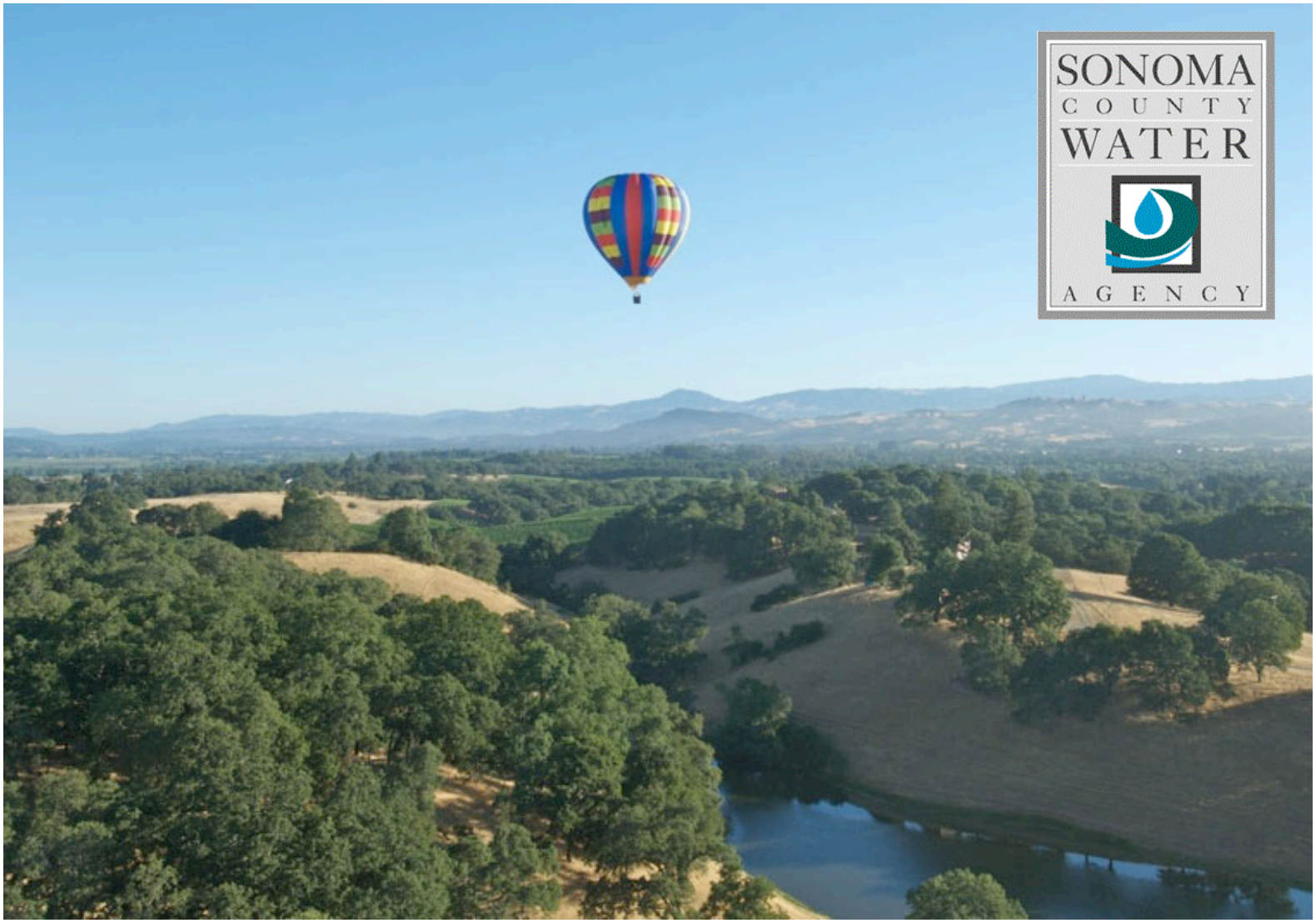

ICLEI Local Governments for Sustainability USA

Analysis of Community Inventory Methodologies

May 2010

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1. INTRODUCTION

1.1 BACKGROUND

In response to expected federal and state legislation that will create mandatory restrictions on emissions of greenhouse gases, Sonoma County, other local governments and the communities in the region, have become increasingly interested in quantifying their greenhouse gas emissions using common guidelines and principles. The State of California is leading this effort with AB 32 and SB 375. AB 32 establishes a goal to reduce statewide emissions to 1990 levels by 2020 and directs CARB to implement regulations to achieve that goal. A primary strategy will be to regulate all stationary sources greater than 25,000 metric tons CO_2e per year and create a cap and trade system for the long term reduction of emissions from these sources. SB 375 establishes regional targets for transportation emissions and requires that metropolitan planning organizations (MPOs) include sustainable community strategies in their regional transportation plans. While the implementation details of these laws are being developed, both have the potential to directly affect community emissions in Sonoma County and present opportunities for the County to partner with large emitters and MPOs to reduce greenhouse gases in the community.

In September 2008, ICLEI, The Climate Registry, California Climate Action Registry and California Air Resources Board published the Local Government Operations Protocol (LGOP) that has become the national standard for how local governments quantify their operational emissions. The success of this protocol has informed this draft community protocol framework recommended in this report and will also inform the development of a detailed community emissions protocol. This draft community protocol framework seeks to address not only the sources that are under the direct financial or operational control of the local government itself, but those of the community at large.

Local governments are uniquely positioned to do this measuring based on their pre-existing contact and partnerships with MPOs, waste boards, water boards and other state and national agencies that house much of the community-scale data that is required to complete a community level inventory.

1.2 PURPOSE

The purpose of this document is to provide guidance on the best available quantification methodologies for the greenhouse gas sources that are directly related to Sonoma County's community activities. Particular attention has been paid to sources that have relevance in carbon markets and present opportunities for creative collaboration and partnership with entities at the point of regulation.

While this document provides basic quantification guidance on a comprehensive list of sources, it is not intended to be a detailed quantification protocol for any source of emissions. Rather, the purpose if this document is to be a framework of all relevant sources, provide additional links and sources for calculation methodologies and provide a justification for why these sources ought to be quantified. Where relevant, this document provides a discussion on possible ways Sonoma County may be able to leverage emissions data for participation in a carbon market. In cases where Sonoma County has little or no operational control over emissions, or where participation in a

carbon market seems unlikely, only basic guidance has been provided for how to quantify emissions.

The methodologies described here are taken from internationally recognized greenhouse gas emission protocols, exemplary local government inventories and ICLEI's long expertise with developing community inventories. Since there is no nationally or internationally recognized standard community protocol, the framework below is a best guess at what sources would be included under a community GHG cap and how these emissions will be calculated when such a standard exists.

This document is not an emissions reduction guide. While, in some cases, emission reductions will be quantified based on changes in baseline consumption, this framework does not provide methodologies for estimating consumption reductions from particular projects.

2. Summary of Results and Work Performed

2.1 Summary of Study Results

Starting in November 2009, ICLEI – Local Governments for Sustainability (ICLEI) undertook a study to examine approaches in which Sonoma County could complete the following two tasks:

- Complete a comprehensive community inventory
- Quantify emissions in a way that would facilitate participation in carbon markets

2.1.1 Key Findings

The result of this research is contained in the Draft Community Protocol Framework below. The key findings from this research are:

- A number of exemplary local community and regional inventories have been completed by communities throughout the U.S. This list is growing, particularly in California where ICLEI has partnered with counties throughout the state to produce city and county-level community inventories.
- No two communities are exactly alike, which makes a direct comparison of emissions tricky and ill advised
- No U.S. standard community protocol yet exists. ICLEI has made a best-guess scenario of what might be included in a community protocol and the calculation methodologies that would be employed.
- International and U.S. based protocols for quantifying greenhouse gas emissions often recommend differing methods for quantifying emissions
- The most commonly referenced protocols that currently underpin a majority of community inventories are: the IPCC Guidelines for National GHG Inventories (IPCC), the Emissions Inventory Improvement Program Guidance (EIIP) and the International Local Government GHG Emissions Analysis Protocol (IEAP)
- A national community protocol will likely recommend the use of national statistics and data kept by the Energy Information Administration (EIA) or the U.S. Environmental Protection Agency (EPA). While regional or state level data is

typically preferred to aggregate national figures, the role of state-level data is yet to be determined. Completing an inventory that addresses Sonoma County's desire to participate in a state carbon market will likely require that the County supplement its own inventory data with California state data where available. In cases where state data is not available, the County has the opportunity to engage the California Air Resources Board (CARB) to improve its state inventorying techniques.

- A multi-stakeholder process including an executive, steering and various technical committees is needed to debate and finalize calculation methodologies that would be included in a U.S. standard for community inventories.
- In order to engage in the carbon markets and to derive financial value from emissions reductions activities, standard greenhouse gas emissions protocols are needed. In a separate supporting ICLEI research paper entitled "Analysis of Carbon Market Opportunities for Sonoma County Water Agency," ICLEI has made numerous recommendations for how Sonoma County can participate in carbon markets.

In order to understand how Sonoma County can move toward completing an inventory that meets the requirements and recommendation of the framework contained in this document, ICLEI compared Sonoma County's existing 2005 (updated in 2006 and 2007) community inventory calculation methodologies to those contained in the draft protocol framework below. The key findings from this analysis are:

- Sonoma County has completed a community inventory for key sectors such as: utility-delivered stationary fuels, purchased electricity, solid waste and on-road transportation that are relevant to potential participation in CARB's proposed cap and trade plan under AB 32.
- Of the sectors completed in Sonoma County's 2005/2006/2007 inventories, only the utility-delivered fuel and electricity sectors were calculated in a way that conforms to the direct measurement of fuel consumed that is used in AB 32. For these, new emissions factors should be applied.
- Sonoma County's community inventories should be updated in order to incorporate new emissions factors published in the Local Government Operations Protocol (LGOP)
- The draft framework below presents new calculation methodologies for Sonoma County's solid waste and transportation sectors. Standard solid waste methodologies were established in 2008 by the LGOP through a partnership between ICLEI, CARB, The Climate Registry (TCR) and the California Climate Action Registry (CCAR). Transportation methodologies are taken from best practice examples and protocols where possible.
- Sonoma County should expand the scope of its community inventory to incorporate as many of the sources included in the draft framework as possible. Those sectors which should be incorporated that are most directly relevant to AB 32 include: community decentralized fuel consumption, industrial processes, wastewater treatment, industrial processes, agriculture, and other mobile and off road sources.

