but the analysis demonstrates that in the case of Chico, they certainly aren't positively correlated; emissions levels are changing in spite of changes in these factors rather than because of them.

In terms of progress towards the Climate Action Plan's interim 2015 target of reducing community-wide GHG emissions levels 10% below base year (2005) levels by 2015, both analyses show that this goal has been reached and exceed by 2015 (Figures 12-13). The initial analysis shows a reduction of 23.6%, nearly to the level of the 2020 CAP target of 25% below base year levels, while the alternate transportation analysis shows a reduction of 16.3%, more than 50% beyond the 2015 interim CAP target. While aggregate community-wide emissions levels increased year-on-year in 2006, 2007 and 2012/2013 (depending on analysis) they have trended down every other year inventoried and substantially overall.

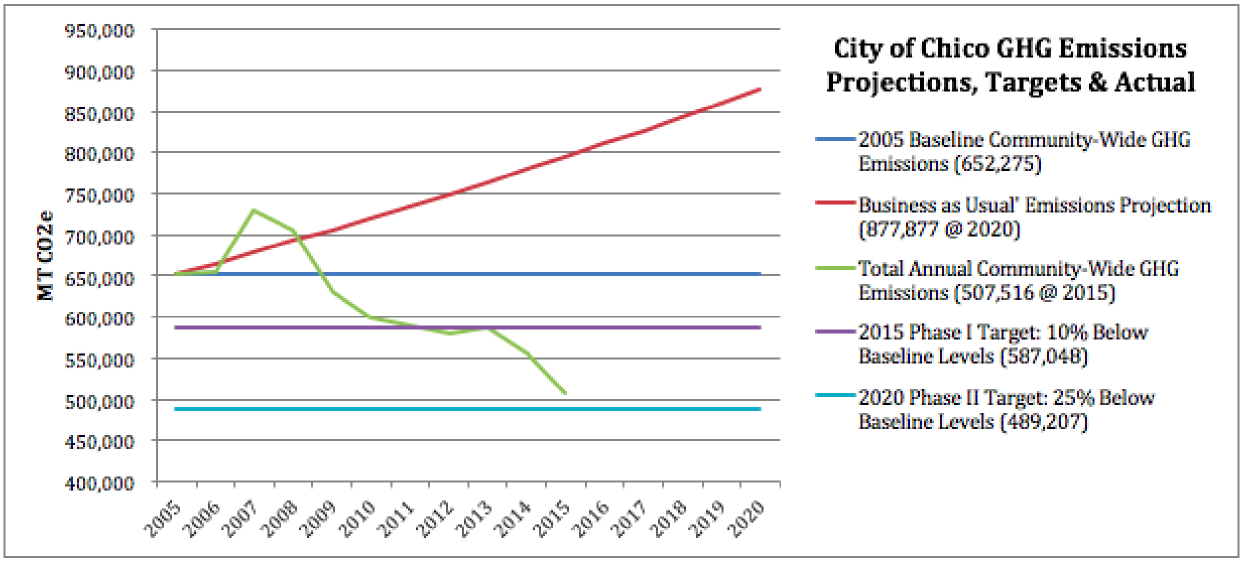

Figure 12: City of Chico Climate Action Plan 2020 Greenhouse Gas Emissions Projections, Targets and Estimated Reductions Through 2015 Interim Target Levels.

