Memo

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Date: April 13, 2016

To: David Morrison and Jason Hade (County of Napa)

From: Honey Walters, Erik de Kok, and Brenda Hom (Ascent Environmental, Inc.)

Subject: Napa County Climate Action Plan
Final Technical Memorandum #1: 2014 Greenhouse Gas Emissions Inventory and Forecasts

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INTRODUCTION

The initial phase in the preparation of Napa County's Climate Action Plan (CAP) includes: (1) updating the unincorporated County's community-wide greenhouse gas (GHG) emissions inventory to 2014, and (2) preparing new GHG emissions forecasts for 2020, 2030, and 2050. This final technical memorandum provides the results of the 2014 GHG emissions inventory update and future year emissions forecasts, including associated methods, assumptions, emission factors, and data sources. This final revision supersedes the version dated February 2, 2016, and incorporates changes throughout based on feedback from County staff and public input, as well as technical corrections.

The updated GHG emissions inventory and forecasts will provide a foundation for the forthcoming phases of work on the CAP including the development of GHG emissions reduction targets, GHG emissions reduction measures, and an action plan to help the County achieve identified targets.

ORGANIZATION OF THIS MEMORANDUM

This memorandum consists of two main parts:

- Section 1 summarizes the updated 2014 GHG emissions inventory for each sector, including any new sectors not previously included in the 2005 baseline inventory. Key components include:
  - A summary of annual emissions by sector; and
  - Data sources and methods used.
- Section 2 summarizes the forecasted GHG emissions under "business-as-usual" (BAU) and legislative-adjusted BAU scenarios. A BAU scenario is one in which no action is taken by local, State or federal agencies to reduce GHG emissions. A legislative-adjusted scenario is one in which BAU conditions are adjusted to reflect policy or regulatory actions enacted by State or federal agencies, without taking into account any local actions to reduce GHG emissions.

1 2014 GREENHOUSE GAS EMISSIONS INVENTORY UPDATE

SUMMARY OF RESULTS

Based on the modeling conducted, the unincorporated area of Napa County generated approximately 484,602 metric tons of carbon dioxide equivalents ($MTCO_2e$) in 2014. Major emissions sectors included building energy use, on-road vehicles, off-road vehicles and equipment, wastewater management, solid waste, agriculture, and land use changes. In addition, the 2014 inventory update included several new emissions sources that were not included in the 2005 baseline inventory. These new sectors include emissions from methane generated at landfills (e.g., waste-in-place), electricity use from importing water, fuel use in recreational watercrafts, and the release of high global warming potential (GWP) gases.

Table 1 and Figure 1 present the County's 2014 GHG emissions inventory by sector. A description of each emissions sector, including key sources of emissions, is provided in further detail below.

Table 1 2014 Unincorporated Napa County Greenhouse Gas Inventory

Sectors	2014[1] ($MTCO_2e$/yr)	Percent of Total (%)
Building Energy Use	148,338	31
On-Road Vehicles	125,711	26
Solid Waste	83,086	17
Agriculture	52,198	11
Off-Road Vehicles	42,508	9
High GWP Gases	13,481	3
Wastewater	11,189	2
Land Use Change	8,002	2
Imported Water Conveyance	88	<1
Total with new sectors	**484,602**	**100**
Total without new sectors	**375,049**	**77**

Notes: For a comparison of the 2005 and 2014 inventories, see Table 2. Note that columns may not add to totals due to rounding.

$MTCO_2e$ = metric tons of carbon dioxide equivalent
GWP = Global Warming Potential
IPCC = Intergovernmental Panel on Climate Change
NA = Not applicable

[1] Uses GWP Factors from IPCC's Fourth Assessment Report
[2] Includes new off-road subsectors

Source: Data compiled by Ascent Environmental in 2016.

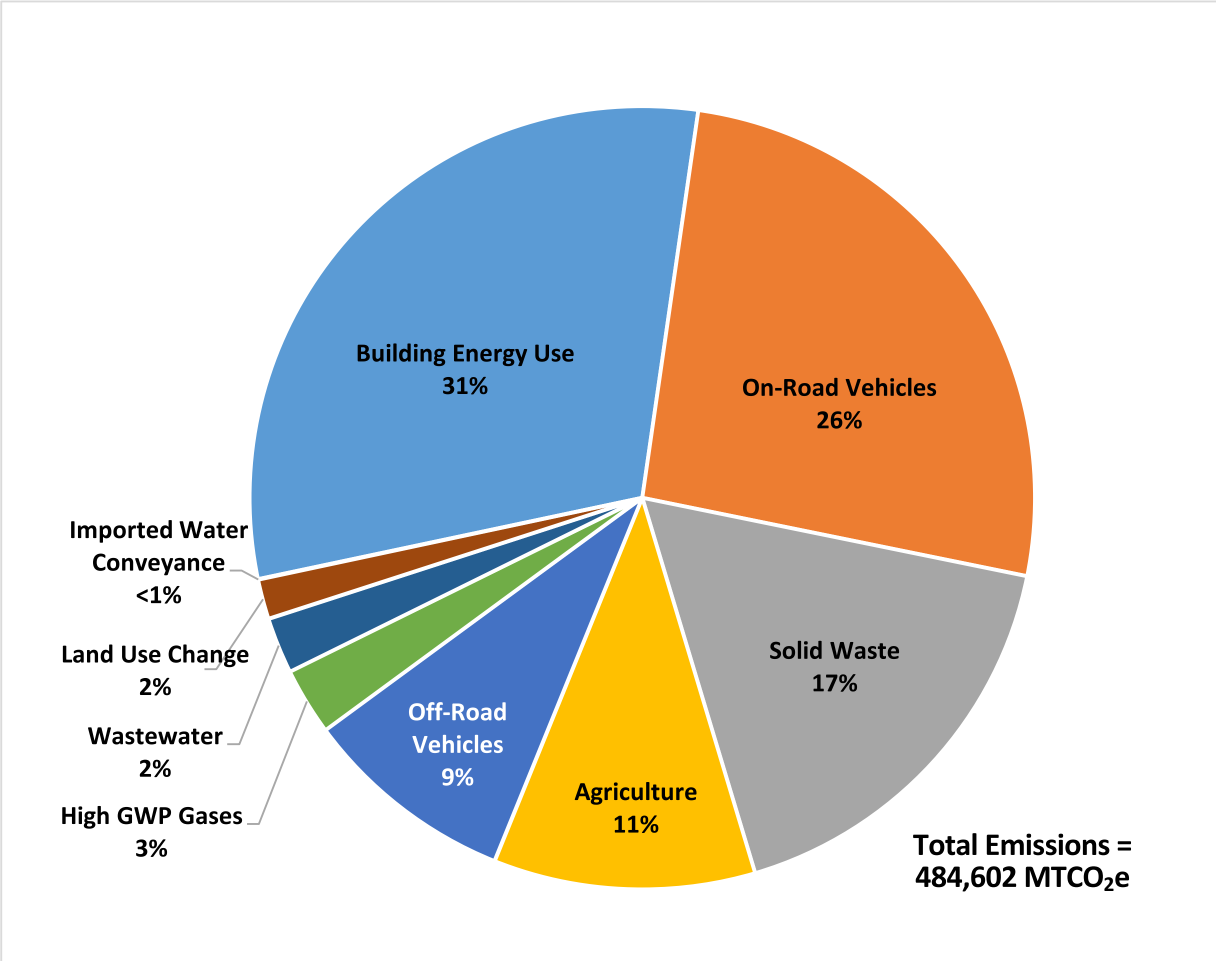


Figure 1: 2014 Unincorporated Napa County Greenhouse Gas Inventory

For comparison purposes only, Table 2 shows the 2005 baseline inventory alongside the 2014 inventory, which has been adjusted to use GWP factors from the IPCC's Second Assessment Report, consistent with the methodology used in the 2005 inventory. This approach was necessary because the 2005 inventory did not make methane (CH_4) and nitrous oxide (N_2O) emissions available for adjustment with newer GWP factors from the IPCC Fourth Assessment Report. In addition, the Table 2 only includes sectors that were present in the 2005 inventory and does not include sectors introduced in the 2014 inventory shown in Table 1. After comparing the two inventories using the same GWP factors and considering only emissions sectors included in the 2005 inventory, County emissions decreased by about 14 percent between 2005 and 2014. This decrease in emissions between 2005 and 2014 is due to a variety of factors including, but not limited to:

- adjustments in calculation methodologies (e.g., equations and emission factors),
- differences in data sources between the two inventories, and
- changes in actual activity levels within the County (e.g., building energy use and vehicle travel).

Table 2 Comparison of Unincorporated Napa County Greenhouse Gas Inventories (2005 and 2014) using GWP factors from IPCC's Second Assessment Report (for comparison only)

Sectors	2005 ($MTCO_2e$/yr)	2014[1] ($MTCO_2e$/yr)	Difference ($MTCO_2e$/yr)	% change from 2005
Residential and Commercial Building Energy Use	143,540	145,994	2,453	2
Wastewater	9,900	9,457	-443	-4
Solid Waste (Waste Generation)	9,240	16,767	7,527	81
On-Road Vehicles	191,270	125,830	-65,440	-34
Off-Road Vehicles (old categories)	16,620	10,740	-5,880	-35
Agriculture	46,800	49,982	3,182	7
Land Use Change	26,300	8,002	-18,298	-70
Total	**443,670**	**365,704**	**-77,966**	**-18**

Notes: This table contains adjusted 2014 inventory numbers and is only to be used for comparing the 2014 inventory with the 2005 inventory. See Table 1 for the official 2014 inventory results.

$MTCO_2e$ = metric tons of carbon dioxide equivalent
GWP = Global Warming Potential
IPCC = Intergovernmental Panel on Climate Change
NA = Not applicable

[1] Emissions have been adjusted to use the global warming potentials in IPCC's Second Assessment Report to be consistent with the 2005 baseline GHG inventory assumptions. The 2005 baseline inventory did not make methane and nitrous oxide emissions available for adjustment with newer GWP factors from the IPCC Fourth Assessment Report. This inventory only shows emissions for sectors that were present in the 2005 inventory.
[2] Uses unincorporated-only solid waste generation data from CalRecycle. The 2005 inventory used data directly from waste providers.

Source: ICF Jones & Stokes, 2012 (2005 inventory data); 2014 inventory prepared by Ascent Environmental in 2016.

DATA SOURCES AND METHODS

In addition to including new GHG emissions sectors and sources, the 2014 inventory update includes several changes to the data sources and emission factors used, along with changes in methods. These differences were necessary in cases where the original data sources used in the 2005 inventory were no longer available or have been updated. New methods that provide more accurate emissions estimates are available for sectors such as the on-road vehicles and solid waste sectors. The general approach used to estimate the County's 2014 GHG inventory is consistent with the latest guidance from the *U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions* (Community Protocol) (Versions 1.0) produced by the International Council for Local Environmental Initiatives (ICLEI) (ICLEI 2012).

The following summarizes data sources and methods used in estimating the unincorporated County's 2014 GHG emissions inventory (see Table 3 for further detail):

- **Building Energy:** Annual electricity and natural gas usage data for the unincorporated areas were obtained from Pacific Gas and Electric's (PG&E's) Green Communities report for Napa County. Data were only available for 2013 and; thus, was scaled to 2014 based on the change in the unincorporated population and jobs between 2013 and 2014.

- **Solid Waste:** The solid waste inventory was updated using disposal and landfill data from the California Department of Resources Recycling and Recovery (CalRecycle) and landfill gas data from the U.S. Environmental Protection Agency (EPA), respectively. Domestic wastewater emissions were calculated using population-based equations from the Community Protocol (ICLEI 2012).

- **Water and Wastewater:** Winery wastewater emissions were also estimated using guidance from EPA and county-specific data. Water import numbers were available from each of the specific water suppliers that service the unincorporated areas of Napa County.

