MCCAP

Marin County Climate Action Plan

(2015 Update)

July 2015

Prepared by:
ICF International

Prepared for:
Marin County

Photo: Carlos Porrata

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Community Groups and Agencies

Bolinas Community Public Utility District
Central Marin Sanitation Agency
Las Gallinas Valley Sanitary District
Marin Carbon Project
Marin Municipal Water District
Marin Sanitary Service
Marin Clean Energy (MCE)
Metropolitan Transportation Commission
North Marin Water District
Novato Sanitary District
Pacific Gas and Electric Company
Sausalito Marin City Sanitary District
Sewerage Agency of Southern Marin
Stinson Beach County Water District
Tomales Village Community Services District
Transportation Authority of Marin
UC Cooperative Extension

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Tables

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Acronyms and Abbreviations

2006 GHG Reduction Plan	Marin County Greenhouse Gas Reduction Plan in 2006
AB	Assembly Bill
ABAG	Association of Bay Area Governments
ARB	California Air Resources Board
BAAQMD	Bay Area Air Quality Management District
BACERP	Bay Area Climate & Energy Resilience Project
BayREN	Bay Area Regional Energy Network
BCDC	Bay Conservation and Development Commission
C&D	construction and demolition
CAA	federal Clean Air Act
CAFF	Community Alliance with Family Farmers
CalCAN	California Climate and Agriculture Network
Caltrans	California Department of Transportation
CAP Update	Climate Action Plan Update
CAPCOA	California Air Pollution Control Officers Association
CCA	Community Choice Aggregation
CEQA	California Environmental Quality Act
CIMIS	California Irrigation Management Information System
cm	centimeters
County	County of Marin
Countywide Plan	2007 Marin Countywide Plan
EOF	Emergency Operations Facility
EPA	U.S. Environmental Protection Agency
EVs	electric vehicles
GHG	greenhouse gas
GWP	global warming potential
HFCs	hydrofluorocarbons
ICLEI	ICLEI—Local Governments for Sustainability
JPA	Joint Powers Authority
LGOP	Local Government Operations Protocol
MCE	Marin Clean Energy
MCEP	Marin Climate and Energy Partnership
MCEW	Marin County Energy Watch

MCP	Marin Carbon Project
$MMTCO_2e$	million metric tons of carbon dioxide equivalent
MTC	Metropolitan Transportation Commission
$MTCO_2e$	metric tons of carbon dioxide equivalent
MTCO2e	metric tons of carbon dioxide equivalent
NPV	net present value
NRCS	Natural Resources Conservation Service
OPC	Ocean Protection Council
PACE	property assessed clean energy
PFCs	perfluorinated carbons
PG&E	Pacific Gas and Electric
RCD	Marin Resource Conservation District
RPS	Renewables Portfolio Standard
SB 375	Senate Bill 375
SCS	sustainable communities strategy
SLR	sea level rise
SMART	Sonoma-Marin Area Rail Transit
TAM	Transportation Authority of Marin
UCCE	University of California Cooperative Extension
USDA	U.S. Department of Agriculture
VMT	vehicle miles traveled

Executive Summary

Photo: Marin Community Development Agency

Introduction

The Unincorporated County of Marin (hereafter referred to as "County" or "Marin County") acknowledges that climate change due to global warming poses an immediate threat to the environment and to human health and society. The consensus among leading scientists is that it is essential to reduce greenhouse gas (GHG) emissions.

Marin County was one of the first counties in California to take formal action addressing GHG emissions when it adopted the *Marin County Greenhouse Gas Reduction Plan*[1] in 2006 (2006 GHG Reduction Plan). Measures identified in the GHG Reduction Plan were then incorporated into the *Marin Countywide Plan* update which was adopted in 2007. The 2006 GHG Reduction Plan set a target to reduce GHG emissions from both community and municipal activities in the unincorporated areas of Marin County by at least 15% below 1990 levels by 2020. The County government and private sector have invested heavily in energy efficiency, renewable energy, alternative fuel vehicles, water conservation, and waste minimization to reduce GHG emissions substantially. By 2012, the County had already reduced community emissions to 15% below 1990 levels—8 years ahead of the 2020 target.

This document, the *Marin County Climate Action Plan 2015 Update* (CAP Update), builds on the 2006 GHG Reduction Plan and provides an update of GHG emissions in 2012, forecasts of emissions for 2020, and an assessment of actions that the County will take to further reduce emissions by 2020. The CAP Update includes two targets.

- **2020 Community Emissions Reduction Target**—a goal to reduce GHG emissions from community activities in unincorporated areas of Marin County by at least 30% below 1990 levels by 2020. This target is more than the 2006 GHG Reduction Plan target and more ambitious than the state's goals in Assembly Bill (AB) 32, which commits to reducing statewide GHG emissions to 1990 levels by 2020. California Executive Order S-03-05, which was issued in 2005, articulates a long-term goal for the state of 80% below 1990 emissions levels by 2050. If adopted, the County's target of 30% below 1990 levels by 2020 would be one of the most ambitious local jurisdiction reduction targets in California and the United States. Because the County is already ahead of its 2006 community target for 2020, Marin is now adopting a more aggressive community target in the CAP Update to achieve even greater reductions than previously planned in an attempt to get ahead of the curve and be on-track to meet the S-03-05 statewide target for 2050.
- **2020 Municipal Emissions Reduction Target**—a goal to reduce GHG emissions from the County's municipal activities by at least 15% below 1990 levels by 2020.[2] This target is consistent with the 2006 GHG Reduction Plan target. Because the County is on-track to meet the original 2006 municipal target for 2020, Marin is retaining the same target for the CAP Update.

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[1] At that time, the term "Climate Action Plan" had not yet been adopted but the Greenhouse Gas Reduction Plan was the functional equivalent of a CAP.

[2] The current 1990 municipal emissions estimate does not account for all sources of emissions because of data limitations. Actual emissions in 1990 are therefore higher than emissions reported here. Consequently, municipal emissions in 2012 are likely lower compared to actual 1990 emissions than reported here, and the county may be able to reduce actual emissions by more than 15% below 1990 levels by 2020.

The proposed new community emissions target would put the County on the forefront of climate action planning in California and a trajectory to reduce emissions significantly by 2050.

This CAP Update describes the County's plan for reaching these targets, including specific strategy areas for each of the major emissions sectors, and provides details on the 2012 and projected 2020 emissions in the unincorporated areas.

Implementing state measures and the local measures in the CAP Update would avoid the generation of more than 100,000 metric tons of carbon dioxide equivalent ($MTCO_2e$) in 2020 (annually), which is equivalent to the following individual actions (U.S. Environmental Protection Agency 2014a):

- removing more than 20,000 passenger vehicles from the road each year,[3] or
- reducing gasoline consumption by more than 11 million gallons per year, or
- providing renewable energy to power over 9,000 homes each year.

The actions in the CAP Update are priority actions and intended for near-term implementation, such that the County can achieve its GHG reduction targets for 2020 for the unincorporated areas of Marin County.

Marin County Greenhouse Gas Emissions Inventories and Forecasts

In 2012, estimated GHG emissions generated by community activities in Marin County's unincorporated areas were approximately 477,000 $MTCO_2e$ (Figure ES-1), or per capita emissions of approximately 7.1 $MTCO_2e$ for the 67,000 residents in the unincorporated areas. This amount is equivalent to the annual GHG emissions generated by approximately 100,000 passenger vehicles. Of these total emissions, as shown in Figure ES-1, on-road transportation and building energy use (residential and non-residential) are the largest sources of emissions (35% each). The third largest source is agriculture (23%)[4], followed by off-road equipment (4%), solid waste treatment (2%), wastewater treatment (1%), and water conveyance (0.2%).

For municipal activities from County government operations, estimated GHG emissions in 2012 were approximately 15,000 $MTCO_2e$ (Figure ES-2), or emissions of 7.0 $MTCO_2e$ per County employee. This amount is equivalent to the annual GHG emissions generated by approximately 3,000 passenger vehicles. Of these total emissions, as shown in Figure ES-2, employee commute is the largest source of emissions (43%). Building energy use is the second largest source of emissions (36%). The third largest source is the vehicle fleet (18%), followed by wastewater treatment (1.4%), streetlights and traffic signals (0.6%), refrigerants (0.4%), stationary sources (0.4%), solid waste generation (0.3%), and water conveyance (0.2%).

[3] Assuming 10,000 miles traveled per year in a typical vehicle.

[4] Nearly all of Marin County's agricultural activity occurs in the unincorporated area. When comparing agricultural emissions to countywide emissions, including emissions in the incorporated cities, agricultural emissions make up only about 6% of overall emissions. California's agricultural emissions, by comparison, are 8% of total emissions.

Figure ES-1. Unincorporated Marin County 2012 Community Greenhouse Gas Emissions Inventory by Sector

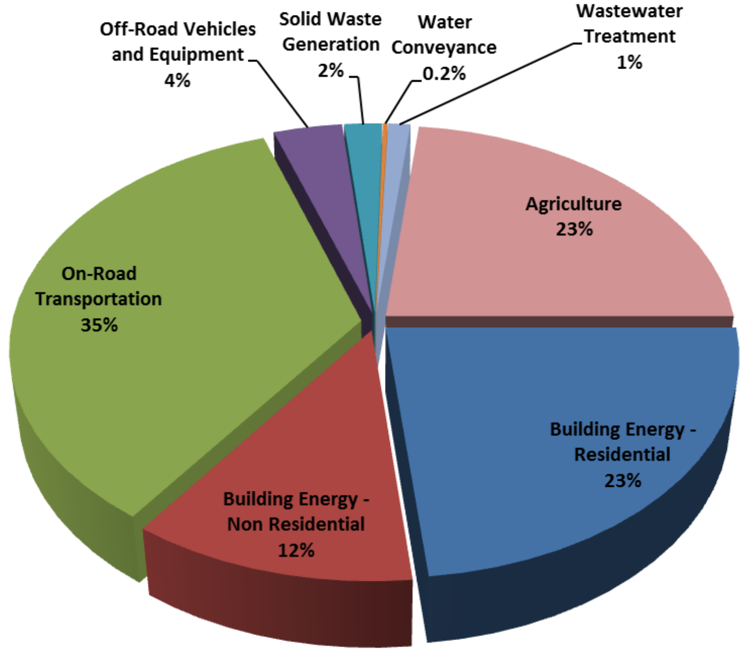
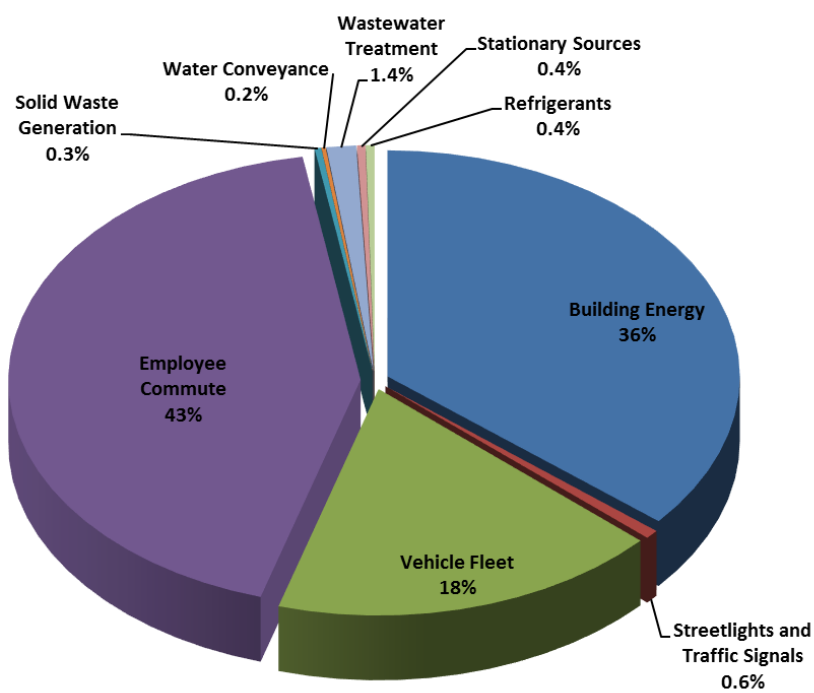


Figure ES-2. Unincorporated Marin County 2012 Municipal Greenhouse Gas Emissions Inventory



The CAP Update is composed of state and local actions to reduce GHG emissions within the unincorporated areas. The state actions considered in the CAP Update include the Renewables Portfolio Standard, Title 24 Standards for Commercial and Residential Buildings (Energy Efficiency and CALGREEN), Pavley/Advanced Clean Cars (Vehicle Efficiency), the Low Carbon Fuel Standard, and various AB 32 transportation reduction strategies. These state actions generally do not require action from the County but will result in local GHG reductions in the unincorporated areas.

State Actions

The following state actions will reduce GHG emissions in the County.

RPS: The RPS obligates certain utilities to procure at least 33% of retail sales from renewable resources by 2020.

Title 24: Requires that building shells and building components be designed to conserve energy and water.

Pavley: Will reduce GHG emissions from automobiles and light-duty trucks by 30% from 2002 levels by the year 2016.

LCFS: Will reduce GHG emissions by requiring a low carbon intensity of transportation fuels sold in California by at least 10% by the year 2020.

As the county grows, energy consumption, water usage, waste generation, and transportation activities will increase. For the CAP Update, the County developed two business-as-usual (BAU) forecasts to evaluate the impacts of this growth on future GHG emissions in 2020, one for community emissions (referred to as the *2020 BAU Community Forecast*) and one for municipal emissions (referred to as the *2020 BAU Municipal Forecast*). These forecasts are based on changes in population, households, and employment and represent scenarios that do not consider the effects of future local, state, or federal actions to reduce GHG emissions. Table ES-1 compares the 2020 BAU Community Forecast to the 1990 and 2012 Community GHG Inventories and indicates that community GHG emissions are expected to increase by 3% (13,392 $MTCO_2e$) between 2012 and 2020. Much of this difference is attributable to increases in building energy use, vehicle trips, and off-road equipment. Table ES-2 compares the 2020 BAU Municipal Forecast to the 1990 and 2012 Municipal GHG Inventories and indicates that municipal GHG emissions are expected to increase by 13% (1,899 $MTCO_2e$) between 2012 and 2020. This difference is largely due to the new Emergency Operations Facility (EOF) and increasing activity as the County hires new employees.

Table ES-1. Unincorporated Marin County 1990 and 2012 Community Greenhouse Gas Emissions Inventories and 2020 Business-as-Usual Forecast

Emission Sector[a]	Emissions ($MTCO_2e$) 1990	2012	2020	Percent Growth 1990–2012	2012–2020
Building Energy—Residential	131,265	111,484	115,713	-15%	4%
Building Energy—Non-Residential	74,190	55,142	61,194	-26%	11%
On-Road Transportation	193,544	166,773	167,002	-14%	0.1%
Off-Road Vehicles and Equipment	19,300	17,126	19,823	-11%	16%
Solid Waste Generation	14,414	9,362	9,358	-35%	-0.04%
Water Conveyance	1,319	1,157	1,215	-12%	5%
Wastewater Treatment	5,453	5,562	5,745	2%	3%
Agriculture[b]	122,366	110,850	110,798	-9%	-0.05%
Marin County Total	**561,851**	**477,456**	**490,848**	**-15%**	**3%**
Emissions for Informational Purposes					
Stationary Sources ($MTCO_2e$/year)	–	648	688	–	6%
Forestry ($MTCO_2e$/year)	–	*-207,151*	*-207,151*	–	*0%*
Rangeland Soil Carbon Stock (MT C)[c]	–	*10,783,021*	*10,783,021*	–	*0%*
Aboveground Carbon Stock (MT C)[c]	–	*7,248,888*	*7,248,776*	–	*0%*

Notes:

$MTCO_2e$ = metric tons of carbon dioxide equivalent. MT C = metric tons of carbon.

Additional emissions sources that were not estimated (or included in the inventory or forecasts) include aircraft, non-local passenger rail, freight rail, ferries, ozone depleting substances, and other gases with high global warming potential.

Agricultural emissions make up about 6% of overall countywide emissions when including the cities.

Rangeland soil carbon and aboveground carbon stock numbers are in units of metric tons of carbon, not metric tons of carbon dioxide equivalent. These are reported on a total mass basis, not on an annual basis.

Table ES-2. Unincorporated Marin County 1990 and 2012 Municipal Greenhouse Gas Emissions Inventories and 2020 Business-as-Usual Forecast

Emission Sector[a]	Emissions ($MTCO_2e$) 1990	2012	2020	Percent Growth 1990–2012	2012–2020
Building Energy	3,100	5,499	6,701	77%	22%
Streetlights and Traffic Signals	52	97	98	87%	1%
Vehicle Fleet[b]	4,900	2,732	2,973	-44%	9%
Employee Commute	7,100	6,528	6,957	-8%	7%
Solid Waste Generation	29	47	50	63%	7%
Water Conveyance	0	29	32	–	8%
Wastewater Treatment	0	207	222	–	7%
Stationary Sources	0	59	63	–	7%
Refrigerants	0	61	78	–	29%
Marin County Total	**15,181**	**15,258**	**17,175**	**1%**	**13%**

Notes:

$MTCO_2e$ = metric tons of carbon dioxide equivalent.

[a] Emissions from energy consumed in leased facilities are not included because energy use data were not available from Pacific Gas & Electric.

[b] Emissions from off-road vehicles are included in the vehicle fleet sector.

Actions to Reduce Greenhouse Gas Emissions

The CAP Update includes a variety of regulatory and incentive-based strategies that will reduce GHG emissions from both existing and new development in the county. Local strategies adopted by the County will supplement state programs and achieve additional emissions reductions.

There are 15 local community actions and 8 local municipal actions included in the CAP Update. Additional supporting but unquantified actions are described in Appendix C. These local actions are grouped into the following strategy areas.

- Energy Efficiency and Renewable Energy (community and municipal actions).
- Land Use, Transportation, and Off-Road Equipment (community actions only).
- Vehicle Fleet and Employee Commute (municipal actions only).
- Water Conservation and Wastewater Treatment (community and municipal actions).
- Waste Reduction, Reuse, and Recycling (community and municipal actions).
- Agriculture (community actions only).

Many of the local actions are cost effective, particularly in the Energy Efficiency and Renewable Energy strategy area, with several energy efficiency investments that can recoup initial costs in 1–5 years. In addition to reducing GHG emissions, all local actions have many co-benefits, such as improved public health.

The following figures present the GHG Reduction Targets for community and municipal emissions. They show the BAU emissions for 2020 along with the contribution of state and local measures, by individual sector, toward the target. Figure ES-3 presents the community greenhouse gas reduction goal, and Figure ES-4 presents the municipal greenhouse gas reduction goal.

Greenhouse Gas Reduction Goals

Figure ES-3. Unincorporated Marin County Community Greenhouse Gas Reduction Goal

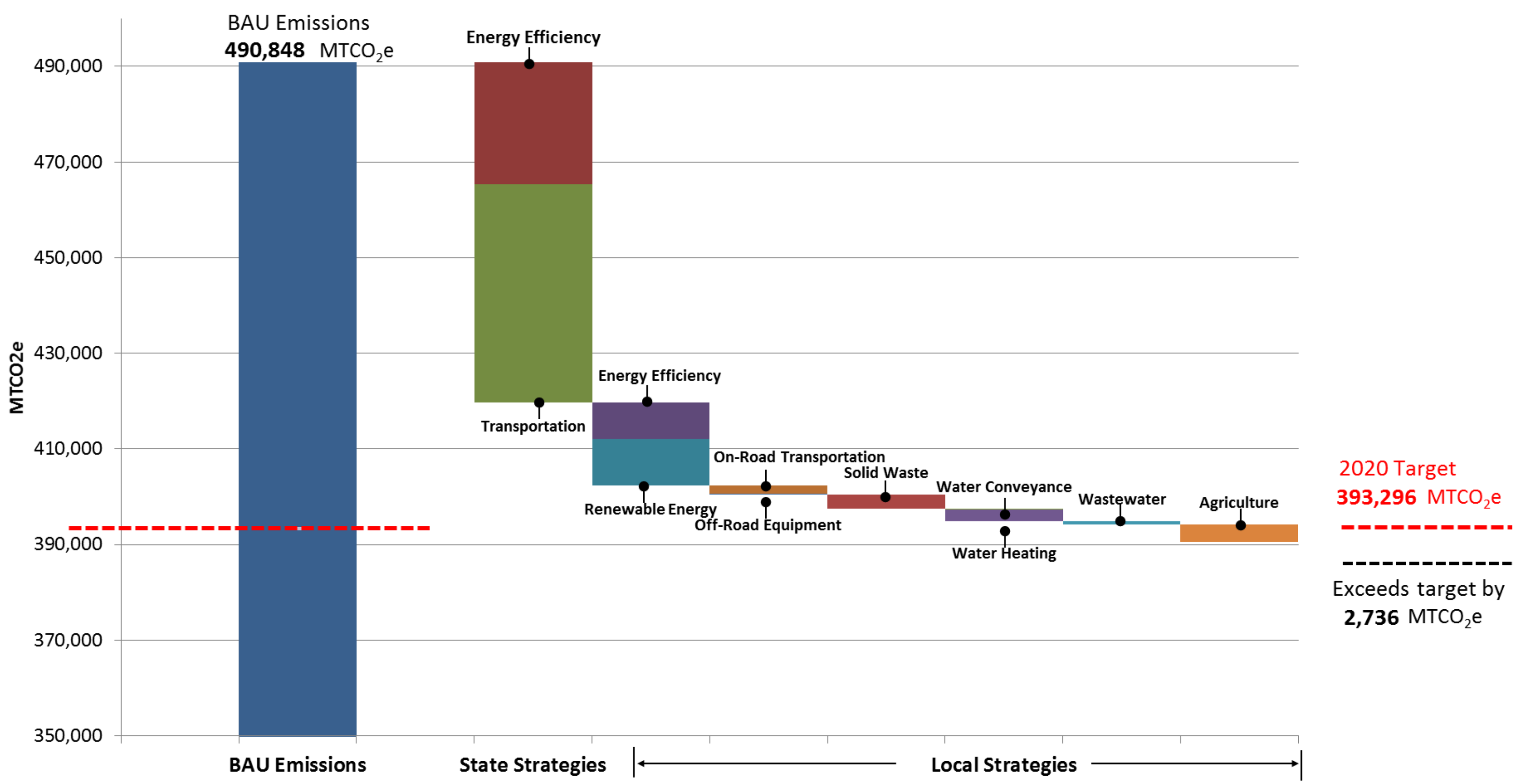
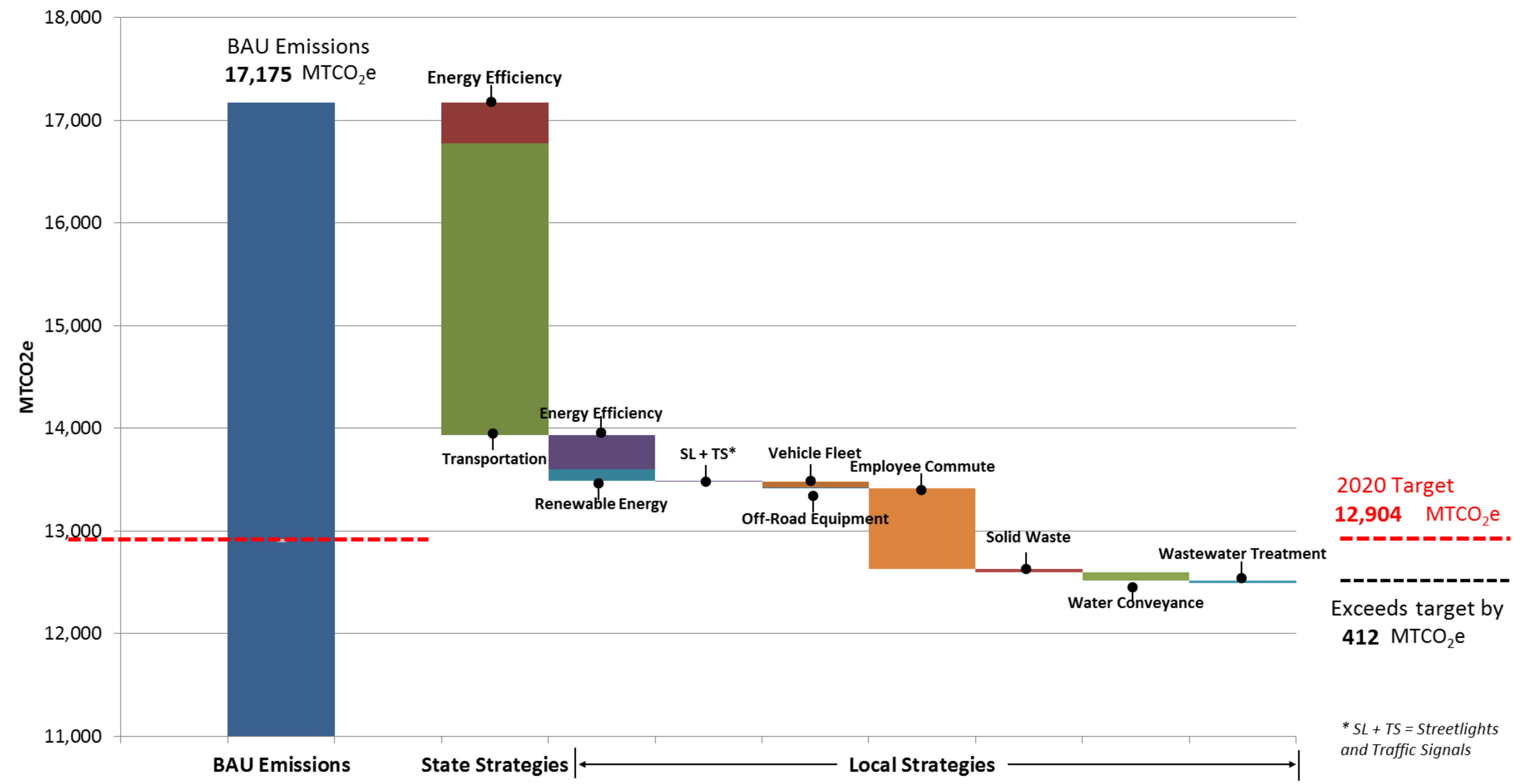


Figure ES-4. Unincorporated Marin County Municipal Greenhouse Gas Reduction Goal



The following summaries for each strategy area include information on existing and continuing initiatives, estimated GHG reductions, potential community co-benefits, and the relevant CAP Update actions. Anticipated community co-benefits are presented in Figure ES-5.