See Table 1, Comparison of Draft Framework and Sectors Inventoried by Sonoma County in Appendix A for a comparison of sectors inventoried by Sonoma County and a complete list of sectors that are recommended to be included in a community protocol. Additionally, this table notes where new factors are available to update the 2005

inventory and where general methodologies used do not match the methodologies expected to be used in the community protocol.

2.1.2 Suggested Next Steps

- Assess the recommendations in the above mentioned supporting research paper to engage with CARB and other local governments to codify methods for Sonoma County to participate in carbon markets.
- Complete a 2008 or 2009 inventory using the methods described below and update Sonoma County's 2005, 2006 and 2007 inventories using current methods.
- Support the development of a national Community Protocol being developed by ICLEI-Local Governments for Sustainability.
- Partner with the Sonoma County Transportation Authority (SCTA) and/or the Metropolitan Transportation Commission (MTC) to identify more accurate approaches to modeling VMT emissions.

2.2 Work Performed

This community protocol framework was informed by a survey of best practices from available greenhouse gas emissions protocols as well as numerous local, regional and state inventories. To develop this draft framework ICLEI:

- Compiled a list of local, regional and state greenhouse gas community inventories that are: regionally focused, comprehensive in their scope, serve as regional models, and address novel emissions sectors
- Used a comprehensive list of research questions to evaluate each local, regional and state inventory and each existing greenhouse gas emissions protocol
- Compiled the resulting data into an Excel matrix for quick reference
- Worked closely with Sonoma County to iteratively focus the white paper on those sectors that would be most relevant to the County as it investigates options for participating in a carbon market
- Drafted a community protocol framework that mined the best available methodologies based on the goals of Sonoma County and ICLEI's expertise in the field of greenhouse gas inventories

An Excel document summarizing all the data complied on each inventory and protocol is available upon request.

2.3 Methodology

Over 600 ICLEI local government members have either completed a community greenhouse gas emissions inventory or are currently in the process of doing so. Of the completed and published local community emissions inventories (city and county scale), ICLEI identified and reviewed eight (8) exemplary inventories (see section 1.4 for the list) based on the following criteria:

- The inventory must be comprehensive
- The inventory must tackle a novel or new emissions source
- The local government that developed the inventory must have unique services

- The inventory must have a regional focus

Six (6) regional emissions (large county, multi-county scale) inventories were also selected for review (see section 1.4 for the list) based on the criteria listed above. These regional inventories were particularly important because they represented a wide range of possible ways of defining a community boundary and the scope of emissions emanating from within that boundary.

Although no national standard community emissions protocol yet exists, numerous inventory protocols and other guidance documents are available and these documents are consistently referenced by local governments who have completed a community inventory. This document will refer to methodology, guidance documents and protocols collectively as "protocols". The protocols investigated here have a range of purposes. Some focus on local government operations, while others focus on Scope 3 emissions or are dedicated specifically to national-level inventories. Although the purposes are varied, each protocol contains methodologies or definitions of boundaries that are relevant to community inventories.

ICLEI also selected eight (8) protocols for review (see section 1.4 for the list) based on its experience working with local governments and its experience creating the LGOP, the standard by which local governments conduct emission inventories of their internal operations. While the list of protocols reviewed is not exhaustive, it includes the most widely used and referenced protocols by local, regional and state governments. In most cases, community inventories reference one or more of the protocol documents selected for analysis here.

Between November 2009 and January 2010, ICLEI completed a research review of each inventory and protocol selected. Principally, ICLEI sought data on:

- The definition of a community boundary
- The calculation methodologies used to calculate emissions
- The sources covered by the inventory or protocol
- A wide range of other attributes that affect how a community inventory is reported and used to set emissions reduction goals.

For a complete list of the questions used for the review of each protocol document, see Appendix B.

2.4 Literature Reviewed

The community inventories reviewed include:

- Sonoma County, CA
- Chula Vista, CA
- Denver, CO
- Broward County, FL
- Iowa City, IA
- New York, NY
- Pittsburgh, PA
- Seattle, WA

Community emissions are often quantified at the regional (multi-county) or state level. For this reason, ICLEI found and researched a set of regional, state and national inventories that provided best practice methods for the regions they serve. These regional inventories include:

- San Diego County Inventory
- Delaware Valley Regional Planning Commission Inventory
- New England and Eastern Canadian Region Inventory
- Travis County, TX Inventory
- U.S. EPA Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2007
- U.S. EPA Opportunities to Reduce GHG Emissions through Material and Land Management Practices (2009)

Although no U.S. national standard for community inventories currently exists, many organizations have begun the process of addressing how to measure emissions from relevant sectors, or have assembled relevant calculation methodologies. ICLEI selected a core group of state, national and international greenhouse gas protocols for this draft framework. Protocols studied include:

- EPA State Inventory Tool Guide (2008)
- World Resources Institute Scope 3 Protocol (Draft)
- Emissions Inventory Improvement Program Guidance
- International Local Government GHG Emissions Analysis Protocol (IEAP)
- The Climate Registry General Reporting Protocol Version 1.1
- IPCC Guidelines for National GHG Inventories (2006)
- A Demand-Centered, Hybrid Lifecycle Methodology for City-Scale Greenhouse Gas Inventories
- Local Government Operations Inventory

3. IDENTIFY YOUR EMISSIONS

3.1 COMMUNITY BOUNDARY

Communities vary in their political and economic structure, geographic and population size, climate, and operational boundaries, all of which impact the design of a community inventory. Although communities, or the local governments that run them, do not have operational control over all the buildings, vehicles and industries that reside within the geo-political boundary that defines their city/county/region, local governments do exercise some control over the consumption habits and activities of businesses in this sphere.

Local governments typically account for and report all relevant emissions that occur over the course of one calendar year within the spatial city, county or regional boundary as delineated by city, county or regional borders. For example, Sonoma County would report all emissions from stationary sources with postal addresses in Sonoma County and all mobile emissions that occurred within the geographic area that defines the county.

Entities who wish to conduct an inventory for a region that crosses city, county or state borders can still use the methods described below.

Note that a community inventory will not limit itself to government owned or operated facilities. A community inventory will account for all activity - including government, residential, commercial and industrial - that occurs within that community's border. Unlike the LGOP that defines a boundary based on a control approach, a community boundary is defined by geographic boundaries.

Cross-boundary emissions

While a geographic definition of a community's boundary works well for stationary sources, it presents some problems for mobile sources that often produce emissions in multiple locations over the course of a year. Although the AB 32 cap and trade plan calls for the quantification of transportation fuels at the site of delivery, estimations of vehicle miles travelled will be used in this framework. See mobile source sections below for a detailed explanation for this choice and the particular calculation methodologies for each mobile source.

3.2 SCOPES

This draft framework employs the approach to categorizing emissions by scope, outlined in the WRI GHG Protocol and the International Local Government GHG Emissions Analysis Protocol. Differentiating between emission scopes helps to avoid the possibility of double counting emissions and misrepresenting emissions when reporting, but allows all policy relevant information to be captured. Four classifications are used to categorize emissions sources, differing slightly when applied in the context of government operations and community-scale inventories.

Community Scopes Definitions

Scope 1 emissions – All direct emission sources located within the geopolitical boundary of the local government.

Scope 2 emissions – Indirect emissions that result as a consequence of activity within the jurisdiction's geopolitical boundary limited to electricity, district heating, steam and cooling consumption.

Scope 3 emissions – All other indirect and embodied emissions that occur as a result of activity within the geopolitical boundary.

Information Items – Biogenic emissions and other indicators that may be relevant to a complete understanding of a community's energy use and climate impact, but that are not conventionally included in greenhouse gas accounting.

Scopes and Cap and Trade

Cap and trade programs look exclusively at Scope 1 emissions from the point of view of the regulating emissions at the source, ignoring emissions that require circuitous fuel

use estimations, VMT estimates or methodologies that employ lifecycle analyses. This document will focus on emissions that can be considered Scope 1 or Scope 2 for Sonoma County. Scope 2 emissions are included because they may be counted as Scope 1 for a regulated entity under AB 32 and based on current practices are typically included in community inventories.

Note: A final community protocol may itemize and recommend the quantification of numerous Scope 3 sources.

4. QUANTIFYING EMISSIONS

This draft framework includes only sources that are relevant for Sonoma County. For a more complete list of the sources that would be included in a national draft protocol, see Table 1 in Appendix A.

This document focuses on best practice methodologies and provides recommended and alternate approaches when the required data is not available.

SCOPE 1 SOURCES

4.1 STATIONARY COMBUSTION

Stationary combustion of natural gas from residential, commercial and industrial sectors made up roughly 20% of Sonoma County's 2005 greenhouse gas inventory. Although Sonoma County's ability to participate in AB 32's carbon market is uncertain, ICLEI believes that electricity consumption and natural gas reduction strategies present two of the most viable means through which to claim allowance value under a cap and trade system.

Stationary combustion sources most commonly include the combustion of natural gas, propane, and stationary diesel (#2 distillate fuel oil). Other less common types of solid or liquid fuels are also consumed. In communities where electricity is not widely used for heating, stationary combustion can be a key source of emissions from buildings and can, in the case of utility delivered fuels, be measured directly. Some fuels are not distributed by utilities, but rather via a decentralized network of privately-owned wholesalers and retailers. For these fuels, the Energy Information Administration (EIA) has data on sales of distillate fuel oil and kerosene products at the state level.

An alternative data source for diesel consumption is state tax records since these records differentiate between mobile diesel and stationary diesel. Data that is more accurate than EIA's could, therefore, be potentially derived from state tax records.

4.1.1 Residential

Description/Justification

Having an accurate inventory of residential stationary fuels, particularly those that are purchased from a utility, will be central to any opportunities Sonoma County has for participating in a carbon market. Since utilities have accurate records of purchased fuels,

reductions from utility delivered sources can easily be shown to have a 1-to-1 correlation with fuels sold upstream. While the accurate measurements of these fuels are well established, significant obstacles remain before Sonoma County will be able to claim any allowances, as described in the companion *Carbon Markets* paper.

Having a good estimation of decentralized fuels consumed will benefit the County and may lead to claiming allowance value in the future, but these estimations will be difficult to validate since there are no good direct estimates of the decentralized fuels sold.

Sources Covered
1) Utility delivered fuels
2) Decentralized fuel consumption

There are numerous potential sources of solid and liquid fuels that could be combusted in residences. A thorough, but not necessarily exhaustive list of fuels can be found in LGOP Appendix Table G.1.

Best Practice Calculation Method
For fuels that are distributed by a utility, most commonly natural gas, meter data should be used to compile a total amount of a fuel consumed for all residential units within the jurisdictional boundary. This fuel should be tabulated in a standard volume unit such as gallons or cubic feet, or in energy units such as therms.