- **On-Road and Off-Road Vehicles:** For the on-road vehicle sector, annual vehicle miles travelled (VMT) by speed bin (e.g., zero to five miles per hour, or twenty to twenty-five miles per hour) were obtained from the Metropolitan Transportation Commission (MTC) for the unincorporated area, using the Regional Technical Advisory Committee's (RTAC's) origin-destination method. Vehicle emission factors were available from California Air Resources Board's (ARB's) 2014 EMissions FACtor (EMFAC) model. Off-road vehicle emissions were estimated from ARB's OFFROAD 2007 model and scaled by population, jobs, or location of activity in the unincorporated area. For example, the majority of countywide watercraft emissions occur within the unincorporated County because most navigable waterways, such as Lake Berryessa and Napa River, in the County are located in the unincorporated area. On the other hand, use of lawn and garden equipment would be proportional to the population distribution between the unincorporated and incorporated areas of the County.

- **Agriculture:** Agricultural emissions were based on livestock and crop data from the County's 2014 Crop Report; pesticide use data from the California Department of Pesticide Regulation (DPR); fertilizer use from the California Department of Food and Agriculture (CDFA), ARB's GHG inventory, and University of California Davis Agricultural studies; diesel irrigation pump information from ARB; and open burning permit data from the Bay Area Air Quality Management District (BAAQMD).

- **Land use change:** Lost sequestration potential due to land use changes were based on estimated changes in natural lands from the County's assessor parcel data and associated differences in carbon sequestration potential by land cover type.

- Demographic data related to population, jobs, and housing in the unincorporated County were obtained from the California Department of Finance (DOF) and the California Employment Development Department (EDD) (DOF 2015, EDD 2015).

- Emissions associated with aircraft operations were not included because they are outside of the County's jurisdictional control.

Table 3 below compares the differences in data sources, calculation methods, and emission factors by sector and between the two GHG inventory years.

Table 3 Unincorporated Napa County GHG Inventory : Data Sources and Methods by Year and Sector

Sector	2005 Inventory	2014 Inventory
Residential and Commercial Building Energy Use	**Data sources:** Energy consumption provided by sector from PG&E **Method:** ICLEI CACP software.	**Data sources:** PG&E Green Communities Report for 2013 for the unincorporated Napa County. Scaled to 2014 by population growth between 2013 and 2014. **Method:** PG&E 2014 Emission Factors for CO_2 electricity generation emissions. EPA's eGrid2010 emission factors for CH_4 and N_2O from electricity generation. Natural gas emission factors from 2014 TCR emissions factor report.
Wastewater	**Data sources:** Residential wastewater volumes and populations served (provided by County). On-site septic based on number of homes with septic (provided by the	**Data sources:** Population of unincorporated Napa County from DOF. Percentage of unincorporated Napa population served by septic and sewer systems, provided by the County. Total winery

Table 3 Unincorporated Napa County GHG Inventory : Data Sources and Methods by Year and Sector

	County). Commercial wastewater based on volume of wine produced annually in Napa County and default values for wastewater produced per gallon of wine. **Method:** LGOP methods for residential wastewater; EPA methods for commercial wastewater.	wastewater produced based on gallons of wastewater generated per ton of grape from a Napa San report. Profile of winery wastewater treatment from Napa Green, Napa San, and EBMUD. **Method:** Equations WW.11 (Alt) and WW.6 from the ICLEI Community Protocol to calculate domestic wastewater CH_4 emissions. Winery wastewater emissions based on industrial wastewater method from Chapter 7 of U.S. GHG Inventory 1990-2013.
Imported Water Conveyance	Sector not included	**Data sources:** Total volume of potable and recycled water delivered by incorporated cities to the unincorporated areas in 2014. Volume broken down by water source (e.g., State water project). **Method:** Electricity factors for each water source from CEC water-energy study, when electricity use was not provided by a utility. PG&E 2013 Emission Factors for CO_2 electricity generation emissions. EPA's eGrid2010 emission factors for CH_4 and N_2O from electricity generation.
Solid Waste (Waste Generation and Waste-in-Place Emissions)	**Data sources:** Waste generation data provided by waste provider. Waste-in-place emissions not included. **Method:** ICLEI CACP software.	**Data sources:** Unincorporated County solid waste generation by amount, type, and disposal landfill available from CalRecycle. Landfill gas emissions within the unincorporated County from EPA's LMOP Landfill/Project database. **Method:** Equation SW.4.1 from ICLEI Community Protocol combined with known CH_4 capture rates at landfills to calculate CH_4 from waste generation. Waste type emissions based on EPA WARM emission factors. EPA landfill gas reports provided CH_4emissions from American Canyon and Clover Flat landfills located within the unincorporated area. These landfills did not accept unincorporated waste, so there was no double-counting.
On-Road Vehicles	**Data sources:** VMT estimates using the Napa-Solano travel demand model; origin-destination analysis; **Method:** EMFAC emissions factors applied to total VMT	**Data source:** VMT from MTC using the RTAC origin-destination method **Method:** EMFAC 2014 Emission Factors per vehicle mile CARB approved methods for N_2O, PG&E 2014 Emission factors for electric vehicles.
Off-Road Vehicles	**Data source/Method:** ARB Off-Road model used for lawn/garden and construction/industrial sectors only. No indication of whether emissions were scaled to the unincorporated area.	**Data source/Method:** ARB's OFFROAD 2007 model, scaled to unincorporated areas by unincorporated jobs or population depending on the vehicle category (e.g., recreational equipment scaled by population).
Agriculture	**Data sources:** Vehicle and equipment data from ARB Off-Road model. Enteric fermentation and manure management data from livestock populations from Napa County agriculture report. Fertilizer data from crop acres from Napa County agriculture report and UC Davis Cost Return Studies. **Method:** ARB methods	**Data sources:** Vehicles and equipment from ARB's OFFROAD 2007 model for agricultural equipment only. Agricultural diesel pump estimates from ARB. Enteric fermentation and manure management from livestock populations from Napa County agriculture report. Nitrogen fertilizer used in County from ARB 2013 GHG Inventory. Lime and urea sold in County from 2012 CDFA Fertilizer Tonnage Report. 2014 Napa County Crop Report. Fertilizer use by crop from UC Davis Cost Return Studies. Open burning permit data for burns in 2014 from BAAQMD. **Method:** ARB agricultural emissions inventory methods. BAAQMD emissions inventory methodology for open burning.
Land Use Change	**Data sources:** Acres and land cover types converted for period 1993-2007 provided by Napa County Conservation, Development and Planning Department.	**Data source:** Change in land cover acreages from 2005 through 2015 provided by Napa County. **Method:** Carbon sequestration and storage factors by land use

Table 3	Unincorporated Napa County GHG Inventory : Data Sources and Methods by Year and Sector	
	Existing acres and land cover types in Napa Baseline Data Report **Method:** IPCC methods	type from various studies applied to estimated change in land use.
High-GWP Gases	Sector not included	**Data source/Method:** SF_6 emissions based on total electricity usage. SO_2F_2 emissions based on CDPR pesticide sales reports. HFC, PFC, and PFE emissions based on unincorporated population and statewide per-capita emission factors calculated from the most recent California 2013 inventory. These emission factors were scaled to 2014 assuming that per capita emissions would increase by two percent between 2013 and 2014, consistent with recent historical trends.

Notes: ARB = California Air Resources Board, BAAQMD = Bay Area Air Quality Management District, CACP = Clean Air and Climate Protection, CDFA = California Department of Food and Agriculture, CDPR= California Department of Pesticide Regulation., CEC = California Energy Commission, CH_4 = CH_4, CO_2 = carbon dioxide, DOF=California Department of Finance, EBMUD = East Bay Municipal Utility District, eGRID = Emissions & Generation Resource Integrated Database, EMFAC = ARB's Emission Factor model, EPA = U.S. Environmental Protection Agency, GHG = greenhouse gases, GWP = global warming potential, HFC = hydrofluorocarbons, ICLEI = International Council for Local Environmental Initiatives, IPCC = Intergovernmental Panel on Climate Change, LMOP = Landfill Methane Outreach Program, N_2O = nitrous oxide, Napa San = Napa Sanitation District, RTAC = Regional Technical Advisory Committee, NA = Not Applicable, PFC = perfluorinated compounds , PFE = perfluoroethane, PG&E = Pacific Gas & Electric, SF_5 = sulfur hexafluoride, SO_2F_2 = sulfuryl fluoride, TCR= The Climate Registry, UC = University of California, WARM = Waste Reduction Model

Source: ICF Jones and Stokes, 2012: Table A-1; 2014 Inventory prepared by Ascent Environmental 2016

Global Warming Potentials

GHG emissions other than carbon dioxide (CO_2) generally have a stronger insulating effect (e.g., ability to warm the earth's atmosphere or greenhouse effect) than CO_2. This effect is measured in terms of a pollutant's global warming potential (GWP). CO_2 has a GWP factor of one while all other GHGs have GWP's measured in multiples of one. ARB currently uses GWP factors published in the Fourth Assessment Report (FAR) from the Intergovernmental Panel on Climate Change (IPCC), where CH_4 and N_2O have GWP's of 25 and 298, respectively (IPCC 2007). This means that CH_4 and N_2O would be 25 and 298 times stronger than CO_2, respectively, in their potential to insulate solar radiation within the atmosphere. This inventory uses the same FAR GWP values. (In comparison, the Second Assessment Report, used in the development of the 2005 inventory, reported GWP's of 21 and 310 for CH_4 and N_2O, respectively.)

Additionally, the 2014 GHG inventory includes an additional assessment of high-GWP gas emissions, including sulfur hexafluoride (SF_6), sulfuryl fluoride (SO_2F_2), hydrofluorocarbons (HFCs), perfluorinated compounds (PFCs), and perfluoroethane (PFEs). GWP values for high-GWP gases range from 124 to 22,800. SF_6 is most commonly used as an electrical insulator in electricity transmissions and any associated emissions are primarily due to leakage. SO_2F_2 is predominantly used as a pest fumigant in residential and commercial buildings. The IPCC formally identified SO_2F_2 and its associated GWP in IPCC's Fifth Assessment Report. HFCs, PFC, and PFEs are most commonly used in refrigerants, aerosols, fire protection, foams, and solvents. Other high-GWP gases are used in specific industrial applications like semiconductor manufacturing or make up less than 0.01 percent of the overall State's emissions inventory (ARB 2015b). Because Napa County is not a major center for semiconductor manufacturing and because these other high-GWP gases make minimal contributions to the State's inventory, other high-GWP emissions are not included in the County's GHG inventory.

1.1 BUILDING ENERGY SECTOR

Based on GHG emissions modeling conducted, residential and non-residential building energy use in 2014 resulted in approximately 148,338 $MTCO_2e$ in 2014. This sector comprised approximately 31 percent of the unincorporated County's emissions, resulting in the largest emissions sector in the inventory. These emissions were a result of electricity and natural gas energy use at buildings and facilities. The building energy sector consumed 336 megawatt-hours (MWh) of electricity and 12 million therms of natural gas. This estimate includes a negative credit for electricity consumption from electric vehicle charging to avoid double-counting with the on-road vehicle sector. PG&E supplied all electricity and natural gas in the County in 2014, and provided electricity with a renewable mix of 27 percent (PG&E 2015a).

Marin Clean Energy, a new community choice aggregation (CCA) program offering additional renewable electricity options to northern Bay Area counties through PG&E, did not begin automatic enrollment of customers in the unincorporated County until February 2015. Through automatic enrollment, MCE customers would immediately have a 50 percent renewable mix in their electricity consumption and customers are allowed to either increase their renewable mix for an additional fee or opt out of the program. Those opting out would have, by default, PG&E's renewable mix (MCE 2015a).

Natural gas and electricity use each accounted for approximately half of total emissions from the building energy sector. Approximately 68 percent of building energy emissions were from commercial and industrial facilities, contributing a total of 100,379 $MTCO_2e$ in 2014. Residential buildings generated 47,984 $MTCO_2e$, or approximately 32 percent of total building energy sector emissions. Table 4 presents building energy use and associated emissions by fuel and source. Table 5 presents emission factors used to quantify emissions from electricity and natural gas use, which are also used to quantify emissions in other sectors that also use electricity and natural gas.