Figure ES-5. Community Co-Benefits

Community Actions

ENERGY EFFICIENCY AND RENEWABLE ENERGY

2020 GHG Reductions
17,386 $MTCO_2e$

Strategies

Energy-1 Community Choice Aggregation
Energy-2 Energy Efficiency
Energy-3 Solar Energy

Community Co-Benefits

60%
of 2020 Local Reductions

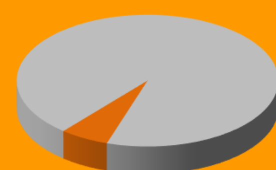
LAND USE, TRANSPORTATION, AND OFFROAD EQUIPMENT

2020 GHG Reductions
1,769 $MTCO_2e$

Strategies

Trans-1 Land Use Design and VMT Reduction
Trans-2 Expand Transit Service
Trans-3 Electric Vehicle Charging Stations
Trans-4 Electric-Powered Landscaping Equipment

Community Co-Benefits



6%
of 2020 Local Reductions

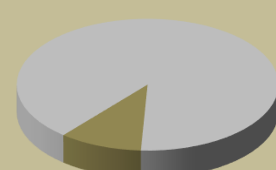
WASTE REDUCTION, REUSE, AND RECYCLING

2020 GHG Reductions
2,995 $MTCO_2e$

Strategies

Waste-1 Zero Waste by 2025

Community Co-Benefits



10%
of 2020 Local Reductions

WATER CONSERVATION AND WASTEWATER TREATMENT

2020 GHG Reductions

3,256 $MTCO_2e$

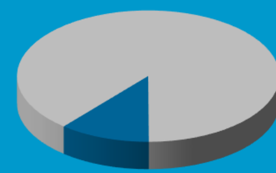
Strategies

Water/Wastewater-1 Water Conservation

Water/Wastewater-2 Increase Pump Efficiency

Water/Wastewate-3 Reduce Wastewater Generation

Community Co-Benefits



11%

of 2020 Local Reductions

AGRICULTURE

2020 GHG Reductions

3,691 $MTCO_2e$

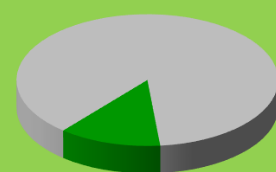
Strategies

Agriculture-1 Methane Capture and Energy Generation at Dairies

Agriculture-2 Carbon Farming (not included in reduction total)

Agriculture-3 Promote the Sale of Locally Grown foods and/or products

Community Co-Benefits



13%

of 2020 Local Reductions

Municipal Actions

ENERGY EFFICIENCY AND RENEWABLE ENERGY

2020 GHG Reductions

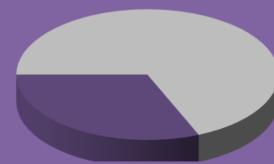
451 $MTCO_2e$

Strategies

Energy-1 Energy Efficiency

Energy-2 Solar Energy

Community Co-Benefits



31%

of 2020 Local Reductions

VEHICLE FLEET AND EMPLOYEE COMMUTE

2020 GHG Reductions

851 $MTCO_2e$

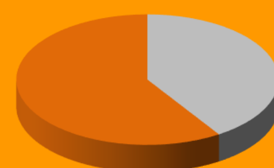
Strategies

Trans-1 New Vehicles

Trans-2 Alternative Transportation

Trans-3 Trip Reduction

Community Co-Benefits



59%

of 2020 Local Reductions

WASTE REDUCTION, REUSE, AND RECYCLING

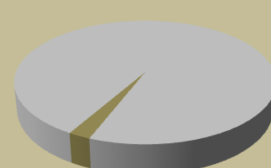
2020 GHG Reductions

34 $MTCO_2e$

Strategies

Waste-1 Increase Recycling at County Facilities

Community Co-Benefits



2%

of 2020 Local Reductions

WATER CONSERVATION AND WASTEWATER TREATMENT

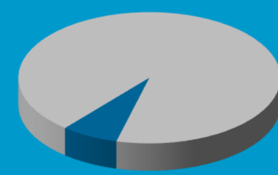
2020 GHG Reductions

102 $MTCO_2e$

Strategies

Water/Wastewater-1 Water Conservation

Community Co-Benefits



7%

of 2020 Local Reductions

Summary of Strategies

The following tables present a list of the GHG reduction strategies and their overall goals/targets.

Table ES-3. Summary of Community Emissions Reduction Strategies

Strategy Area	Local Strategy	Target/Goal
ENERGY EFFICIENCY AND RENEWABLE ENERGY	Energy-1. Community Choice Aggregation	Increase participation in the Deep Green program from 1% to 5%
	Energy-2. Energy Efficiency	
	Energy-2.1. Community Energy Efficiency Retrofits	All existing energy retrofit programs
	Energy-2.2. Expand Community Energy Efficiency Retrofits Program	Existing buildings will be retrofit as follow: • 20% of existing single-family homes • 20% of existing multi-family homes • 15% of existing nonresidential buildings
	Energy-2.3. Shade Tree Planting	Plant at least 310 shade trees per year
	Energy-3. Solar Energy	
	Energy-3.1. Solar Installations for New Residential Development	Install solar on 20% of new residential buildings
	Energy-3.2. Solar Installations for New Nonresidential Development	Install solar on 20% of new nonresidential buildings
	Energy-3.3. Solar Installations for Existing Residential Development	Install solar on 20% of existing residential buildings
	Energy-3.4. Solar Installations for Existing Nonresidential Development	Install solar on 15% of existing nonresidential buildings

Strategy Area	Local Strategy	Target/Goal
LAND USE AND TRANSPORTATION	Trans-1. Land Use Design and VMT Reduction	
	Trans-1.1 Promote Mixed-Use, Infill, and Transit-Oriented Developments	Promote longstanding Countywide Plan growth control strategy of focusing new development in the city center corridor through mixed-use, infill, and transit-oriented developments in downtown neighborhoods, transit-hubs, and transit corridors
	Trans-1.2. Vehicle miles traveled (VMT) Reduction Monitoring and Implementation and Transportation Demand Management Program	Require performance thresholds for reducing the VMT 20% below BAU levels in new developments
	Trans-1.3. Transportation Marketing	Implement marketing strategies to reduce commute trips
	Trans-2. Expand Transit Service	Expand local and regional bus service in range and/or frequency where service expansion would result in higher bus occupancy and lower GHG emissions per passenger mile than for average passenger vehicles.
	Trans-3. Electric Vehicle Charging Stations	Install 20 new electric vehicle (EV) charging stations by 2020
	Trans-4. Electric-Powered Landscaping Equipment	10% of landscaping equipment will be electric- or battery-powered
WASTE REDUCTION, REUSE, AND RECYCLING	Waste-1. Zero Waste by 2025	Divert from landfills at least 83% of waste generated in the county overall by 2020
WATER CONSERVATION AND WASTEWATER TREATMENT	Water/Wastewater-1. Water Conservation	
	Water/Wastewater-1.1. Senate Bill X7-7	20% reduction in urban per capita use
	Water/Wastewater-1.2. Additional Water Conservation for New Construction	Require adoption of the voluntary CALGreen Tier 1 water efficiency measures for new residential and nonresidential construction
	Water/Wastewater-1.3. Additional Water Conservation for Existing Buildings	Encourage existing buildings to adopt voluntary CALGreen Tier 1 water efficiency measures
	Water/Wastewater-2. Increase Pump Efficiency	10% reduction in water-related energy use by 2020
	Water/Wastewater-3. Reduce Wastewater Generation	Reduce residential wastewater generation by at least 15% and nonresidential wastewater generation by at least 10%
AGRICULTURE	Agriculture-1. Methane Capture and Energy Generation at Dairies	Encourage the installation of methane digesters to capture methane emissions from the decomposition of manure. Capture 50% of methane emissions from 20% of all cows
	Agriculture-2. Carbon Farming	Support voluntary efforts of Marin County farmers and ranchers to increase soil carbon through sustainable farming practices.
	Agriculture-3. Promote the Sale of Locally Grown Foods and/or Products	Support local farmer's markets and school and community gardens to support local sustainable agricultural practices.

Table ES-4. Summary of Municipal Emissions Reduction Strategies

Strategy Area	Local Strategy	Target / Goal
ENERGY EFFICIENCY AND RENEWABLE ENERGY	Energy-1. Energy Efficiency	
	Energy-1.1. Energy Efficiency Measures for the New Emergency Operations Facility	Save 1.17 million kilowatt hours and 812 therms at the EOF
	Energy-1.2. Existing Building Retrofit Program	Reduce electricity use by 5% through retrofits of existing County buildings
	Energy-1.3. Energy Efficiency Measures for County-Owned Computers and Printers	• replace 100 traditional desktop or laptop computers with tablets • replace 50 printers with EnergyStar printers
	Energy-1.4. Computer Energy Management	Use Verdiem software (or other similar software) to reduce energy consumption in computers
	Energy-1.5. Shade Tree Planting	Plant 10 new shade trees each year
	Energy-1.6. Install Energy-Efficient Street Lights	Require that all streetlights use LED bulbs. Install light meters on streetlights at key distribution points
	Energy-2. Solar Energy	
	Energy-2.1. Install Solar Panels on Municipal Facilities	Install solar on municipal facilities by aiming to provide 1.1% of all 2012 electricity consumed by County buildings and properties by 2020
	Energy-2.2. Solar Panel Carports and Parking Areas[b]	Install solar panels over carports and parking areas (the equivalent of 200 parking spaces)
VEHICLE FLEET AND EMPLOYEE COMMUTE	Trans-1. New Vehicles	
	Trans-1.1. Purchase Fuel-Efficient (e.g., hybrid) and/or Smaller Fleet Vehicles to Replace Existing Fleet Vehicles	Replace 25 County-owned traditional-fueled vehicles (passenger/light-duty, medium-duty, and heavy-duty vehicles) with the most efficient vehicles (hybrid, compressed natural gas, or diesel) available
	Trans-1.2. Electric Vehicles	Replace 20 non-emergency gasoline-powered sedans with electric vehicles
	Trans-1.3. Electric Landscaping Equipment	Replace 10 pieces of County landscaping equipment with electric equipment
	Trans-2. Alternative Transportation	
	Trans-2.1. Guaranteed Ride Home	Provide a free shuttle or taxi ride home to employees in case of an emergency
	Trans-2.2. Green Commute Program	Reestablish the County's Green Commute Program
	Trans-2.3. Electric Vehicle Charging Stations	Install 10 new EV charging stations at County facilities by 2020
	Trans-3. Trip Reduction	
	Trans-3.1. Encourage Telecommuting by Municipal Employees	Update telework policies and practices for employees
	Trans-3.2. Municipal Parking Management	Implement a Municipal Parking Management Program to discourage private vehicle use; implement a $1.00 parking price for employees at selected County facilities

Strategy Area	Local Strategy	Target / Goal
WASTE REDUCTION, REUSE, AND RECYCLING	Waste-1. Increase Recycling at County Facilities	Increase the recycling rate at County facilities: • Civic Center – 83% • County Jail – 83% • 120 North Redwood – 83% • Kerner Campus – 83% • Marin County Fair – 95% • Marin Home Show – 95%
WATER CONSERVATION AND WASTEWATER TREATMENT	Water/Wastewater-1. Water Conservation	
	Water/Wastewater-1.1. Water Conservation for Existing Buildings	Require a 10% savings in indoor and outdoor water use for existing buildings
	Water/Wastewater-1.2. Irrigation Monitoring and Management System	Install a water monitoring and management system for all of the County's irrigation needs

Implementation Program

The county faces many challenges—and correspondingly many opportunities—as it moves to reduce GHG emissions. Establishing a realistic and effective management program is necessary to ensure the CAP Update meets its GHG reduction objectives and is implemented in a timely and efficient manner. The County's Sustainability Team will lead and coordinate the County's efforts on implementing, monitoring, and managing the emissions reduction strategies. Composed of County staff, the Sustainability Team will be responsible for updating and adaptively managing the CAP Update.

Involvement from residents, businesses and County departments is integral to the success of the CAP Update, particularly because several strategies depend on voluntary commitment. Community members will incur some costs of implementing the emissions reduction strategies, although the County will help identify funding opportunities and resources to reduce monetary burdens on the private sector. The County will also develop a detailed community outreach and education plan to leverage community involvement, interests, and perspectives. The County will encourage and seek public participation in the implementation process. The County will reach out to vulnerable populations and make sure that a diversity of voices is heard and included in planning efforts for emission reductions and adaptation. The County will invest in grassroots education and training programs for the public, such as the Shore Up Marin partnership.[5]

Following adoption of the CAP Update, the emissions reduction strategies will be implemented to ensure the County's 2020 emissions reduction targets are achieved. Beginning in 2015, strategies will be prioritized for implementation based on several factors including cost effectiveness, emissions reduction efficacy, and general benefits to the community. Specific timelines and milestones for each strategy will be developed by the Sustainability Team (through consultation with various agencies, regional partners, community organizations, etc.) early in the implementation process.

[5] Shore Up Marin is a partnership founded by Earth Day Marin, the Canal Welcome Center, Marin Grassroots, and GreenUp Learning. The mission is to support a diverse coalition of Marin residents across race, class, and other differences and advocate for equitable responses to climate change and sea level rise. More information is available here: http://earthdaymarin.org/ShoreUpMarin.html.

During each year of implementation, the County will monitor emissions reductions achieved by the state and local strategies. Data collected by routine monitoring will document the County's progress in reducing emissions and enable the County to make informed decisions on future priorities, funding, and scheduling. The County will monitor and track emission reduction progress, using tools that will allow for easy communication with the public. For example, In January 2015, the Marin Climate and Energy Partnership launched a new website to help track the climate efforts of Marin County jurisdictions over time.[6] The County will also update the Community and Municipal Inventories, first in 2017 and again in 2019, to measure overall emissions trends in the community. The updated inventories will be submitted to the Board of Supervisors and distributed to the public for review. As the year 2020 approaches, the County will develop reduction targets for years beyond 2020 to continue the County's commitment to reducing GHG emissions.

Adaptation Plan

Adaptation refers to reducing the impact of unavoidable climate change effects. Although Marin currently enjoys a relatively mild climate, climate change may exacerbate existing climate-related hazards in the county (such as increased incidence of flooding) or introduce new challenges (such as erosion or coastal and bayland flooding due to sea level rise). These climate change effects could have wide-ranging impacts across the county's various economic sectors. It is important that Marin County considers potential climate change vulnerabilities as it moves forward with other planning activities.

Current research efforts have shown that Marin County and the North Bay region have already experienced some changes in climate, including increases in temperature and precipitation. Projections indicate that temperatures will continue to increase (North Bay Climate Adaptation Initiative 2013a) and that the region will most likely experience a shift to drier summers and wetter winters, characterized by heavier rain events (North Bay Climate Adaptation Initiative 2013a), and there will be a rise in local sea levels (Cayan et al. 2008; Knowles 2010, State of California Ocean Protection Council 2013). Increases in temperature, changes in precipitation, and sea level rise could result in the increased frequency or intensity of certain climate hazards, including shifts in the water supply and demand, wildfires, extreme heat, and inland flooding. Section 7 of this report explores the impacts of these climate hazards, potential adaptation actions, and suggests key stakeholders to engage relative to the following sectors: water, natural heritage, transportation, agriculture, energy, and human health.

There are many adaptation efforts already under way in Marin County. The County has proven to be a leader in thinking about adaptation and taking action to increase resiliency of local resources. However, there has not been a consolidated look at the vulnerabilities of Marin County across sectors and climate change stressors. A more comprehensive, countywide vulnerability assessment would help highlight where resources should be focused under adaptation planning efforts. Furthermore, effective adaptation requires coordination across many different stakeholders within a county, and a "big picture" understanding of the sectors and geographic locations that are most vulnerable would help demonstrate where coordination and collaboration are most needed.

[6] For more information, please see: http://www.marintracker.org/

Funding Acknowledgement

Funding for the CAP Update was provided in part by the Marin County Energy Watch (MCEW), a joint project of Pacific Gas and Electric (PG&E) and the County of Marin.[7] MCEW provides resources and incentives to residents, businesses, and public agencies to increase energy efficiency. All public agencies, business, and residences in the county who are PG&E or Marin Clean Energy customers can participate.

[7] MCEW is funded by California utility ratepayers under the auspices of the California Public Utilities Commission.

Chapter 1
Introduction and Purpose

Photo: Fabio Sironi

Chapter 1
Introduction and Purpose

1.1 Purpose of the Climate Action Plan Update

The County of Marin (County) plans to reduce and avoid greenhouse gas (GHG) emissions associated with both community and municipal activities, which include everyday activities of local residents and businesses within the unincorporated county along with municipal County government operations. The goal of this CAP Update is two-fold: to reduce community GHG emissions to 30% below 1990 levels—a goal referred to as the *2020 Community Emissions Reduction Target;* and to reduce municipal GHG emissions to 15% below 1990 levels by 2020—a goal referred to as the *2020 Municipal Emissions Reduction Target*. Emissions that result from the County's municipal operations are distinct from community activities and include activities like municipal building operation and operation of the County's police and fire vehicles.

The CAP Update consolidates many of the County's existing initiatives on climate change and provides a blueprint for a more sustainable future. The actions outlined in the CAP Update have other benefits beyond reducing GHG emissions, and will improve air quality, reduce traffic congestion, and create new opportunities for walking and biking. The County's 2020 emissions reduction targets go above and beyond larger statewide efforts established by Assembly Bill (AB) 32, the California Global Warming Solutions Act. New development proposed within the county can use the CAP Update to address GHG impacts and streamline project-level environmental review of climate change impacts under the California Environmental Quality Act (CEQA). The CAP Update therefore serves as a mechanism to facilitate sustainable development[8] as well as a tool to support community-wide reductions in GHG emissions.

The CAP Update also outlines a plan to adapt to climate change, which will better prepare the County to address potential economic, environmental, and social effects of climate change. GHG concentrations in the atmosphere are believed to be already high enough that some degree of climate change will happen despite emissions reduction efforts. Preparing for these changes—or *adaptation*—is therefore a necessary component of the County's strategy to address climate change. The CAP Update identifies key areas of potential vulnerability and establishes a framework for responding to potential climate change threats in an effective and coordinated manner that promotes long-term community resiliency.

The CAP Update covers the unincorporated county and the areas of the County's jurisdiction. It does not include the incorporated cities. The cities have jurisdiction over their own areas, and thus, the cities are not included in the CAP Update. Many of the cities already have or are working on their own local CAPs. However, to implement successful planning to reduce GHG emissions and adapt to climate change on a regional scale, the County will coordinate with the cities as part of implementation of this plan. The County and the cities may also consider funding a joint regional planning effort to combine, streamline, and implement the various GHG emission reduction

[8] Sustainable development is a broad category of development, but it generally means development that minimizes environmental impacts such that intact environmental resources are maintained for future generations.

programs and adaptation actions contained within each separate local CAP. This effort would ensure that programs throughout the county would be consistent and that the combined financial and logistical resources of all cities and the County would be used to make meaningful climate action planning a reality.

1.2 Basic Terms

Definitions of common terms used in this CAP Update appear below.

- **AB 32.** The California Global Warming Solutions Act of 2006, widely known as AB 32, requires the California Air Resources Board (ARB) to develop and enforce regulations for the reporting and verification of statewide GHG emissions. The heart of the bill is the requirement that statewide GHG emissions must be reduced to 1990 levels by the year 2020 of the AB 32 Scoping Plan.
- **AB 32 Scoping Plan**. The Scoping Plan for AB 32 was developed by ARB and approved in December 2008. The Scoping Plan has a range of GHG reduction actions, which include direct regulations, compliance mechanisms, monetary and non-monetary incentives, voluntary actions, and market-based mechanisms such as a cap-and-trade system. ARB has already adopted numerous regulations and is currently conducting additional rulemaking for reducing GHG emissions to achieve the emissions cap by 2020. On May 15, 2014, ARB posted the first update to the Scoping Plan. This update builds upon the initial Scoping Plan with new strategies and recommendations, identifies opportunities to leverage existing and new funds, defines the climate change priorities of ARB for the next 5 years, and builds a foundation to support the long-term goals identified in Executive Orders S-3-05 and B-16-2012. The update also presents the state's progress toward meeting the 2020 GHG emission reduction goals defined in the initial scoping plan. The AB 32 Scoping Plan provides a roadmap for achieving these reductions and recommends a complementary reduction goal for local governments of 15% below current emissions levels (2008), which is roughly equivalent to 1990 emission levels.
- **Business-as-Usual (BAU) Forecasts**. BAU represents a future scenario that does not consider the possible reduction of GHG emissions that may result from any legislation or regulation that would go into effect after the inventory year. The BAU projections are estimates of future emissions based on energy and carbon intensity in the existing economy with the expected increases in population and economic growth in the future. Two BAU forecasts are presented in this CAP Update: the *2020 BAU Community Forecast*, which estimates GHG emissions from the community, and the *2020 BAU Municipal Forecast*, which estimates GHG emissions from County operations.
- **Community GHG Emissions Inventory**. Abbreviated as *Community Inventory*, this inventory quantifies GHG emissions occurring in association with the land uses within the jurisdictional boundaries of the unincorporated county, and generally consists of emissions sources that the community can influence or control. It is an activity-based inventory (as opposed to a consumption-based inventory). The inventory includes emissions that occur both inside and outside the jurisdictional boundaries, but only to the extent that such emissions are due to land uses and activities within the unincorporated county. Data from the 1990 Community Inventory and the 2012 Community Inventory are presented in this CAP Update.