Once utility data has been obtained, use emissions factors from LGOP Appendix Table G.1 and G.3 to calculate emissions.

Some fuels, such as stationary diesel, are distributed in a decentralized fashion by privately-owned wholesalers and retailers. For these fuels, emissions can be estimated using data from EIA, which publishes annual figures of residential distillate fuel oil and kerosene sales by state. To estimate community consumption of stationary fuels from EIA data, use U.S. Census data on housing characteristics to identify the proportion of households in your community using a stationary fuel compared to the statewide total of households using that fuel. Based on this ratio, assign the appropriate percentage of statewide consumption to your community.

Accurate sources of other fuels may be difficult to find. Where possible, data on total community use of fuels should be gathered from the primary energy providers.

References:
- International Local Government GHG Emissions Analysis Protocol
  http://www.icleiusa.org/programs/climate/ghg-protocol
- Energy Information Association Website
  http://tonto.eia.doe.gov/dnav/pet/pet_cons_top.asp

4.1.2 Commercial

Brief Description/Justification
Commercial utility-delivered natural gas data is readily available from PG&E. The measurement of other fuels used by businesses that reside in the community boundary

involve the same opportunities and challenges as measuring stationary fuel used in residences, as described above. .

Sources Covered
1) Utility delivered fuels
2) Decentralized fuel consumption

There are numerous potential sources of solid and liquid fuels that could be combusted by the commercial sector. A thorough, but not necessarily exhaustive list of fuels can be found in LGOP Appendix Table G.1.

Best Practice Calculation Method
For fuels that are distributed by a utility, (most commonly natural gas) meter data should be used to compile a total amount of a fuel consumed for all commercial structures within the jurisdictional boundary. This fuel should be tabulated in a standard volume unit such as gallons or cubic feet, or in energy units such as therms.

Once utility data has been obtained, use emissions factors from LGOP Appendix Table G.1 and G.3 to calculate emissions.

Some fuels, such as stationary diesel, are distributed in a decentralized fashion by privately-owned wholesalers and retailers. For these fuels, emissions can be estimated using data from EIA, which publishes annual figures of commercial distillate fuel oil and kerosene sales by state. To estimate community consumption of stationary fuels from EIA data, use U.S. Census data on employment characteristics to identify the proportion of employment in your community compared to the statewide total employment. Based on this ratio, assign the appropriate percentage of statewide consumption to your community.

References:
- International Local Government GHG Emissions Analysis Protocol
  http://www.icleiusa.org/programs/climate/ghg-protocol
- Energy Information Association Website
  http://tonto.eia.doe.gov/dnav/pet/pet_cons_821use_dcu_nus_a.htm

4.1.3 Industrial > 25,000 $MTCO_2e$

Brief Description/Justification
Industries can be a major contributor to a community's greenhouse gas emissions. In Sonoma County's 2005 inventory, assuming that non-agricultural industrial consumption of electricity and natural gas is split 50/50 between the two fuels, natural gas from these sources accounted for roughly 2.7% of total emissions. Although not a large contributor to the inventory, these emissions are still significant. A small increase in industrial facilities could dramatically increase industry's contribution to emissions from natural gas. Since AB 32's cap and trade program is devoted predominantly to industrial sources, this protocol framework will provide some outline guidance on emission quantification

Stationary industrial emissions from large emitters can be broken up into two categories – fuel combustion and emissions from industrial processes.

Fuel combustion

Industrial stationary combustion sources include the combustion of natural gas, stationary diesel and other solid or liquid fuels consumed by industries within that community. Where these fuels are provided by a utility, data can be obtained from the utility. EIA tracks industrial consumption of distillate fuel oil, residual fuel oil and kerosene. To estimate community consumption, multiply the total amount of state consumption by the ratio of Sonoma County's population divided by the state population in the inventory year.

Sources Covered

Numerous solid and liquid fuels are typically combusted on site. See the LGOP for a complete list of fuels.

Best Practice Calculation Method

Utility delivered fuels - where metered fuel data is available from utilities, this should be used to obtain a total amount of a fuel used in volume units such as gallons, cubic feet, etc or in energy units such as therms of Btu.

Use LGOP factors to calculate emissions from once utility data has been obtained.

References:

- International Local Government GHG Emissions Analysis Protocol
  http://www.icleiusa.org/programs/climate/ghg-protocol
- Energy Information Association Website
  http://tonto.eia.doe.gov/dnav/pet/pet_cons_821use_dcu_nus_a.htm

Industrial Processes

A community may contain any number of industries or industrial processes. Some of these may be privately owned and others may be operated by the local government. In either case, if the industrial facility creates greenhouse gas emissions and is located within the local government boundary, these emissions should be counted in a community inventory.

Best Practice Calculation Methodologies

In many cases, reporting of emissions from industrial sources will be done through AB 32 reporting mechanisms. In these cases, this research paper provides references for more information, but has not gone into the steps necessary to calculate emissions. For those industrial processes that are included in AB 32's cap and trade system, but where the ability for Sonoma County to participate is unlikely, this research paper has deferred to CARB for calculation methodologies. References for other industrial processes calculation methodologies outside of CARB are cited where relevant.

Industrial processes that emit less that 25,000 metric tons CO_2e are not covered by the AB 32 Mandatory Reporting Regulation or the proposed cap and trade program.

Note that not all of the industrial processes listed below fall under the AB 32 cap and trade system. Other protocols have listed industrial processes such as adipic acid

production as relevant to a community inventory. This research paper lists the industrial processes covered by a range of inventory protocols, but does not provide detailed quantification methods for them.

Although this is not the case in Sonoma County, those jurisdictions that contain a co-generation or power generation operations with a nameplate capacity of 1 MW or higher and emit at least 2,500 metric tons of CO_2 per year, or a stationary combustion source that emits over 25,000 metric tons of CO_2 per year, the facility will be subject to CARB's mandatory reporting regulation under AB 32.

Sources Covered

Large Industrial Sources

- Stationary Combustion (AB 32)
- Electricity Generation (AB 32)
- Ammonia Production (LGOP)
- Cement Production (AB 32, LGOP)
- Cogeneration (AB 32)
- Petroleum Refining (AB 32)
- Hydrogen Production (AB 32)
- Aluminum Production (AB 32, LGOP)
- Facility Operators Calcining Carbonates (AB 32)
- CO_2 Supplier or Transfer Recipient (AB 32)
- Glass production (AB 32)
- Iron and Steel Production (AB 32, LGOP)
- Lime Production (AB 32, LGOP)
- Natural Gas Transmission and Distribution (AB 32)
- Adipic Acid Production (LGOP)
- Nitric Acid Production (AB 32, LGOP)
- Oil Extraction Field Operation (AB 32)
- Gas Extraction Field Operation (AB 32)
- Production of Industrial Gases (AB 32)
- Pulp and Paper Production (AB 32, LGOP)
- Soda Ash Production (AB 32)
- HCFC-22 Production (LGOP)
- Refrigeration and Air Condition Equipment Manufacturing (LGOP)
- Semiconductor Manufacture (LGOP)

4.1.4 Industrial < 25,000 $MTCO_2e$

Relevant Small Industrial Sources

- Stationary Sources (AB 32)
- Power Generation (AB 32, LGOP)

References:

- LGOP, Chapter 11 - *http://www.icleiusa.org/programs/climate/ghg-protocol*
- ARB Reporting Guidance - *http://www.arb.ca.gov/cc/reporting/ghg-rep/ghg-rep.htm*

4.2 SOLID WASTE FACILITIES

Brief Description/Justification

Solid waste facilities can be significant contributors to community inventories – in some cases up to 30% of total emissions. Landfills are regulated at the state level and enforced at the jurisdiction level, making them good candidates for measures aimed at reducing emissions. In addition, due to growing regulation of landfills over the last 30 years, data on emissions from landfills is increasingly available, making them important sources and relatively easy to quantify. Landfills with landfill gas collection (LFG) systems that adhere to New Source Performance Standards have the data required to utilize standard calculation methodologies. Landfills without LFG collection systems will require historical data on waste disposed per year.

On June 21, 2007, CARB approved the Landfill Methane Capture Strategy as an early action measure. Accordingly, CARB staff, in collaboration with California Integrated Waste Management Board (CIWMB) staff, is developing a control measure to provide enhanced control of methane emissions from municipal solid waste (MSW) landfills. The control measure will reduce methane emissions from MSW landfills by requiring gas collection and control systems on landfills where these systems are not currently required and will establish statewide performance standards to maximize methane capture efficiencies. As part of this process, CARB and CIWMB staff will explore opportunities to increase energy recovery from landfill methane gas.

Those jurisdictions that contain a solid waste facility that includes co-generation or power generation operations with a nameplate capacity of 1 MW or higher and emit at least 2,500 metric tons of CO_2 per year, or a stationary combustion source that emits over 25,000 metric tons of CO_2 per year, the facility will be subject to CARB's mandatory reporting regulation under AB 32. More information on this is available in the Stationary Combustion chapter of this document under Industrial processes.

The methodologies used by Sonoma County in the 2005 inventory for solid waste emissions are not consistent with the methodologies recommended below. The method for calculating waste emissions in ICLEI's Clean Air and Climate Protection Software (CACP), which was used by the County, and numerous communities, is based on the EPA WARM model. In recent years, ICLEI has recommended that communities using CACP remove factors that show emissions as being sequestered in landfills. Since 2008, ICLEI has recommended that communities use LGOP methods which are fundamentally different from WARM and CACP. Given this discrepancy in calculation methodology, and that no landfills under LGOP methods will appear to be net carbon sinks, Sonoma County is significantly under-estimating the emissions from solid waste and mistakenly classifying landfills as emission sinks. ICLEI recommends that the County update its 2005 inventory with solid waste emission estimates based on methodologies from the LGOP.

Sonoma County should be able to use direct measurements of LFG to estimate CH_4 emissions based on the equations for solid waste in the LGOP.

Sources Covered

Fugitive CH_4

Best Practice Calculation Methodologies

The LGOP provides methodologies and equations for calculating fugitive CH_4 emissions from solid waste landfills. These methodologies and equations are applicable to landfills regardless of whether they are owned and operated by a local government or a private company. LGOP includes methods for landfills in three categories; those with partial landfill gas collection systems, those with comprehensive landfill gas collection systems, and those with no landfill gas collection system.