Table 4 2014 Unincorporated Napa County GHG Inventory: Building Energy Use and GHG Emissions by Source

Source		$MTCO_2$/yr	MT CH_4/yr	MT N_2O/yr	$MTCO_2e$/yr
Electricity	MWh/yr				
Residential	116,340	21,756	2	0	21,893
Commercial	214,162	40,048	3	1	40,300
Industrial	5,281	987	<1	<1	994
Electric Vehicles[1]	-137	-24	>-1	>-1	-25
Electricity Total	335,643	62,767	4	1	63,149
Natural Gas	Therms/yr				
Residential	3,809,649	20,199	190	4	26,096
Commercial	8,626,723	45,739	431	9	59,093
Industrial[2]	0	0	0	0	0
Natural Gas Total	12,436,372	65,938	622	12	85,189
Energy Combined	MMBTU/yr				
Residential	777,935	41,954	192	4	47,984
Commercial	1,593,424	85,787	434	9	99,385
Industrial	18,018	987	<1	<1	993
Electric Vehicles	-445	-24	>-1	>-1	-26
Total	2,388,931	128,703	626	13	148,337

Notes: Totals in columns may not add due to rounding. PG&E provided electricity and natural gas use for 2013. 2014 was not available at the time of this writing. 2013 emissions are scaled to 2014 levels by population for residential energy use and employment for commercial and industrial energy use.

MWh = megawatt-hours; MT = metric tons; CO_2 = carbon dioxide; CH_4 = methane; N_2O = nitrous oxide; CO_2e = carbon dioxide equivalent, MMBTU = Million British Thermal Units, PG&E=Pacific Gas and Electric

[1]Electric vehicle charging is subtracted from total building electricity, based on the total kilowatt-hours (kWh) of charging already estimated under the on-road vehicle fleet sector.

[2] PG&E reported zero natural gas usage in the unincorporated area in 2013 from the industrial sector.

Table 4	2014 Unincorporated Napa County GHG Inventory: Building Energy Use and GHG Emissions by Source				
Source		$MTCO_2$/yr	MT CH_4/yr	MT N_2O/yr	$MTCO_2e$/yr
Source: Data provided by Ascent Environmental in 2016 based on modeling using data provided by PG&E's Green Communities program.					

Table 5	2014 Unincorporated Napa County GHG Inventory Building Energy Emission Factors	
Emission Factor	Unit	Source
Electricity		
0.187	$MTCO_2$/MWh	PG&E 2015 for 2014
28.49	lb CH_4/GWh	EPA eGrid 2010 (2014)
6.03	lb N_2O/GWh	EPA eGrid 2010 (2014)
Natural Gas		
53.02	kg CO_2/MMBtu	2014 Climate Registry Emission Factors. Table 12.1. (TCR 2014)
5	g CH_4/MMBtu	2014 Climate Registry Emission Factors. Table 12.9. (TCR 2014)
0.1	g N_2O/MMBtu	2014 Climate Registry Emission Factors. Table 12.9. (TCR 2014)

Notes: CH_4 = CH_4; CO_2 = carbon dioxide; eGrid = Emissions & Generation Resource Integrated Database; EPA = U.S. Environmental Protection Agency; GHG = greenhouse gas; GWh = gigawatt-hours; kg = kilograms; lb = pounds; MMBTU = million British thermal units; MT = metric tons; MWh = megawatt-hours; N_2O = nitrous oxide; PG&E = Pacific Gas and Electric; TCR = The Climate Registry

Source: PG&E 2015, EPA 2014, TCR 2014; compiled by Ascent Environmental 2016.

1.2 WASTEWATER GENERATION

Based on modeling conducted, wastewater generation in 2014 resulted in emissions of approximately 11,189 $MTCO_2e$, or 2 percent of total emissions, primarily from fugitive CH_4. The County does not own or operate any wastewater treatment plants. All wastewater generated by the unincorporated areas of the County is treated in a number of methods: (1) conveyed to other wastewater treatment facilities in the region through sewer systems, (2) stored in septic or winery waste tanks then occasionally hauled to an off-site wastewater treatment facility, or (3) treated on-site, particularly in the case of winery wastewater.

This sector accounts for both the CH_4 emissions from wastewater treatment processes and emissions resulting from electricity use for treatment. Because wastewater treatment facilities are located outside of the unincorporated area, electricity use at those facilities is not captured in the building energy sector and is included in the wastewater sector instead. Wastewater process and electricity use emissions were evaluated in two parts: 1) domestic wastewater and 2) commercial winery wastewater. These emissions are summarized in Table 6.

Table 6	2014 Unincorporated Napa County Wastewater Methane Emissions by Source				
Wastewater Treatment Process Emissions					
Wastewater Source	MG / yr	$MTCO_2$/yr	MT CH_4/yr	MT N_2O/yr	$MTCO_2e$/yr
Domestic - Septic	214	0	22	0	546
Domestic - Sewer	759	0	209	0	5,230
Domestic - Total	*973*	*0*	*231*	*0*	*5,776*
Winery Wastewater[1]	80	0	202	0	5,053
Conveyance and Treatment Electricity Use					
Wastewater Source	Electricity Use (kWh)	$MTCO_2$/yr	MT CH_4/yr	MT N_2O/yr	$MTCO_2e$/yr
Domestic – Septic[2]	0	0	0	0	0

Table 6 2014 Unincorporated Napa County Wastewater Methane Emissions by Source

Domestic – Sewer[3]	1,730,868	324	0	0	326
Domestic – Total	*1,730,868*	324	0	0	*326*
Winery Wastewater[1,3]	182,194	34	0	0	34
Total[4]	**1,913,062**	**358**	**433**	**0**	**11,189**

Notes: MG = million gallons; MT = metric tons; CH_4 = methane; CO_2e = carbon dioxide equivalent, LGOP = Local Government Operations Protocol, MGD = million gallons per day, PG&E= Pacific Gas and Electric

[1] Estimates only account for winery wastewater sent to off-site treatment facilities and assumes those facilities use aerobic systems. On-site treatment of wastewater is not accounted for here because it is generally aerobically treated on-site and would not generate significant CH_4 emissions. Building energy use at on-site treatment facilities are captured under the building energy sector.
[2] According to the LGOP Community protocol, wastewater discharge and treatment energy intensities associated with septic tanks and other on-site systems are assumed negligible. Also, electricity use for facilities that require discharge pumping is difficult to separate from treatment plant energy use as a whole (ICLEI 2012:81). Hauling emissions are captured in the on-road vehicle sector.
[3] Wastewater conveyance and treatment electricity factors were obtained from Tables WW.15.2 (median values) and WW.15.3 for a 5-20 MGD treatment facility, based on Napa Sanitation District's treatment capacity. Emission factors were based on PG&E factors for 2014.
[4] Totals may not add due to rounding.

Source: ICLEI 2012, Data provided by Ascent Environmental in 2016.

WASTEWATER TREATMENT PROCESS EMISSIONS

Domestic Wastewater

Domestic wastewater CH_4 emissions were based on average population-generated wastewater rates from:

- equations WW.11 (alt) for septic systems and WW.6 (alt) for sewer systems from the ICLEI Community Protocol;
- the County's estimate of the percent of the population that are serviced by sewer connections and septic connections; and
- the 2014 population estimate for the unincorporated county, available from the California Department of Finance.

The County estimated that approximately 78 percent of the unincorporated population is served by sewer connections while the other 22 percent use septic tanks for wastewater treatment. Table WW.15.1 from the LGOP shows that California's average wastewater generation factor is 100 gallons per day per capita. Using this factor, the County is estimated to have generated 973 million gallons (MG) in 2014. Although only population was required to calculate CH_4 emissions from wastewater treatment process, total wastewater volumes were used to estimate electricity use associated with wastewater conveyance and treatment.

Winery Wastewater

Winery wastewater emissions are unique to the region due to the wine industry's presence in the County, warranting a separate calculation from domestic wastewater emissions. Napa Sanitation District (Napa San) estimates that 1,100 gallons of wastewater are generated for every ton of grapes produced (Napa San 2009). Based on Napa San's wastewater generation factor and the 2014 Napa County Crop Report, Napa County produced 175,607 tons of grapes and 193 million gallons of winery wastewater. According to the Napa County Winery Database listing available from the County website, wineries in the unincorporated area produced 95 percent of the county's total wine production (Napa County 2015a). Thus, the unincorporated County would have produced approximately 183 million gallons of winery-related wastewater. However, wineries differ in their disposal and treatment methods of wastewater, affecting potential downstream GHG emissions. The discussion below addresses these differences.

According to a survey done by Napa Sanitation District (Napa San) for the district's service area, wineries within the County are known to use a wide variety of methods to treat wastewater generated from the winemaking process (Napa San 2009). These methods include on-site aerobic and anaerobic treatment, pre-treatment prior to off-site treatment, and hauling of untreated wastewater to an off-site treatment facility. However, the Napa San survey did not quantify the overall level of anaerobic treatment used for winery wastewater within the County. Thus, the assessment of the County's wastewater treatment profile for wineries depended on total estimated winery wastewater production, known winery wastewater volumes accepted by wastewater treatment plants, the treatment processes at those plants, and estimated volumes of wastewater generated by Napa Green certified wineries.

Communications with Napa San and East Bay Municipal Water District (EBMUD) revealed that winery wastewater treated at these facilities either underwent aerobic treatments generating no CH_4 or anaerobic treatments where generated CH_4 was captured and flared or converted to energy. Napa San and EBMUD together accepted 25 million gallons of winery wastewater in 2014, primarily through hauled delivery (Damron, pers. comm., 2015; Pham, pers. comm., 2015).

Napa Green, the County's local sustainability certifier, reports that approximately 4.5 million cases of wine were produced by Napa Green Certified Wineries in 2014 (Novi, pers. comm., 2015). Assuming 9 liters per case and 64 cases per ton of grapes, this would translate to 154 million gallons of wine and 79 million gallons of wastewater (Napa San 2009). Although Napa Green does not explicitly require aerobic treatment for certification, many certified sustainable wineries use on-site aerobic wastewater treatment systems or pretreat wastewater such that most solids are filtered out and used as compost. Thus, it is assumed that that all wastewater produced at Napa Green certified wineries are treated aerobically, generating no CH_4.

After subtracting the winery wastewater sent to Napa San and EBMUD and those generated by Napa Green certified wineries from total estimated wine production in the unincorporated county (183 minus 104 million gallons), the remaining 79 million gallons of winery wastewater were assumed to undergo anaerobic treatment. According to the EPA, on average, 4.2 percent of wastewater from fruit and vegetable processing was treated anaerobically during secondary treatment. Using the industrial wastewater equation provided in Chapter 7 of the U.S. GHG Inventory 1990-2013 and biochemical oxygen demand (BOD) levels identified in the Napa San report, the CH_4 emissions from winery wastewater were estimated to be 202 MT CH_4/year or 5,053 $MTCO_2e$/year (EPA 2015: 7-21).

WASTEWATER CONVEYANCE AND TREATMENT EMISSIONS

Electricity used to convey and treat wastewater generated by the unincorporated County was based on total wastewater volumes in 2014, as shown in Table 6, and energy intensity factors per gallon of wastewater (ICLEI 2012: Tables WW.15.2 and WW.15.3). In 2014, no municipal wastewater treatment facilities were located within the unincorporated County, confirming that emissions from conveyance and treatment of wastewater are not double-counted in the building energy sector. For wastewater conveyed to and treated at these off-site wastewater treatment facilities, it is assumed that 280 kWh/MG is required for conveyance and 2,000 kWh/MG is required for treatment. This assumes a median level of conveyance energy intensity and a treatment facility with a capacity size between 5 and 20 MGD, similar to that of Napa San.

According to the ICLEI Community Protocol, wastewater discharge and treatment energy intensities associated with septic tanks and other on-site systems are assumed negligible. In addition, electricity use for facilities that require discharge pumping is difficult to separate from treatment energy use as a whole. (ICLEI 2012:81). Hauling emissions associated with maintenance of septic tanks are captured in the on-road vehicle sector and not included in this sector.

1.3 IMPORTED WATER CONVEYANCE

Based on modeling conducted, water imports into the unincorporated area accounted for 88 $MTCO_2e$ in 2014, less than one percent of the County's 2014 GHG inventory. These resulted from GHG emissions from electricity generation required to deliver and treat water outside unincorporated areas. Water conveyance within the unincorporated County is accounted for under the electricity usage reports from PG&E. However, the unincorporated area imported over 194 million gallons of potable and recycled water in 2014 from water suppliers located within the five incorporated city areas. Much of this water was used for vineyard irrigation.