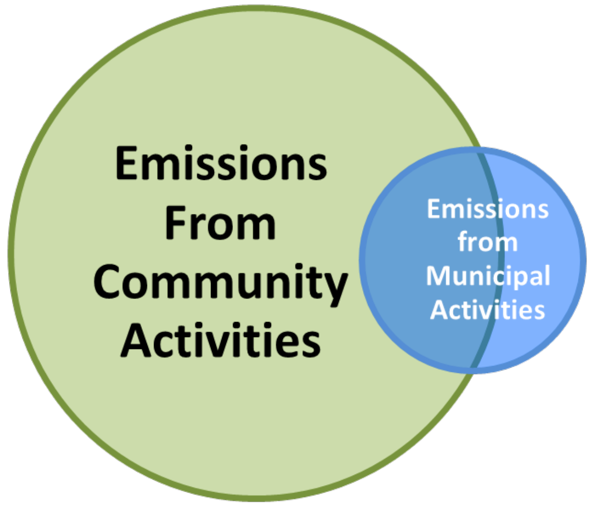
- **Municipal GHG Emissions Inventory**. Abbreviated as *Municipal Inventory*, this inventory quantifies GHG emissions occurring in association with municipal operations and activities of the County government. It is an activity-based inventory (as opposed to a consumption-based inventory). The inventory boundaries are defined by the "operational control" approach, which means that the local government has the full authority to introduce and implement its operating policies at each emissions source. Examples include County buildings, vehicle fleet, and activities required to provide services to the community. Data from the 1990 Municipal Inventory and the 2012 Municipal Inventory are presented in this CAP Update.
- **Emissions Type**. GHG emissions can be classified as either *direct* (emissions that occur at the end use location, such as natural gas combustion for building heating) or *indirect* (emissions that result from consumption at the end use location but occur at another location, such as the consumption of electricity in a residence which results in emissions that occur at the power plant). The CAP Update addresses both types of emissions. The term *emissions* refers to GHG emissions and not to emissions of air quality pollutants.
- **Unit of Measure**. The unit of measure used throughout the CAP Update is metric tons of carbon dioxide equivalent ($MTCO_2e$). Presenting inventories in carbon dioxide equivalence allows characterization of the complex mixture of GHG as a single unit taking into account that each gas has a different global warming potential (GWP). One million $MTCO_2e$ is abbreviated $MMTCO_2e$.

1.3 Community and Municipal Climate Action Planning

The CAP Update includes various programs and policies that will reduce community GHG emissions to 30% below 1990 levels and municipal GHG emissions to 15% below 1990 levels. The 2012 Community Inventory focuses on GHG emissions that result from activities within the unincorporated areas of the County. Some of these emissions may be due to municipal activities and some may not. The 2012 Municipal Inventory focuses on GHG emissions that result from the County's municipal operations and does not include GHG emissions generated by the community (i.e., these emissions are included in the 2012 Community Inventory).

Within the CAP Update, community actions and municipal actions are distinct from one another with separate approval processes and timelines. However, there may be some minor overlap in the emissions that are accounted for in both inventories where County facilities and actions occur in the unincorporated County areas. The emissions in these sectors may be counted as both municipal and community emissions, as illustrated in Figure 1-1. For example, employee commute emissions are counted as municipal emissions, but they may also occur in the unincorporated areas and would therefore be included in vehicle miles traveled data for the unincorporated areas. As such, there may also be some overlap in the associated actions to reduce these emissions. Because some of the County's operations take place within the jurisdiction of cities and pertain only to municipal operations, the County's municipal emissions do not entirely overlap with community emissions in the unincorporated areas (Figure 1-1). To the extent that any overlap of programs or policies may occur, the County anticipates working with all appropriate departments and stakeholders to ensure that these programs and policies are developed as efficiently as possible, while still meeting both the community and municipal goals of the CAP Update.

Figure 1-1. Overlap between Community Emissions and Municipal Emissions[9]



1.4 Contents of the Climate Action Plan Update

The CAP Update consists of the following chapters. Several appendices that provide additional detail and background information are included at the end of the document.

- Chapter 1, *Introduction and Purpose*, describes the purpose of the CAP Update and provides recommendations for using the CAP Update.
- Chapter 2, *Climate Change Science and Regulations*, summarizes information about climate change projections and GHG regulations.
- Chapter 3, *Updated Emissions Inventories and Forecasts*, includes the 1990 and 2012 GHG emissions inventories for community and municipal activities, as well as the County's 2020 BAU forecasts.
- Chapter 4, *Community Greenhouse Gas Reduction Goals and Measures*, identifies the County's community emissions reduction goals for the CAP Update and describes the measures the County will pursue to reduce community GHG emissions. The chapter estimates potential GHG reductions and associated co-benefits for each measure.
- Chapter 5, *Municipal Greenhouse Gas Reduction Goals and Measures*, identifies the County's municipal emissions reduction goals for the CAP Update and describes the measures the County will pursue to reduce municipal GHG emissions. The chapter estimates potential GHG reductions and associated co-benefits for each measure.
- Chapter 6, *Agriculture*, provides a discussion of GHG reduction efforts in the County that are focused on increasing carbon stock within agricultural soils and vegetation.

[9] The sizes of the circles are not to scale but attempt to illustrate the difference between community and municipal emissions.

- Chapter 7, *Greenhouse Gas Reduction Measure Implementation*, provides recommendations for implementing the GHG reduction measures, including funding approaches, County actions, and mechanisms for monitoring and updating the analysis.
- Chapter 8, *Climate Change Adaptation*, discusses the implications of climate change within the county and outlines adaptation strategies.
- Chapter 9, *References*, includes citations for the documents used to prepare the CAP Update.

1.5 How to Use the Climate Action Plan Update for CEQA "Tiering"

Marin County can use the CAP Update to comply with project-level review requirements pursuant to the California Environmental Quality Act (CEQA). CEQA guidelines specify that CEQA project evaluation of GHG emissions can "tier off" a programmatic analysis of GHG emissions, provided that the programmatic analysis (or climate action plan) does the following (CEQA Guidelines Section 15183.5).

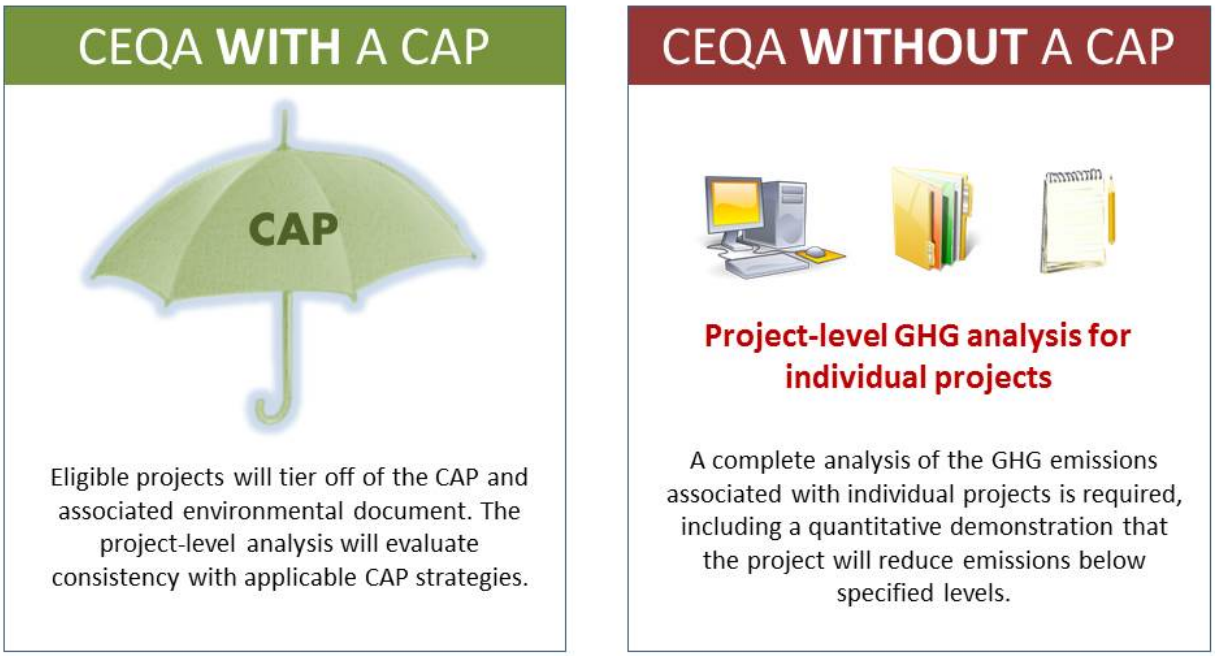
- Quantify GHG emissions, both existing and projected over a specified time period, resulting from activities within a defined geographic area.
- Establish a level, based on substantial evidence, below which the contribution to GHG emissions from activities covered by the plan would not be cumulatively considerable.
- Identify and analyze the GHG emissions resulting from specific actions or categories of actions anticipated within the geographic area.
- Specify measures or a group of measures, including performance standards that substantial evidence demonstrates, if implemented on a project-by-project basis, would collectively achieve the specified emissions level.
- Monitor the plan's progress.
- Adopt the GHG reduction strategy in a public process following environmental review.

The CAP Update meets CEQA Guidelines Section 15183.5 listed above by 1) quantifying all primary sectors of GHG emissions within the county for 1990, 2012, and 2020; 2) including a reduction target of 30% below 1990 levels for community emissions, which is above and beyond the recommendations in the AB 32 Scoping Plan for municipalities to support the overall AB 32 reduction targets; 3) analyzing community emissions for the County and including predicted growth expected by 2020; 4) including specific measures to achieve the overall reduction target; 5) including periodic monitoring of plan progress; and 6) submitting the CAP Update to be adopted in a public process following compliance with CEQA.

Once the CAP Update is adopted, project-specific environmental documents that incorporate applicable CAP measures can tier off the CAP (and any necessary CEQA documentation for adoption of the CAP) to meet project-level CEQA evaluation requirements for GHG emissions. Tiering can eliminate the need to prepare a quantitative assessment of project-level GHG emissions. Rather, project-specific environmental documents that rely on the CAP Update can qualitatively evaluate GHG impacts by identifying all applicable CAP measures and describing how those measures have been incorporated into the project design and/or identified as mitigation. This type of tiered analysis can reduce project costs and streamline the County CEQA process as it relates to GHG emissions. Projects that demonstrate consistency with applicable CAP Update actions can be determined to have a less–than-significant cumulative impact on GHG emissions and climate change (notwithstanding substantial evidence that warrants a more detailed review of project-level GHG emissions). The CEQA process for all issues other than GHG emissions would not be affected by the CAP streamlining.

Figure 1-2 shows the benefits of tiering off of the CAP and associated environmental document (also known as *project streamlining*) to meet CEQA requirements.

Figure 1-2. CEQA and the CAP: Project Streamlining Benefits



The Bay Area Air Quality Management District (BAAQMD) issued recommended CEQA guidelines in 2011 that included recommended GHG evaluation methods and thresholds. Although the guidelines are not presently recommended by the district because of a legal challenge pending at the California Supreme Court on a matter that is not related to the GHG evaluation methods and thresholds, the BAAQMD CEQA guidelines still provide a useful framework for consideration by local jurisdictions. The BAAQMD CEQA guidelines state that a project that is consistent with a "qualified GHG reduction strategy" per State CEQA Guidelines Section 15183.5 can be considered less than significant for GHG emissions. If a project is not consistent with a "qualified GHG reduction strategy," then the BAAQMD CEQA guidelines also include a recommended quantitative GHG emissions significance threshold of 1,100 $MTCO_2e$ for land use projects and a recommended GHG "efficiency" significance threshold of 4.6 $MTCO_2e$ per service population (service population = employees + residents).

The County will retain the discretion to determine the specific CEQA evaluation approach to individual projects. For land use development projects, such as residential, commercial, and mixed-use projects, for which this CAP Update has fully analyzed GHG emissions and adopted appropriate local GHG reduction measures, it is likely that the County will evaluate projects for their consistency with the CAP Update and use that determination of consistency as the significance evaluation for GHG emissions under CEQA. However, the County may also decide, on a case-by-case basis, to utilize the BAAQMD mass emissions GHG threshold (or other thresholds) for certain projects, particularly projects that may not precisely be anticipated in the GHG analysis done for this CAP Update.

Chapter 2
Climate Change Science and Regulations

Photo: Marin Community Development Agency

Chapter 2
Climate Change Science and Regulations

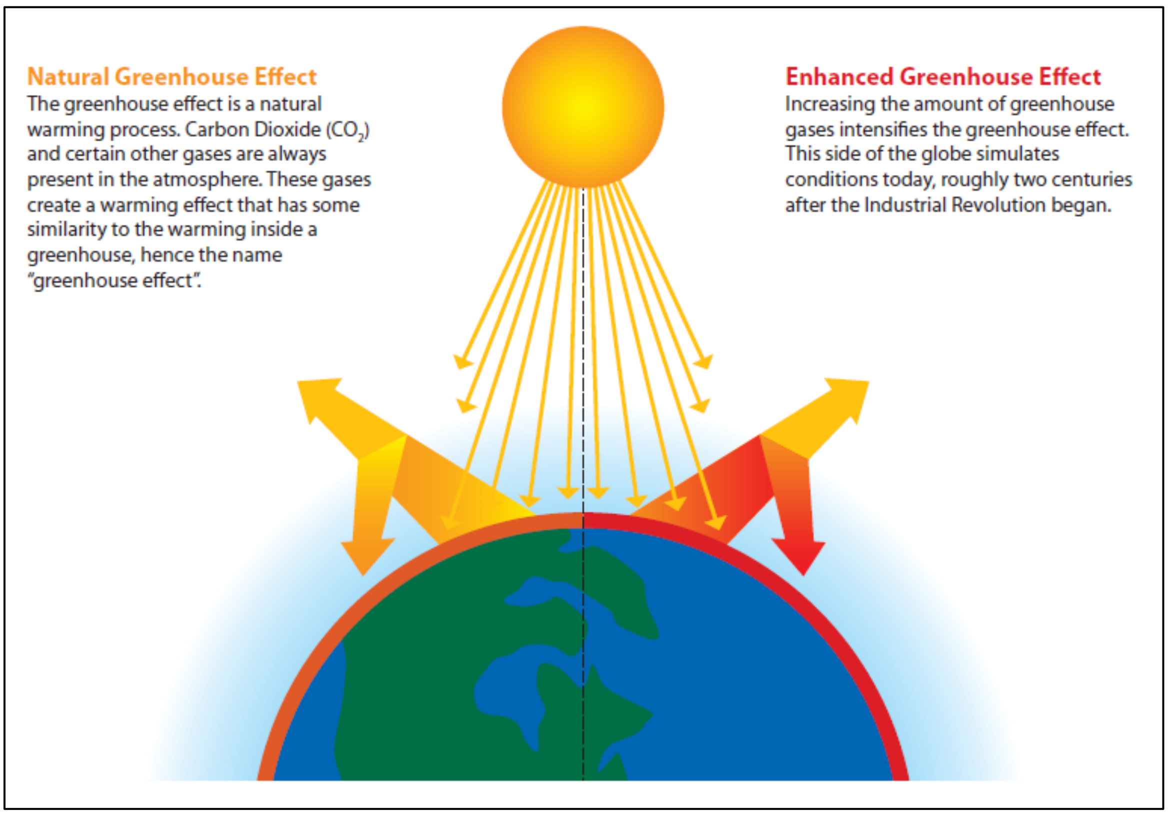
2.1 Introduction

This chapter provides a background on climate change and the greenhouse effect, a summary of local climate change effects, and an overview of climate change regulations, including state and local actions.

2.2 Background on Climate Change and GHG Emissions

The phenomenon known as the *greenhouse effect* keeps the atmosphere near Earth's surface warm enough for the successful habitation of humans and other life forms. The greenhouse effect is created by sunlight that passes through the atmosphere (Figure 2-1). Some of the sunlight striking Earth is absorbed and converted to heat, which warms the surface. The surface emits a portion of this heat as infrared radiation, some of which is absorbed by GHGs in the atmosphere and re-emitted in all directions, including back toward Earth's surface. Human activities that generate GHGs increase the amount of infrared radiation absorbed by the atmosphere, thus enhancing the greenhouse effect and amplifying the warming of the Earth (Center for Climate and Energy Solutions 2011).

Figure 2-1. The Greenhouse Effect



Increases in fossil fuel combustion and deforestation have exponentially increased concentrations of GHGs in the atmosphere since the Industrial Revolution. Rising atmospheric concentrations of GHGs in excess of natural levels result in increasing global surface temperatures—a phenomenon commonly referred to as *global warming*. Higher global surface temperatures in turn result in changes to Earth's climate system, including increased ocean temperature and acidity, reduced sea ice, variable precipitation, and increased frequency and intensity of extreme weather events (Intergovernmental Panel on Climate Change 2013). Large-scale changes to Earth's climate system are collectively referred to as *climate change*.

Climate Change and Global Warming

The terms *global warming* and *climate change* are often used synonymously, but they refer to two different processes. Increasing global surface temperatures as a result of rising atmospheric concentrations of GHGs, in excess of natural levels, is known as *global warming*. Large-scale changes to the Earth's system induced by higher global surface temperatures are collectively referred to as *climate change*.

While changes in global climate have been recorded throughout history, there is strong consensus among the scientific community that recent changes are the result of human-made GHG emissions. A recent study published in *Environmental Research Letters* indicates that 97% of climate scientists agree that human activity is "very likely" causing current global warming trends (Cook et al. 2013). Every national academy of science in the world likewise concurs that human-made GHG emissions are accelerating the magnitude and pace of climate change.

AB 32 identifies the following compounds as the major GHGs: carbon dioxide, methane, nitrous oxide, perfluorinated carbons (PFCs), sulfur hexafluoride, and hydrofluorocarbons (HFCs). Generally, these emissions are quantified in terms of $MTCO_2e$ emitted per year, which accounts for the relative warming capacity, or global warming potential (GWP) of each gas. Water vapor is not identified by AB 32 as a key GHG because natural concentrations and fluctuations far outweigh anthropogenic influence. Table 2-1 describes the key characteristics and sources of the six major GHGs identified by AB 32.

Sources, Sinks, and Global Warming Potentials for Greenhouse Gases

Natural and human activities that generate GHGs are commonly referred to as emissions *sources*. The burning of fossil fuels to power buildings and vehicles is the primary source of CO_2 and a key contributor of CH_4 and N_2O emissions. A GHG *sink* removes and stores GHGs. For example, vegetation is a sink because it removes atmospheric CO_2 during photosynthesis.

GHGs are not created equally. The Global Warming Potential, or GWP, is used to compare GHGs based on their potential to trap heat and remain in the atmosphere. Some gases can absorb more heat than others, and thus have a greater impact on global warming. For example, CO_2 is considered to have a GWP of 1, whereas N_2O has a GWP of 265. This means that N_2O is 265 times more powerful than CO_2.

Table 2-1. Principal Greenhouse Gas Emissions

Greenhouse Gas	Chemical Formula(s)	Primary Emissions Sources	Global Warming Potential[a]	Atmospheric Lifetime (years)
Carbon Dioxide	CO_2	• Burning of fossil fuels • Gas flaring • Cement production • Land use changes • Deforestation	1	50–200
Methane	CH_4	• Agricultural practices • Natural gas combustion • Landfill outgassing	28	12.4
Nitrous Oxide	N_2O	• Agricultural practices • Nylon production • Gas-fired power plants • Nitric acid production • Vehicle emissions	265	121
Perfluorinated Carbons	CF_4 C_2F_6	• Aluminum production • Semiconductor manufacturing	6,630–11,100	10,000 – 50,000
Sulfur Hexafluoride	SF_6	• Power distribution • Semiconductor manufacturing • Magnesium processing	23,500	3,200
Hydrofluorocarbons	HFC-23 HFC-134a HFC-152a	• Consumer products • Automobile air conditioners • Refrigerants	138–12,400	1.5–222

Source: Intergovernmental Panel on Climate Change 2013.

[a] The GWPs listed here are 100-year values without carbon-climate feedbacks.

The majority of GHG emissions generated in the United States and California are in the form of carbon dioxide. In 2011, for example, carbon dioxide accounted for 84% of the federal GHG inventory, with most of these emissions generated through the combustion of fossil fuels. Fossil fuels are burned to create electricity and heat to power homes, commercial buildings, and vehicles. In the United States, energy used to power buildings is the primary source of GHG emissions, representing 33% of the 2011 federal GHG inventory. The transportation sector is the next largest source GHG emissions (28%) (U.S. Environmental Protection Agency 2013). In California, the emissions profile is reversed, with the transportation sector representing the largest source of emissions (38%), following by electricity generation (23%) for a total of 61% of the state's emissions (California Air Resources Board 2013). By comparison, the unincorporated county follows the federal trend with emissions from on-road transportation and building energy use constituting the largest sources of emissions (each representing 35% of the total 2012 community inventory for a total of 70%). Other sources of GHG emissions generated in the United States and California include industrial processes, commercial and residential buildings, and agricultural activities.

2.3 Local Climate Change Effects

Increases in Extreme Heat Conditions. Heat waves and very high temperatures could last longer and become more frequent. On average, the North Bay region (including Marin County) is expected to warm 2–7 degrees Fahrenheit over land by mid-century (North Bay Climate Adaptation Initiative 2013a). Extreme heat in this historically temperate climate may threaten human health, cause heat stress in animals, and shorten the expected lifespan or increase the need for repairs in the built environment.

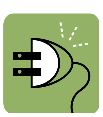
Inland Flooding. Increased intensity of winter storm events combined with sea-level rise may cause more frequent flooding, especially in low-lying areas. An increase in the variability of rainfall could contribute to an increase in the likelihood of the frequency and intensity of extreme events such as floods in the North Bay (Micheli et al. 2012; North Bay Climate Adaptation Initiative 2013a).

Rising Sea Levels. Sea levels are expected to steadily rise by mid-century, which could inundate portions of the coastline (Cayan et al. 2008; Knowles 2010, State of California Ocean Protection Council 2013). Increased sea levels and elevation of storm surge could cause more area within the county to be temporarily or permanently inundated by salt and brackish waters.

Shift in Water Demand and Supply. Although models project divergent trends of either more or less precipitation in the future, all scenarios indicate more variability and intensity of extreme events, including droughts (Flint et al. 2012; North Bay Climate Adaptation Initiative 2013a). Shifting precipitation patterns and extended periods of drought would limit the available supply of water. Increased temperatures and low soil moisture increase the demand for water as people require more water for their gardens, agriculture, etc.

Wildfires. The risk of wildfire danger in Marin County will likely increase due to increased temperatures and shifts in precipitation patterns, which may include extended dry spells (Westerling and Bryant 2008; North Bay Climate Adaptation Initiative 2013b).

Changes in Growing Season. Changes in growing season conditions could cause variations in crop quality and yield. Plant and wildlife distributions may also be affected by changes in temperature, competition from colonizing species, regional hydrology, sea level, and other climate-related effects (Cornwell et al. 2012; North Bay Climate Adaptation Initiative 2013b).