4.2.1 Partial LFG Collection

Fugitive CH_4 emissions for a landfill with a partial LFG collection system can be derived using the data on actual LFG collected together with standard collection efficiency and a factor to account for emissions from the uncollected area of the landfill. LGOP considers an LFG collection system to be comprehensive only if the landfill is required to have a LFG collection system under U.S. EPA's New Source Performance Standards (NSPS), or a system more stringent than NSPS as dictated by a local air district. Thus, if a landfill is not subject to NSPS, the LFG collection system is considered partial.

Section 9.3.3 of LGOP outlines the calculation methodologies for partial LFG collection systems. A number of defaults are used in LGOP Equation 9.2. Listed below are the facility-specific data necessary to estimate the fugitive CH_4 emitted by landfills within the jurisdiction:

- Annual landfill gas collected
- Fraction of CH_4 in LFG from source testing (default value available)
- Factor to account for emissions from the uncollected surface area of the landfill

4.2.2 Comprehensive LFG Collection

Fugitive CH_4 emissions for a landfill with an active and comprehensive LFG collection system can be derived using the data on actual LFG collected and applying standard collection efficiency. This data is available from the Bay Area Air Quality Management District (BAAQMD) or from landfill operators. BAAQMD has data for some closed landfills that have LFG recovery systems. Old landfills may not have LFG collection systems. See below for more detail on calculating emissions from closed landfills with no LFG collection systems. LGOP considers an LFG system to be comprehensive if the landfill is required to have a LFG collection system under NSPS, or a system more stringent than NSPS as dictated by a local air district. Below are the facility-specific data that you will use with Equation 9.1 in order to estimate the fugitive CH_4 emitted by your landfill:

- Annual landfill gas collected
- Fraction of CH_4 in LFG from source testing (default value available)

4.2.3 Landfills with No LFG Collection System

If a landfill does not have an LFG collection system in place, the fugitive CH_4 emissions can be estimated using a first order kinetics model based on the amount of waste disposed annually, its composition, and the climate and operational conditions of the landfill. This includes older closed landfills which continue to emit methane even after they are capped. See below for emissions estimation methodologies where direct measurements of methane are not available.

The IPCC has developed a First Order Decay (FOD) model for national governments to quantify waste emissions as part of its 2006 guidelines. This model is based on the assumption that the amount of organic material that will decay is directly proportional to the current amount of material available in the landfill to undergo decay. The excel-based tool provided as a companion to the LGOP is based on the IPCC FOD model. The California Air Resources Board developed this tool for local governments. It facilitates entry for waste characterization numbers and local parameters from US EPA, state or local environmental agencies. Where facility-specific data is available to use in the model, default values are provided in LGOP for many variables. These default values are also available in the tool itself.

The California Integrated Waste Management Board (CIWMB) houses data on yearly waste deposition for landfills in Sonoma County. Waste facility data can be found at http://www.calrecycle.ca.gov/LGCentral/Reports/DRS/Origin/FacSummary.aspx

If there is no landfill gas collection system on closed landfills, and data is not available from CIWMB on yearly deposition, yearly waste deposition can be estimated based on the total amount of waste in the closed landfill and the density of the waste[1]. Note that this estimate assumes a constant amount of waste deposited each year.

To estimate yearly waste deposition:

- Obtain data on the total amount of waste contained in the landfill when it was closed. This should be available from the landfill operator or can be estimated using the volume of the landfill and the density of waste deposited.
- Obtain data on the number of years the landfill was open. If you do not have this data, you can use 60 years as an average.
- Divide the total amount of waste by the number of years the landfill was open – this is your yearly deposition[2]
- Enter this yearly deposition in the FOD calculator provided by ARB to get yearly emissions for your baseline year.

References:

- LGOP, Chapter 9 - *http://www.icleiusa.org/programs/climate/ghg-protocol*
- ARB Reporting Guidance - *http://www.arb.ca.gov/cc/reporting/ghg-rep/ghg-rep.htm*
- FOD Model - *www.arb.ca.gov/cc/protocols/localgov/localgov.htm*

4.3 WASTEWATER TREATMENT FACILITIES

The Sonoma County Water Agency operates and maintains 6 small wastewater treatment facilities. The largest facility in the County is operated by the City of Santa Rosa. Several other cities and local agencies also operate treatment plants of various

[1] The density of waste varies roughly between 300 lbs/cubic yard and 1,300 lbs/cubic yard according to the type of waste and its compaction ratio. For compacted waste where you do not know the compaction ratio, use 1,300 lbs/cubic yard.

[2] For a more fine grained analysis, you may find data on the population served by this landfill on a yearly basis – or assume this population increased or decreased along with the population of the County. A higher population served in a particular year would yield a larger amount of total waste deposited in that year. This will affect when emissions from that waste deposition are being emitted.

sizes. Although wastewater treatment facilities are not explicitly covered by the EPA Mandatory Rule or the AB 32 cap and trade program, wastewater treatment emissions can often exceed 25,000 $MTCO_2e$ and are therefore candidates to be included into these two programs in the future. Wastewater treatment emissions were not included in the 2005 Sonoma County inventory. ICLEI recommends including wastewater emissions in an updated community inventory using methods outlined in the LGOP.

Brief Description

The focus of this section is Scope 1 emissions that result from processes at wastewater facilities that are within the jurisdictional boundary. Septic systems are included here even though they are typically distributed throughout a community and would not likely be considered as a facility under the AB 32 cap and trade program. Taken in aggregate, septic systems are significant contributors to greenhouse gases based on well established calculation methodologies. These emissions should be considered for inclusion in an alternative carbon market.

This includes activities such as wastewater collection, managing septic systems, primary and secondary treatment, solids handling and effluent discharge. Wastewater treatment processes can encompass many different sources of GHG emissions. This section focuses solely on calculating the CH_4 and N_2O emissions created by septic systems and centralized wastewater treatment. The calculation methodologies described below for septic systems were developed for local governments that operate a network of septic systems, but can be applied to residential systems as well. Methods for estimating community scale activity data for septic systems are not covered here.

For guidance on how to treat emissions from stationary combustion and purchased electricity that may occur at these facilities, refer to other chapters of this document.

Justification

Process emissions from wastewater treatment plants are not typically a significant source of emissions. This is, however, greatly dependent on the controls and processes in place at an individual plant. Wastewater treatment plants can be a significant source of alternative energy production.

Sources Covered

Stationary, Process and Fugitive Emissions

Best Practice Calculation Methodologies

Wastewater treatment processes can create a unique set of process and fugitive emissions.

Wastewater from domestic and industrial sources is treated to remove soluble organic matter, suspended solids, pathogenic organisms, and chemical contaminants. Wastewater treatment systems may include a variety of processes, ranging from septic systems to lagooning to advanced tertiary treatment technology for removing nutrients and providing disinfection.

In LGOP, Table 10.2 summarizes the sources of fugitive and process CH_4 and N_2O emissions discussed in this chapter. For most sources, two methodologies are provided - a source-specific method that requires source-specific data and a general method that requires only population served by the facility. For each applicable source, you will choose a method and associated equation based on data available.

References:

- LGOP, Chapter 10 - http://www.icleiusa.org/programs/climate/ghg-protocol

4.4 MOBILE SOURCES

Brief Description

AB 32's cap and trade program simplified the difficult task of accounting for greenhouse gas emissions from mobile sources by moving up the chain of distribution to the first deliverer of fuel to State commerce. This turns millions of mobile sources (vehicles) into a few point sources. While this simplifies the process of calculating emissions, it does not provide communities with an accurate estimation of the fuel consumption or emissions that occur within their regional boundary. While having fuel consumption data is the most accurate way of quantifying greenhouse gas emissions from mobile fuels, fuel delivery data is not congruent with the definition of a local government boundary laid out in this document. Fuel purchased within a community may be burned or consumed in another jurisdiction. This is particularly true at highway fuel stops and at fuel stations near the community border. Since fuel delivery is not a best practice method for calculating greenhouse gas emissions from within a local government boundary, this protocol framework has adopted a method consistent with that of numerous California local governments that have opted to conduct a community mobile source inventory. A brief discussion of the alternative models to fuel sales are discussed below along with a more detailed look at the best practice method using vehicle miles travelled data.

Once fuel sales are eliminated as one possible means of calculating community mobile emissions, there are two options left – trip generation and in-community vehicle miles travelled (VMT) estimates. A trip generation analysis requires detailed information on the beginning and end point of each vehicle trip made coupled with control technology data on the vehicle that has driven that particular distance. This model is gaining support in many transportation circles since it accounts for emissions resulting from residents of a particular community (regardless of where these emissions occur) and removes emissions from trips that pass-through the community and over which the local government exerts little control. Few communities have utilized this methodology and it, like fuel consumption above, does not mesh well with our definition of a community boundary since emissions that occur outside the community boundary are counted.

A third option is an estimation of VMT within the community boundary. Most community inventories calculate their mobile emissions through this general method and there is a wide variety of ways in which it is applied. Here we will discuss the best option for Sonoma County, using region-specific data from regional transportation agencies to estimate the amount of vehicle miles travelled within the local government boundary from all vehicles. The general methodology could apply to local governments across the United States.

The VMT estimation methodology described here has been used by numerous local governments in California, but differs from the way CARB calculates its statewide inventory. CARB uses fuel dispensed information, which, as described above, has not translated well for communities due to uncertainties about where fuel is combusted. In some cases, fuel use records can be harmonized with California Board of Equalization data to account for the differences seen between each model. The discrepancy between

California Board of Equalization fuel estimates and those calculated through CARB's Emission Factor (EMFAC) regional model for transportation emissions vary from -0.8% to 9.3% per year.

Justification
In California, mobile source emissions account for 40% or more of community emissions. The share of mobile source emissions is expected to increase in the coming decades. Since transportation fuels are covered by AB 32s cap and trade program, partnership opportunities with fuel distributors to claim allowances may exist, as might opportunities for alternate markets mobile source allowances or offsets.

Sources Covered
CH_4, N_2O, and CO_2 from:

- On road vehicle travel within the local government boundary over the course of the baseline year
- Freight travel/transport
- Airline travel/transport
- Off road vehicle travel

Best Practice Calculation Methodologies
See 4.4.1, 4.4.2, 4.4.3 and 4.4.4 below.

4.4.1 Vehicles Operated Within the Community Boundary

The California Air Resources Board tracks community vehicle data and emissions through its EMFAC on-road modeling tool. Although CARB did not use EMFAC for its California statewide inventory (CARB used fuel dispensed), the use of the EMFAC model with region specific data will enable all California local governments to leverage the same data sources and promote a harmonization of methods in greenhouse gas accounting throughout the state. Even though this model does not use fuel consumption as its activity data, a VMT estimate method will provide the best opportunity for Sonoma County to work with fuel deliverers and CARB to participate in carbon markets.