Water suppliers from each of the five incorporated cities provided total water volume deliveries to the unincorporated area in 2014 broken out by water source and type of water (e.g., recycled or potable). Water conveyance and treatment energy rates per gallon vary by water source and type. These factors were available from a 2006 California Energy Commission report (CEC 2006). Water conveyed from the State Water Project (SWP) requires thirty times more energy than water sourced from local surface water. Approximately 44 percent of water imported to the unincorporated county was sourced from the SWP, as shown in Table 8.

Water energy intensity rates are shown in Table 9. Emission factors in Table 5 were applied to the calculated electricity use to estimate associated GHG emissions. Results are shown below in Table 7 and 8 below.

Table 7 2014 Unincorporated Napa County Imported Water Conveyance GHG Emissions by Supplier

Water Suppliers	$MTCO_2e$/yr
City of Napa	8
City of American Canyon	8
Town of Yountville	47
City of Calistoga	7
City of St. Helena	18
Total	88

Notes: MWh = megawatt-hours; MT = metric tons; CO_2e = carbon dioxide equivalent.

Source: Data compiled by Ascent Environmental in 2016.

Table 8 2014 Unincorporated Napa County Imported Water Conveyance Energy Use by Supplier

Water Suppliers	Volume Transported (MG/yr)	Water Source Breakdown by Percent (%)			Percent Recycled Water[1] (%)	MWh/yr
		Local Surface Water	State Water Project (Bay Area)	Groundwater		
City of Napa	18	44	56	0	22	42
City of American Canyon	13	0	100	0	0	44
Town of Yountville	116	100	0	0	93	252
City of Calistoga	16	35	65	0	0	35
City of St. Helena	31	79	0	21	0	94

Total	194	52	44	4		467

Notes: MG = million gallons; MWh = megawatt-hours; MT = metric tons; CO_2e = carbon dioxide equivalent

[1] Potable Water Volume = Total water volume – Recycled Water Volume

Source: City of Napa 2015, City of American Canyon 2010, Baer, pers. comm., 2015, Moore, pers. comm., 2015, Harrington, pers. comm., 2015, Tuell, pers. comm., 2015; Data compiled by Ascent Environmental in 2016.

Table 9 2014 Unincorporated Napa County GHG Inventory: Water Energy Intensity Factors

Water Source	Conveyance Energy Intensity (kWh/MG)	Treatment Intensity (kWh/MG)
Local Surface Water	120	100
State Water Project (Bay Area)	3,150	100
Groundwater	4.45 kWh/MG/foot	100
Recycled (Average)	2,100	0

Notes: kWh = kilowatt-hours; MG = million gallons

Source CEC 2006: Table 9

Sufficient stormwater pumping energy use was not available from the incorporated water suppliers and was not included in the 2005 inventory. Incorporated utilities either could not apportion stormwater pumping energy use to the unincorporated area or did not provide stormwater pumping services to the unincorporated area (Moore, pers. comm., 2015, Tuell, pers. comm., 2015, Baer, pers. comm., 2015). Thus, energy and emissions associated with stormwater management by incorporated utilities were not included in this analysis or in the County's GHG inventory.

1.4 SOLID WASTE (WASTE GENERATION AND WASTE-IN-PLACE EMISSIONS)

Based on modeling conducted, the solid waste sector was responsible for approximately 83,086 $MTCO_2e$, or 17 percent of the County's 2014 GHG inventory. The ICLEI Community Protocol recommends that community GHG inventories include emissions from both solid waste facilities located in the community (i.e., "waste-in-place") and waste generated by the community. Waste-in-place CH_4 emissions from landfill gas (LFG) generated at solid waste facilities located within the unincorporated area accounted for 63,125 $MTCO_2e$, or 76 percent of emissions from the solid waste sector. CH_4 emissions from decay of waste generated annually by residences and businesses in the unincorporated community accounted for 22,357 $MTCO_2e$, or 24 percent of emissions from the solid waste sector. Table 10 summarizes emissions from the solid waste sector.

Table 10 2014 Unincorporated Napa County GHG Inventory: Solid Waste Emissions by Source

Source	Disposal Tonnage	MT CH_4	$MTCO_2e$
Waste-in-Place LFG emissions within Unincorporated Napa County	N/A	2,525	63,125
Solid Waste generated by Unincorporated Napa County	20,155	798	19,961
Total	20,155	3,324	83,086

Notes: LFG = Landfill Gas

Source Data provided by Ascent Environmental 2015 based on data from EPA 2015b.

LFG is a mix of gases, primarily composed of CH_4, generated from decomposing organic waste and waste chemical reactions and evaporation in landfills. If a landfill has an impermeable membrane that covers a portion or all of the landfill (i.e., cover-and-capture), it can harvest the LFG and prevent CH_4 emissions from being released into the atmosphere. Once captured, a landfill can either convert the CH_4 to CO_2 through flaring or use it as a fuel for other energy-related applications. For the two landfills in the unincorporated County, LFG generation and flaring rates for 2014 were available from EPA's GHG emissions database and EPA's Landfill Methane Outreach Program (LMOP). Any CO_2 emissions from flaring were not counted toward the County's inventory because the IPCC considers any CO_2 emissions from flaring or fugitive emissions to be of biogenic origin and not significant to overall solid waste emissions (IPCC 2006).

The only landfills located within the unincorporated area are the American Canyon Landfill and the Clover Flat Landfill near Calistoga. While Clover Flat is open and currently accepting waste, the American Canyon Landfill closed in 1995 and currently has an active LFG collection system. According to EPA's Facility-Level Information on Greenhouse Gases (FLIGHT) database, in 2014, the American Canyon landfill generated 2,044 MT CH_4 in fugitive CH_4 emissions from accumulated waste at the landfill in 2014 (EPA 2015b). Clover Flat also has an active LFG collection system, but does not anticipate closure of the landfill until 2053. In 2014, Clover Flat generated 481 MT CH_4 in fugitive CH_4 emissions (EPA 2015b). CH_4 emissions from closed landfills generally decrease overtime due to the gradual reduction in organic decomposition. According to CalRecycle, the landfills within the unincorporated area do not contain any waste generated by the unincorporated County itself (CalRecycle 2015).

For emissions related to annual solid-waste generation from the community in the unincorporated County, CH_4 emissions are also generated from organic decomposition. The release of CH_4 emissions from community-generated waste depends on the LFG management systems of the landfills at which the waste are disposed. According to CalRecycle reports, 98 percent (19,751 tons) of the waste generated by the unincorporated County in 2014 were sent to the Potrero Hills Landfill in Solano County, approximately 30 miles east of the County (CalRecycle 2015). In 2014, Potrero Hills Landfill did not have an active LFG collection system in place; although, according to EPA's LMOP database, the landfill plans to install such a system by January 2016 (EPA 2015c). Calculations of emissions from County-generated waste used factors unique to the unincorporated area. EPA's WARM model provides decay emissions factors for various types of waste, such as food or paper waste. The latest profile of the unincorporated County's waste stream was available from CalRecycle for the 1990 calendar year. The data from EPA and CalRecycle were used to calculate a weighted CH_4 emissions factor per ton of waste generated by the unincorporated County. The result was applied to the unincorporated County's total waste tonnage to calculate CH_4 emissions. However, because the waste stream profile for the County was only available for 1990, the County could have shown improved recycling rates of paper and reduction in food waste due to recent composting efforts, meaning that actual waste generation emissions could be lower than estimated.

1.5 ON-ROAD VEHICLES

Based on modeling conducted, on-road vehicle usage in the unincorporated County resulted in 125,711 $MTCO_2e$ in 2014, or 26 percent of the County's inventory. On-road vehicle emissions are primarily the result of exhaust from the combustion of gasoline and diesel fuels. To a smaller degree, emissions from on-road vehicles also result from upstream electricity generation for electric vehicles. Due to lack of available data, emissions from the combustion of natural gas and other non-electric alternative fuels in on-road vehicles were not included in this analysis, and are assumed to have minimal contribution to total emissions.

On-road passenger vehicle emissions were calculated by estimating the annual vehicle miles traveled (VMT) associated with trips that begin or end in the unincorporated County. These vehicle trips included 100 percent of vehicle trips that both originate from and end in the unincorporated area (i.e., fully internal trips), 50 percent of trips that either end in or depart from the unincorporated area (i.e., internal-external or external-internal trips), and zero percent of vehicle trips that are simply passing through the area (i.e., external-external, or "pass-through", trips). This passenger vehicle trip accounting method is consistent with the method recommended to ARB in 2010 by the RTAC (established through the Sustainable Communities and Climate Protection Act of 2008 [Senate Bill 375]). Table 11 shows total annual VMT by vehicle fuel type and associated emissions estimates for the unincorporated County.

Table 11 2014 Unincorporated Napa County GHG Inventory: On-Road Vehicle Fleet Activity and Emissions by fuel type

Vehicle Type	VMT/yr	Fuel Use (1000 gallons or MWh)/yr	$MTCO_2$/yr	MT CH_4/yr	MT N_2O/yr	$MTCO_2e$/yr
Gasoline	238,043,173	111,497	94,146	4.64	2.44	94,990
Diesel	23,527,464	27,721	27,943	0.56	9.19	30,696
Electric	450,077	131	24	0.00	0.00	25
Total	262,020,714		122,113	5	12	125,711

Notes: VMT = vehicle miles travelled; kWh = kilowatt-hour; MT = metric tons; CO_2 = carbon dioxide; CH_4 = methane; N_2O = nitrous oxide; CO_2e = carbon dioxide equivalent

Source: Metropolitan Transportation Commission (Brazil, pers. comm., 2016a); data compiled by Ascent Environmental 2016

MTC provided vehicle travel information for the unincorporated County based on their regional travel demand model. MTC provided average daily VMT estimates in 2014 for both passenger and commercial vehicles for the unincorporated area, which were multiplied by 347 days per year to estimate annual VMT to account for lower VMT during weekends, holidays, and summer periods. Passenger VMT was calculated using the RTAC method with VMT available by origin and destination categories from MTC. However, due to modeling limitations, MTC was only able to provide commercial VMT using the boundary method. The boundary method accounts for all vehicle travel occurring within the physical boundaries of a given jurisdiction regardless of origin or destination. This means the commercial VMT estimates only include travel within the physical boundary of the unincorporated area. Without commercial VMT available by origin and destination, the RTAC method could not be applied to commercial VMT. As a proxy, the available commercial VMT was scaled based on the ratio between passenger VMT calculated by the RTAC method (available from MTC) and passenger VMT calculated by the boundary method (calculated from Caltrans VMT data) (Caltrans 2014:72, Caltrans 2016). This alternative method for estimating commercial VMT is consistent with MTC recommendations (Brazil, pers. comm., 2016).

MTC also provided the speed distribution profile by fuel and vehicle class, which allowed for the use of detailed emission factors calculated for the same categories from EMFAC 2014. Although, EMFAC provides CO_2 and CH_4 emissions data, direct N_2O emission factors were not available. Instead, N_2O emissions were calculated using ARB inventory methods that assume N_2O emissions are equal to 4.16 percent of NO_X emissions for gasoline vehicles and 0.3316 g N_2O per gallon fuel for diesel vehicles (ARB 2014a). Emissions from electricity use in electric vehicles were quantified using the same methods used for the building energy inventory.

1.6 OFF-ROAD VEHICLES

Based on modeling conducted, off-road vehicles operating in the unincorporated County emitted approximately 42,508 $MTCO_2e$ in 2014, or nine percent of the County's 2014 inventory. These emissions were the result of fuel combustion in off-road vehicles and equipment used in construction, industry, and recreation and were available from ARB's OFFROAD 2007 model. Unfortunately, the OFFROAD 2007 model only provides emissions detail at the State, air basin, or county level. Napa County emissions data from

OFFROAD 2007 were apportioned to the unincorporated area using custom scaling factors depending on the off-road fleet type, as shown in Table 12. For example, due to the likely correlation between commercial activity and employment, the unincorporated portion of emissions from light commercial equipment in the County is assumed to be proportional to the number of jobs in the unincorporated County as compared to the County as a whole. On the other hand, emissions from pleasure craft are assumed to occur entirely within the County because the majority of navigable waterways in the County are located in the unincorporated area. Further details on how OFFROAD emissions from each fleet type were scaled to the unincorporated area are discussed below. Note that, although reported by the OFFROAD model, emissions from agricultural equipment included separately in the agriculture sector and are excluded from the off-road vehicles sector.