Shift in Energy Demand and Supply. Increased temperatures and a decreased (or inconsistent) water supply could have a negative impact on the availability of energy. Although there are no electric generation facilities in Marin County, changes in energy supply and demand could lead to higher energy prices, brownouts, or other impacts that affect Marin.

2.4 Climate Change Regulations

2.4.1 Federal, State, and Regional Initiatives

Climate change is widely recognized as an imminent threat to the global climate, economy, and population. The U.S. Environmental Protection Agency (EPA) has acknowledged potential threats imposed by climate change in a Cause or Contribute Finding, which found that the GHG emissions from new motor vehicles contribute to pollution that threatens public health and welfare and was a necessary finding prior to adopting new vehicle emissions standards that reduce GHG emissions. Federal climate change regulation under the federal Clean Air Act (CAA) is also currently under development. Standards for carbon dioxide emissions from new fossil-fuel-fired electricity power plants have also been proposed by the U.S. Environmental Protection Agency (EPA) and outlined in the *President's Climate Action Plan*. If approved, these standards would be the first to establish national GHG limits for the electric power industry. In summer 2014, the EPA released draft emissions standards for existing electricity power plants that are scheduled to be adopted in 2015.

California has adopted statewide legislation to address various aspects of climate change and reduce GHG emissions. AB 32 codified the state's GHG emissions target by requiring that statewide GHG emissions be reduced to 1990 levels by 2020. The AB 32 Scoping Plan identifies specific measures to achieve this goal and requires that the ARB and other state agencies develop and enforce regulations and other programs for reducing GHGs. Many of the state regulations under AB 32 are aimed at large sources of emissions such as stationary sources and transportation fuels. The AB 32 Scoping Plan also articulates an important role for local governments in achieving the statewide target, recommending that they establish GHG reduction goals for both their municipal operations and the community, consistent with those of the state.

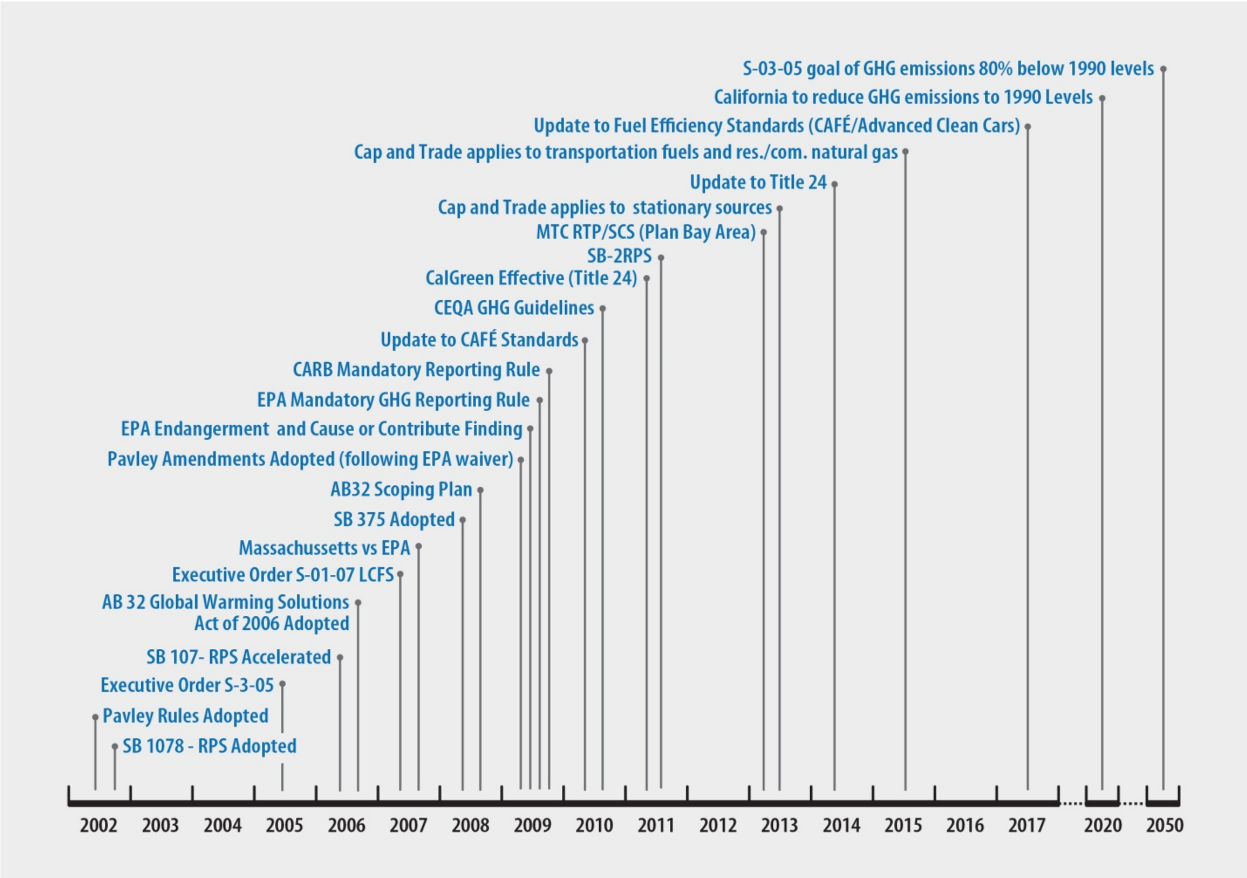
The Metropolitan Transportation Commission (MTC) is the metropolitan transportation organization in the region. Pursuant to Senate Bill 375 (SB 375), MTC has adopted a sustainable communities strategy (SCS) that promotes reductions in on-road transportation GHG emissions by fostering improved regional land use policies and increased transit and other alternatives to vehicular travel.

The Bay Area Air Quality Management District (BAAQMD) leads regional regulation of stationary sources and also often coordinates with local governments on reduction of air pollution from new projects, both of which can also result in reduction of GHG emissions.

2.4.2 Local Actions

Marin County has a long history of implementing and promoting initiatives to protect the environment and conserve natural resources. The County's commitment to environmental stewardship is born from an understanding that the community and its residents depend on the health of the environment. The following community-based sustainability programs and policies have been adopted by the County and will contribute to long-term GHG reductions. Many of these actions were included in the 2006 *Marin County Greenhouse Gas Reduction Plan* (2006 GHG Reduction Plan). The CAP Update builds on these existing programs and proposes additional strategies the County and community can implement to help reduce GHG emissions within Marin County.

Figure 2-2. Key Federal, State, and Regional Greenhouse Gas Legislation



2.4.2.1 Community Actions

- **Marin Clean Energy**. Marin Clean Energy, launched in 2010, is a community choice aggregation program and electricity provider that works with Pacific Gas & Electric Company (PG&E) to provide customers with 50%–100% renewable energy.
- **Green Business Program**. Business in the county can be certified with Green Business Program if they pledge to stay green, and select measures to conserve water, conserve energy, reduce waste, and prevent pollution. Businesses that participate receive streamlined environmental assistance, money saving opportunities, and promotional items to distribute to customers.
- **Marin Energy Watch Partnership**. The Marin Energy Watch Partnership provides resources and incentives to residents, businesses, and public agencies to increase energy efficiency. All public agencies, business, and residences in the county who are PG&E or Marin Clean Energy customers can participate.
- **Energy Upgrade California**. Property owners in the county can apply for rebates, incentives, and financing through the Energy Upgrade California Program. In addition, the County offers a $1,000 incentive for homeowners who have completed an Advanced Upgrade Package and who host a Home Showcase Event.

- **Marin Clean Energy—Solar Rebate**. Since 2011, this program has allocated nearly $40,000 to solar rebates for MCE customers. The program is currently offering rebates to low income MCE customers who install solar.
- **Marin Clean Energy—Energy Efficiency Programs**. Energy efficiency programs and financing are offered for multi-family, single-family and commercial properties.
- **Bay Area Regional Energy Network (BayREN)—Energy Efficiency Programs**. Programs include additional rebates for the Energy Upgrade California program, commercial property assessed clean energy (PACE) financing, codes and standards programs, and a multi-family program.
- **Green Building Requirements**. The County passed a green building ordinance in November 2010 that requires green building standards to be met by both residential and commercial new construction and remodels.
- **Various Transportation-Related Actions**. The 2006 GHG Reduction Plan outlined a number of actions to reduce GHG emissions associated with on-road transportation, including improving traffic signal synchronization/ decreasing stop rate and time; encouraging community car-sharing; expanding local or regional bus service in range and/or frequency; offering prioritized parking for hybrid cars; expanding community bicycle infrastructure (e.g., dedicated bicycle lanes, additional bicycle parking spaces); expanding the Safe Routes to School Program; fostering downtown neighborhood development; encouraging mixed-use development; promoting transit-oriented development; establishing city-centered corridors;[10] instituting growth boundaries, ordinances, or programs to limit suburban sprawl; implementing a Housing Overlay Zone focused on a city-centered corridor, and maintaining a jobs/housing balance.
- **Zero Waste Marin**. The Marin Hazardous and Solid Waste Joint Powers Authority (JPA) seeks to send zero tons of waste to landfills by the year 2025.
- **Construction and Demolition Reuse and Recycling Ordinance (Ordinance No. 3389)**. All building and demolition permits must use a 50% minimum of reused or recycled construction and demolition materials. This ordinance was passed in September 2003.
- **Plastic Bag Ban (Ordinance No. 3553)**. Stores shall not provide single-use carry-out bags to customers at the point of sale. Stores shall make reusable bags available to customers. This ordinance was passed in January 2011.
- **Polystyrene Ban (Ordinance No. 3531)**. Prohibits the use of polystyrene foam disposable food packaging and requires the use of environmentally preferable food packaging (biodegradable and compostable materials) by retail food vendors, restaurants, and County facilities. This ordinance was passed in November 2009.
- **Various Waste-Related Actions**. The 2006 GHG Reduction Plan outlined a number of actions to reduce GHG emissions associated with solid waste, including establishing/expanding recycling programs in the community, implementing a solid waste reduction program through the creation of reuse facilities/programs, establishing a system for reuse or recycling of construction and demolition materials, and producing electricity from recovered methane in local landfills.

[10] The Marin Countywide Plan describes The City-Centered Corridor as follows: Along Highway 101 in the eastern part of the county, near San Francisco and San Pablo Bays, the corridor is designated primarily for urban development and the protection of environmental resources. This corridor is divided into six planning areas, generally based on watersheds.

- **Wood Smoke Reduction Ordinance (Ordinance No. 3395) and Wood Stove and Insert Replacement Rebate Program**. Non-EPA Phase II Certified wood burning heaters or wood burning fireplaces will not be allowed in new construction, additions, or remodels; and will be removed for all remodels and additions over 500 square feet. The County is offering a rebate for the proper removal and replacement of non-EPA certified wood-burning appliances with cleaner burning stoves or gas insert replacements.
- **Graywater Systems Ordinance (Ordinance No. 3564)**. This ordinance amended the building code to establish standards for permitting the reuse of graywater systems.
- **Marin Carbon Project**. This program seeks to identify and implement strategies for enhancing carbon sequestration on agricultural and rangelands in Marin County and beyond. The project focuses on carbon farming, which implements practices to increase the rate at which carbon dioxide is removed from the atmosphere and converted to plant material and soil organic matter on farms and rangelands. The goal of a carbon farming project is to sequester more carbon from enhanced land management and conservation practices than is emitted through farming operations, making the agricultural ecosystem a net carbon sink that will be capable of offsetting emissions from both agriculture and other sectors.

2.4.2.2 Municipal Actions

- **Solar and Streetlights.** Since 2003, the County has installed 1 MW of solar panels on municipal facilities along with over 2,000 energy-efficient LED street lights.
- **Various Vehicle Fleet and Employee Commute Actions.** The 2006 GHG Reduction Plan outlined a number of actions to reduce GHG emissions associated with the municipal vehicle fleet and employee commuting, including encouraging carpooling or vanpooling by municipal employees; encouraging telecommuting by municipal employees; purchasing fuel efficient (e.g., hybrid) and/or smaller fleet vehicles; and implementing the employee carpool program, the guaranteed ride home program, and the transit reimbursement program.

Chapter 3
Updated Emissions Inventories and Forecasts

Chapter 3
Updated Emissions Inventories and Forecasts

3.1 Introduction

The unincorporated areas of Marin County comprise of more than 430 square miles and are home to over 67,000 residents. These areas are economically, geographically, and socially diverse, which presents unique challenges and opportunities for robust climate action planning.

Marin County's 2012 Community Inventory serves as a snapshot of current emissions to see how the County has made progress in reducing GHG emissions since the 2006 GHG Reduction Plan. It builds on the foundation created by the 2006 GHG Reduction Plan for climate action planning efforts in the county. Specifically, the inventory identifies existing emissions sources and the magnitude of their emissions, which enables the County to tailor specific reduction strategies based on the community's unique emissions profile.

The inventory also supports development of the 2020 BAU Community Forecast, which is a prediction of how community emissions may change in the future, in absence of state and local actions to reduce GHG emissions. A BAU projection is an estimate of future emissions; it does not include the effects of *any* new federal, state, or local measures. The CAP Update 2020 BAU Community Forecast is similar to a BAU projection but differs slightly because 1) the data used to forecast 2020 emissions include General Plan socioeconomic assumptions and 2) the transportation emissions forecast accounts for future planned highway and transit network improvements (including the launch of SMART). Local actions and all other state regulations (e.g., AB 32) are not included in the forecast. Please refer to Appendix B for additional information on this topic.

Like the 2012 Community Inventory, the County's 2012 Municipal Inventory serves as a snapshot of current municipal emissions to illustrate how the County has made progress in reducing municipal GHG emissions since the 2006 GHG Reduction Plan—it also builds on the foundation created by this plan, enabling the County to tailor specific reduction strategies based on the unique emissions profile of local government operations. The inventory also supports development of the 2020 BAU Municipal Forecast, which is a prediction of how municipal emissions may change in the future, in absence of state and local actions to reduce GHG emissions.

As noted above, the inventories are activity-based inventories (also called "production" inventories), not consumption-based inventories. Consumption-based inventories include the global "lifecycle" emissions associated with satisfying the purchase and use of products and services. These include fuels used in buildings and transportation as well as the production of food, other goods, and services. It is a lifecycle emissions approach that estimates total supply chain emissions. Typically, this method is applied at the household level or corporate entity level, not for community or municipal emissions. Estimating lifecycle emissions from a consumption-based approach is notoriously challenging for community and municipal inventories because of the need to track a massive diversity of emissions associated with consumed products. Further, consumption-based inventories include large amounts of emissions over which a local jurisdiction will not have any control, whereas activity-based inventories are focused on those emissions over which a local jurisdiction can exert control. There is currently no adopted and accepted guidance for conducting consumption-based inventories at the community or municipal level. The ICLEI—Local

Governments for Sustainability (ICLEI) *U.S. Community Protocol for Accounting and Reporting Greenhouse Gas Emissions* (2012) and the *Local Government Operations Protocol for the Quantification and Reporting of Greenhouse Gas Emissions Inventories* (LGOP) (2010) (used here) are both activity-based inventory protocols that do not require the preparation of lifecycle inventories for community or municipal inventories.[11] Consumption-based inventory protocols are currently under development. For these reasons, the community and municipal inventories for Marin County are activity-based inventories.

This chapter describes the 2012 Community Inventory and 2020 BAU Community Forecast for Marin County along with the 2012 Municipal Inventory and 2020 BAU Municipal Forecast.

3.2 Overview of Analysis Methods

3.2.1 Community Emissions Overview

Marin County's 2012 Community Inventory and 2020 BAU Community Forecast include GHG emissions generated by activities within the unincorporated areas. The inventory also includes emissions that occur outside the unincorporated areas, but only to the extent that such emissions are the result of community activities. For example, GHG emissions generated by regional power plants to provide electricity to local homes and businesses in the unincorporated areas are considered even though the power plants themselves may not be located within the unincorporated areas. Each of Marin's cities/towns is responsible for developing their own Climate Action Plan for emissions from their jurisdictions. However, staffs from the County and cities coordinate their climate efforts through various joint programs including the Marin Climate and Energy Partnership, Marin Clean Energy and the Marin Hazardous and Solid Waste Joint Powers Authority.

Estimating Building Energy Emissions

Here is a quick overview of how GHG emissions are estimated for the building energy sector:

Step 1: Determine which utilities supply electricity and natural gas to residents and businesses in the unincorporated areas.

Step 2: Obtain annual energy usage from the utilities. Electricity consumption is provided in terms of kilowatt-hours, whereas natural gas usage is provided in terms of therms.

Step 3: Multiply electricity and natural gas quantities by GHG emission factors.

Step 4: Add emissions from electricity and natural gas to determine total GHG emissions from building energy use.

The 2012 Community Inventory and 2020 BAU Community Forecast are divided into seven major sectors. Each sector represents a subset of community emissions, and some comprise multiple emissions-generating activities. For example, natural gas and electricity consumption are both included in the building energy sector. The seven sectors analyzed represent the major emissions categories within the county and are defined as follows.

[11] The ICLEI U.S. Community Protocol (2012) states the following: "Consumption-based accounting of greenhouse gas emissions at the community scale is a relatively young field. Methods are still being tested, evaluated, and compared, and "best practices" have not yet been identified. Additional new methods and variations on those methods may still be developed."

- **Building Energy**—emissions from electricity generation and natural gas combustion by residential, commercial, and industrial buildings.
- **On-Road Transportation**—fuel consumption emissions from vehicles operating within the unincorporated areas.
- **Off-Road Vehicles and Equipment**—fuel consumption emissions from use of off-road equipment (e.g., cranes, bulldozers, lawnmowers, water craft).
- **Solid Waste Generation**—methane emissions from waste generated by the community within the unincorporated areas.
- **Water Conveyance**—emissions from electricity and natural gas consumption associated with water conveyance, including groundwater pumping, local water distribution, and surface water diversion.
- **Wastewater Treatment**—process (i.e., fugitive) emissions from community wastewater treatment.
- **Agriculture—**nitrogen oxide emissions from fertilizer application and methane emissions from manure management and enteric fermentation from livestock in the unincorporated areas.

Additional emissions were estimated for informational purposes but were not included in the inventory for the following reasons.

- **Stationary Sources**—stationary fuel combustion and process emissions for residences (propane/LPG, kerosene, and wood) and industrial and commercial facilities (does not include natural gas combustion; this is included in the building energy sector). These emissions were not included because the County has limited jurisdictional control over stationary sources, and large stationary point source emissions are regulated by the State of California (under AB 32 through cap-and-trade) and through the EPA (under the Clean Air Act) for GHG emissions. Thus, in particular for the larger stationary point sources, local regulation of such sources (as part of this CAP Update) can be duplicative of state and federal authority.
- **Forestry—**carbon sequestration from forested lands reported as an annual value (in $MTCO_2e$ per year). Sequestration from urban and natural forests and sequestration from national forests represent an emissions "sink."[12] Forest lands are considered emissions "sinks" because these lands naturally remove carbon dioxide from the atmosphere. However, as these existing urban and natural forests are part of global atmospheric carbon cycling, *the U.S. Community Protocol for Accounting and Reporting Greenhouse Gas Emissions* (ICLEI–Local Governments for Sustainability 2012) recommends that this emissions sink be disclosed but not combined with other emissions created by human activity in an emissions inventory. The emissions sink potential of the existing forested lands can provide a useful comparison to the emissions sources in the inventory or to changes in the emissions sink that might result from future land use change.
- **Rangeland Soil Carbon Stock**—carbon storage in rangeland soils; this represents total storage and not sequestration or emissions. Units presented are in metric tons of carbon, not $MTCO_2e$. This was not included in the inventory or forecast because ICLEI does not recommend

[12] An *emissions sink* is a natural or artificial reservoir that accumulates and stores GHG or carbon-containing compounds for an indefinite period.

combining global atmospheric carbon cycling with other anthropogenic emissions in an emissions inventory as noted above. Carbon storage in non-rangeland soils has not been estimated due to lack of data. Please refer to Chapter 6 for a discussion of GHG reduction efforts that are focused on increasing carbon stock within agricultural soils and vegetation.

- **Aboveground Carbon Stock—**carbon stock in aboveground biomass in the county such as croplands, rangeland/pasture, oak woodlands/riparian woodlands, shrublands, and vineyards. This is not a source or sink of GHG emissions; it just represents the total amount of carbon storage in biomass in 2012. Units presented are in metric tons of carbon, not $MTCO_2e$. This was not included in the inventory or forecast because ICLEI does not recommend combining global atmospheric carbon cycling with other anthropogenic emissions in an emissions inventory as noted above. Please refer to Chapter 6 for a discussion of reduction efforts that are focused on increasing carbon stock within agricultural soils and vegetation.

Emissions generated by community activities were analyzed using widely accepted methodologies and procedures that are recommended by federal, state, and local air quality management agencies. The primary protocol used to develop the community inventory is the *U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions* (ICLEI–Local Governments for Sustainability 2012). Additional protocols were consulted as needed. The 2012 Community Inventory was developed using actual activity data, like kilowatt-hours of electricity consumed, reported by local utilities and other entities. The 2020 BAU Community Forecast is based on expected growth in the population, employment, and households.[13] All emissions were quantified in terms of $MTCO_2e$. Please refer to Appendix B for detailed information on methods and assumptions used to prepare the 2012 Community Inventory and 2020 BAU Community Forecast.

3.2.2 Municipal Emissions Overview

Marin County's 2012 Municipal Inventory and 2020 BAU Municipal Forecast include GHG emissions generated by the County's local government operations as it provides services to the public.[14] The 2012 Municipal Inventory and 2020 BAU Municipal Forecast are divided into nine major sectors. Each sector represents a subset of municipal emissions, and some comprise multiple emissions-generating activities. For example, natural gas and electricity consumption are both included in the building energy sector. The nine sectors analyzed represent the major emissions categories associated with municipal operations and are defined as follows.

- **Building Energy—**emissions from electricity generation and natural gas combustion by County-owned buildings.[15]

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[13] Marin County does not have jurisdictional authority over adjacent counties or cities (e.g., Sonoma County or cities in Sonoma County). Marin County cannot limit growth in adjacent counties; it can only control land use within the unincorporated parts of Marin County. The Marin Countywide Plan allows only a limited amount of growth in the unincorporated county, and the CAP Update does not change the land use plan in the Countywide Plan.

[14] The Municipal Inventory only includes emissions associated with direct County of Marin operations. It does not include the emissions from separate government agencies or special districts within the unincorporated County. Those emissions are captured in the Community Inventory when those operations occur in the unincorporated County.

[15] Energy use in leased facilities for which the County does not pay the utility bill is not included because PG&E did not provide energy use information for these facilities. These sites constitute only 7% of total municipal building square footage.

- **Streetlights and Traffic Signals**—emissions from electricity generation to operate County-owned streetlights and traffic signals.
- **Vehicle Fleet**—fuel consumption emissions from County vehicles (e.g., police cars, fire trucks).
- **Employee Commute**—fuel consumption emissions from County employees commuting to and from their worksites.
- **Solid Waste Generation**—methane emissions from waste generated by municipal operations.
- **Water Conveyance**—emissions from electricity and natural gas consumption associated with the conveyance of water to County facilities, including groundwater pumping, local water distribution, and surface water diversion.
- **Wastewater Treatment**—process (i.e., fugitive) emissions from the treatment of wastewater generated by municipal operations.
- **Stationary Sources**—stationary fuel combustion for County-owned stationary source equipment.
- **Refrigerants**—fugitive emissions (leaks) from equipment that require the use of refrigerants (e.g., vending machines, refrigerators, air conditioners).