Although this emission estimation relies on VMT instead of fuel consumed, the resulting emissions numbers obtained after running EMFAC can be normalized to the CARB state inventory by applying a factor derived by the California Board of Equalization to compare CARB inventory figures to EMFAC outputs.

CO_2 and CH_4 Emissions

- Obtain VMT numbers from CalTrans Highway Performance Monitoring System reports for local roads.
- Obtain highway VMT from Sonoma County Transportation Authority or Metropolitan Transportation Commission and utilize GIS to clip road segments that cross local government borders.
- Calculate the number of highway and non-highway miles travelled using the percentage of each road segment that falls within the local government boundary.
- Input these highway and non-highway VMT numbers into EMFAC while keeping the ratios of VMT to trip length and vehicle population constant.
- Obtain daily EMFAC CO_2 and CH_4 emissions after running the model.
- Convert to annual CO_2 and CH_4 by multiplying by 365.25.

- The resulting CO_2 and CH_4 emissions should be normalized to CARB's statewide Board of Equalization inventory numbers taken from fuel purchases. This can be done by applying a factor that is derived from dividing yearly BOE gallon estimates with yearly EMFAC gallon estimates. Multiply the EMFAC CO_2 values by this ratio factor. Table 1 below contains the ratio factors for baseline years 1990 to 2004. For inventory years after 2004, use the mean factor.

Table 1 – Discrepancies in EMFAC versus Board of Equalization Data

Year	BOE (gal)	EMFAC (gal)	Ratio	Difference	Calculated CO_2 (MMT)[2]	Inventory CO_2 (MMT)	Difference
1990	12,637,497,939	13,639,555,100	0.92653	7.9%	111.302	111.972	0.5982%
1991	12,338,747,509	13,486,584,921	0.91489	9.3%	108.671	109.326	0.5997%
1992	13,056,175,585	13,386,482,071	0.97533	2.5%	114.989	115.680	0.5970%
1993	12,843,615,551	13,461,504,421	0.95410	4.8%	113.117	113.795	0.5960%
1994	12,796,082,876	13,510,280,950	0.94714	5.6%	112.699	113.373	0.5946%
1995	13,035,911,481	13,530,213,164	0.96347	3.8%	114.811	115.499	0.5959%
1996	13,241,954,296	13,449,858,164	0.98454	1.6%	116.625	117.322	0.5935%
1997	13,428,553,265	13,440,507,764	0.99911	0.1%	118.269	118.988	0.6047%
1998	13,710,068,388	13,715,662,764	0.99959	0.0%	120.748	121.484	0.6060%
1999	14,096,599,514	13,982,858,793	1.00813	-0.8%	124.153	124.907	0.6042%
2000	14,308,616,857	14,402,325,807	0.99349	0.7%	126.020	126.791	0.6081%
2001	14,692,046,835	15,255,167,164	0.96309	3.8%	129.397	130.177	0.5996%
2002	15,386,147,717	15,417,818,207	0.99795	0.2%	135.510	136.330	0.6018%
2003	14,961,706,228	15,937,360,243	0.93878	6.5%	131.772	132.578	0.6078%
2004	15,579,787,590	16,545,748,471	0.94162	6.2%	137.215	138.056	0.6091%
		Median	0.96347	3.8%			
		Mean	0.96718	3.5%			

Based on (California Air Resources Board 2009), (California Board of Equalization n.d.) (California Air Resources Board 2009) (California Air Resources Board 2007)

Taken from *Use of EMFAC and Fuel Use data to Create Transportation GHG Emissions*, Measuring Progress Symposium, March 5, 2010

N_2O Emissions[3]
Use VMT data obtained above for both highway and non-highway vehicles and apply N_2O factors from the Local Government Operations Protocol based on regional vehicle types from the EMFAC model.

4.4.2 Rail and Freight Transport

While Sonoma County does not currently have a significant amount of rail lines that it operates or that run through the county, plans to develop the $590 million Sonoma-Marin Area Rail Transit (SMART) system will make tracking rail emissions a priority for the County. Inventorying emissions from the diesel multiple unit vehicles that SMART employs will be critical to verify predictions of emissions reductions and enable Sonoma County to improve the system in the future. ICLEI recommends working with the

[3] Nitrous Oxide factors have not been available for all California counties from EMFAC. ICLEI has worked with the Bay Area Air Quality Management District and other Bay Area counties to produce nitrous oxide factors consistent with EMFAC methods. These methods may be able to be employed to produce one set of CO_2, CH_4 and N_2O factors for Sonoma County in the future.

Sonoma Marin Rail Transit District which oversees implementation of SMART to ensure that fuel consumption and ridership data is readily available to the County for future inventories. Following the guidance below for standard rail inventories, Sonoma County will want to account for a fraction of total SMART emissions based on its share of rail miles that are located in the county.

Another option for SMART will be to attribute emissions to communities based on the miles travelled by community residents for each community serviced by SMART. An analysis of this kind would require data on where people start and end their trip along with emissions attributable to Sonoma County based on the number of person-miles traveled by Sonoma County residents. Since this trip-generation method (as has been discussed elsewhere) diverts from the definition of our community boundary, ICLEI recommends using the intercity passenger rail calculation methodology below for estimating emission from SMART. This method is based not on passenger-miles but on a more traditional method that uses rail miles located within the county boundary.

Note: Although a trip-generation approach will not likely yield figures usable in a carbon market, Sonoma County may still want to undertake a trip generation study and report this as a Scope 3 emission in its next community inventory.

Types of rail travel
Below is a quantification methodology for three typical types of rail travel. While only freight travel is currently applicable, data tracking for SMART should follow a similar method as outlined for intercity passenger rail.

In many communities, local public transit and other rail systems include electrically powered vehicles. Since SMART will use diesel fuel, ICLEI has omitted estimation methodologies for gathering data on electricity consumption from rail.

Traditional types of rail include:

- Local public transit.
- Intercity passenger rail (Amtrak)
- Freight rail

For local public transit (fuel consumption):

- Collect energy consumption data from the National Transit Database for local public transit agencies.
- Calculate the number of vehicle miles that are within your community relative to U.S. total to create a factor (local rail miles / national rail miles).
- Apply factor to total U.S. fuel use data to calculate your local government's fuel use.
- Use locomotive factors provided by the LGOP.

For intercity passenger rail (fuel consumption):

- Collect energy consumption data from the intercity passenger rail operators (SMART). This data will likely be at the regional level.

- Calculate the number of vehicle miles that are within your community relative to regional total. Create a factor based on the community VMT / regional VMT.
- Apply factor to total fuel use to calculate your community's fuel use.
- Use locomotive factors provided by the LGOP to calculate emissions from your local government's portion of total fuel consumed.

For freight rail:

This is a calculation that will give you a magnitude of emissions. It will not likely be useful for an allowance market based on fuel use since the estimation is circuitous. There may only be a few opportunities to reduce fuel consumption from freight rail.

Recommended method (fuel consumption):

- Collect energy consumption data from the intercity freight rail operator.
- Calculate the number of vehicle miles that are within your local government relative to total to create a factor
- Apply factor to total fuel use to calculate your local government's fuel use
- Use locomotive factors provided by the LGOP

Alternate method (fuel consumption):

- Obtain freight flow data from the Freight Analysis Framework which provides estimated tonnage of goods shipped by type of commodity and mode of transportation.
- Calculate tonnage of goods for flows originating within your community boundary.
- Divide the tonnage of your local government's rail flows by the national total amount to create a factor.
- Find the U.S. total amount of fuel used by freight from the Bureau of Transportation Statistics
- Apply this factor to the total amount of fuel consumed by freight to determine the amount for fuel used by freight within your community.
- Use locomotive factors provided by the LGOP.

4.4.4 Off Road

There is no clear best practice calculation methodology for off road vehicles. Many protocols ignore this source or admit that better data collection system have to be created. Below are methods that ICLEI believes will give Sonoma County a useful means for calculating off road emissions. Depending on the sector, these methods may draw data from the U.S. Inventory or utilize EPA's NONROAD Model. Both National data and models have been used here because off road fuel consumption from vehicles was not itemized in CARB's 2000-2006 state inventory. In the event that state numbers are available, these sources can be used instead of national figures.

Unlike other highway mobile source emissions, vehicle miles travelled and control technology (model year) are not relevant for off road vehicles. For off road sources, your community will need estimates of fuel consumed to which can be applied an emissions factor from the LGOP that is specific to off road vehicles. Below are estimation methodologies for four off road types: Construction/Mining, Agricultural and Other Off Road Equipment and Marine Vehicles.

Using National Data to Calculate Regional Emissions
The 2007 U.S. GHG Inventory Annex 3 provides cumulative U.S. data on the total diesel and gasoline fuel consumed in the construction/mining and agricultural sectors as well as from other off road equipment[4] in this off-road category. If your community houses mining operations, a subset of this consumption will be applicable to your community.

Construction/Mining Sector

- For your baseline year, prorate fuel consumed based on the total community construction and mining payrolls compared to U.S. annual construction and mining payroll (U.S. Census Bureau, County Business Patterns).
- Calculate emissions from gasoline and diesel emission factors for construction and mining contained in the LGOP Tables G-9 and G-12.

Agricultural Sector

- Determine the area of your local community that is agricultural land
- Prorate the total the U.S. agricultural consumption by the area of agricultural land in your community.
- Calculate emissions based on your community's share of fuel consumption.
- Gasoline and diesel emission factors for the agricultural sector are based on LGOP Tables G-9 and G-12.

Other Off-Road Equipment

- Prorate the U.S. data based on ratio of your community population in your baseline year to the U.S. population in the same year.
- Calculate emissions using LGOP gasoline and diesel emission factors for off-road equipment from the LGOP Tables G-9 and G-12.

Note: EPA currently has a Draft 2010 US GHG Inventory available at
http://epa.gov/climatechange/emissions/usinventoryreport.html

Using EPA's NONROAD Model to Calculate Emissions
Off-road CO_2 emissions can be calculated using EPA's NONROAD2005 model. NONROAD provides estimates of various off-road equipment types by county, summed by equipment segment. The equipment segments represented in the model are agriculture, airport support equipment, commercial equipment, construction, industrial, lawn & garden, logging, other oil field equipment, other underground mining equipment, railway, recreational, and recreational marine. ICLEI does not know of any communities in California that have used this model, but it was utilized by the Delaware Valley Regional Planning Commission for their 2005 baseline inventory.