Emissions from locomotives are not included in the OFFROAD model and were added in separately to account for the Napa Valley Wine Train, which is the only operating locomotive in the County at this time. The estimated annual emissions and scaling factors are presented in Table 12 below by fleet type.

Table 12 2014 Unincorporated Napa County GHG Inventory: Off-Road Emissions by Fleet Type

Off-Road Fleet Type	$MTCO_2$/yr	MT CH_4/yr	MT N_2O/yr	$MTCO_2e$/yr	Unincorporated : Countywide Scaling Method
Pleasure Craft[1]	29,004	20	6	31,440	not scaled
Construction and Mining Equipment	6,546	1	0	6,575	jobs
Transport Refrigeration Units	1,413	0	0	1,420	jobs
Industrial Equipment	1,182	0	0	1,212	jobs
Light Commercial Equipment	851	0	0	899	jobs
Lawn and Garden Equipment	460	1	0	568	population
Recreational Equipment[1]	196	1	0	325	population
Oil Drilling	34	0	0	34	jobs
Locomotives (Napa Valley Wine Train) [1]	20	0	0	20	not scaled
Entertainment Equipment[1]	14	0	0	14	jobs
Railyard Operations	0	0	0	0	jobs
Total	**39,721**	**24**	**7**	**42,508**	

Notes: MT = metric tons; CO_2 = carbon dioxide; CH_4 = CH_4; N_2O = nitrous oxide; CO_2e = carbon dioxide equivalent; GHG = greenhouse gas

[1] Not in 2005 emissions inventory

Source: Data provided by Ascent Environmental in 2016, based on modeling from OFFROAD 2007

All commercial and industrial off-road emissions were scaled from Countywide estimates by the unincorporated percentage of jobs in 2014. Emissions related to lawn and garden and recreational equipment were scaled by population. Countywide emissions from pleasure craft were assumed to entirely occur in the unincorporated areas such as Lake Berryessa and Lake Hennessey. Locomotive emissions were based on locomotive information from the Napa Valley Wine Train website, which provided engine model types, fuel types, car weights, average trip distance, and number of daily trips (Napa Valley Wine Train 2015). Locomotive fuel efficiency and emissions factors were available from the Alternative Fuels Data Center and the Climate Registry, respectively (AFDC 2014, TCR 2014).

Although ARB has released newer category-specific models designed to replace OFFROAD 2007, these newer models estimate statewide emissions without county-level detail and focus primarily on criteria pollutant emissions. ARB recommends using OFFROAD 2007 where desired information is unavailable from the newer off-road models (ARB 2015a). Notwithstanding ARB recommendations, OFFROAD 2007 model may tend to overestimate emissions in 2014. The model was developed prior to the 2009-2010 recession and, thus, presumes a higher growth rate in equipment population than what may have actually transpired in 2014 (ARB 2010). Additionally, the model does not include recent regulatory changes such as idling limits and newer engine tier requirements (ARB 2014b).

1.7 AGRICULTURE

Based on modeling conducted, emissions from the agriculture sector accounted for approximately 52,198 from agricultural activity such as farm equipment operations, direct emissions from livestock, and fertilizer use. Fuel combustion in farm equipment and CH_4 emissions from livestock made up 60 percent and 32 percent of total emissions from the sector, respectively. Other emissions estimated for this sector were from fertilizer use, lime application, burning of agricultural residue, and diesel-powered agricultural pumps. These emissions are summarized in Table 13 below.

Table 13 2014 Unincorporated Napa County GHG Inventory: Agriculture Emissions by Source

Source	$MTCO_2$/yr	MT CH_4/yr	MT N_2O/yr	$MTCO_2e$/yr
Farm Equipment	31,359	4	0	31,571
Enteric Fermentation from Livestock	0	414	0	10,345
Manure Management from Livestock	0	165	2	4,829
Fertilizer Use	0	0	9	2,683
Agricultural Irrigation Pumps	1,657	0	0	1,657
Residue Burning	533	10	1	1,094
Urea Fertilization	16	0	0	16
Lime Application	4	0	0	4
Pesticide Application[1]	0	0	0	0
Total	**33,568**	**593**	**13**	**52,198**

Notes: : MT = metric tons; CO_2 = carbon dioxide; CH_4 = CH_4; N_2O = nitrous oxide; CO_2e = carbon dioxide equivalent; GHG = greenhouse gas

[1] Pesticide application emissions were less than 0.5 MT.

Source: Data compiled by Ascent Environmental, 2016.

GHG emissions associated with farming equipment were obtained from ARB's OFFROAD2007 model. ARB has a more recent off-road equipment model, the 2011 off-road inventory model, but it is limited to construction, industrial, and oil drilling equipment types and does not include agricultural equipment. In cases where the new model does not cover a desired category, the ARB recommends using OFFROAD2007 as the current tool for estimating emissions. Farming equipment emissions reported for Napa County are assumed to occur entirely within the unincorporated County.

With respect to livestock emissions, CH_4 and nitrous oxide emissions are released through enteric fermentation (a type of digestion process) and exposure of manure produced by these animals. The 2014 Napa County Crop Report provided estimates of total weight of cattle, lamb, and slaughter sheep in the County. Average weight per head of livestock were calculated by comparing historical County livestock population estimates from the California Agricultural Statistical Review and total livestock weights reported in the County crop reports in the same year. This was used to calculate livestock population needed for emissions estimates. All livestock-generated GHG emissions were estimated using population-based emission factors and quantification methods identical to those by ARB in the statewide inventory.

Emissions from fertilizer use vary by crop type and acreage. The acreage of crops cultivated in the County was based on the *2014 Napa County Crop Report* (Napa County 2015b). The amount of fertilizer application for each crop type grown in the County was based on sample cost reports for each crop that are published by the University of California Cooperative Extension (UCCE). UCCE have special fertilizer reports available for wine grapes grown in the Napa region. Information about the mass amounts of urea and lime was provided in the Fertilizing Materials Tonnage Report for January to June of 2012. Emission factors and quantification methods for GHG emissions associated with urea and lime fertilizer application were obtained from IPCC (IPCC 2000). These emission factors and quantification methods were also used by ARB in its development of the statewide GHG inventory and subsequent updates (ARB 2015b).

The GHG emission factor and quantification method for agricultural irrigation pumps and number of pumps were obtained from ARB reports on diesel irrigation pumps (ARB 2003, 2006). Latest reports provided total diesel pumps in the Bay Area Air Quality Management District in 2006, but did not break down the inventory by County. However, an older report reported pumps at both the county-level and air district-level. Assuming the ratio of pumps in the air district remained the same as in 2003, approximately 26 pumps were estimated to operate in the County in 2006. The County's pump inventory in 2014 was assumed unchanged from 2006. (ARB 2006: Table D-2).

Residue burning refers to the burning of croplands after they are harvested to clear the land of residual vegetation. The GHG emissions from residue burning in Napa County were based on BAAQMD emissions inventory methods for open burning (emissions per ton of material burned), 2014 open burning permit data submitted to the air district (ton or cubic yard of material burned), and organic waste densities from CalRecycle (tons per cubic yard) (BAAQMD 2014, Reed, pers. comm., 2016, CalRecycle 2010). BAAQMD provided the permit information in response to a public records request. However, the air district had not yet quantified emissions from open burning for the 2014 calendar year. The permit data provided either cubic yards or tons of material (e.g. orchard pruning, crop replacement) burned by material category and location. Thus, it was necessary to calculate emissions separately. In Napa County, over 102,000 cubic yards, or 82 percent, of material openly burned in Napa County consisted of discarded grapevines (Reed pers. comm., 2016). BAAQMD opening burning permits also included open burning of flood control debris, forest and fire management, and other non-agricultural prescribed burns. Although these are not necessarily agricultural, emissions from those burns are included in the residue burning sub-sector to facilitate a more complete inventory.

A common pesticide that is also categorized as a GHG is methyl bromide. Based on the published factors from IPCC's Fifth Assessment Report, methyl bromide is assumed to have a GWP factor of 2. However, according to the California Pesticide Information Portal, no methyl bromide was used in 2013. 2014 information was not available, but no changes in methyl bromide use are expected. Sulfuryl fluoride is also considered a pesticide, but is most often used in structural pest control as a fumigant, and is not included as an agricultural emissions source. Sulfuryl fluoride is discussed in the High-GWP sector.

1.8 LAND USE CHANGE

Land use change in Napa County resulted in the indirect emissions of approximately 8,002 $MTCO_2e$, or two percent of total emissions, due to lost carbon sequestration potential and removal of stored carbon. As developed areas and vineyard acreages continue to expand with the growth of the wine industry and the County's population, certain natural land cover types are replaced with vineyards, residential/commercial development, and other anthropogenic development. Natural flora present on these lands such as forests, rangelands, and shrublands remove carbon dioxide from the atmosphere and sequester the carbon in plant material through photosynthesis. The conversion of these lands to urban development eliminates further carbon sequestration potential from these plants. Conversion of natural flora to vineyards may also result in a net reduction of carbon sequestration potential, depending on the type of land cover displaced. Removing vegetation also removes carbon stored in the plant material, which, if burned, would release sequestered carbon dioxide back into the atmosphere.

According to County records, from 2005 to 2014, vineyard expansions displaced an estimated 1,492 acres of natural land cover, including 700 acres of grasslands, 300 acres of shrubland, and 250 acres of oak woodland. This means that, on average, 166 acres of natural lands have been converted to vineyards every year between 2005 and 2014.

Land use change affects emissions in two ways: 1) change in carbon sequestration potential and 2) change in carbon storage. To estimate net emissions in 2014 associated with land use change, carbon sequestration and carbon storage factors per acre were applied to the change in acreage by land cover type between 2013 and 2014. These carbon sequestration and storage factors were collected from various sources and are listed in Table 15. These factors are converted to carbon dioxide by multiplying by 44/12, the molecular weight ratio of CO_2 to carbon. Table 14 presents a summary of the land use changes that occurred between 2013 and 2014 along with the estimated net GHG emissions due to lost carbon storage and sequestration potential.

Table 14 — 2014 Unincorporated Napa County GHG Inventory: Lost Carbon Stock and Sequestration Potential from Land Use Change between 2013 and 2014

	Change in acreage between 2013 and 2014[a]	Lost Carbon Storage due to Land Use Change ($MTCO_2$)	Loss in carbon sequestration potential ($MTCO_2$)	Total Net Emissions ($MTCO_2$)
Coniferous Forest	-4	1,127	10	1,137
Croplands (Not Vineyards)[1]	-181	1,652	54	1,706
Grasslands	-29	272	0	272
Oak Woodlands	-34	3,897	53	3,951
Riparian Woodlands	-2	675	6	681
Shrublands	-21	973	0	973
Vineyards	152	-708	-9	-717
Other[2]	119	0	0	0
Total	0	**7,888**	**114**	**8,002**

Notes: Land use change based on acreages provided by Napa County. MT = metric tons; CO_2 = carbon dioxide; GHG = greenhouse gas

[1] "Cropland (Not Vineyards)" includes the County mix of olives, vegetables, and hay as reported in the 2014 Napa County Crop Report.

[2] "Other" refers to wetlands and non-vegetative land uses such as developed areas and rock outcrops. Non-vegetative land uses are assumed to have no carbon storage or sequestration potential and are not included here. Carbon sequestrations and storage potential of wetlands vary greatly depending on location, ecosystem, and other factors. Factors for wetlands unique to Napa County are not available and were assumed to be zero.

Source: Napa County (Hade, pers. comm., 2015); data compiled by Ascent Environmental, 2016.