Emissions generated by municipal activities were analyzed using widely accepted methodologies and procedures that are recommended by federal, state, and local air quality management agencies. The primary protocols used to develop the 2012 Municipal Inventory are the ARB's *Local Government Operations Protocol for the Quantification and Reporting of Greenhouse Gas Emissions Inventories* (LGOP; California Air Resources Board 2010) and the 2012 *U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions* (ICLEI–Local Governments for Sustainability 2012). Additional protocols were consulted as needed. The 2012 Municipal Inventory was developed using actual activity data, like kilowatt-hours of electricity consumed in County buildings, reported by local utilities and other entities. The 2020 BAU Municipal Forecast is based on expected growth in County employees and incorporates plans for new building construction. All emissions were quantified in terms of $MTCO_2e$. Please refer to Appendix B for detailed information on methods and assumptions used to prepare the 2012 Municipal Inventory and 2020 BAU Municipal Forecast.

3.2.3 Previous Inventories

Marin County assessed community and municipal GHG emissions for a number of years as part of its 2006 GHG Reduction Plan. Emissions were estimated for the years 1990, 1995, 2000, and 2005. Community emissions included emissions for the entire County, including both the cities and the unincorporated areas. The municipal emissions included activities associated with local government operations. These inventories used slightly different methods and data sources from those used in the inventory for this CAP Update, as data sources have expanded and improved, and methods for calculating emissions have grown more robust.

The previous community inventories included emissions for building energy (residential, commercial, and industrial), transportation, waste, and agriculture. The previous municipal inventories included emissions for buildings, streetlights, vehicle fleet, employee commute, and waste. The new inventories contained in this CAP Update include additional emissions sectors to encompass more sources of emissions and provide a more comprehensive picture of emissions associated with the county. In addition, the CAP update includes a revised 1990 inventory of community emissions in order to be consistent with the latest GHG protocols, and so that 1990 emissions are consistent with the 2012 GHG inventory and 2020 BAU forecast. This is important because the 2020 GHG reduction target is based on 1990 emissions, so consistent GHG accounting across all years of analysis is necessary.

The 1990 municipal emissions are not completely consistent with the 2012 emissions in terms of sectors, data, and methods. There were some significant data gaps in the 1990 Municipal Inventory, which makes comparisons between years difficult. These data gaps include missing utility data for certain buildings (including some fire stations and the fairgrounds), missing electricity consumption data for some streetlights and traffic signals, over-reported solid waste diversion, fuel sold to other agencies not controlled by the County in the vehicle fleet sector, and a lack of data for water use, wastewater treatment, stationary sources, and refrigerants. Because of these data gaps, comparing municipal emissions in 1990 with emissions in 2012 (or 2020) should be done with care.

3.3 Marin County Community Inventories and Forecast

3.3.1 1990 and 2012 Emissions Inventories

Total GHG emissions generated by community activities occurring in the unincorporated areas of the county in 2012 were 477,456 $MTCO_2e$, which is approximately 0.1% of California's GHG emissions in the same year.[16] This is a 15% decrease from estimated 1990 emissions, which were 561,851 $MTCO_2e$.

As shown in Table 3-1 and Figure 3-1, building energy and on-road transportation emissions represent the largest sources of community emissions (approximately 35% of the 2012 Community Inventory for each sector). Building energy is often one of the largest sources of GHG emissions in community inventories and includes energy consumed for heating, cooling, lighting, and cooking in the residential, commercial, and industrial sectors. Similar to the building energy sector, on-road transportation is typically a considerable component of a community's total GHG emissions, ranging from 30% to 70% depending on other sources and local conditions. The majority of on-road emissions in the county come from personal and light-duty vehicles. The third-largest source is agriculture, with a contribution of 23% of the total 2012 Community Inventory. However, it should be noted that the vast majority of agricultural activity (and therefore emissions) is located in the unincorporated county; therefore, the unincorporated county bears the burden of countywide agricultural emissions (on a countywide level, when including emissions from the incorporated cities, agriculture represents approximately 5% of total emissions[17]). Agriculture is followed by off-road equipment (4%), solid waste generation (2%), wastewater treatment (1%), and water conveyance (0.2%).

[16] California statewide GHG emissions in 2011 were 448.11 million metric tons of CO_2e (California Air Resources Board 2013).

[17] Emissions from incorporated areas provided by Marin Climate and Energy Partnership. According to MCEP, total countywide emissions are 2.2 million $MTCO_2e$ without agriculture; agricultural emissions in the unincorporated county (where the majority of agricultural emissions occur) are approximately 111,000 $MTCO_2e$, representing 5% of total countywide emissions (Marin Climate and Energy Partnership 2015).

Table 3-1. Marin County 1990 and 2012 Community Greenhouse Gas Inventories

Emission Sector[a]	1990 Inventory Emissions ($MTCO_2e$)	1990 Inventory Percent of Inventory	2012 Inventory Emissions ($MTCO_2e$)	2012 Inventory Percent of Inventory
Building Energy— Residential	131,265	23%	111,484	23%
Building Energy— Non Residential	74,190	13%	55,142	12%
On-Road Transportation	193,544	34%	166,773	35%
Off-Road Vehicles and Equipment	19,300	3%	17,126	4%
Solid Waste Generation	14,414	3%	9,362	2%
Water Conveyance	1,319	0.2%	1,157	0.2%
Wastewater Treatment	5,453	1%	5,562	1%
Agriculture[b]	122,366	22%	110,850	23%
Marin County Total	**561,851**	**100%**	**477,456**	**100%**
Emissions for Informational Purposes				
Stationary Sources($MTCO_2e$/year)	–	–	*648*	–
Forestry ($MTCO_2e$/year)	–	–	*-207,151*	–
Rangeland Soil Carbon Stock (MT C)[c]	–	–	*10,783,021*	–
Aboveground Carbon Stock (MT C)[c]	–	–	*7,248,888*	–

Notes:

$MTCO_2e$ = metric tons of carbon dioxide equivalent.

MT C = metric tons of carbon.

[a] Additional emissions sources that were not estimated (or included in the inventory) include aircraft, non-local passenger rail, freight rail, ferries, ozone depleting substances, and other gases with high global warming potential.

[b] Agricultural emissions make up about 5% of overall countywide emissions when including the cities.

[c] Rangeland soil carbon and aboveground carbon stock numbers are in units of metric tons of carbon, not metric tons of carbon dioxide equivalent.

Figure 3-1. Marin County 2012 Community Inventory by Sector

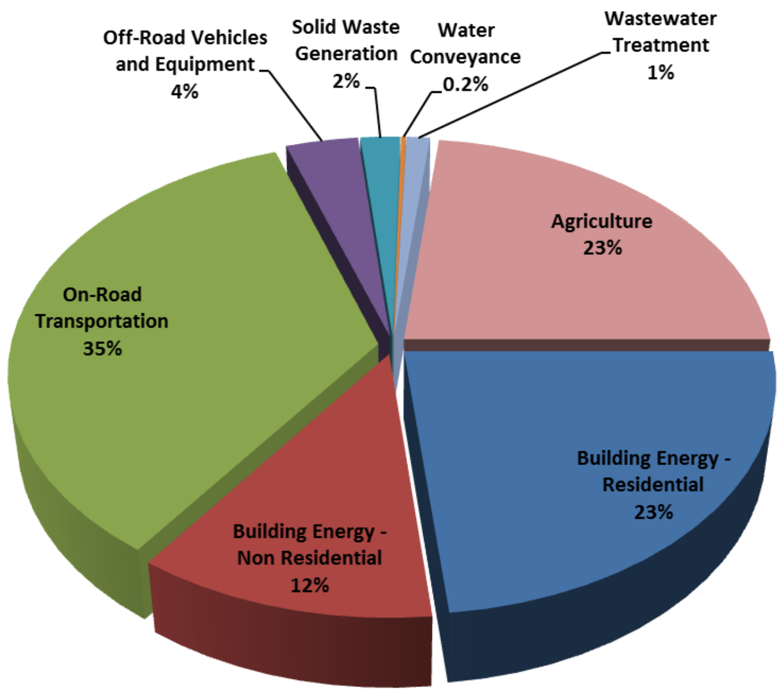

Table 3-2 presents total community emissions for Marin County and compares them with California statewide emissions, U.S. national emissions, and emissions from other regions within the Bay Area for context. Marin County represented 0.10% of statewide emissions and 0.01% of national emissions in 2012.[18] It should be noted that these inventories differ in their methodology and data, so there are some inconsistencies when comparing emissions.

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[18] GHG emissions represent a cumulative problem. Just because Marin County's GHG emissions are small in comparison to state, national, or global GHG emissions does not mean that it is not important for the County to take action. State and local actions in the U.S. are key for promoting GHG reductions, particularly because of the lack of comprehensive federal legislation to date. Although countries that emit large amounts of GHG emissions, such as China, are taking actions, they are not likely to initiate policies that promote deep GHG emissions reductions if the U.S. and other developed nations do not take action first. Marin County can be an example in California, and California is an example for the U.S., helping to motivate national action and ultimately international action.

Table 3-2. Marin County 2012 Community GHG Inventory Compared with Other Jurisdictions

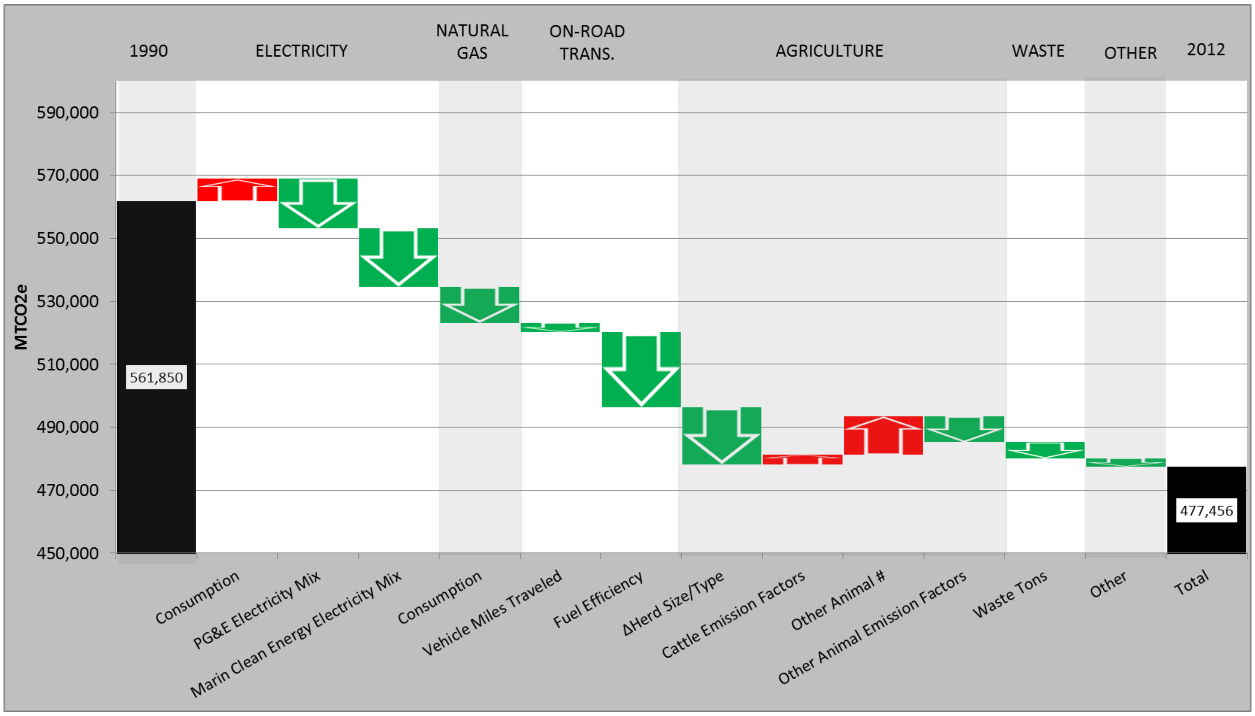
Region	Year	GHG Emissions (thousand $MTCO_2e$)
United States[a]	2012	6,525,600.00
California[b]	2012	458,680.00
San Francisco Bay Area[c]	2007	95,800.00
San Francisco County[d]	2010	5,299.76
Sonoma County[e]	2009	4,282.27
City of Berkeley[f]	2012	690.00
Marin County	**2012**	**477.46**

Notes:
[a] U.S. Environmental Protection Agency 2014b
[b] California Air Resources Board 2014a
[c] Bay Area Air Quality Management District 2010
[d] San Francisco Department of the Environment 2014
[e] Climate Protection Campaign 2010
[f] City of Berkeley 2014

Community emissions have decreased by 15% from 1990 levels. This decrease is due to a number of factors, including changes in energy use, increases in renewables, and increases in vehicle fuel efficiency. Figure 3-2 presents a graphical representation of the causes of the 15% decrease in emissions from 1990 to 2012. A summary of these changes is presented below.

- **Electricity**. Electricity consumption increased slightly, as a result of growth within the county. However, emissions from electricity generation have decreased significantly, due to the increased use of renewable energy sources in PG&E's electricity generation mix, and because of Marin Clean Energy, a Community Choice Aggregation (CCA) program, which supplies additional renewable electricity to county homes and businesses (Armanino pers. comm.; Kudo pers. comm.).
- **Natural Gas**. Natural gas consumption decreased likely due to improving efficiency (Armanino pers. comm.).
- **On-Road Transportation**. Vehicle miles traveled (VMT) decreased and vehicles got much more fuel efficient (Brazil pers. comm.).
- **Agriculture**. The livestock herd size decreased and changed in composition, and the cattle emission factors slightly increased (due to changes in diet). The number of non-cattle livestock animals (chickens, goats, swine) increased, raising emissions slightly (Marin County Department of Agriculture 1991, 2013).
- **Waste**. Total tons of waste going to landfills decreased, due to expanded recycling and composting programs (CalRecycle 2013; Devine pers. comm.).
- **Other Emissions**. Emissions from other sectors, including water treatment and off-road vehicles and equipment, decreased slightly.

Figure 3-2. Trends in Community Emissions from 1990 to 2012 by Sector



3.3.2 2020 Business-as-Usual Forecast

The 2020 BAU Community Forecast is a prediction of community emissions that would occur in 2020 without accounting for future federal, state, and local actions designed to reduce GHG emissions. Emissions are estimated based on future changes in population, households, and employment from the Association of Bay Area Governments' (ABAG's) 2013 *Plan Bay Area* (Wong pers. comm.). Since the forecast does not account for GHG reductions achieved by the CAP Update or other state actions, it represents a starting point for the County's 2020 Community Emissions Reduction Target.

Is the 2020 Forecast a BAU Projection?

A "business as usual" (BAU) projection is an estimate of future emissions; it does not include the effects of *any* new federal, state, or local measures. The 2020 forecast is similar to a BAU projection but differs slightly because 1) the data used to forecast 2020 emissions include ABAG socioeconomic assumptions and 2) the transportation emissions forecast accounts for future planned highway and transit network improvements. Local actions and all other state regulations (e.g., AB 32) are not included in the forecast. Please refer to Appendix B for additional information on this topic.

As shown in Table 3-3 and Figure 3-3, community GHG emissions are expected to increase modestly by 3% (13,392 $MTCO_2e$) from 2012 to 2020. The majority of this increase in emissions is due to increases in building energy use, vehicle trips, and off-road equipment. Energy consumption, transportation activity, and off-road equipment emissions will increase as a result of the limited amount of new development and increased construction activity. However, this development is anticipated to occur in the unincorporated county at a very low rate compared to the more urbanized areas of the state.

GHG emissions from waste generation and agriculture activities[19] are expected to slightly decrease relative to the 2012 Community Inventory. Reductions in waste-related emissions are predominantly a result of improvements in the methane capture rate at regional landfills. The decline in agriculture emissions is a result of expected reductions in overall agricultural activity. Refer to Appendix B for more information.

Despite these changes, the overall emissions profile for the 2020 BAU Community Forecast is similar to the 2012 Community Inventory, with building energy, transportation, and agriculture representing the top three sources and a vast majority (93%) of emissions (see Figure 3-3).

Table 3-3. Summary of Marin County's 2020 Business-as-Usual Community Forecast and Comparison to the 2012 and 1990 Community Inventories ($MTCO_2e$)

	2020 BAU Forecast		Change in Emissions	
Emission Sector[a]	Emissions ($MTCO_2e$)	Percent of Forecast	From 1990	From 2012
Building Energy—Residential	115,713	24%	-15,552	4,229
Building Energy—Non Residential	61,194	12%	-12,996	6,052
On-Road Transportation	167,002	34%	-26,542	229
Off-Road Vehicles and Equipment	19,823	4%	523	2,697
Solid Waste Generation	9,358	2%	-5,056	-4
Water Conveyance	1,215	0.2%	-104	58
Wastewater Treatment	5,745	1%	292	183
Agriculture	110,798	23%	-11,568	-52
Marin County Total	**490,848**	**100%**	**-71,003**	**13,392**
Emissions for Informational Purposes				
Stationary Sources (MTCO2e/year)	*688*	–	–	–
Forestry (MTCO2e/year)	*-207,151*	–	–	–
Rangeland Soil Carbon Stock (MT C)[b]	*10,783,021*	–	–	–
Aboveground Carbon Stock (MT C)[b]	*7,248,776*	–	–	–

Notes:

$MTCO_2e$ = metric tons of carbon dioxide equivalent.

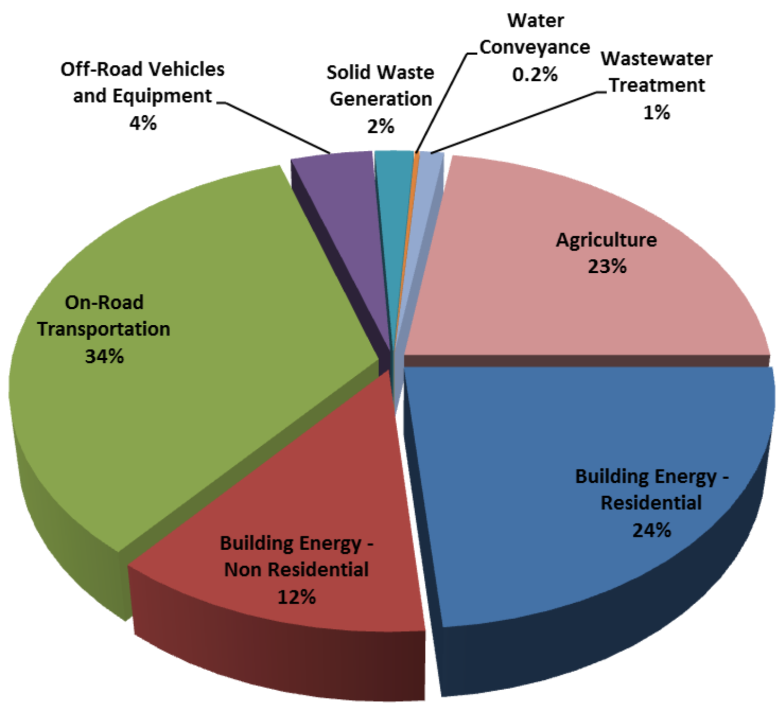
MT C = metric tons of carbon.

[a] Additional emissions sources that were not estimated (or included in the inventory) include aircraft, non-local passenger rail, freight rail, ferries, ozone depleting substances, and other gases with high global warming potential.

[b] Rangeland soil carbon and aboveground carbon stock numbers are in units of metric tons of carbon, not metric tons of carbon dioxide equivalent.

[19] The slight decrease in agricultural emissions is due to a slight decline in fertilizer emissions resulting from shifting acres of agricultural land by crop type, based on historical trends from 2008 to 2012. Please refer to Appendix B for more information on the agriculture forecasts.

Figure 3-3. Marin County's 2020 Business-as-Usual Community Forecast by Sector



3.4 Marin County Municipal Inventories and Forecast

3.4.1 1990 and 2012 Emissions Inventories

Total GHG emissions generated by municipal activities in 2012 were 15,215 $MTCO_2e$ (Table 3-3). This is a 0.2% increase from 1990 emissions, which were 15,181 $MTCO_2e$.[20]

As shown in Table 3-4 and Figure 3-4, employee commute represents the largest source of municipal emissions (approximately 43% of the 2012 Municipal Inventory). Employee commute is often one of the largest sources of GHG emissions in municipal inventories. Building energy is the second largest source of emissions, accounting for 36% of total municipal emissions. The third largest source is vehicle fleet, with a contribution of 18% of the total 2012 Municipal Inventory, followed by wastewater treatment (1.4%), streetlights and traffic signals (0.6%), refrigerants (0.4%), stationary sources (0.4%), solid waste generation (0.3%), and water conveyance (0.2%).

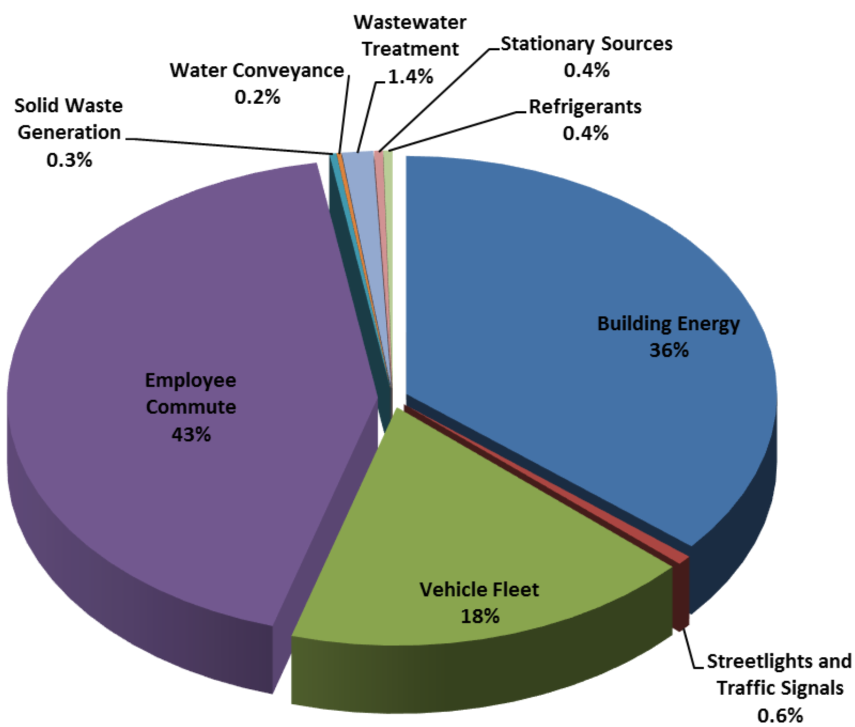
[20] The 1990 municipal emissions are not completely consistent with the 2012 emissions in terms of sectors, data, and methods. There were some significant data gaps in the 1990 municipal inventory, which makes comparisons between years difficult.

Table 3-4. Marin County 1990 and 2012 Municipal Inventories

Emission Sector	1990 Inventory		2012 Inventory	
	Emissions ($MTCO_2e$)	Percent of Inventory	Emissions ($MTCO_2e$)	Percent of Inventory
Building Energy	3,100	20%	5,499	36%
Streetlights and Traffic Signals	52	0.3%	97	1%
Vehicle Fleet	4,900	32%	2,732	18%
Employee Commute	7,100	47%	6,528	43%
Solid Waste Generation	29	0%	47	0.3%
Water Conveyance	-	-	29	0.2%
Wastewater Treatment	-	-	207	1.4%
Stationary Sources	-	-	59	0.4%
Refrigerants	-	-	61	0.4%
Marin County Total	**15,181**	**100%**	**15,258**	**100%**

Note:
$MTCO_2e$ = metric tons of carbon dioxide equivalent.