[4] The 2007 U.S. GHG Inventory, Annex 3 classifies other off-road equipment as recreation vehicles (fourwheelers, snowmobiles, dirt bikes, etc), lawn and garden equipment, tree maintenance and tree harvesting equipment, mobile support equipment at airports, rail yards (excluding locomotives), warehouses and similar equipment exclusive of agricultural, construction, and mining equipment. Watercraft (both commercial and recreational) are not included.

NONROAD allows users to customize their inventories through

- Reid vapor pressure
- annual average temperatures
- stage II vapor recovery
- percent oxygen

Note that some sources modeled by NONROAD may be quantified in other sectors.

Marine Vehicles

The best methods for quantifying emission from marine vehicles are still being determined. Numerous models and methodologies have been used throughout the country. In Sonoma County marine sources will likely be very small contributors to the total inventory – coming mostly from recreational vehicles registered to residents who live in Sonoma County.

Recreational Vehicles
Use the NONROAD model to estimate emissions from recreational marine vehicles. The EIA also tracks fuel used in marine vessels.

Shipping Vessels
Sonoma County does not have significant sources of shipping ports. More information is needed to determine the applicability for this quantification methodology to Sonoma County. Below is general guidance for quantifying emissions form shipping vessels:

- Determine the number of ships that docked at ports along the Sonoma Coast
- Find EIA data on national residual fuel oil used for vessel bunkering (fuel used while ships are in port)
- Attribute emissions to Sonoma County based on the number of ships docked during the baseline year compared to the total number of ships inventoried by EIA

References:

- LGOP, Chapter 7 - http://www.icleiusa.org/programs/climate/ghg-protocol
- Use of EMFAC and Fuel Use data to Create Transportation GHG Emissions, *Measuring Progress Symposium, March 5, 2010*
- California Department of Transportation, Highway Performance Monitoring System Website, http://www.dot.ca.gov/hq/tsip/hpms/
- Freight Analysis Framework - http://www.ops.fhwa.dot.gov/freight/freight_analysis/faf/index.htm
- Fuel Consumption by Domestic Freight Mode - *Bureau of Transportation Statistics, National Transportation Statistics* - http://www.bts.gov/publications/national_transportation_statistics/index.html#chapter_4
- 2010 Draft U.S. Greenhouse Gas Inventory Report http://epa.gov/climatechange/emissions/usinventoryreport.html
- EPA NONROAD Model - *http://www.epa.gov/otaq/nonrdmdl.htm*
- Delaware Valley Regional Planning Commission Regional Greenhouse Gas Emissions Inventory - http://www.dvrpc.org/asp/pubs/publicationabstract.asp?pub_id=09038

4.5 AGRICULTURE

Background/Justification
Agriculture, while not new to inventory methodologies like the EPA, EIIP and the IPCC, is still considered a new source for many local governments completing an inventory today. Largely, this is due to the lack of standardized methodology at the local government level for how to quantify these emissions. Agriculture is a significant source for Sonoma County because roughly 50% of the county is devoted to agricultural land. Given the importance of agriculture in the county and the state, its ability to sequester carbon and reduce emission through smart agricultural practices, agriculture is a promising candidate to be included into a new carbon trading scheme in California.

Sources Covered
CH_4 and N_2O

Best Practice Calculation Methodologies
See 4.5.1, 4.5.2 and 4.5.3 below

4.5.1 Domesticated Animal Production

Animal Digestion
Enteric fermentation is the normal livestock digestive process in animals. During digestion, microbes in the animal's digestive system ferment food that has been consumed. This microbial fermentation process, referred to as enteric fermentation, produces methane, which is exhaled or belched. CH_4 produced as part of the normal digestive processes of animals result in emissions that account for a significant portion of CH_4 emissions in the United States, approximately 5.4 million metric tons annually, or 19 percent of total U.S. CH_4 emissions according the EPA.

In its 2005 inventory, Sonoma County used the EIIP basic methodology along with numerous assumptions to model the number of cattle in the county to calculate emissions from animal digestion. The EIIP is the basis for the recommended methodology in this draft framework. According to Sonoma County's 2005 inventory, methane emissions from animal digestion accounted for 11.1% of total emissions, slightly less than the national figures, but still a sizable chuck of total emissions. For more detail on the method Sonoma County used to approximate the number of cows, see the County's 2005 inventory. For more detail on EIIP methods, see Chapter 7 of the EIIP.

Calculating Emissions from Enteric Fermentation

- Obtain population data for cattle, sheep, goats, swine, and horses from the USDA's National Agricultural Statistics Service.
- Use animal census data to create an annual average population for each type of animal
- Multiply each animal population by the appropriate national or regional emission factor provided in the EIIP.
- Convert CH_4 to metric tons CO_2e

4.5.2 Manure Decomposition and Treatment

The management of livestock waste (manure) produces both methane and nitrous oxide emissions. Methane is produced from the anaerobic decomposition of manure. Direct nitrous oxide emissions are produced as a part of the nitrogen cycle through the nitrification and denitrification of the organic nitrogen in livestock manure and urine. Indirect nitrous oxide emissions are produced as a result of the volatilization of nitrogen as ammonia (NH3) and nitrogen oxides (NOX) and runoff and leaching of nitrogen during treatment, storage, and transportation.

Sonoma County estimated its emission from manure in its 2005 inventory. These emissions were relatively low, approximately 0.2% of total emissions. The methods in Sonoma County's 2005 inventory and that are described here follow the EIIP. For more detail on EIIP methods, see Chapter 8 of the EIIP.

Calculation Methodology for Methane from Manure Decomposition and Treatment

- Obtain the required data on animal populations and manure management practices
- Calculate the amount of volatile solids (VS) produced by each animal type
- Estimate CH_4 emissions from each animal type, using animal specific Bo values and weighted methane conversion factors (MCFs)
- Convert emissions to metric tons of CH_4
- Sum across animal types to estimate total annual CH_4 emissions
- Convert units to metric tons of carbon equivalent (MTCE)

Calculation Methodology for Nitrous Oxide from Manure Decomposition and Treatment

- Obtain required data
- Calculate the total Kjeldahl nitrogen for manure managed in each system type
- Calculate nitrous oxide emissions from manure management
- Convert to units of metric tons of carbon equivalent.

4.5.3 Cropping Practices

Agricultural Soil Management

N_2O is produced naturally in soils through the microbial processes of denitrification and nitrification. A number of anthropogenic activities add nitrogen to soils, thereby increasing the amount of nitrogen available for nitrification and denitrification, and ultimately the amount of N_2O emitted. These activities include application of fertilizers, animal production, cultivation of nitrogen-fixing crops, and incorporation of crop residues. Another agricultural activity that leads to N_2O emissions, through the mineralization of old nitrogen-rich organic matter, is the cultivation of histosols (highly organic soils). In addition, applied nitrogen (i.e., from animal wastes or fertilizer) contributes indirectly to emissions from agricultural soils through volatilization, leaching, and runoff.

Nitrous oxide emission are broken down into two categories that are both relevant for Sonoma County

1) Direct emissions from agricultural soils due to animal production - animal wastes that are not used as commercial fertilizer, applied in daily spread applications, or managed in manure management systems, but instead are deposited directly on soils by animals in pastures, ranges, and paddocks.

2) Emissions from soils indirectly induced by agricultural applications of nitrogen - N_2O that is emitted indirectly from nitrogen applied as fertilizer and excreted by livestock.

Although Sonoma County did not include emissions from soil management in its 2005 inventory, these may represent a significant source since much of the county is devoted to farmland. As noted in the accompanying white paper on carbon markets created by ICLEI, agriculture is one of five sources ICLEI recommends bringing under the AB 32 cap for emission trading.

General Calculation Methodology for Agricultural Soil Management

- Estimate direct emissions of N_2O from agricultural soils due to cropping practices
- Estimate direct emissions of N_2O from animal production
- Estimate indirect emissions from nitrogen in manure and nitrogen used as fertilizer
- Sum the emissions of N_2O from all of these sources and convert to units of metric tons of carbon equivalent (MTCE).

Burning Agricultural Residues

Farming activities produce large quantities of agricultural residues that require disposal. Residues can be plowed into the field; composted and then applied to soils; landfilled; burned; used as fuel, animal bedding material, supplemental animal feed, or construction material. Although carbon dioxide is released during crop burning, the carbon dioxide released to the atmosphere during burning is not considered a GHG under relevant protocols because the carbon dioxide released was assumed to have been absorbed during the growth cycle. However, methane and nitrous oxide released were not absorbed during growth and are thus accounted for in a GHG inventory.

The method described here for quantifying emissions from burning agricultural residues is based on the EIIP's alternative methodology in Chapter 11. This alternative method is derived from a calculation methodology developed at U.C. Davis, using California-specific parameters for calculating emissions from burning crop wastes from almonds, walnuts, wheat barley, corn and rice. Although Sonoma County does not grow significant amount of the crops listed above except walnuts and corn[5], for the sake of completeness, these emissions should be added to Sonoma County's next inventory.

General Calculation Methodology for Burning Agricultural Residues

- Determine the production area for almonds, wheat, barley, corn and rice in Sonoma County
- Multiplying the crop's production area by the residue yield
- Multiply by the fraction burned

[5] Sonoma County Agricultural Crop Report 2008 available at http://www.sonoma-county.org/agcomm/pdf/2008_crop_report.pdf

- Multiply by the emission factors for each type of crop and greenhouse gas[6]

Table 2 Crop-Specific California Parameters

	Almonds	Walnuts	Wheat	Barley	Corn	Rice
Burn Fraction (%)	84	95	11	7	3	99
Residue Yield (ton/hectare dry basis)	1.89	1.46	3.66	2.51	9.06	6.75
CH_4 Emission Factor (% dry crop mass)	0.12	0.16	0.18	0.25	0.18	0.08
N_2O Emission Factor (% dry crop mass)	0.02	0.02	0.01	0.02	0.01	0.02

Source: Jenkins et al. 1992, Jenkins and Turn 1994, as cited in the Inventory of California Greenhouse
Gas Emissions and Sinks: 1990-1999

Harvested Wood Products

Wood from harvested products such as forest land and Christmas tree farms remains in use for differing lengths of time. CO_2 emissions from harvested wood materials are typically considered to be greenhouse gas neutral since these stocks can be regrown in subsequent years. Emissions from net decreases of forest land from should not be assumed to be emissions neutral. Wood harvesting may yield significant sources of CO_2 emissions for Sonoma County. These emissions were not included in Sonoma County's 2005 inventory report and do not seem particularly promising for inclusion in a cap and trade program.