Table 15 — 2014 Unincorporated Napa County GHG Inventory: Lost Carbon Stock and Sequestration Factors by Land Use Type[1]

	Stored Carbon		Annual Sequestration	
Land Use Type	Carbon stored per acre (MT C/acre)	Sources and Notes	Annual Net Carbon Sequestration per acre (MT C/acre/yr)	Sources and Notes
Oak Woodlands	29.5	a) assume equal to Western Oak	0.425	d) assume equal to Hardwoods
Riparian Woodlands	77.0	a) Straight average of Redwood, Oak, and Tanoak/Laurel per description in County	0.737	d) Straight average of Redwood and hardwood per description in County GP DEIR (p. 4.5-f)

Table 15 2014 Unincorporated Napa County GHG Inventory: Lost Carbon Stock and Sequestration Factors by Land Use Type[1]

		GP DEIR (p. 4.5-f)		
Coniferous Forest	78.2	a) Straight average of Ponderosa Pine, Redwood, and Mixed Conifer per description in County GP DEIR (p. 4.5-f). Weighted average would be preferable, but data is not available.	0.701	d) Average of Douglas Fir, Redwood, and Mixed Conifer types per description in County GP DEIR (p. 4.5-f). Weighted average would be preferable, but data is not available.
Grasslands	2.6	c) Battles et al. Table 5	0	d) Brown, et. al. P. 19
Shrublands	12.8	c) Battles et al. p. 18	0	d) Brown, et. al. P. 19
Croplands (Not Vineyards)	2.2	d) e) f). Factors from d) and e) scaled by Crop Report acreage in f).	0.081	e) f) g) Assumes vegetables and hay have zero annual sequestration.
Vineyards	1.2	d)	0.016	g) Only includes sequestration in woody mass. Accounts for pruning, removal of vineyards after a 25-year lifetime, burial in soil, and a California-average level of conversion to biomass energy. Many of these activities return sequestered carbon into the atmosphere.

Note: ARB = California Air Resources Board; MT = metric tons; C = carbon; GHG = greenhouse gas; GP DEIR = General Plan Draft Environmental Impact Report

[1] Changes in land use patterns do not immediately change soil carbon levels. Instead, changes to soil carbon may be gradual, while change in land use patterns would have immediate impacts on aboveground and some belowground biomass. As such, soil carbon is not included in this analysis. ARB's current GHG Emissions Inventory is still based on sequestration factors from the 2004 Brown study. There is no region-specific sequestration rate published for Napa County. "Cropland (Not Vineyards)" includes the County mix of olives, vegetables, and hay as reported in the 2014 Napa County Crop Report.

a) EPA 2015a : Annex C
b) Gaman and Firman 2008
c) Battles, et. al. 2014. Commissioned by ARB. Updates Brown et.al. 2004. Uses IPCC land categories.
d) Brown, et. al. 2004
e) Proietti et. al. 2014
f) Napa County 2015
g) Kroodsma, et. al. 2006

With respect to sequestration from vineyard growth and production, the information on carbon sequestration in vineyards is very limited. One study found that vineyards, over their lifetime, sequester approximately 4 g C per square meter per year (or 0.016 MT C/acre/year) in its woody biomass (Kroodsma and Field 2006:1980). Soil carbon was also quantified in this study, but is outside the scope of this inventory. This study accounted for pruning levels and usage of vineyard biomass at the end of a 25 year lifetime. It assumed that mature vines convert 35 to 50 percent of sequestered carbon as fruit, which was assumed to release the sequestered carbon after consumption. The study also noted that actual sequestration rates depend on what is done with the discarded vineyard biomass. Burying biomass can help increase soil carbon rates, but carbon levels in soil can saturate and decomposition would also return some sequestered carbon back into the atmosphere. Burning biomass, either out in the open or in a biomass plant, would return sequestered carbon into the atmosphere. However, using biomass as energy also offsets fossil fuel emissions. The Kroodsma study assumed some statewide level of biomass-to-energy conversion. Given this research and the uncertainty of how vineyard biomass in Napa County is treated, Napa County vineyards are assumed have an average statewide net annual sequestration level of 0.016 MT C/acre/year.

1.9 HIGH-GWP GASES

High-GWP gases accounted for 13,481 $MTCO_2e$, or approximately three percent of total emissions in 2014. This sector includes emissions from SO_2F_2, a fumigant; SF_6, an electric insulator used in electricity transmission; and a list of other high-GWP gases including various HFCs, PFE, and PFCs as listed in Table 16. HFCs and CFCs are generally emitted into the atmosphere through off-gassing, leakage, or direct emission of refrigerants, solvents, aerosols, foams, and fire protection. County-specific information was available for inventorying of SO_2F_2 and SF_6; however, estimates of other high-GWP gases were only available at the State level and were scaled from the statewide GHG inventory to the unincorporated area by population. Emissions from the various high-GWP gases included in the unincorporated County's 2014 inventory are shown in Table 16, by GHG.

Table 16 2014 Unincorporated Napa County GHG Inventory: High-GWP Gases by Greenhouse Gas

Greenhouse Gas[1]	GWP	Application	2013 State Mass Emissions (MT/yr)	2014 State per capita Emissions (MT/yr-cap)[2]	Unincorporated Napa County Emissions (MT/yr)	Unincorporated Napa County Emissions ($MTCO_2e$/yr)
HFC-125	3,500	Fire Protection, Refrigerants	1359	3.65E05	0.9720	3,402
HFC-134a	1,430	Aerosols, Foams, Refrigerants	5676	1.52E04	4.0593	5,805
HFC-143a	4,470	Refrigerants	758	2.03E05	0.5419	2,422
HFC-152a	124	Aerosols, Refrigerants	4080	1.09E04	2.9176	362
HFC-227ea	3,220	Fire Protection, Aerosols	58	1.56E06	0.0416	134
HFC-236fa	9,810	Fire Protection, Refrigerants	10	2.59E07	0.0069	68
HFC-245fa	1,030	Foams, Solvents	466	1.25E05	0.3330	343
HFC-32	675	Refrigerants	673	1.80E05	0.4810	325
HFC-365mfc	794	Solvents	0	1.10E08	0.0003	0
HFC-43-10mee	1,640	Solvents, Aerosols	18	4.77E07	0.0127	21
PFC-14 (CF_4)	7,390	Fire Protection, Solvents	0	8.19E09	0.0002	2
Other PFC and PFE's	9,300	Solvents	0	6.40E09	0.0002	2
Sulfuryl Flouride[3]	4,090	Fumigant	5	NA	0.0950	389
Sulfur Hexaflouride[4]	22,800	Electrical Insulator	NA	NA	0.0091	207
				TOTAL	9.4709	13,481

Note: ARB= California Air Resources Board, DPR = California Department of Pesticide Regulation, GHG = greenhouse gas, MT = metric tons, CO_2e = carbon dioxide equivalents, HFC = hydrofluorocarbons, IPCC = Intergovernmental Panel on Climate Change, NA = not applicable, PFC = perfluorinated compounds, PFE = perfluoroethane

[1] Names of gases consistent with ARB's list of "Use of substitutes for ozone depleting substances". Sulfur hexafluoride is also accounted for in the State's GHG inventory. IPCC recently included sulfuryl fluoride in its list of GHGs, but it has not yet been included in the State's inventory. (IPCC 2013)
[2] Assumes a 2% growth in per capita emissions from 2013 to 2014. This is based on historical year-to-year changes in per-capita emissions from compounds used in ARB category, "Use of substitutes for ozone depleting substances".
[3] Calculations based on statewide emissions scaled to the unincorporated area by total electricity usage in the unincorporated area in 2014, not population.
[4] Calculations based on actual consumption reports for Napa County from DPR and scaled to the unincorporated area by population.

Source: ARB 2015b, DPR 2013, IPCC 2007: Table 2.14, IPCC 2013; data compiled by Ascent Environmental in 2016.

As mentioned, HFC, PFC, and PFE emissions were calculated based on ARB's 2013 State GHG inventory. 2013 statewide per-capita emission factors were calculated from the most recent California 2013 inventory. These emission factors were then scaled to 2014 assuming that per capita emissions would increase by 2 percent between 2013 and 2014, consistent with recent historical trends. The final 2014 emission factors were applied to the known population of unincorporated County to obtain county-level emissions. As shown in Table 16 and following statewide trends, emissions of HFC-134a, HFC-143a, and HFC-125 account for 86 percent of the high-GWP gas sector in 2014. According the breakdown of these emissions in Table 17, most of these gases are used as refrigerants in the commercial and in refrigerated vehicles, such as trucks transporting perishables. Given the prominence of the wine industry in the County where wine, grape juice, and grapes may be transported in refrigerated trucks, the percent of refrigerants used in transportation could be higher than what is reported in Table 16 and 17.

Table 17 2014 Unincorporated Napa County GHG Inventory: HFC-125, HFC-134a, and HFC-143a emissions by Source and Application

Emissions Source and Application	Unincorporated Napa County Emissions ($MTCO_2e$/yr)
Commercial	**5,456**
Aerosols	102
Fire Protection	2
Foams	57
Refrigeration and Air Conditioning	5,294
Industrial	**1,908**
Aerosols	14
Fire Protection	1
Foams	332
Refrigeration and Air Conditioning	1,561
Residential	**1,776**
Aerosols	653
Foams	139
Refrigeration and Air Conditioning	983
Transportation	**2,490**
Aerosols	140
Refrigeration and Air Conditioning	2,350
Grand Total	**11,629**

Note: GHG = greenhouse gas, MT = metric tons, CO_2e = carbon dioxide equivalents, HFC = hydrofluorocarbon

Source: Source: ARB 2015b, DPR 2013, IPCC 2007: Table 2.14, IPCC 2013; data compiled by Ascent Environmental in 2016.

With respect to SO_2F_2, the latest report from the California Department of Pesticide Regulation indicates that Napa County used 1,627 pounds of SO_2F_2 in 2013 (DPR 2013). A 2009 article in the Journal of Geophysical Research estimated that approximately one third of SO_2F_2 used in fumigation would be destroyed in the fumigation process (Mühle et.al. 2009). Assuming that all sulfuryl fluoride used in the County was for fumigation and scaling the resulting emissions by the unincorporated population in 2013 and population growth to 2014, total sulfuryl fluoride emissions from the unincorporated County in 2014 are estimated to be 389 $MTCO_2e$.

To estimate emissions from SF_6, an average statewide emissions factor (MT SF_6 per kWh) was calculated using ARB's 2013 GHG inventory that reported both total emissions and total associated electricity use. Using the total 2014 electricity use for the unincorporated area based on data provided by PG&E, total sulfuryl hexafluoride emissions from the unincorporated County in 2014 are estimated to be 207 $MTCO_2e$.

2 GHG EMISSIONS FORECASTS TO 2020, 2030, AND 2050

BAU emissions forecasts provide the County with an assessment of how the County's emissions would change over time without further action from the County. In addition to accounting for the County's growth under a BAU scenario, an adjusted BAU forecast can also include legislative actions at the State and federal levels that would affect emissions without any local action, such as through regulatory requirements to increase vehicle fuel efficiency or renewable energy sources. These forecasts provide the County with the information needed to focus efforts on certain emissions sectors and sources that have the most GHG reduction opportunities.

BAU forecasts described in this section for 2020, 2030, and 2050 are generally based on the State's GHG reduction target years established in key State legislation and policies, including Assembly Bill (AB 32), Executive Order B-30-15, and Executive Order S-305. Estimated BAU emissions forecasts were based on predicted growth in existing demographic forecasts, including population, jobs, and household growth between 2014 and 2040 for Napa County, as shown in Table 16 below. Forecasted emissions also account for anticipated changes in future vehicle emissions factors and electricity emissions factors due to State and federal policies that would occur with or without County action, which can be referred to as "legislative adjustments" to the forecasts. These actions are reflected in forecasted emissions factors either provided by PG&E or assumed in EMFAC 2014.

Table 16 Napa County Demographic Forecasts

Input	2014	2040	Change
Napa County (Countywide)			
Households	49,859	56,312	6,453 (13%)
Population	136,550	158,792	22,242 (16%)
Employment	74,697	89,550	14,853 (20%)
Unincorporated Napa County Only			
Households	11,635	13,893	2,258 (19%)
Population	30,958	38,225	7,267 (23%)
Employment	17,320	19,503	2,183 (13%)

Source: Metropolitan Transportation Commission (Brazil, pers. comm., 2016); data compiled by Ascent Environmental in 2016.