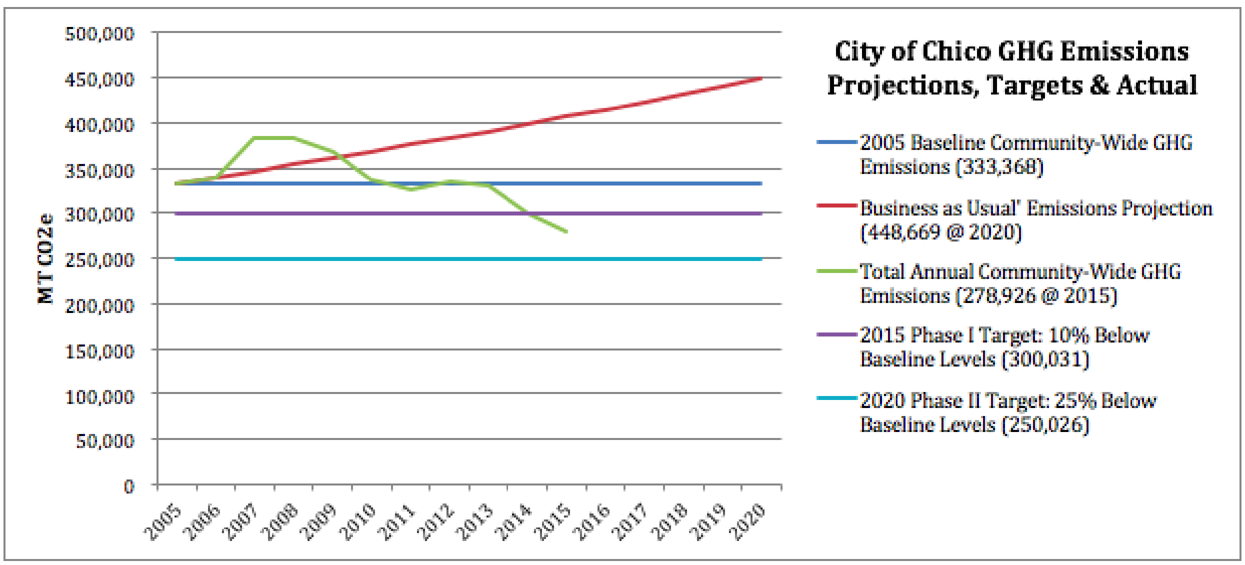

Figure 13: City of Chico Climate Action Plan Alternate Transportation Analysis 2020 Greenhouse Gas Emissions Projections, Targets and Estimated Reductions Through 2015 Interim Target Levels.

CHAPTER V

SUMMARY, CONCLUSIONS & RECOMMENDATIONS

Summary

In terms of the results generated by implementing the protocol for the City of Chico for the years 2005-2015, the data demonstrate a successful downward trend of community-wide GHG emissions from essentially every sector within the scope (except residential natural gas consumption) and in aggregate. They also show which of the sectors included in the scope have seen the steepest reductions and which should perhaps be prioritized in planning efforts. The trends demonstrated in the initial analysis are confirmed by the alternate transportation analysis.

Contextualizing these results with population growth and economic activity figures demonstrates that these downward trends in terms of absolute numbers are actually more significant on a per-capita and per-dollar of sales tax revenue basis. Community-wide emissions levels have been decreasing while the local population has increased significantly and economic activity has rebounded from the recession. The results demonstrate that the City of Chico is on-track in implementing their 2020 Climate Action Plan and appear to have met, and exceeded, the interim target of reducing community-wide emissions levels 10% from the 2005 base year levels by 2015.

The customized protocol calculator developed for the City of Chico can be used on an annual basis to update these GHG emissions inventory results as subsequent years of primary form input data becomes available. The calculator was designed to accommodate additional years of input data and results through the City’s final CAP target of a 25% reduction from 2005 levels by the end of 2020.

Conclusions

The protocol has proved to meet the needs identified at the outset of the project: it produces a high-level estimate of community-wide GHG emissions on an annual basis that includes emissions from the five Basic Emissions Generating Activities, which represent the majority of emissions generating activities within the urban area and those which the local government has significant influence over. It does so in a manner that has relevance and utility for users (in this case, the City of Chico) and is accurate, complete, measureable, consistent and transparent. The Excel-based calculator works well for running the initial analysis and for running the alternate transportation analysis. It is easy to customize and use and is transparent in its calculations.

This protocol can be utilized by other communities interested in tracking emissions levels from a high-level on an annual basis. Depending on the relative degree of urban isolation, the proximity of other communities and the quality of VMT estimates available, some communities may be better served by using VMT estimates as the transportation sector input. Adjusting the protocol to accommodate this alternate input is relatively simple and requires only one additional step - calculating annual emission factors for VMT that take into consideration changes in average vehicle fuel efficiency.

Including in the analysis estimates of population growth and local economic activity can provide valuable insight into the potential impacts of each on changes in emissions levels, or whether efforts to reduce emissions are moving forward despite growth in either or both. This data is already reported to or collected by local government planning departments and is therefore easy to access and incorporate into the analysis.

Recommendations

The following recommendations are made specifically for the City of Chico in refining their use of this protocol over time:

1) Given Chico's circumstances - it's relative isolation as an urban area and its lack of high-quality estimates of local vehicle miles travelled - using fuel sales data as the transportation sector input is most likely the more accurate and thorough methodology for estimating emissions from this sector.
2) Future work with the California Board of Equalization should be able to determine if it's possible to conduct a more thorough accounting of local transportation fuel sales to include fuel sold at stations owned out-of-area.
3) Future work with Pacific Gas & Electric may be able to determine if Direct Access energy purchases can be tracked and included within the input data for the energy sector. Direct Access purchases apply only to electricity consumption, not natural gas.
4) Future work with staff at the Neal Road Landfill, to which Chico's waste is hauled, should be able to determine if it is possible to capture the weights of loads of waste dumped at the landfill by private residents using their own vehicles to haul the waste.
5) The Neal Road Landfill has captured and flared methane emissions since before 2005. The emission factor calculated for converting tons of waste into an estimate of MTCO2e takes this into consideration. Sometime around 2015 the landfill began using captured methane emissions to produce electricity in a landfill-gas-to-energy facility. This has essentially eliminated those emissions as a contributor to community-wide GHG emissions levels; it is in fact creating an offset, but the offset is captured in reduced electricity consumption from

PG&E. The emission factor for waste-to-landfill used in the protocol should be updated to reflect this change.

6) Going forward, it should be possible to update the City of Chico's GHG emissions inventory with new years' data within six months of the end of a calendar year. This would mean data for a given year can all be collected by the end of June of the following year and inputted into the protocol calculator. Working with the reporting agencies to ensure timely delivery of input data can result in an annual update to the inventory by the end of each fiscal year (July 1-June 30).

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