For a detailed methodology on how to account for emission from harvested wood product, see Chapter 12, Harvested Wood Products of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Agriculture, Forestry and Other Land Use.

References:

- U.S. EPA Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2007
- Emissions Inventory Improvement Program Guidance (EIIP)
- Chapter 12, Harvested Wood Products of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Agriculture, Forestry and Other Land Use - http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html

[6] Factors and a more detailed description of the methodology is available in Chapter 11 of the Emissions Inventory Improvement Program

SCOPE 2 SOURCES

4.6 PURCHASED ELECTRICITY

4.6.1 Residential

Brief Description/Justification
Nearly all jurisdictions have indirect emissions associated with the purchase and use of electricity by residential customers. In many jurisdictions, buildings account for over half of total energy consumption. Depending on a jurisdiction's built environment, indirect emissions from residential electricity use may comprise the largest source of a jurisdiction's GHG emissions. The generation of electricity through the combustion of fossil fuels typically yields CO_2, and to a smaller extent, N_2O and CH_4.

Note: electricity consumption is accounted for at the first deliverer of electricity to the California grid under AB 32. Quantifying emissions from electricity consumption will be relevant to Sonoma County if it wants to claim allowance value for reducing emissions under the cap.

Sources Covered
Electricity used to heat, cool, light, and power appliances and accessories in residential dwellings.

Best Practice Calculation Methodologies
Sonoma County's 2005 inventory used California Energy Commission figures for electricity (and natural gas) usage data. While this method is good, ICLEI recommends obtaining data directly from the utility that provided energy where possible. The following methodology has been employed by numerous communities throughout California. The basic principles of obtaining activity data and applying national standard emissions factors remain the same. Note that emissions factors have been updated in newer version of CACP per the LGOP.

Calculating emissions from purchased electricity begins with determining annual electricity use of the jurisdiction. Pacific Gas and Electric (PG&E) can be of assistance in finding this information. The preferred sources are monthly electric bills or electric meter records aggregated by the utility for the entire jurisdiction. Either source provides the number of kilowatt hours (kWh) of electricity consumed. PG&E will "roll up" these figures for all households inside the jurisdictional boundary, protecting the anonymity of individual account holders.

An electricity emission factor represents the amount of GHGs emitted per unit of electricity consumed. These factors are used to convert consumption of purchased electricity into GHGs emissions. Emissions are usually reported in units of pounds of GHG per kWh or MWh.

The LGOP provides two options for recommended electricity emission factors. The first option is to use utility-specific emission factors that have been third party verified to the standard of the CCAR Power/Utility Protocol for CO_2 emissions and either eGRID or California Grid Average Factors for N_2O and CH_4. The second method is to either use eGRID or California Grid Average Factors CO_2, N_2O and CH_4 factors.

All factors required for calculating emissions from purchased electricity can be found in Appendix G of the Local Government Operations Protocol.

References:

- LGOP, Chapter 6 - http://www.icleiusa.org/programs/climate/ghg-protocol

4.6.2 Commercial

Brief Description/Justification

Nearly all jurisdictions have indirect emissions associated with the purchase and use of electricity by commercial customers. In many jurisdictions, buildings account for over half of total energy consumption. Depending on a jurisdiction's built environment, indirect emissions from commercial electricity use may comprise the largest source of a jurisdiction's GHG emissions. The generation of electricity through the combustion of fossil fuels typically yields CO_2, and to a smaller extent, N_2O and CH_4.

Sources Covered

Electricity used to heat, cool, light, and provide power for other applications in commercial facilities.

Best Practice Calculation Methodologies

Calculating emissions from purchased electricity begins with determining annual electricity use of the jurisdiction. PG&E can be of assistance in finding this information. The preferred sources are monthly electric bills or electric meter records aggregated by the utility for the entire jurisdiction. Either source provides the number of kilowatt hours (kWh) of electricity consumed. PG&E will "roll up" these figures for all commercial establishments inside the jurisdictional boundary, protecting the anonymity of individual account holders.

An electricity emission factor represents the amount of GHGs emitted per unit of electricity consumed. These factors are used to convert consumption of purchased electricity into GHGs emissions. Emissions are usually reported in units of pounds of GHG per kWh or MWh.

The LGOP provides two options for recommended electricity emission factors. The first option is to use utility-specific emission factors that have been third party verified to the standard of the CCAR Power/Utility Protocol for CO_2 emissions and either eGRID or California Grid Average Factors for N_2O and CH_4. The second method is to either use eGRID or California Grid Average Factors CO_2, N_2O and CH_4 factors.

All factors required for calculating emissions from purchased electricity can be found in Appendix G of the LGOP.

Purchased electricity in the commercial sector may be impacted by the PG&E 15/15 rule. The 15/15 rule requires that any aggregated information provided by the Utilities must be made up of at least 15 customers and a single customer's load must be less than 15 percent of an assigned category. If the number of customers in the complied data is below 15, or if a single customer's load is more than 15 percent of the total data, categories must be combined before the information is released. The Rule further

requires that if the 15/15 Rule is triggered for a second time after the data has been screened once already using the 15/15 Rule, the customer be dropped from the information provided. In addition to the 15/15 Rule, the CPUC further determined that no information about customers with demands above 500 kW should be included in the distributed information. The rule is particularly relevant in protecting the account information of large energy users in small jurisdictions where the release of such information would allow for the identification of specific entities.

References:
PG&E 15/15 Rule - *http://www.pge.com/tariffs/tm2/pdf/ELEC_SCHEDS_E-CCAINFO.pdf*
LGOP, Chapter 6 - *http://www.icleiusa.org/programs/climate/ghg-protocol*

4.6.3 Industrial

Brief Description/Justification
Many jurisdictions have indirect emissions associated with the purchase and use of electricity by industrial customers. In many jurisdictions; buildings account for over half of total energy consumption. Depending on a jurisdictions built environment, indirect emissions from industrial electricity use may comprise the largest source of a local government's GHG emissions. The generation of electricity through the combustion of fossil fuels typically yields CO_2, and to a smaller extent, N_2O and CH_4.

Sources Covered
Electricity used to heat, cool, light, and power equipment and processes in industrial facilities.

Best Practice Calculation Methodologies
Calculating emissions from purchased electricity begins with determining annual electricity within the jurisdiction. PG&E can be of assistance in finding this information. The preferred sources are monthly electric bills or electric meter records aggregated by the utility for the entire jurisdiction. Either source provides the number of kilowatt hours (kWh) of electricity consumed. PG&E will "roll up" these figures for all industrial establishments inside the jurisdictional boundary, protecting the anonymity of individual account holders. See the commercial sector above for more details on the15/15 rule.

The LGOP provides two options for recommended electricity emission factors. The first option is to use utility-specific emission factors that have been third party verified to the standard of the CCAR Power/Utility Protocol for CO_2 emissions and either eGRID or California Grid Average Factors for N_2O and CH_4. The second method is to either use eGRID or California Grid Average Factors CO_2, N_2O and CH_4 factors.

References:
- PG&E 15/15 Rule - *http://www.pge.com/tariffs/tm2/pdf/ELEC_SCHEDS_E-CCAINFO.pdf*
- LGOP, Chapter 6 - *http://www.icleiusa.org/programs/climate/ghg-protocol*

SCOPE 3 SOURCES

4.7 Airline Transport

Airline emissions are almost exclusively outside of what this document has defined as a community boundary and can be difficult to quantify for several reasons. First, the emissions from international air travel are not reported as part of national inventories under the UNFCCC guidelines. Second, a significant portion of the emissions associated with air travel occur outside of the geopolitical boundaries of the community, and it is nearly impossible to determine which portion occurred on one side of the boundary or the other. Third, it can be argued that in many cases airports serve a region rather than an individual community, so while the airport's emissions might be attributed to the community in which it happens to reside, it is likely that a large proportion of the passengers are neither residents of, nor traveling to that community.

Although this document has taken pains to remove emissions that occur outside the community boundary, airline travel is an exception to the rule. Airline travel is a significant source and should be quantified by Sonoma County. Since fuel records will be used, air travel emissions will be known with greater certainty than VMT estimates. This may lead to earlier participation in a carbon market. Here ICLEI has provided two calculation methodologies that do not conform to the community boundary definition. These two methods should be considered mutually exclusive within reporting.

Air Travel Originating within the Community: Community emissions inventories for airports located within their geopolitical boundaries should determine the total amount of fuel used by planes on all flights originating at the airport. Example: Charles M. Schultz Airport.

Air Travel Serving the Needs of the Community's Residents: Communities should consider the air travel footprint of their citizens. To determine these emissions, communities should identify all airports in their region which support the local demand (including any within the community's geopolitical boundary) and determine the total amount of fuel used by planes on all flights originating at each airport. As above, fuel loaded onto planes at each airport will be a common surrogate data set. This fuel should then be apportioned to the community inventory based on the portion of travelers at the airport who are residents of the community. Example: San Francisco International Airport, Oakland International Airport, etc.

Steps to calculate emissions from either air travel originating within your community or for air travel serving the needs of community residents:

- Obtain fuel used by outgoing travel at your local airport by gathering information on re-fueling airplanes - only the fuel used to re-fuel the planes at the local airport. Fuel consumed to get the airplane to your local airport will be considered as an emission source for a different community's inventory.
- Use available data from your airport or regional transportation agency on the residence of travelers to attribute percentages of fuel used at your local airport to

the appropriate communities. Only the percentage of fuel attributable to Sonoma County should be included in Sonoma County's community inventory.

- Multiply the amount of fuel attributable to your community by LGOP factors for jet fuel or aviation gasoline.

5. CONCLUSION

Local governments are increasingly subject to requirements for greenhouse gas emissions quantification but have not been included in carbon markets either as the beneficiary or allowances or as sellers of offsets. As a leading California county in greenhouse gas emission quantification with multiple inventories, and where state legislation may create a carbon market, Sonoma County is uniquely positioned to participate in AB 32's carbon market or an alternative, yet to be formulated, carbon market designed for local governments.

Numerous opportunities exist for Sonoma County to improve its 2005, 2006 and 2007 community inventories based on the methodologies provided here. In cases where nationally or internationally-established calculation methods were unavailable, ICLEI has provided best practice guidance based on the experience of its members and other exemplary inventories. The sectors from Sonoma County's inventories that differ the most from the guidance above were solid waste and mobile sources. Sources that can be added to the inventory include decentralized fuel consumption, industrial processes, wastewater treatment, industrial processes, agriculture, and other mobile and off road sources.