To forecast GHG emissions in future years, different methods were used depending on the emissions sector. For example, residential building energy emissions were scaled using household forecasts and certain agricultural emissions subsectors were scaled by the County's anticipated change in future croplands. Forecasted emissions and the respective forecast methods are shown in Tables 17 and 18, respectively.

LEGISLATIVE GHG REDUCTIONS

From 2014 through 2050, Napa County's unincorporated housing, employment, and population will increase by over 23 percent. Without any legislative reductions, the unincorporated County's emissions would also increase proportionally to the County's growth. However, several existing legislative reductions would limit the County's emissions growth. These reductions are discussed below.

Building Energy

Electricity Emission Factors

Emissions from the building energy sector would see gradual declines into the future without additional County action, even with population increase, due to local and State measures already in place. As mentioned previously, Marin Clean Energy (MCE) is a CCA that began servicing unincorporated County in February 2015. As part of MCE's service, MCE automatically provides customers within its service area with 50 percent renewable electricity, although customers are allowed to opt out of MCE's service or pay into MCE's "Dark Green" program that would allow for a higher percentage renewable mix. Those that opt out would remain under PG&E's electricity service, which is currently 27 percent renewable (MCE 2015). According to MCE's Integrated Resource Plan, MCE plans to increase the minimum renewable energy supply of the program from 50 to 80 percent by 2025 (MCE 2015b).

With respect to BAU forecasts, it is assumed that the unincorporated County would continue to participate in the MCE program. This assumes that the unincorporated County's current opt-out rate would remain at approximately 11 percent into future years (MCE 2015b). Thus, the BAU forecast estimates that 50-percent-renewable electricity emission factors would be applied to 89 percent of future electricity use in unincorporated County buildings. The remaining 11 percent of electricity use would use PG&E emission factors that are scheduled to reach a 33 percent renewable mix by 2020 and 50 percent by 2050, pursuant to statewide legislation of the Renewable Portfolio Standard and SB 350.

PG&E anticipates that by 2020, the utility's CO_2 emission factor will be 0.131 $MTCO_2$ per MWh (PG&E 2015b). This takes into account the utility's achievement of the State's RPS goal to source 33 percent of electricity generation from renewables by 2020. Assuming emission factors from non-renewable sources remain the same, a 50 percent and 80 percent renewable mix would have emissions of 0.127 and 0.051 $MTCO_2$ per MWh, respectively. CH_4 and N_2O electricity emission factors in future years are assumed to be reduced from 2014 levels proportional to the anticipated change in CO_2 emission factors.

Energy Efficiency

California has two major policies that would affect the energy efficiency of buildings in future years. The State's Title 24 Building Energy Efficiency Standards and SB 350 would affect energy efficiency rates in new construction and existing buildings, respectively. The 2016 Title 24 standards were adopted in December 2015 and will go into effect January 2017. The California Energy Commission (CEC) estimates that new residential buildings built to these standards would be 28 percent more efficient than buildings built to the current 2013 Title 24 standard. Relative savings for non-residential buildings was not readily available from the CEC; thus, it was assumed that non-residential buildings built to 2016 standards would have similar improvements as the residential standards. (CEC 2015).

SB 350, in addition to targeting a 50 percent renewable mix in California electricity by 2030, targets a cumulative doubling of statewide energy efficiency savings in electricity and natural gas final end uses of retail customers by January 1, 2030 with annual targets established by the CEC. SB 350's energy efficiency goals are applicable to both existing building stock and new construction, but would have the most impact on existing building stock.

Forecasts of future building energy use account for both Title 24 and SB 350 policies. It is assumed that all new construction taking place between 2014 and 2050 would have energy efficiencies 28 percent better than current energy usage rates (i.e., energy use per household and employment). Although this method does not exactly reflect improvements from 2013 Title 24 standards, this method is a conservative approach as a 28 percent reduction from current energy usage rates would result in more energy use than a 28 percent reduction from building built to the 2013 Title 24 standard. In addition, it is assumed that all existing building stock (i.e., buildings built before 2015) would continue to operate through 2050 and would use 50 percent less energy starting in 2030. The forecasted energy efficiency improvements in existing building stock are meant to reflect implementation of SB 350 energy efficiency goals met by 2030. As a conservative assumption, estimated energy efficiency levels in existing buildings are assumed to stay constant from 2030 through 2050.

Water and Wastewater

Water imports, wastewater conveyance, and wastewater treatment all involve use of electricity for pumping and treatment. Most of these activities addressed in the inventory occur outside of the unincorporated County in the incorporated Napa cities. Although MCE currently does not serve incorporated areas in Napa County, many cities in the County have expressed interest in joining MCE in the future (Choi, pers. comm., 2016). In fact, the City of Calistoga currently already participates in MCE's program (Kirn pers. comm., 2015). Because City applications for MCE are not yet public, forecasts for the water and wastewater sector assume electricity emissions factors consistent with PG&E's progress towards RPS and SB 350 targets, except for water conveyance from the City of Calistoga that would follow MCE's targets.

On-Road Vehicle Fleet

State and federal policies and associated regulations incorporated in the on-road vehicle emission forecasts include:

- Advanced Clean Cars (State)
- Tractor-Trailer Greenhouse Gas (TTGHG) Regulation (State)
- Federal Pavley Regulations (GHG emission reduction standards) (Federal)
- Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles (Federal)

These policies are already included in EMFAC's emission factor estimates and forecasts. It should be noted that the Low Carbon Fuel Standard regulation was excluded in EMFAC 2014 forecasts because most of the emissions benefits originate from upstream fuel production.

Solid Waste

CalRecycle established a target pursuant to AB 341 (Chapter 476, Statutes of 2011) to achieve a statewide waste diversion rate of 75 percent by 2020, or 2.7 pounds of waste per resident per day (lb/resident/day). To meet the State target, the unincorporated County would need to reduce its disposal rate from 4.1 lb/resident/day to the State's target of 2.7 lb/resident/day or a 34 percent reduction from 2014 disposal rates (CalRecycle 2015, CalRecycle 2012: 7). Future years would also see additional landfills adopting LFG capture systems, including Potrero Hills Landfill to which the unincorporated County sent 98 percent of its waste in 2014. Emission forecasts of the solid waste sector assume CalRecycle targets are met by 2020 and continue through 2050 and Potrero Hills Landfill would successfully implement its LFG capture system before 2020.

High-GWP Gases

A few current and potential policies could affect emissions of high-GWP gases included in this sector. At the federal level, effective on August 15, 2015, the EPA enacted a national ban on a variety of HFC emissions with very high-GWP values (many over 2,500) under 40 CFR Part 82. ARB estimates that this ban would reduce California's HFC emissions by ten percent annually below current emission rates by 2025 (ARB 2015c: 58). At the State level, ARB's current program in reducing fluorinated gases (F-gases), including HFCs, is the Refrigerant Management Program. This program requires facilities with refrigeration systems to inspect and repair leaks, maintain service records, and in some cases, report refrigerant use (ARB 2015c:

58). ARB is also considering additional reduction measures to reduce high-GWP gases in the state. ARB developed a draft paper in September 2015 that addresses the State's strategy to reduce emissions of short-lived climate pollutants, including F-gases. The draft strategy estimates that the additional State reduction measures could reduce F-gases by 40 percent below forecasted 2030 emissions that take into account current federal and State regulations (ARB 2015c). ARB is also considering developing regulatory requirements to use refrigerants with GWP values less than 150 in new commercial refrigeration systems no later than 2025.

Despite the State's proposed strategies, reduction targets for F-gases have not yet been adopted. Thus, the BAU forecast for this sector only applies EPA's current ban and assumes the ban would stay in place through 2050. However, it is speculative as to what gases would be used to replace the banned high-GWP gases. For the sake of simplifying calculations, it is assumed that high-GWP gases used in the County in future years would have GWP values of no more than 2,500 and overall gas usage would grow proportionally with population.

Other Sectors

Forecasted emissions from the off-road vehicle and agricultural sector are based on MTC's forecasted changes in employment and population and forecasted agricultural acreages from the County. Although OFFROAD 2007 incorporates regulatory actions such as reformulated fuels and more stringent emissions standards, the model was also developed before the recession and has population forecasts that would not be consistent with current estimates from the MTC. As such, current off-road emission factors are assumed to stay constant into the future and total emissions are scaled by either job or population growth depending on the off-road vehicle type (see Table 18). Agricultural emissions are directly scaled by the anticipated change in acreages.

DISCUSSION

As shown in Table 17 and Figure 2 below, the unincorporated County's BAU emissions, accounting for applicable legislative reductions, would decrease by 28 percent between 2014 and 2050 and be distributed evenly among emissions sources. Figure 2 also shows the emissions trend that would occur without anticipated legislative reductions and accounting only for population, housing, and employment changes. Without the legislative reductions, discussed above, emissions would be 58 percent higher in 2050 compared to BAU forecasts.

Between 2014 and 2020, emissions would decrease by five percent although population would grow by about one percent during the same time. This decrease would be due to several near term legislative actions including:

- The unincorporated County's membership in MCE starting from February 2015 which provides electricity with a 50 percent renewable mix (compared to 33 percent under PG&E) by 2020,
- New 2016 Building Energy Efficiency standards, improving energy efficiency in new buildings,
- The inception of a new LFG collection facility at Potrero Hills Landfill, which take 98 percent of the unincorporated County's waste, starting in early 2016,
- Reductions in vehicle emission factors forecasted in EMFAC 2014 (e.g. fuel efficiency improvements, 2 percent EV usage by 2020), and
- Reduced carbon sequestration from forecasted reductions in forest land, oak woodlands, and shrub lands by 2020, resulting in an increase in "emissions" from land use change.

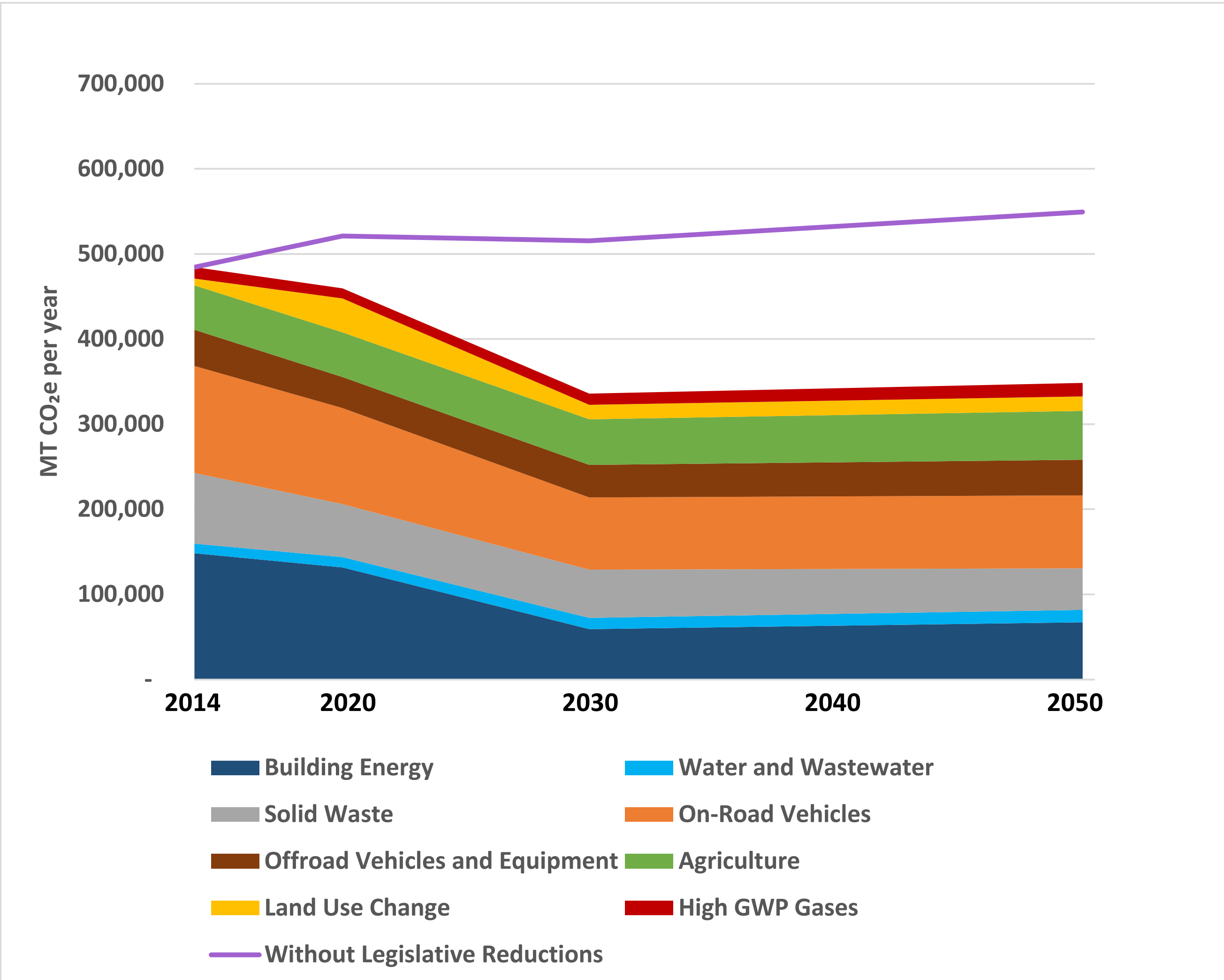
From 2020 to 2030, emissions would decrease by 31 percent below 2014 levels alongside a two percent population increase from 2014. This decrease would be due to a combination of continued and future planned legislative actions including:

- A 50 percent improvement in energy efficiency in existing buildings by 2030 as targeted under SB 350, considerably decreasing energy use in existing buildings,
- An increase in MCE's renewable mix to 80 percent by 2030, further reducing electricity related emissions,
- Non-MCE participants reaching the SB 350 schedule of meeting a 50 percent renewable mix goal by 2050 (this equates to 39 percent by 2030), and
- Reductions in vehicle emission factors forecasted in EMFAC 2014 (e.g. fuel efficiency improvements, 9 percent EV usage by 2030),

From 2030 to 2050, fewer new legislative actions are assumed to be in place, due to the lack of available information about potential State or federal actions beyond 2030. Thus, the County's population growth would begin to overtake any reductions afforded by existing legislative reductions. The main legislative reductions beyond 2030 would come from SB 350's target of a minimum 50 percent renewable mix for all electricity providers, which would apply to non-MCE participants. Other minor additional reductions would be in forecasted improvements in vehicle fuel economy and increased VMT share of EVs (10 percent by 2050), as estimated in the EMFAC2014 model. Other previous legislative actions would continue to apply into the future, but would not outpace growth in population, employment, and housing. Further forecast details are given in Table 18.

From the sector perspective, emissions from the on-road vehicle sector would replace building energy as the largest emissions sector in 2050 with 25 a percent of the inventory. From 2014 to 2050, building energy would transition from accounting for 31 percent of total emissions to 19 percent. Emissions from solid waste, agriculture, land use change would contribute equally to the inventory, between 13 and 14 percent per sector. Emissions from high-GWP gases, off-road equipment, and agriculture would remain steady between 2030 and 2050. Emissions from lost carbon sequestration would peak in 2020 due to forecasted land use changes by 2020 as natural land cover types would be converted to vineyards. Land use changes after 2020 would be more gradual. Future BAU emissions would decrease through 2050, even though total population would increase by 23 percent between 2014 and 2050.

Figure 2: Unincorporated Napa County Emissions Business-as-Usual Forecasts by Sector



Note that the temporary increase in 2020 for the "Without Legislative Reductions" trend line is due to forecasted changes in land usage that are not associated with any legislative reductions. Otherwise this trend is solely due to demographic forecast data shown in Table 16.

Table 17 Unincorporated Napa County Emissions Inventory and BAU Forecasts ($MTCO_2e$/yr)

Sector and Subsector	2005	2014	2020	2030	2050
Energy					
Residential	NA	47,984	42,497	19,436	22,914
Commercial	NA	99,385	88,606	39,981	44,573
Industrial	NA	993	696	174	184
Electric Vehicles	NA	-26	-164	-464	-487
Energy Subtotal	*143,540*	*148,337*	*131,635*	*59,127*	*66,184*
Water[1]					
Imported Water	NA	88	66	65	59
Wastewater Treatment Electricity Use outside of the Unincorporated County	NA	360	271	275	243
Wastewater (Domestic)	5,630	5,776	6,443	7,151	8,540
Wastewater (Wine Making)	4,270	5,053	5,348	5,743	5,737
Water Subtotal	*9,900*	*11,277*	*12,128*	*13,233*	*14,578*
Waste					
Solid Waste	9,240	19,961	3,537	3,938	4,744
Waste-In-Place	NA	63,125	58,809	52,773	44,109
Waste Subtotal	*9,240*	*83,086*	*62,345*	*56,711*	*48,854*
On-Road Vehicles					
Gasoline	NA	94,990	82,988	56,216	54,384
Diesel	NA	30,696	29,710	28,189	30,864
Electric	NA	25	156	441	487
Transportation Subtotal	*191,270*	*125,711*	*112,854*	*84,846*	*85,735*
Off-Road Vehicles and Equipment					
Construction	15,870	31,440	32,355	33,879	36,878
Transportation Refrigerants	NA	14	15	16	17
Lawn And Garden	750	1,212	1,301	1,448	1,745
Light Commercial	NA	899	925	969	1,054
Recreational And Pleasure Craft	NA	325	349	389	468
Industrial	NA	1,420	1,461	1,530	1,666
Locomotive	NA	20	20	20	20
Other	NA	7,177	7,701	8,575	10,331
Off-Road Vehicles and Equipment Subtotal	*16,620*	*42,508*	*36,406*	*38,230*	*41,828*
Agriculture					
Soil Management (includes residue burning)	1,900	3,797	3,889	4,108	4,606
Livestock	10,440	15,174	14,600	13,527	12,533
Farm Equipment	34,460	33,228	34,032	35,953	40,307
Agriculture Subtotal	46,800	52,198	52,521	53,588	57,445
Land Use Change					
Land Use Change Subtotal	*26,300*	*8,002*	*39,912*	*17,012*	*17,012*

Table 17 Unincorporated Napa County Emissions Inventory and BAU Forecasts ($MTCO_2e$/yr)

High-GWP Gases					
High-GWP Gases Subtotal	*NA*	*13,481*	*11,828*	*13,169*	*15,867*
Total without High-GWP Gases	**443,670**	**471,121**	**447,809**	**322,771**	**332,636**
Total with High-GWP Gases	**NA**	**484,602**	**459,637**	**335,940**	**348,503**

Notes: BAU = Business as usual, CO_2e = carbon dioxide equivalents, NA = Not Available, GWP = Global Warming Potential, MT = metric tons

[1] There was insufficient information on stormwater energy use for the unincorporated County. Thus, stormwater energy use and related emissions were excluded.
[2] This large increase in land use change "emissions" is due to land use forecasts from the County that show a high rate of land use change between 2015 and 2020 compared to other years.

Source: Ascent Environmental, 2016

Table 18 Unincorporated Napa County: BAU Forecast Methods and Legislative Adjustments, by Emissions Sector

Sector and Subsector	BAU Forecast Methods	
	Scaling Factors	Applied Legislative Reductions
Energy		
Residential Electricity	Scaled by housing units.	MCE 50% renewables baseline applied to 89% of energy use, based on current participation rates starting in early 2015. RPS scheduled targets applied to PG&E emission factors for 11% of customers assumed to opt out of MCE. Accounts for 2016 Title 24 energy efficiency gains for all new construction. Accounts for 50% renewable mix by 2050 for P&GE emission factors and 50% improvement in energy efficiency in all existing buildings starting in 2030, per SB 350.
Residential Natural Gas	Scaled by housing units.	Accounts for 2016 Title 24 energy efficiency gains for new construction. Accounts for 50% improvement in energy efficiency in all existing buildings starting in 2030, per SB 350.
Commercial Electricity	Scaled by employment	MCE 50% renewables baseline applied to 89% of energy use, based on current participation rates starting in early 2015. RPS scheduled targets applied to PG&E emission factors for 11% of customers assumed to opt out of MCE. Accounts for 2016 Title 24 energy efficiency gains for all new construction. Accounts for 50% renewable mix by 2050 for P&GE emission factors and 50% improvement in energy efficiency in all existing buildings starting in 2030, per SB 350.
Commercial Natural Gas	Scaled by employment	Accounts for 2016 Title 24 energy efficiency gains for new construction. Accounts for 50% improvement in energy efficiency in all existing buildings starting in 2030, per SB 350.
Industrial Electricity	Scaled by employment	MCE 50% renewables baseline applied to 89% of energy use, based on current participation rates starting in early 2015. RPS scheduled targets applied to PG&E emission factors for 11% of customers assumed to opt out of MCE. Accounts for 2016 Title 24 energy efficiency gains for all new construction. Accounts for 50% renewable mix by 2050 for P&GE emission factors and 50% improvement in energy efficiency in all existing buildings starting in 2030, per SB 350.
Industrial Natural Gas	Scaled by employment	Accounts for 2016 Title 24 energy efficiency gains for new construction. Accounts for 50% improvement in energy efficiency in all existing buildings starting in 2030, per SB 350.
Water		
Imported Water	Scaled by population	Assumes only City of Calistoga has joined MCE's program with at least a 50% renewable mix. All other water providers outside the unincorporated area are assumed to follow the RPS and SB 350 target schedule.
Wastewater (Domestic)	Scaled by population	Assumes electricity use at all treatment plants outside the unincorporated area follow the RPS and SB 350 target schedule.
Wastewater (Wine Making)	Scaled by vineyard acres	Assumes electricity use at all treatment plants outside the unincorporated area follow the RPS and SB 350 target schedule.
Waste		
Solid Waste	Scaled by population.	Incorporates completion dates of near term LFG projects. Assumes California's 75% waste diversion goal would be achieved in Napa by 2020.
Waste-in-Place	Scaled by population	Assumes California's 75% waste diversion goal would be achieved Napa by 2020.
On-Road Vehicles		
Vehicle Miles Traveled	Estimated by the Metropolitan Transportation Commission	EMFAC emission factors considerations include ACC, Pavley, TTGHG, and fuel efficiency standards for medium- and heavy-duty vehicles.

Off-Road Vehicles and Equipment		
Construction	Scaled by employment	No additional legislative reductions.
Transportation Refrigerants	Scaled by employment	No additional legislative reductions.
Lawn and Garden	Scaled by population	No additional legislative reductions.
Light Commercial	Scaled by employment	No additional legislative reductions.
Recreational and Pleasure Craft	Scaled by population	No additional legislative reductions.
Industrial	Scaled by employment	No additional legislative reductions.
Agriculture		
Soil Management	Scaled by change in all cropland including vineyards as provided by the County.	
Livestock	Scaled by change in rangeland forecasts as provided by the County from 2005 through 2030 and 2050 changes in rangeland extrapolated from anticipated growth between 2005 and 2030.	
Farm Equipment	Scaled by change in all cropland including vineyards	No additional legislative reductions.
Land Use Change		
Land Use Change	Forecasted changes in all land use types as provided by the County. County provided forecasted land use changes for land cover types lost to vineyard development from 2005 to 2020 and 2030. County also provided 2015 land use cover estimates. Where forecast data were not available, future land cover estimates were extrapolated from available land use data between 2005 and 2015 or between 2015 and 2030.	
High-GWP Gases		
High-GWP Gases	Scaled by population	Assumes federal ban on refrigerants with GWP higher than 2500.

Notes: ACC = Advanced Clean Cars, BAU = business as usual, GWP = global warming potential, RPS = Renewable Portfolio Standard, LFG = Landfill Gas, MCE= Marin Clean Energy, PG&E = Pacific Gas and Electric, SB = Senate Bill , TTGHG = Tractor-Trailer Greenhouse Gas

Source: Ascent Environmental, 2016

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