Figure 3-4. Marin County 2012 Municipal Inventory by Sector



3.4.2 2020 Business-as-Usual Municipal Forecast

Similar to the community forecast, the 2020 BAU Municipal Forecast is a prediction of municipal emissions that would occur in 2020 without accounting for future federal, state, and local actions designed to reduce GHG emissions. Emissions are estimated based on future changes in municipal employees and anticipated construction of new County facilities. Since the forecast does not account for GHG reductions achieved by the CAP Update or other state actions, it represents a starting point for the County's 2020 Municipal Emissions Reduction Target.

In 2020, the County's municipal operations are projected to result in the release of 17,175 $MTCO_2e$—an increase of approximately 13% over 2012 levels (Table 3-5). This change is attributable to a 1% growth in municipal employees per year along with the construction of the new emergency operations facility, a new County facility that was completed in 2014 and hence was not included in the 2012 inventory.[21] Most County services and activities will increase as the population in unincorporated areas grows, and this increase in service will also increase emissions.

GHG emissions from building energy are expected to increase relative to the 2012 Municipal Inventory, due primarily to the addition of the new emergency operations facility. All other sectors of the inventory are also anticipated to increase as the County hires more employees and expands its operations. Most notably, vehicle fleet and employee commute emissions increase between 2012 and 2020 due to this growth.

Despite these changes, the overall emissions profile for the 2020 BAU Municipal Forecast is similar to the 2012 Municipal Inventory, with building energy, employee commute, and vehicle fleet representing the top three sources and a vast majority (97%) of emissions (see Figure 3-5).

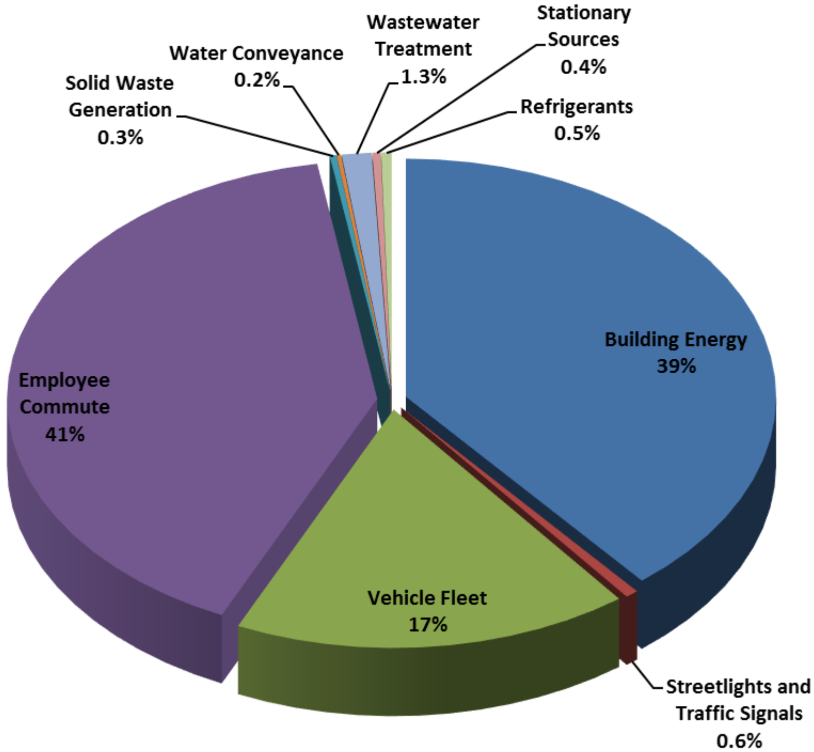
Table 3-5. Summary of Marin County's 2020 BAU Municipal Forecast and Comparison to the 2012 Municipal Inventory ($MTCO_2e$)

	2020 BAU Forecast		Change in Emissions	
Emission Sector	Emissions ($MTCO_2e$)	Percent of Forecast	From 1990	From 2012
Building Energy	6,701	39%	3,601	1,202
Streetlights and Traffic Signals	98	0.6%	46	1
Vehicle Fleet	2,973	17%	-1,927	242
Employee Commute	6,957	41%	-143	430
Solid Waste Generation	50	0.3%	21	3
Water Conveyance	32	0.2%	32	2
Wastewater Treatment	222	1.3%	222	15
Stationary Sources	63	0.4%	63	4
Refrigerants	78	0.5%	78	18
Marin County Total	**17,175**	**100%**	**1,933**	**1,918**

Note:
$MTCO_2e$ = metric tons of carbon dioxide equivalent.

[21] Although operation of the EOF would nominally increase municipal emissions, the EOF was designed with many energy-saving features to reduce energy use and GHG emissions. In addition, existing County facilities that are less energy efficient will no longer be needed, so emissions may actually decrease as a result of the EOF coming online.

Figure 3-5. Marin County's 2020 BAU Municipal Forecast by Sector



Chapter 4
Community Greenhouse Gas Reduction Goals and Measures


Photo: Jeanne Miche

Chapter 4
Community Greenhouse Gas Reduction Goals and Measures

4.1 Introduction

The CAP Update includes a variety of regulatory, incentive-based and voluntary strategies that will reduce emissions from both existing and new development in Marin County. Several of the CAP Update strategies build on existing County programs, whereas others provide new opportunities to address climate change. Statewide sustainability efforts will have a substantial impact on future GHG emissions. Local strategies adopted by the County will supplement these state programs and achieve additional GHG emissions reductions. Successful implementation of the local strategies will rely on the combined participation of County staff along with County residents, businesses, and community leaders.

The following sections summarize the state and local strategies included in the CAP Update for Community emissions. Estimated emissions reductions achieved by the CAP Update are presented, indicating that the County will meet and exceed its 2020 Community Emissions Reduction Target. Costs, savings, and community co-benefits are also described. Please refer to Appendix C for additional information on each strategy, including detailed objectives and assumptions used to quantify emissions reductions and costs.

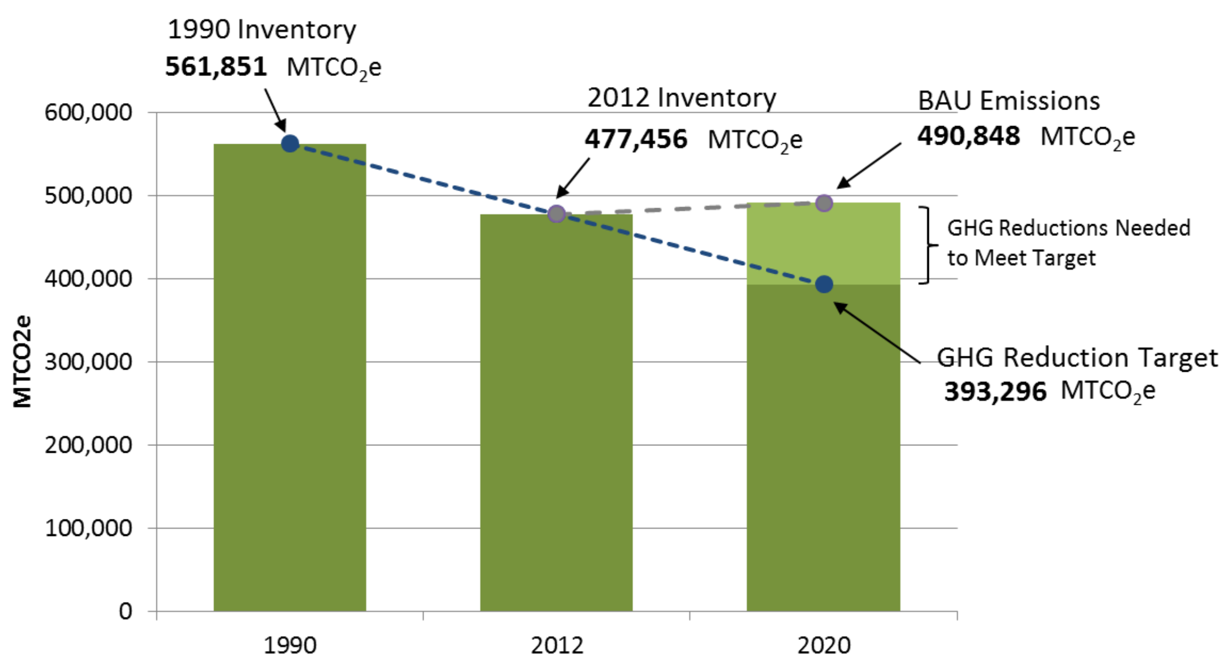
4.2 Marin County Greenhouse Gas Reduction Goals

Establishing a reduction target that is both practical and ambitious is important for guiding future actions that not only contribute to GHG reductions, but also strengthen the community as a whole. In the 2006 GHG Reduction Plan, the County adopted an emissions reduction target for community emissions of 15% below 1990 levels by 2020. From 1990 to 2012, community emissions have been reduced by 15% below 1990 levels. To continue Marin County's progress on reducing emissions and help the County progress toward potential future state targets, this CAP Update sets a new community emissions target for 2020: 30% below 1990 emissions. This target reflects the County's commitment to implement achievable emissions reductions on a timescale that is consistent with major statewide climate change legislation. Meeting the target will depend on a combination of state and local policies, as well as the participation of local residents and businesses. Achieving this goal would avoid the generation of approximately 97,000 $MTCO_2e$ and reduce 2020 Community GHG emissions to approximately 393,000 $MTCO_2e$ from 490,848 $MTCO_2e$ under the BAU scenario. The strategies outlined this chapter represent a combination of local and state initiatives that will collectively lower future community GHG emissions in the county consistent with the County's reduction target (see Figure 4-1).

The County's 2020 emissions reduction target exceeds statewide goals established by AB 32, which commits to reducing statewide GHG emissions to 1990 levels by 2020. The AB 32 Scoping Plan provides a roadmap for achieving these reductions and recommends a complementary reduction goal for local governments of 15% below current emissions levels, which is roughly equivalent to

1990 emissions levels. The County's community emissions reduction target is 30% below 1990 emissions levels—a far more aggressive target than AB 32. California Executive Order S-03-05, which was issued in 2005, articulates a long-term goal for the state of 80% below 1990 emissions levels by the year 2050. In order to reach this target for 2050, the state will have to go above and beyond what is included in the AB 32 Scoping Plan for 2020. Marin County is attempting to get ahead of the curve and be on-track to meet the S-03-05 statewide target for 2050 by adopting an aggressive community target.

Figure 4-1. Marin County 2020 Community Emissions Reduction Goals



Community Emissions Reductions in Context

Implementation of the CAP Update would avoid the generation of more than 100,000 $MTCO_2e$ for the community, which is equivalent to the following actions (U.S. Environmental Protection Agency 2014a):

- Removing more than 21,000 passenger vehicles from the road each year (assuming average fuel efficiency of 21.4 mpg and 11,318 miles driven per year);
- Reducing gasoline consumption by more than 11 million gallons per year; and
- Providing renewable energy to power over 9,000 homes each year (assuming the average home consumes 12,069 kWh of electricity and 52,372 cubic feet of natural gas per year).

4.3 Climate Action Plan Framework

4.3.1 Reduction Measures

The CAP Update comprises a variety of state and local actions to reduce GHG emissions within the unincorporated areas. Statewide efforts to reduce GHG emissions are a fundamental part of the County's CAP Update. For example, the state's Renewables Portfolio Standard (RPS) will reduce the carbon content of electricity throughout the state, including in Marin County. Electricity provided to the County will therefore be cleaner and less GHG intensive than if the RPS had not been established. The CAP Update includes the local impact of seven state actions to reduce GHG emissions, as discussed further in Section 4.5.1.

The County has identified 15 local community actions to supplement the 7 statewide initiatives. Although identified individually in the CAP Update, these actions will be implemented together as part of a comprehensive GHG emissions reduction program. The local strategies align with the goals and policies outlined in the *Marin Countywide Plan* and are grouped into five strategy areas.

- Energy Efficiency and Renewable Energy.
- Land Use, Transportation, and Off-Road Equipment.
- Waste Reduction, Reuse, and Recycling.
- Water Conservation and Wastewater Treatment.
- Agriculture.

Coordinating GHG reduction programs will streamline CAP implementation and potentially boost GHG reduction outcomes through synergies created among measures. See Chapter 7, *Greenhouse Gas Reduction Measure Implementation Program*, and Appendix C for implementation details.

The majority of the local actions include voluntary, incentive-based programs that will reduce emissions from both existing and new development in the county. Several other actions will be implemented by the County or other agencies within the region. A small subset of actions will establish mandates for development, either pursuant to state regulations or through existing County programs. Together, the CAP Update actions will improve building energy efficiency and renewable energy production, increase alternative modes of transportation, enhance open spaces, and reduce water consumption and waste generation. The actions were selected following a comprehensive review of candidate strategies recommended by the California Attorney General, California Air Pollution Control Officers Association (CAPCOA), existing CAPs throughout California, and the *Marin Countywide Plan*.

A number of the actions build on existing County programs, whereas others provide new opportunities to address climate change. Successful implementation of these actions will require commitment and dedication from the County, its various departments, and its residents. As discussed in Chapter 7, *Greenhouse Gas Reduction Measure Implementation Program*, the County will adaptively manage the implementation of the CAP Update to maximize GHG reductions and operational efficiency for each action. Accordingly, the County may revise actions or add new actions to ensure that the County achieves its 2020 Community Emissions Reduction Target. If adopted and implemented prior to 2020, new federal programs that achieve local GHG reductions beyond state and local mandates may also be added to the County's CAP Update.

The County will develop and lead the implementation of the majority of the 13 local actions. However, for a few of the CAP Update actions, another local agency, such as operators of water treatment facilities, will have primary responsibility for measure development. The County anticipates supporting the lead entities for these actions, as needed, to identify targets and other strategies for implementation. Despite the County's supporting role, these actions are considered a critical component of a comprehensive CAP, as many of the actions build upon and expand existing programs. Please refer to Chapter 7, *Greenhouse Gas Reduction Measure Implementation Program*, and Appendix C for additional information on lead entities for each action.

4.3.2 Emissions Reductions

Emissions reductions for 2020 are estimated for many state and local strategies. Strategies that do not currently support a quantitative reduction analysis are provided as supporting measures that strengthen the quantified measures (see Appendix C). Although emissions reductions have not been quantified for these strategies, they are still an important part of the CAP Update and ensure a comprehensive approach to climate action planning. Further development and implementation of these strategies may result in sufficient data to quantify the GHG reductions in the future. Please refer to Appendix C for additional information on emission reduction quantification methods.

4.3.3 Cost–Effectiveness Analysis

Private residents, businesses, utilities, and other public sector agencies will incur some costs to implement the GHG reduction strategies included in the CAP Update. In some cases, these entities will also realize long-term savings that can help recoup their initial investments. Costs and savings that would be incurred by residents and businesses were quantified for the local emissions reduction strategies. Economic effects are based on the best available data at the time of the CAP Update and represent total annual costs and savings in 2020. Costs and savings for strategies that do not currently support a quantitative analysis are assessed qualitatively.

Cost-Effectiveness Terms Explained

Cost per MT CO_2e: This is the ratio of the net cost of the strategy to the GHG reduction achieved. For this analysis, net costs are annualized, consistent with the GHG reductions achieved in 2020. The approach adjusts for the significant variation in the lifetime of an individual GHG reduction strategy (e.g., from energy-efficient household appliances that last 10 years to solar panels that could last up to 25 years), as well as variations in capital costs and annual cost savings. A negative cost per ton indicates measures that result in net savings.

Simple payback period: The simple payback period represents the estimated number of years before the initial investment is repaid. It is estimated by dividing the total initial capital cost by the annual cost savings.

Net present value: Net present value (NPV) represents the current worth of a stream of costs and savings over the entire lifetime of the GHG reduction measure. To estimate current worth (or "present value"), future costs and savings are discounted to account for interest-earning potential and other considerations. A positive NPV indicates that a measure is cost-saving over its lifetime.

Monetary costs and savings were estimated using information specific to the county, when available, or for similar cities in the region, California, or United States, prioritized in that order. The majority of data was from public sources, including the California Public Utilities Commission, PG&E, United States Department of Energy, California Energy Commission, and EPA. Some cost data were also based on price quotes provided from suppliers serving the northern California region. Costs estimated include initial capital cost and programmatic costs, whereas savings include reduced costs associated with electricity, natural gas, fuel usage, and required maintenance. Ranges were provided for most strategies due to the uncertainties and variability associated with estimating project costs. In general, ranges reflect differences in price estimates for technologies, based on the use of multiple data sources.

The following metrics are considered in the economic analysis and are reported in Appendix C: net present value (NPV), cost per $MTCO_2e$, and simple payback period. Please refer to Appendix C for cost information and additional information on cost quantification methods.

It is important to note that the cost-effectiveness analysis is reporting financial costs or benefits per ton of $MTCO_2e$ reduced and does not include the full economic/social costs. Since it is commonly recognized that the long-term economic/social costs of GHG emissions are not captured in energy prices or other prices for goods and services, the financial analysis is only telling part of the story. These long-term economic/social costs are commonly referred to as the "social cost of carbon." The social cost of carbon is an estimate of climate change damages and includes changes in net agricultural productivity, human health, property damages from increased flood risk, and changes in energy system costs, such as reduced costs for heating and increased costs for air conditioning. However, given current modeling and data limitations, it does not include all important damages. The USEPA's current estimate (in $2014) of the social cost of carbon, depending on the discount rate and statistic used ranges from approximately $12/$MTCO_2e$ to $117/$MTCO_2e$ for 2012 and between $29/$MTCO_2e$ to $240/$MTCO_2e$ for 2050.[22] If these long-term social costs of carbon were included in the financial analysis, then many of the measures would show greater net savings and/or lower net costs.

4.3.4 Community Co-Benefits

Implementing the CAP Update will result in environmental and community benefits that supplement the expected GHG emission reductions. For example, many of the actions will reduce criteria air pollutants in the county, including ozone, carbon monoxide, and fine particulates, which will improve public health. Measures to improve mobility and alternative modes of transportation will enhance walkability and mobility throughout the community. Active transport, like walking and biking, has been shown to substantially lower the burden of disease. These strategies can also complement and encourage other, more sustainable modes of transportation, including public transit (Maizlish et al. 2011).

Several actions directly target resource efficiency within the county. Building energy and transportation actions will reduce electricity, natural gas, and gasoline usage, which may help lessen consumer sensitivity to increases in future energy prices. Reducing gasoline consumption has an additional benefit of reducing dependence on foreign oil supplies. Recycling and waste diversion programs will also reduce material consumption and the need for landfill space. Water efficiency improvements and land use measures will conserve natural resources and the long-term viability of the County's natural spaces. Open spaces may also offer aesthetic and recreational benefits for community members, as well as habitat for native wildlife and plants.

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[22] See http://www.epa.gov/climatechange/EPAactivities/economics/scc.html.

The combined implementation of the CAP Update actions provides an opportunity to lower carbon emissions and achieve a diverse suite of community co-benefits. Section 4.4 provides additional information on the relevant co-benefits for each community CAP strategy area.

Anticipated community co-benefits associated with the CAP Update are listed in Figure 4-2.

Figure 4-2. Community Co-Benefits

4.4 Meeting Marin County's Greenhouse Gas Reduction Goals

Combined, the state and local strategies included in the CAP Update are expected to reduce 2020 community-wide GHG emissions by approximately 100,000 $MTCO_2e$, which exceeds the 2020 Community Emissions Reduction Target by nearly 3,000 $MTCO_2e$. This is equivalent to removing more than 21,000 passenger vehicles from the road each year (U.S. Environmental Protection Agency 2014a). As shown in Table 4-1, the majority (71%) of emissions reductions are achieved by state programs, such as the Pavley standards and RPS,[23] which is typical of other CAPs throughout

[23] Pavley will reduce GHG emissions from automobiles and light-duty trucks (2009 model years and newer) by 30% from 2002 levels by the year 2016. The RPS obligates certain utilities and electric-service providers to procure at least 33% of retail sales from renewable resources by 2020.

California. Local strategies implemented by the County supplement reductions achieved by the state programs to help meet and exceed the reduction target. Strategies not currently quantified, as well as local effects of the state's cap-and-trade program, will likely contribute additional reductions beyond those estimated by the CAP Update.

Table 4-1. Achieving Marin County's 2020 Community Greenhouse Gas Reduction Target—Sector View

Parameter	Emissions ($MTCO_2e$)
2020 BAU Community GHG Emissions Forecast[a]	490,848
2020 Community Emissions Reduction Target (30% below 1990 levels)[b]	393,296
Total Reductions Needed to Reach Target	***97,552***
2020 Emissions Reductions from State Strategies	71,192
2020 Emissions Reductions from Local Strategies	29,097
Energy Efficiency and Renewable Energy	17,386
Land Use, Transportation, and Off-Road Equipment	1,769
Waste Reduction, Reuse, and Recycling	2,995
Water Conservation and Wastewater Treatment[c]	3,256
Agriculture[d]	3,961
$Total_2$ Emissions Reductions Achieved by the CAP Update	***100,289***
Emissions Reductions in Excess of Target ($Total_2$ minus $Total_1$)	2,736

Notes:

BAU = business as usual.

$MTCO_2e$ = metric tons of carbon dioxide equivalent.

[a] 2020 BAU emissions do not include stationary sources.

[b] Total GHG emissions in 1990 were 561,851 $MTCO_2e$; an 30% reduction equals 393,296 $MTCO_2e$.

[c] Water conveyance measures result in water efficiency improvements to reduce water consumption, which will contribute to reductions in building energy use. For example, efficient faucets that use less water will require less energy for hot water heating. Most of the reductions achieved by Water-1 are associated with reduced hot water heating.

[d] As discussed in Chapter 6, this total includes only quantified reductions from Agriculture-1, which focused on methane digesters. Potential reductions from Agriculture-2 (carbon farming) are not included or relied upon to meet the reduction target for the reasons described in Chapter 6.

Table 4-2 summarizes the community CAP Update strategies, including their estimated GHG reduction in 2020. Many of the local strategies are cost effective, particularly those that target energy efficiency and renewable energy (see Appendix C for details). In addition to reducing GHG emissions, all local strategies will result in community co-benefits, such as improved public health, resource conservation, and better air quality.

Table 4-2. Summary of 2020 Greenhouse Gas Emissions Reductions by Community Measure ($MTCO_2e$)

State Strategy		2020 GHG Reduction	% Total of Reductions	Co-Benefits[a]
State-1. Renewables Portfolio Standard		17,512	17%	
State-2. Title 24 Standards for Commercial and Residential Buildings		1,362	1%	
State-3. Lighting Efficiency and Toxics Reduction Act		6,419	6%	
State-4. Residential Solar Water Heaters		178	0.2%	
State-5. Pavley and Low Carbon Fuel Standard		42,920	43%	
State-6. Advanced Clean Cars		2,226	2%	
State-7. Assembly Bill 32 Vehicle Efficiency Measures		574	0.6%	
Strategy Area	**Local Strategy**	**2020 GHG Reduction**	**% Total of Reductions**	
ENERGY EFFICIENCY AND RENEWABLE ENERGY	Energy-1. Community Choice Aggregation	2,744	3%	
	Energy-2. Energy Efficiency	7,548	8%	
	Energy-3. Solar Energy	7,093	7%	
LAND USE, TRANSPORTATION, AND OFF-ROAD EQUIPMENT	Trans-1. Land Use Design and VMT Reduction	1,554	2%	
	Trans-2. Expand Transit Service	116	0.1%	
	Trans-3. Electric Vehicle Charging Stations	15	0.01%	
	Trans-4. Electric-Powered Landscaping Equipment	84	0.1%	
WASTE REDUCTION, REUSE, AND RECYCLING	Waste-1. Zero Waste by 2025	2,995	3%	
WATER CONSERVATION AND WASTEWATER TREATMENT	Water/Wastewater-1. Water Conservation	1,187	1%	
	Water/Wastewater -2. Increase Pump Efficiency	105	0.1%	
	Wastewater/Wastewater-3. Reduce Wastewater Generation	1,964	2%	
AGRICULTURE	Agriculture-1. Methane Capture and Energy Generation at Dairies	3,691	4%	
	Agriculture-2. Carbon Farming	Not relied upon to meet target (see Chapter 6)		
	Agriculture-3. Promote the Sale of Locally Grown Foods and/or Products	Not quantified		

Notes:

[a] See Figure 4-2 for the key to the co-benefits symbols.