Participation in a carbon market will require that eligible sources are quantified by methods that are transparent and third party verifiable. The draft protocol framework above is ICLEI's best guess at how community emissions would be quantified under any regulatory framework. While a more detailed analysis of the ability for Sonoma County to participate in carbon markets is covered in ICLEI's accompanying *Carbon Markets* white paper, the analysis done here indicates that relatively few sources in Sonoma County's inventories have been completed in a way that conforms directly with methods outlined in AB 32 or in a method that ICLEI believes are most likely to be used in a carbon market for the sources mentioned. ICLEI does not expect that a reinventory according to the methods outlined above will be an onerous process for the County and recommends doing a reinventory when possible.

For a complete list of findings and suggested next steps, see chapter 2; Summary of Results and Work Performed.

APPENDIX A: COMPARISON OF DRAFT FRAMEWORK AND SECTORS INVENTORIED BY SONOMA COUNTY

Community Protocol Sector	Community Protocol Subsector	Inventoried By Sonoma County	Did The County Use Draft Framework Recommended Methods?	Inventory Sectors that Need Improvement
Scope 1 Sources				
Stationary Combustion	Residential Utility Fuels	x	Yes	New emissions factors in the LGOP
	Residential Decentralized Fuels			
	Commercial Utility Fuels	x	Yes	New emissions factors in the LGOP
	Commercial Decentralized Fuels			
	Industrial > 25,000 $MTCO_2e$ Utility Fuels	x	Yes	
	Industrial > 25,000 $MTCO_2e$ Process			
	Industrial < 25,000 $MTCO_2e$ Utility Fuels	x	Yes	
	Industrial < 25,000 $MTCO_2e$ Process			
Solid Waste	Partial LFG Collection			
	Comprehensive LFG Collection	x	No	Eliminate sequestration at site. Use LGOP methods
	Landfills With No LFG Collection			
Wastewater Treatment				
Coal Mining				
Natural Gas and Oil Systems				
Solvent and Other Product Use				

Community Protocol Sector	Community Protocol Subsector	Inventoried By Sonoma County	Did The County Use Draft Framework Recommended Methods?	Inventory Sectors that Need Improvement
Mobile Sources	Vehicles Operated Within the Community Boundary	x	No	CalTrans, EMFAC, Normalize to State fuel data
	Rail and Freight Transport			
	Off Road			
	Marine			
Agriculture	Domesticated Animal Production	x	Yes	
	Manure Decomposition and Treatment	x	Yes	
	Cropping Practices			
Land Use, Land Change and Forestry				
Fugitive Emissions	Stationary Sources			
	Mobile Sources			
	Electric Power			
Scope 2 Sources				
Purchased Electricity	Residential	x	Yes	New emissions factors in the LGOP
	Commercial	x	Yes	New emissions factors in the LGOP
	Industrial	x	Yes	New emissions factors in the LGOP
Scope 3 Sources				
Airline Travel				
Community Solid Waste				
Community Wastewater				
Other Lifecycle Emissions	Embodied Energy in Food (Demand Centered)			

Community Protocol Sector	Community Protocol Subsector	Inventoried By Sonoma County	Did The County Use Draft Framework Recommended Methods?	Inventory Sectors that Need Improvement
	Embodied Energy in Water (Demand Centered)			
	Embodied Energy in Fuel (Demand Centered)			
	Embodied Energy in Concrete (Demand Centered)			
	Embodied Energy in end of Life Wastes (Demand Centered)			
	Purchased Goods and Serves			
	Actual T&D loss Rate Specific to Grid			
	Actual Power Purchase Data and emission Rate for Purchased Power			
	Extraction, Production and Transportation of Fuels Consumed in Generation of Electricity, Steam, Heating and Cooling			
	External Transportation and Distribution of Inputs			
	External Warehousing and Storage of Inputs			

APPENDIX B: COMMUNITY PROTOCOL DRAFT FRAMEWORK RESEARCH QUESTIONS

Document: _____

PART 1

Emissions sources, as defined in this research, are the larger scale sources of greenhouse gas emissions, such as on-road vehicle transportation, decomposition of organic solid waste, etc. These sources are distinguished from individual fuels (gasoline, electricity, etc.). Emissions sources are generally (but not always) grouped into various reporting categories, with the two most common being sector (transportation, waste, agriculture, etc.) and scope.

- List each emissions source identified in the inventory/protocol. For each emissions source identify any categories that they are grouped into (e.g. sector or scope)

Emissions Source	Grouping 1 _____	Grouping 2_____

- List any emissions sources that lie within the boundary that the inventory/protocol explicitly excludes and the reason for the exclusion (e.g., policy relevance, cannot measure, etc).

Excluded Emissions Source	Reason for Exclusion	Notes (Other Sources, Details, etc.)

- List any unusual sectors in the community or unusual jurisdictional authority that may affect the emission sources or policy relevance of specific emission sources. (This could include industrial, agricultural, ports, airports, etc.)

_____
_____
_____
_____

- For each emissions source, list the activity data input/s (kWh consumed, vehicle mile traveled, etc.) and a brief description of the calculation methodology

Emissions Source	Activity Data	Calculation Methodology	Alternate Method

- For each emissions source, list the source of the emissions factor. Common emissions factors sources include:

  - California Air Resources Board, Mandatory Reporting Rule
  - California Climate Action Registry, General Reporting Protocol
  - The Climate Registry, General Reporting Protocol
  - ICLEI, International Local Government GHG Emissions Analysis Protocol
  - IPCC, Guidelines for National Greenhouse Gas Inventories
  - IPCC, Second/Third/Fourth Assessment Report
  - Local Government Operations Protocol
  - US EPA AP 42 Emission Factors
  - US EPA Climate Leaders
  - US EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks
  - World Resources Institute and World Business Council for Sustainable Development, GHG Protocol Corporate Standard

Emissions Source	Emissions Factor Source	Notes (Other Sources, Details, etc.)

How to gather activity data / Where to find it:
•

PART 2

Boundaries

There are multiple ways boundaries can be defined. One is a physical area which is included in an inventory (geographic boundary). As in the LGOP, boundaries may be further defined by additional criteria – in the case of the LGOP, financial and operational control. Be sure to search for any ways in which inventories or protocols define boundaries and any criteria for particular boundary definitions.

1. Does this document define a (or its) local government boundary? (yes/no)
2. Does it use a geopolitical boundary such as a city boundary or a sphere of influence boundary (land it will annex)? (yes/no)
3. If yes, what is used as the definition of the boundary?
4. Does the document include emissions that occur outside of the geographic boundary? (yes/no)
5. If so, what is the criteria for inclusion of emissions outside the geographic boundary? (description)
6. Does this inventory use additional criteria to define a boundary or 'community operation' such as operational, financial control, or policy relevance? (yes/no)
7. If so, what are these additional criteria? (description)

8. If this document defines an inventory boundary as other than a geographic boundary, how does it define a boundary (multi-regional, watershed, etc.) (description)
9. If this document is a protocol, does it address the issue of regionality or describe calculation methodologies that are designed to cross geo/political boundaries?
10. If yes, what calculation methodologies are recommended that address regional issues (trip generation transportation models, etc.)?
11. Did this inventory put its findings in a larger quantified context. If a city, what percent is this in the county; if a county, what part in the state, etc.

Regional Inventories

1. Did this regional inventory break out emissions for each of the local governments that lie within the regional boundary? (yes/no)
2. If a boundary is defined such that is encompasses multiple geo/political boundaries – such as an inventory that includes multiple cities and/or counties – does it tell us if it has been adopted by the local governments that make up the regional boundary? (yes/no)
3. If yes, who has/has not adopted the inventory and why/why not? (description)

Reporting

For all documents

1. What GHGs are included? (CO_2, N_2O, CH_4, HFCs, PFCs, SF6, etc) (short description)
2. Does this document utilize Scopes (Scope 1, 2, 3 and Information Item) to breakout emissions? (yes/no)
3. If this does not utilize the WRI/WBCSD scopes concepts, does it use any reporting framework that breaks out emissions in order to avoid double counting? (yes/no)
4. If so, what is this system? (description)
5. Does this document provide a reporting framework or guidance outside of scopes or other similar concepts? (yes/no)
6. If yes, what are the key aspects of this reporting framework? (e.g., reporting sectors, other means of organization)
7. Does this document use or provide guidance to create a single, or "roll-up: number? (yes/no)
8. If so, how does it calculate that number?
9. Does this document utilize a separate, pre-existing reporting framework such as ICLEI, IPCC, LGOP or EPA? (yes/no)
10. If yes, please name the source of the reporting framework (short description)

For protocol documents,

1. Does the document include a reporting template? (yes/no)
2. Does it include a sample report for carbon market trading? (yes/no)
3. If this document has reporting guidance, templates or examples, does it specify that the following be included in the report: (yes/no)

a) Size of local government (sq miles)
b) Population
c) Climate zone
d) Number of heating and cooling degree days
e) Types of industry contained within the local government boundary
f) Calculation methodologies
g) Emissions factors
h) An exact reporting format through the use of a particular software, required reporting form, exact report specifications for look and feel as well as content
i) Other (please specify):_____

Monitoring

1. Does this document discuss comparing emissions between the baseline year and other years? (yes/no)
2. If so, does it address: (yes/no)

    a. Data inconsistency between years
    b. Standardizing/normalizing for variations across years (e.g., temperature)
    c. Other progress indicators besides greenhouse gas emissions
    d. Obtaining emissions factors for future years
    e. Comparing progress to emissions forecasts
    f. Other (please specify)

3. If so, does this guidance include any of the following suggestions: (yes/no)

    a. Inventorying on a calendar year basis
    b. Other suggested inventory frequency
    c. Strategies for monitoring consumption
    d. Monitoring tools or software

Targets and Forecasting

1. Does this document include an emissions forecast or provide guidance on how to do an emissions forecast? (yes/no)
2. Does this document include an emissions backcast or provide guidance on how to do an emissions backcast? (yes/no)
3. If so, is the forecast a business as usual (BAU) model (no assumption s about changes in emissions factors ... isolating for changes in consumption)?
4. If the document uses a BAU, how does it define what is business as usual?
5. If this document uses or recommends a method other than the BAU method, please describe the method utilized. (description)
6. Does this document include any justification for why you should forecast or backcast. (yes/no)
7. If so, what is this justification? (description)
8. Does this document set a target for emission reductions or provide guidance on how to set a target for emission reductions? (yes/no)

9. If so, what is the target it utilizes/recommends
10. Does the target include intermediate targets? (yes/no)
11. If there are intermediate goals, what are they?
12. Does the document suggest a process for re-evaluating targets as progress is made?