4.5 Measures to Reduce Greenhouse Gas Emissions

4.5.1 State Programs

Programs and initiatives undertaken by the state will contribute to local emissions reductions within the county. For example, the state's RPS will reduce the carbon content of electricity through requirements for increased renewable energy. Renewable resources, such as wind and solar power, produce electricity, just like coal and other traditional sources, but do not emit any GHGs. By generating a greater amount of energy through renewable resources, electricity provided to the County will be cleaner and less GHG-intensive than if the state had not required the RPS.

Seven statewide initiatives will contribute to community emissions reductions. The majority of emissions reductions are gained from building energy efficiency standards and renewable energy generation requirements. For example, Title 24 standards for new residential and nonresidential buildings require building shells and components be designed to conserve energy and water. Additional GHG reductions will be achieved by statewide initiatives to improve vehicle fuel efficiency and reduce the carbon intensity of transportation fuels.

4.5.2 Local Measures

4.5.2.1 Energy Efficiency and Renewable Energy

Residential and nonresidential buildings within the county consume over 350 gigawatt-hours of electricity and 18.5 million therms of natural gas annually. Resources used to generate electricity, as well as the direct combustion of natural gas in buildings, emitted more than 165,000 $MTCO_2e$ in 2012, making building energy use the largest source of community emissions (about 35%). Increases in population and employment, along with rising temperatures and cooling demands, will increase building energy use and associated GHG emissions in the future. By 2020, building energy emissions are forecast to exceed 175,000 $MTCO_2e$ and represent over 36% of total community emissions.

The CAP Update includes strategies that target both energy efficiency and renewable energy generation. Energy efficiency strategies reduce actual building energy consumption through efficient design, whereas renewable energy strategies directly reduce carbon emissions from electricity generation. Energy efficiency and renewable energy strategies both have upfront costs, but they usually result in long-term savings through reduced utility bills. The building energy strategies also achieve a diverse suite of community co-benefits, including reduced regional non-GHG pollutant emissions (such as carbon monoxide, nitrogen oxides, and particulate matter), improved home values, enhanced energy security, and job creation.

One strategy is focused on increasing the renewable portion of the County's energy mix. Energy-1, *Community Choice Aggregation*, represents Marin Clean Energy's growth and expansion to new County customers. As Marin Clean Energy obtains new customers for both its Light Green (50% renewable) and Deep Green (100% renewable) electricity options, building energy emissions in the county will decrease.

The building energy strategies include a combination of regulatory and incentive-based approaches to reduce GHG emissions. Most of the strategies provide incentives to encourage voluntary improvements in energy efficiency and increased renewable energy generation. For example, Energy-2, *Energy Efficiency,* includes residential and nonresidential energy efficiency improvements in existing buildings. These strategies will reduce building energy consumption by providing rebates, low-interest financing, and other support for homeowners and businesses that can be used to complete energy efficiency retrofits. Similar support will be provided through Energy-3, *Solar Energy,* which promotes solar energy installations in both existing and new buildings. Public participation is essential to these incentive-based strategies.

In addition to voluntary and incentive-based approaches, the CAP Update includes strategies that establish new regulatory procedures for construction. For example, Energy-3, *Solar Power*, identifies solar installation requirements for a variety of land uses, including new single-family homes, and multi-family and commercial developments. The County will support project developers with implementation of this strategy by identifying grants and incentives and providing education and outreach.

4.5.2.2 Land Use, Transportation, and Off-Road Equipment

Vehicle trips made by residents and employees are expected to increase slightly as new housing units are developed, new businesses are created or expanded, and new services are provided. By 2020, GHG emissions generated by transportation activities are expected to exceed 167,000 $MTCO_2e$ and represent about 34% of the 2020 BAU Community Forecast.[24] Strategies to support alternative modes of transportation, improve transportation efficiency, and reduce VMT are therefore an essential part of the CAP Update. These strategies can also have far-reaching community co-benefits, including reduced formation of smog and toxic air containments. Alternative modes of transportation such as walking and biking may also help increase physical activity levels and improve public health.

The CAP Update includes four general strategies to reduce GHG emissions from on-road vehicles and off-road equipment (e.g., construction equipment). The CAP Update does not propose any new land use strategies or programs. All land use strategies are adapted from the approved Marin Countywide Plan. The CAP Update just quantifies these strategies (as feasible) in terms of GHG reductions.

The first strategy promotes reduced vehicle travel and improvements to the existing efficiency of the transportation network. Trans-1, *Land Use Design and VMT Reduction,* integrates a variety of actions such as promoting the longstanding Countywide Plan growth control strategy of focusing new development in the city-centered corridor; supporting regional carpool and vanpool programs; and implementing transportation demand management programs. This strategy directly targets land use patterns to allow appropriate densities and improve the diversity of new housing types (as noted above, the CAP Update does not propose any new land use strategies or programs). It will support shorter trips that can be accommodated by non-motorized and alternative transportation. Trans-1 will also reduce vehicle trips by encouraging ride-sharing and car-sharing programs along with employer-sponsored commuting programs.

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[24] Per standard inventory forecast protocols, the 2020 BAU forecast only includes the assumed vehicle improvement over time due to the Low Emissions Vehicle (LEV) and Zero Emissions Vehicle (ZEV) initiatives from CARB that are reflected in the EMFAC 2011 model. The BAU forecast does not include any assumed improvement in the fuel efficiency of Marin's vehicle fleet due to the Pavley requirements (AB 1493) or the Advanced Clear Car Initiative, nor changes in fuel GHG intensity due to the Low Carbon Fuel Standard.

In addition to supporting smart land use and trip reduction, alternative transportation, Trans-2, *Public Transportation,* promotes an integrated bus transit transportation network that will support alternative forms of transportation and help reduce VMT. Under this strategy, the County will work with transit providers to identify where increases in transit service could be beneficial, will reduce GHG emissions, and be cost-effective for transit providers.[25]

The third strategy, Trans-3, *Electric Vehicles*, is to encourage the use of electric vehicles (EVs) in the county by installing 20 new EV charging stations by 2020. The availability of additional charging stations is expected to increase the purchase and use of EVs in Marin County.

The final strategy, Trans-4, *Off-Road Equipment*, is intended to reduce GHG emissions generated by off-road equipment. This strategy proposes an incentive program for electric landscaping equipment.

4.5.2.3 Waste Reduction, Reuse, and Recycling

In 2012, County residents and businesses generated an estimated 180,000 tons of waste, 46,000 tons of which is landfilled, generating about 9,300 $MTCO_2e$ in 2012 (about 2% of the total 2012 Community Inventory). Marin County has a comprehensive waste collection system that currently includes many recycling and composting programs. These programs are designed to reduce the amount of trash that is sent to regional landfills. The programs collectively divert about 75% of all waste generated to recycling centers and other end uses (Marin County Civil Grand Jury 2014).

The Marin Hazardous and Solid Waste JPA seeks to send zero tons of waste to landfills by the year 2025. This program is supported by the County's existing recycling programs, the food waste collection program, the construction and demolition (C&D) waste ordinance, the plastic bag ban, and the polystyrene ban. The County recognizes that residents and businesses will play a vital role in achieving the waste diversion goals. Accordingly, Waste-1, *Zero Waste by 2025,* outlines a number of local recycling and composting initiatives that the County will implement in conjunction with the Marin Hazardous and Solid Waste JPA. This strategy aims for an 83% target diversion rate by 2020 to support the 2025 zero waste goal. Increased outreach and education are important tools that the County will use to help encourage participation in recycling and diversion programs. The County will promote financing to support increased waste diversion, as well as provide food waste and other green waste receptacles at County facilities visited by the public.

4.5.2.4 Water Conservation and Wastewater Treatment

Water conveyance represents less than 1% of the County's 2012 Community Inventory. Although it is a relatively small component of the County's GHG portfolio, homes and businesses throughout the county consume a significant amount of water through indoor plumbing and outdoor irrigation. It is estimated that an average three-bedroom California home uses 174,000 gallons of water each year (ConSol 2010). Water resources are an important part of the Marin County community and economy—local surface and groundwater provide the majority of water to the county, which is supplied by several water agencies including the Marin Municipal Water District, North Marin Water District, and Stinson Beach County Water District. Given the potential for future reductions in water supplies as a result of climate change, Water Conservation and Wastewater Treatment is a critical strategy area for the CAP Update.

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[25] Not all transit service expansions may result in net GHG reductions. For example, low ridership routes may provide non-vehicle populations with mobility options during off-peak hours, but may not result in net GHG reductions, whereas expansion of commute or other higher ridership routes can often result in net GHG reductions.

Wastewater treatment emissions represent about 1% of the County's 2012 Community Inventory. Wastewater treatment results in fugitive emissions of methane and nitrous oxide through the treatment process. Reducing potable water use will reduce the amount of wastewater generated by businesses and residents, which will reduce treatment-related GHG emissions.

The County has identified two strategies to enhance community water conservation and management. Water/Wastewater-1, *Water Conservation*, outlines strategies to reduce water consumption consistent with SB X7-7.[26] The strategy is supported by a number of *Marin Countywide Plan* policies, requires new development to achieve Tier 1 Voluntary CALGreen water efficiency standards, and encourages existing development to achieve the Tier 1 standards. This program may also incorporate free water audits in conjunction with the three local water providers. Water efficiency training, education, and outreach will also be provided. Water reductions achieved by Water/Wastewater-1 will not only help conserve water, but also contribute to building energy savings through reduced electricity and natural gas for hot water heating. Through Water/Wastewater-2, *Increase Pump Efficiency*, the County will work with water agencies to maximize water pump efficiency to achieve a 20% reduction in water pumping energy use by 2020.

The County has identified one strategy to reduce wastewater generation. Water conservation efforts can greatly decrease the need for wastewater treatment. Accordingly, Water/Wastewater-3, *Reduce Wastewater Generation,* endeavors to reduce residential and nonresidential wastewater generation by 10–15% by 2020. This would be supported by water conservation measures that seek to reduce indoor water use in buildings along with the County's Graywater Systems Ordinance. This program is also supported by a number of *Marin Countywide Plan* policies.

4.5.2.5 Agriculture

Agricultural reduction measures are discussed separately in Chapter 6.

[26] SB X7-7 requires urban water agencies throughout California to help achieve the statewide goal of a 20% per capita water use reduction by 2020.

Chapter 5
Municipal Greenhouse Gas Reduction Goals and Measures

Photo: Golden Gate Transit District

Chapter 5
Municipal Greenhouse Gas Reduction Goals and Measures

5.1 Introduction

The CAP Update includes a variety of strategies that will reduce emissions from municipal operations. Several of the CAP Update strategies build on existing County programs and actions, whereas others provide new opportunities to address climate change. Statewide sustainability effort will have a substantial impact on future GHG emissions. Local strategies adopted by the County will supplement these state programs and achieve additional GHG emissions reductions for municipal operations.

The following sections summarize the state and local strategies included in the CAP Update for municipal emissions. Estimated emissions reductions achieved by the CAP Update are presented, indicating that the County will meet and exceed its 2020 Municipal Emissions Reduction Target. Costs, savings, and co-benefits are also described. Please refer to Appendix C for additional information on each strategy, including detailed objectives and assumptions used to quantify emissions reductions and costs.

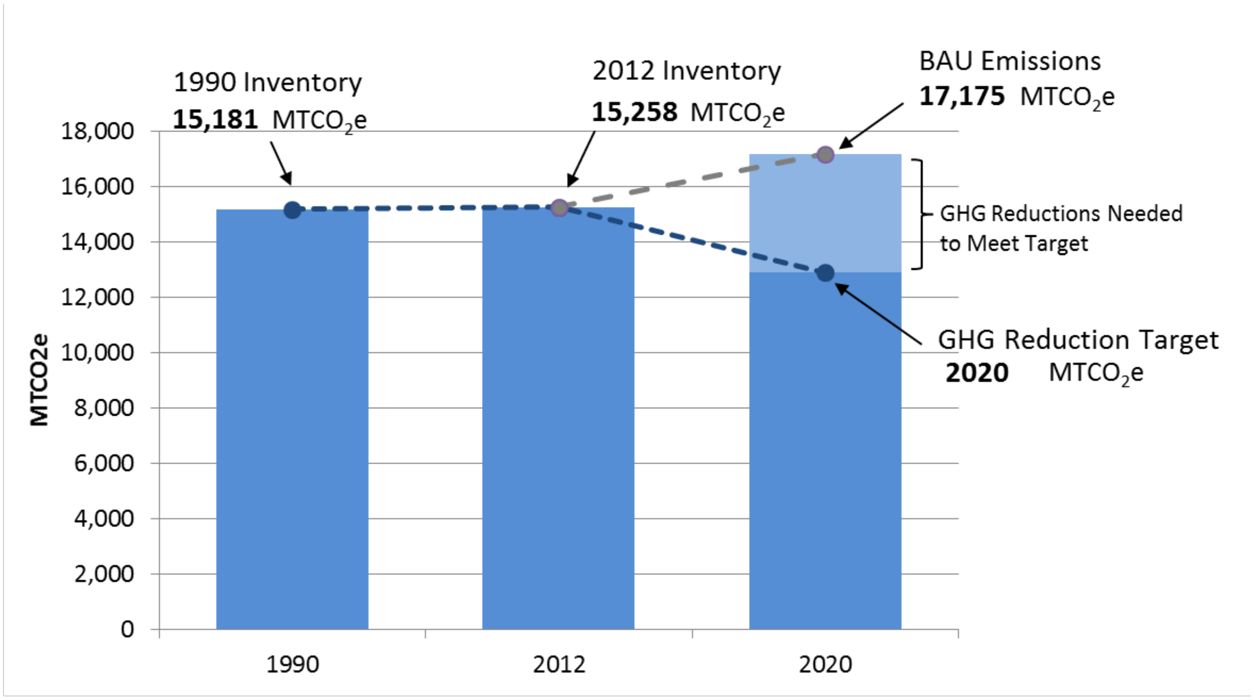
5.2 Marin County Greenhouse Gas Reduction Goals

In the 2006 GHG Reduction Plan, the County adopted an emissions reduction target for municipal emissions of 15% below 1990 levels by 2020. When comparing the original 1990 emissions inventory with the updated 2012 inventory, municipal emissions appear to have increased slightly (0.2% greater than 1990 levels). However, there were significant data gaps in the 1990 municipal inventory, which makes comparisons between years problematic; for example, PG&E was unable to provide electricity and natural gas usage data for 1990 for some municipal accounts, so actual 1990 emissions are different and may be higher than reported in this document (see Section 3.2.3, *Previous Inventories*, for additional discussion). Consequently, municipal emissions in 2012 are likely lower than they actually were in 1990, and the county may be able to reduce emissions by more than 15% below 1990 levels by 2020 . Because of these data limitations, this CAP Update retains the current emissions target of 15% below 1990 levels by 2020. The 2020 Municipal Emissions Reduction Target reflects the County's continued commitment to implement achievable emissions reductions at the municipal level. The major obstacle to increasing the stringency of this target is that the target is based on the 1990 inventory, which had significant data gaps and technical issues as discussed above. If a more accurate and complete 1990 inventory of emissions was available, the County could potentially be on track to meet the current target and could consider a more aggressive target for the year 2020.

Meeting the target will depend on a combination of state and local policies. Achieving this goal would avoid the generation of more than 4,500 $MTCO_2e$ and reduce 2020 Municipal GHG emissions to approximately 13,000 $MTCO_2e$. The strategies outlined in this chapter represent a combination of local and state initiatives that will collectively lower future municipal GHG emissions in the county consistent with the County's reduction target (see Figure 5-1).

The County's 2020 Municipal Emissions Reduction Target aligns with and exceeds statewide goals established by AB 32, which commits to reducing statewide GHG emissions to 1990 levels by 2020. The AB 32 Scoping Plan provides a roadmap for achieving these reductions and recommends a complementary reduction goal for local governments of 15% below current emissions levels (2008), which is roughly equivalent to 1990 emission levels. Because the County's 2012 municipal emissions are already about equal to 1990 levels, and the County's 2020 Municipal Emissions Reduction Target is 15% below 1990 levels by 2020, the Municipal Emissions Reduction Target is more aggressive than the AB 32 scoping plan recommended target for local governments with this complementary reduction goal.

Figure 5-1. Marin County 2020 Municipal Emissions Reduction Goal



Municipal Emissions Reductions in Context

Implementation of the CAP Update would avoid the generation of more than 4,500 $MTCO_2e$ for the County government, which is equivalent to the following actions (U.S. Environmental Protection Agency 2014a):

- Removing nearly 1,000 passenger vehicles from the road each year;
- Reducing gasoline consumption by more than 500,000 gallons per year; and
- Providing renewable energy to power nearly 450 homes each year.

5.3 Climate Action Plan Framework

5.3.1 Reduction Measures

The CAP Update comprises a variety of state and local actions to reduce GHG emissions associated with municipal operations. As for community emissions, statewide efforts to reduce GHG emissions are an important part of the County's strategy to reduce municipal emissions. For example, the state's Pavley vehicle fleet regulations will improve the fuel efficiency of vehicles throughout the state, including those used by Marin County employees to commute to work and those vehicles within the County's municipal vehicle fleet. Vehicle emissions will therefore be reduced much more than if Pavley had not been established. The CAP Update includes the local impact of four state actions to reduce GHG emissions, as discussed further in Section 5.5.1.

The County has identified eight local municipal actions to supplement the statewide initiatives. Although identified individually in the CAP Update, these actions will be implemented together as part of a comprehensive GHG emissions reduction program. Coordinating GHG reduction programs will streamline CAP implementation and potentially boost GHG reduction outcomes through synergies created among measures.

Together, the CAP Update actions will improve building energy efficiency and renewable energy production, increase alternative modes of transportation for municipal employees, reduce emissions from County-owned vehicles, and reduce water consumption and waste generation. The actions were selected following a comprehensive review of candidate strategies recommended by the California Attorney General, CAPCOA, existing CAPs throughout California, and the *Marin Countywide Plan*.

A number of the actions build on existing County programs, whereas others provide new opportunities to address climate change. Successful implementation of these actions will require commitment and dedication from the County and its various departments. As discussed in Chapter 7, *Greenhouse Gas Reduction Measure Implementation Program*, the County will adaptively manage the implementation of the CAP Update to maximize GHG reductions and operational efficiency for each action. Accordingly, the County may revise actions or add new actions to ensure that the County achieves its 2020 Municipal Emissions Reduction Target. If adopted and implemented prior to 2020, new federal programs that achieve local GHG reductions beyond state and local mandates may also be added to the County's CAP.

5.3.2 Emissions Reductions

Emissions reductions achieved in 2020 are estimated for a range of state and local strategies. Strategies that do not currently support a quantitative reduction analysis are provided as supporting measures that strengthen the quantified measures (see Appendix C). Although emissions reductions have not been quantified for these strategies, they are still a key part of the CAP Update and ensure a comprehensive approach to climate action planning. Further development and implementation of these strategies may result in sufficient data to quantify the GHG reductions in the future. Please refer to Appendix C for additional information on emission reduction quantification methods.

5.3.3 Cost–Effectiveness Analysis

A cost–effectiveness analysis was not performed for municipal measures.

5.3.4 Co-Benefits

Municipal GHG reduction measures will result in environmental and community benefits that supplement the expected GHG emission reductions. As for the community measures, many of the municipal actions will reduce criteria air pollutants in the county, including ozone, carbon monoxide, and fine particulates, which will improve public health. The co-benefits for municipal measures are very similar to those for community measures, which include the conservation of natural resources, reducing dependence on foreign oil supplies, reducing material consumption and the need for landfill space, and reducing the need for potable water resources.

The combined implementation of the CAP Update actions provides an opportunity to lower carbon emissions and achieve a diverse suite of community co-benefits. Table 5-1 provides additional information on the relevant co-benefits for each municipal CAP strategy area.

5.4 Meeting Marin County's Greenhouse Gas Reduction Goals

Combined, the state and local strategies included in the CAP Update are expected to reduce 2020 municipal GHG emissions by 4,683 $MTCO_2e$, which exceeds the 2020 Municipal Emissions Reduction Target by 412 $MTCO_2e$. This is equivalent to removing nearly 1,000 passenger vehicles from the road each year (U.S. Environmental Protection Agency 2014a). As shown in Table 5-1, the majority (70%) of emissions reductions are achieved by state programs, such as the Pavley standards and RPS, which is typical of other CAPs throughout California. Local strategies implemented by the County supplement reductions achieved by the state programs to help meet and exceed the reduction target. Strategies not currently quantified, as well as local effects of the state's cap-and-trade program, will likely contribute additional reductions beyond those estimated by the CAP Update.

Table 5-1. Achieving Marin County's 2020 Municipal Greenhouse Gas Reduction Target—Sector View

Parameter	Emissions ($MTCO_2e$)
2020 BAU Community GHG Emissions Forecast	17,175
2020 Municipal Emissions Reduction Target (15% below 1990 levels)[a]	12,904
Total$_1$ Reductions Needed to Reach Target	***4,272***
2020 Emissions Reductions from State Strategies	3,245
2020 Emissions Reductions from Local Strategies	1,438
Energy Efficiency and Renewable Energy	451
Vehicle Fleet and Employee Commute	851
Waste Reduction, Reuse, and Recycling	34
Water Conservation and Wastewater Treatment[b]	102
Total$_2$ Emissions Reductions Achieved by the CAP Update	***4,683***
Emissions Reductions in Excess of Target (Total$_2$ minus Total$_1$)	412

Notes:

BAU = business as usual.

$MTCO_2e$ = metric tons of carbon dioxide equivalent.

[a] Total GHG emissions in 1990 were 15,181 $MTCO_2e$; a 15% reduction equals 12,904 $MTCO_2e$.

[b] Water conveyance measures result in water efficiency improvements to reduce water consumption, which will contribute to reductions in building energy use. For example, efficient faucets that use less water will require less energy for hot water heating.

Table 5-2 summarizes the municipal CAP Update strategies, including their estimated GHG reduction in 2020. Many of the local strategies are also cost effective, particularly those that target energy efficiency and renewable energy (see Appendix C for details). In addition to reducing GHG emissions, all local strategies will result in community co-benefits, such as improved public health, resource conservation, and better air quality.

Table 5-2. Summary of 2020 GHG Emissions Reductions by Municipal Measure ($MTCO_2e$)

State Strategy		2020 GHG Reduction	% Total of Reductions	Co-Benefits[a]
State-1. Renewables Portfolio Standard		403	9%	
State-2. Pavley and Low Carbon Fuel Standard		2,653	57%	
State-3. Advanced Clean Cars		161	3%	
State-4. Assembly Bill 32 Vehicle Efficiency Measures		29	0.6%	
Strategy Area	**Local Strategy**	**2020 GHG Reduction**	**% Total of Reductions**	
ENERGY EFFICIENCY AND RENEWABLE ENERGY	Energy-1. Energy Efficiency	341	7%	
	Energy-2. Solar Energy	111	2%	
VEHICLE FLEET AND EMPLOYEE COMMUTE	Trans-1. New Vehicles	62	1%	
	Trans-2. Alternative Transportation	8	0.2%	
	Trans-3. Trip Reduction	781	17%	
WASTE REDUCTION, REUSE, AND RECYCLING	Waste-1. Increase Recycling at County Facilities	34	0.7%	
WATER CONSERVATION AND WASTEWATER TREATMENT	Water-1. Water Conservation	101	2%	

Notes:
See Figure 4-2 for the key to the co-benefits symbols.

5.5 Measures to Reduce GHG Emissions

5.5.1 State Programs

Just like for community emissions, programs and initiatives undertaken by the state will contribute to local municipal emissions reductions. For example, the state's Pavley vehicle standards will increase the fuel efficiency of the cars that County employees drive to work in the future. More fuel-efficient vehicles use less fuel and produce fewer GHG emissions, so emissions from employee commutes will decrease as a result of the Pavley regulations.

The County quantified four statewide initiatives that will contribute to municipal emissions reductions. The majority of emissions reductions are gained from mandates for renewable energy generation and vehicle standards. Specifically, the state's RPS will increase the amount of electricity generated by renewable resources, reducing GHG emissions from electricity consumption. GHG reductions will also be achieved by statewide initiatives to improve vehicle engine efficiency and reduce the carbon intensity of transportation fuels.

5.5.2 Local Measures

5.5.2.1 Energy Efficiency and Renewable Energy

County-owned buildings along with streetlights and traffic signals consumed enough electricity and natural gas in 2012 to emit nearly 5,600 $MTCO_2e$, representing 37% of total municipal emissions in 2012. These emissions are anticipated to grow by 22% to over 6,700 $MTCO_2e$ in 2020, due to the construction of the new emergency operations facility. The CAP Update includes two major strategies to reduce emissions in the building energy sector, including energy conservation and solar power.

The first strategy, Energy-1, *Energy Efficiency*, includes wide variety of actions that the County will implement to reduce energy consumption in County facilities. This strategy includes energy efficiency measures at the new emergency operations facility that will reduce electricity use by 1.17 million kilowatt-hours and natural gas use by more than 800 therms. Under Energy-1, the County will conduct energy efficiency retrofits of some existing County buildings to improve building-wide energy efficiency by at least 20%. By 2020, the County plans to replace traditional desktops and laptops with tablet computers, which use significantly less energy. The County plans to use software to manage computer energy use and to require employees to turn off computers before they go home. Shade trees will also be planted to reduce the heating and cooling load of buildings. To reduce energy use from streetlights and traffic signals, the County will ensure that all streetlights use LED bulbs.

The second strategy, Energy-2, *Solar Power*, aims to replace utility-supplied electricity with energy generated by solar photovoltaic panels on County roofs. The County will require, where feasible, new or major rehabilitation of County-owned buildings are constructed to allow for easy, cost-effective installation of solar energy systems in the future. The County also plans to install solar panels on unused space over carports and parking areas.

5.5.2.2 Vehicle Fleet and Employee Commute

The County operates a vehicle fleet including gasoline and diesel cars, trucks, vans, and buses. In 2012 these vehicles consumed nearly 300,000 gallons of gasoline and diesel fuels, contributing nearly 3,000 $MTCO_2e$ to the 2012 Municipal Inventory (18%). On-road vehicle emissions from employee commutes also contribute to municipal emissions. In 2012, County employees traveled over 17 million miles, emitting almost 7,000 $MTCO_2e$. This represents over 40% of the 2012 Municipal Inventory, and is the largest sector of the inventory in terms of emissions. Together, vehicle fleet and employee commute emissions compose 61% of total municipal emissions in 2012. Consequently, there is a major opportunity to reduce municipal GHG emissions by implementing programs that target the fuel efficiency of County-owned vehicles and the commuting habits of employees.

Trans-1, *New Vehicles*, attempts to reduce emissions through vehicle technology. While certain vehicles used in County services such as emergency vehicles or heavy duty equipment are not suited for replacement, many County vehicles can be replaced with hybrid vehicles or electric vehicles, both of which produce fewer GHGs than traditional vehicles (i.e., vehicles fueled with gasoline or diesel). Through Trans-1, the County plans to expand on the fuel-efficient fleet vehicles program by purchasing at least 25 new hybrid vehicles and 20 new electric vehicles by 2020 to replace conventional gasoline and diesel vehicles.

In addition to vehicle technology, the CAP Update will reduce GHG emissions through the use of alternative transportation by employees. Trans-2, *Alternative Transportation*, will institute a Guaranteed Ride Home program, which would provide a free shuttle or taxi ride home to employees in case of an emergency (illness, family crisis, unscheduled overtime). This program would be offered to any employee who uses any alternative to driving alone to work (public transit, carpooling, vanpooling, biking, or walking) on the day of the emergency, further encouraging alternative modes of transportation. Trans-2 would also reestablish the Green Commute Program, which could include allowing County employees to purchase public transit fares with pre-tax dollars up to IRS limits, providing employees with low-cost monthly transit passes and/or providing direct incentives to employees that take commute alternatives. Trans-2 also aims to encourage the use of EVs by County employees by installing 10 new 120-volt EV charging stations at County facilities by 2020. The availability of additional charging stations at County facilities is expected to increase the purchase and use of EVs by County employees.

Finally, the County plans to reduce employee commute emissions by encouraging trip reduction. Trans-3, *Trip Reduction*, encourages employees to telecommute and implements a Municipal Parking Management Program to discourage private vehicle use. These programs will reduce the number of trips that employees take to commute to work.

The employee commute programs are anticipated to result in large GHG emission reductions because employee commuting represents the largest sector of the municipal inventory (representing 40% of total emissions) and because the County is committed to implementing aggressive programs to reduce these emissions by encouraging employees to carpool, take alternative modes of transportation to work, and telecommute. Together, these actions will result in sizeable emission reductions for the County.

5.5.2.3 Waste Reduction, Reuse, and Recycling

County employees generate waste through their daily activities and facility operations. Some portion of this waste ultimately is placed in a landfill where it decays and releases methane. In 2012, GHG emissions related to municipal waste generation were estimated at almost 50 $MTCO_2e$, a small part of the County's municipal emissions (less than 1%). Although the total GHG savings potential in this sector is small, there are ample opportunities to reduce these emissions because the waste diversion rate at many County facilities is less than the community diversion rate for the County as a whole.

Waste-1, *Increase Recycling at County Facilities*, will expand County recycling efforts and include the addition of food scrap recycling where feasible. This strategy aims to increase the diversion rate at many County facilities, including Civic Center, the County Jail, 120 North Redwood, and the Kerner Campus to over 80%. It also sets a target diversion rate of 95% for the Marin County Fair and the Marin Home Show. These actions will reduce the amount of waste going to landfill, along with the GHG emissions associated with this landfilled waste.

5.5.2.4 Water Conservation and Wastewater Treatment

The County serves as a consumer of water, just like the many residents and businesses in the county. In 2012, the County consumed more than 78 million gallons of water. In 2012, emissions associated with providing water for municipal uses resulted in 29 $MTCO_2e$ (less than 1% of total emissions). The County will already be working with the water agencies to maintain the pumps for maximum efficiency and to upgrade equipment as needed for maximum energy efficiency (see Section 4.5.2 above).

Emissions are generated when wastewater produced by municipal operations is treated at wastewater treatment plants; these emissions account for 1% of the 2012 Municipal Inventory. The most direct way to reduce these emissions is to reduce wastewater generation, which is primarily accomplished through water conservation efforts aimed at reducing potable water use. If less potable water is used in kitchens and bathrooms, then less wastewater is generated and less wastewater needs to be treated.

As a water consumer, the County can save energy and avoid future GHG emissions by reducing its overall water consumption. Although the total GHG savings potential in this sector is small, the County is committed to a regionally sustainable water supply and can serve as a leader to other jurisdictions and its citizens in this regard.

The CAP Update has one strategy to reduce water use and associated GHG emissions. Water-1, *Water Conservation*, aims to reduce water use through a number of actions. The County will promote site appropriate, low-water use, and drought tolerant native plants in public facilities. Water-1 also involves water conservation for both existing and new buildings by reducing water use by 30–40%, consistent with CALGREEN Tier 1 Voluntary standards for non-residential development. The County will consider installing and or using a water monitoring and management system for all of the County's irrigation needs. This could be accomplished by participation in the California Irrigation Management Information System (CIMIS), such as by installation of a climate station in the county or by using CIMIS irrigation scheduling tools. The County also plans to develop a master plan of County facilities to address water efficient landscape, irrigation and maintenance practices.

The County is also using as much recycled water as the water districts can supply for landscaping water use and other non-potable water uses. While not quantified in the CAP update, the County's current use of recycled water contributes to energy and emission reductions in the water and wastewater sector by offsetting more energy intensive sources of potable water.

Water-1 will also reduce emissions in the wastewater sector, because using less water also means generating less wastewater.

Chapter 6
Agriculture


Photo: Marin Community Development Agency

Chapter 6
Agriculture

6.1 Introduction

Agriculture is an important part of Marin County's economy, identity, and heritage. The County is already ahead of the curve on sustainable agricultural practices. Marin's livestock farms and ranches are pasture-based and grass-fed operations, with documented reductions in emissions relative to other systems (O'Brien et al. 2014). The Marin Carbon Project, as discussed below, has been at the forefront of working with ranchers and dairies in Marin County to promote carbon farming practices and expand soil carbon sequestration and other practices to reduce GHG emissions.

Agriculture is discussed separately from other community and municipal emission reductions strategies because the agricultural economy is different from other emission sectors, such as residential, commercial, industrial and municipal development, and transportation. More important, the opportunities for long-term GHG reductions for the agricultural sector are fundamentally different from those in other sectors in that they are primarily focused not on reducing GHG emissions per se but in increasing sequestration of carbon from the atmosphere through farming practices and other practices on working range lands to improve the fertility and long-term ecological health of the county's agricultural lands. These "carbon farming" practices have the potential, in time, to contribute to large reductions in net GHG emissions in Marin County and, if scaled up, larger landscapes across California and elsewhere. In that context, the demonstrated success of what is being pioneered in Marin County may be critical to the ability of California and the country as a whole to achieve long-term GHG reduction goals long beyond 2020.

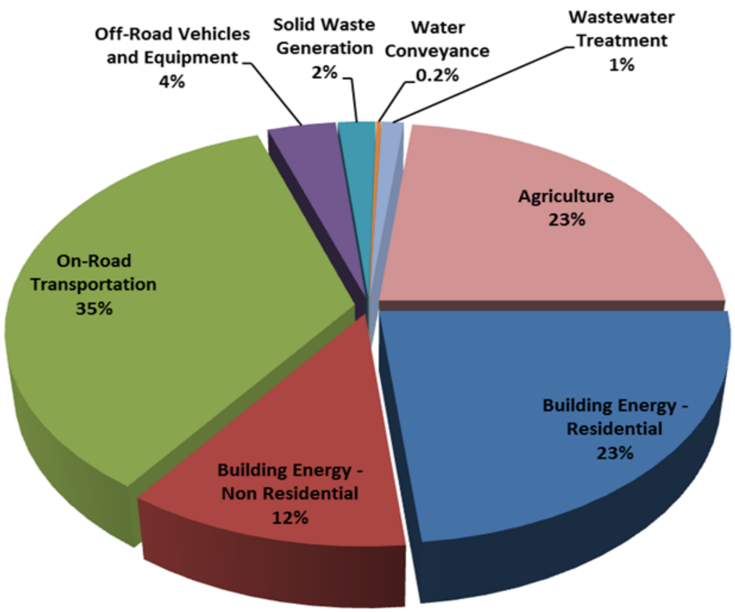
6.2 Agricultural Greenhouse Gas Emissions and Carbon Sequestration

6.2.1 Agricultural GHG Emissions

Emissions from agriculture that were quantified as part of this Climate Action Plan are primarily from manure management and enteric fermentation of livestock but also include fugitive emissions of nitrous oxide from fertilizer application.

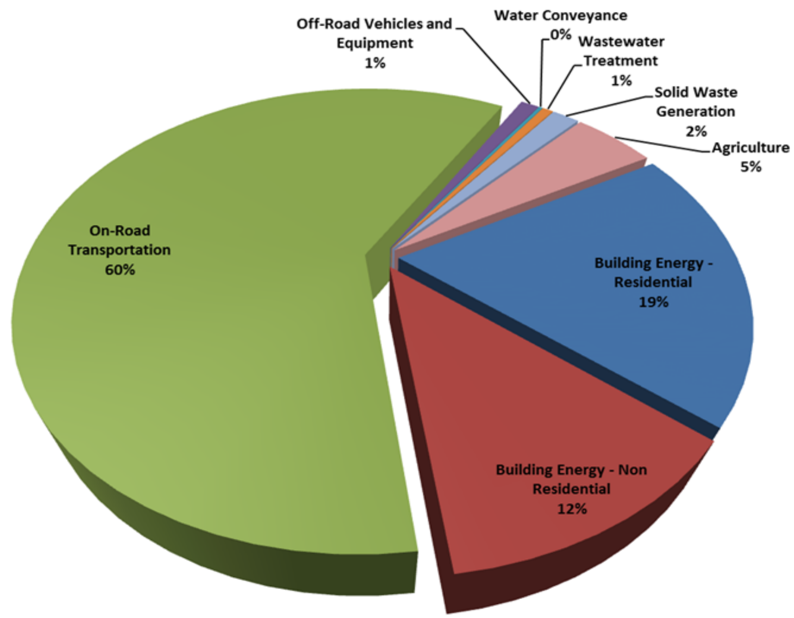
Although emissions from agriculture in the unincorporated county area (110,000 $MTCO_2e$) made up 23% of GHG emissions in the unincorporated county in 2012, this does not portray the proper context because the county has a disproportionate amount of agricultural land and activity; the incorporated cities have very limited agricultural activity. Although governmental jurisdictional boundaries separate the county into incorporated cities and the unincorporated county, from an economic point of view, the jurisdictional boundaries are artificial. The agricultural economy is not separate from the rest of the county, including the incorporated cities. When comparing the amount of agricultural emissions with countywide emissions, including the cities and the unincorporated area, agricultural emissions would constitute only approximately 5% of the total GHG emissions.

Figure 6-1. Comparative Agricultural Share of Overall GHG Emissions



Unincorporated County Only (2012)

Total emissions = 477,456 $MTCO_2e$



Countywide (2010)

Total emissions = 2.3 million $MTCO_2e$

Agricultural GHG Emissions in Context

Agricultural areas are located predominantly in the unincorporated area of Marin County and make up nearly quarter (23%) of the unincorporated area's annual emissions. However, when compared with larger geographies, the role of agricultural emissions is much smaller:

- Agricultural emissions (110,000 $MTCO_2e$) were approximately 5% of Marin's countywide 2010 emissions (2.3 million $MTCO_2e$).
- California's 2012 GHG emissions were approximately 459 million $MTCO_2$, of which agricultural emissions were approximately 38 million $MTCO_2e$, or 8%.

6.2.2 Agricultural Carbon Stocks and Sequestration

Unlike many other emissions sectors, carbon stock and sequestration are key considerations when examining the GHG inventory for the agricultural sector. As noted above in Chapter 3, *Updated Emissions Inventories and Forecast*, the current protocols (such as the 2012 ICLEI Protocol) for local GHG inventories recommends that inventories of carbon in agricultural and forestlands be separated from inventories of other man-made sources of GHG emissions because such carbon stock is part of the cycling of carbon from the atmosphere. However, the amount of carbon stock in agricultural soils and aboveground vegetation in working farms and rangelands is directly related to the agricultural and range management practices that have been historically used and are in use today. A baseline of current carbon stocks can be used to track changes in the amount of carbon stocks over time due to changes in farming and rangeland management. Where agricultural and silviculture practices result in net sequestration of carbon from the atmosphere and increase carbon stocks over baseline levels, this represents a net reduction in GHG emissions.

As described in Appendix B, *Inventory and Forecast Details*, calculating carbon stocks and annual sequestration in agricultural soils and vegetation is often difficult to do accurately because of the lack of comprehensive soil and vegetation data. The amount of soil carbon and vegetative carbon stock can vary substantially for different soils and vegetation from one location to another and can also vary for the same type of soil and the same type of vegetation, depending on belowground organic matter content and vegetation density and extent. Thus, the majority of calculations were performed by using regional estimates of sequestration potentials and carbon stock values that are only approximate. As described below, improving the baseline accounting of current carbon stock and sequestration within Marin County agricultural and natural lands is a recommended action measure in this plan.

As presented in Chapter 3, *Updated Emissions Inventories and Forecast*, rangeland soil carbon stocks in 2012 on the 148,000 acres of rangeland in Marin County were estimated as 10.78 million MT of carbon, which is the equivalent of 39.5 million $MTCO_2e$. Without multiple years of carbon stock inventories, the amount of annual sequestration in rangeland and other land covers was not estimated. However, as discussed below, a 1% increase in the amount of carbon stock in Marin County rangelands by 2030 would result in an annualized amount of emissions reduction that would exceed all of the other local measures included in this plan if realized.

The remainder of this chapter discusses the reduction strategies in the agricultural sector that are currently under way and that have potential to contribute substantially to future GHG reductions through increased carbon sequestration and other measures.

6.3 Greenhouse Gas Reduction Measures

The County has identified a number of new strategies to address emissions from agriculture, which are described below.

This CAP recognizes the significant potential agriculture has with respect to its contributions to climate change mitigation and resilience through the implementation of new strategies and supports the recognition of such practices as offsets for CEQA compliance under County, BAAQMD, and statewide authorities. The County supports the efforts of Marin farmers to implement on-farm practices that help to address GHG emissions, consistent with County policies found in the Countywide Plan and other County directives. This program is supported by a number of Marin Countywide Plan policies.

The County also supports voluntary best management practices for agriculture. This may include adding compost from local community waste to the soil, using no-till and reduced-till practices, using organic fertilizers, reducing fossil fuel use in agricultural equipment, using cover crops in vineyards, using biochar in soils, planting hedgerows, and conserving or restoring natural vegetation, including stream restoration.

6.3.1 Agriculture-1: Methane Capture and Energy Generation at Dairies

This strategy attempts to reduce direct emissions from dairies. This measure is a voluntary measure that encourages the installation of methane digesters to capture methane emissions from the decomposition of dairy manure. The methane could be used on-site as an alternative to natural gas in combustion, for power production, or as a transportation fuel. Using captured biogas could offset natural gas use or off-road fuel use in the county (reductions may be achieved in the building energy sector and/or the off-road sector). Further, individual project proponents can sell GHG credits associated with these installations on the voluntary carbon market.[27]

As a voluntary measure, the County would support dairies that consider existing and new technologies to control emissions from enteric fermentation and manure management and assess the feasibility and cost effectiveness of these technologies. Dairies would be encouraged to explore new technologies and implement feasible and cost-effective manure digestion projects based on their own local conditions and operations. The County would assist in seeking local, regional, state, and/or federal grants to help offset capital costs, linking dairies to new research opportunities, and work with local partners to help assess the feasibility of reduction projects and cost-effective options where available. The County, along with Marin Clean Energy, will also explore the potential for MCE to use electricity from local methane digesters as part of its energy portfolio.

Centralized digester systems are designed to gain economies in digester operation by using the manure from a cluster of dairy farms (Lee and Sumner 2014), but new and emerging biogas recovery technologies suggest this approach may be applicable even to Marin's smaller dairy operations (Greer 2010). To be economically feasible, digesters in California must be designed per regulatory constraints, maximize operational efficiency through the use of recovered heat and co-digestion where possible, capture all potential revenue streams, and secure power purchase agreements or offset their own energy use at favorable prices (Lee and Sumner 2014). Achieving these conditions is extremely challenging but could be made less so by the active engagement of County regulatory agencies that support such projects and the use of Marin dairy digester projects for CEQA mitigation at a CO_2e value that is high enough to render projects economically viable.

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[27] Individual project proponents could also sell GHG credits associated with these installations on the voluntary carbon market to offset GHG emissions due to other activities. To the extent that project proponents sell GHG offset credits, these same credits may not be applied to local GHG emission reductions. Thus, even though there might be reductions in local emissions, there would be no net reduction in emissions globally. Nevertheless, carbon markets offer opportunities for agriculture to provide offsets and be financially compensated for doing so, including the sale of offsets that could be credited to local GHG reduction and then be retired rather than being sold as offsets for other projects.

6.3.2 Agriculture-2: Carbon Farming

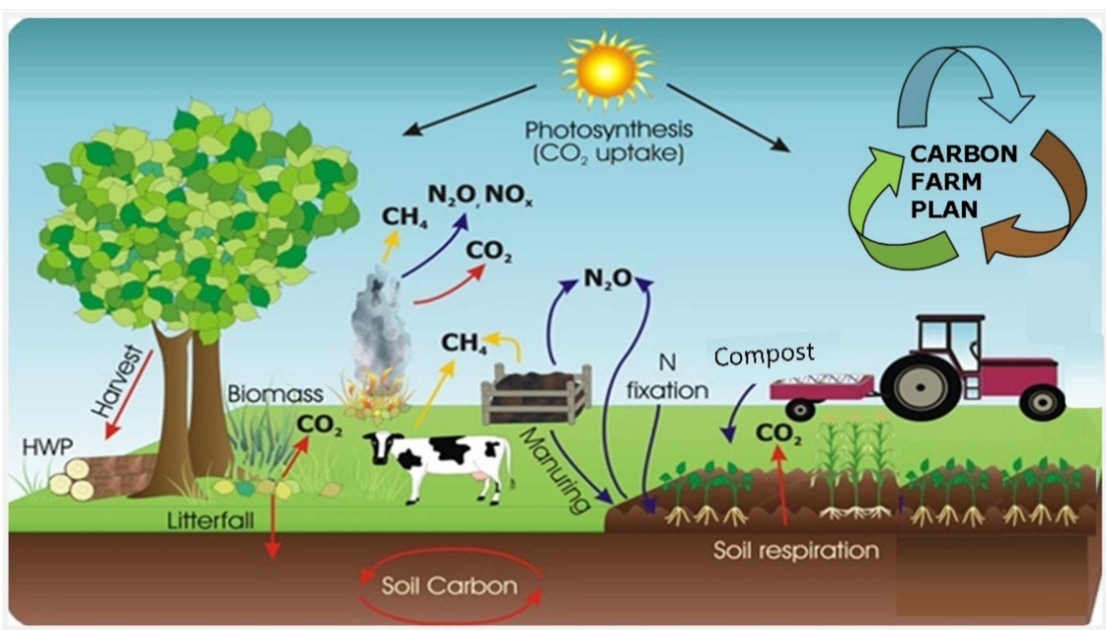
This measure includes voluntary actions by Marin's farmers and ranchers to increase carbon sequestration in farmed and ranched lands in the county. Such actions are supported by non-profit organizations such as the Marin Carbon Project (MCP), University of California Cooperative Extension (UCCE), the Natural Resources Conservation Service (NRCS), Marin Resource Conservation District (RCD), academic researchers, other organizations (e.g., the Carbon Cycle Institute), and Marin County, as described below.

6.3.2.1 Carbon Farming Methods and Reduction Potential

The Marin Carbon Project is a consortium of the leading agricultural institutions and producers in Marin County, university researchers, county and federal agencies, and nonprofit organizations that seek to understand and demonstrate the potential of enhanced carbon sequestration in Marin's agricultural and rangeland ecosystems (MCP 2013). MCP seeks to enhance carbon sequestration in rangeland, agricultural areas, and forest soils through applied research, demonstration, and implementation. For example, compost application, just one of numerous identified climate beneficial practices that are currently being implemented, has the potential to provide significant GHG emission reductions through additional carbon sequestration. A one-time application of 0.5 inch of compost on Marin's rangeland can produce an additional carbon sequestration rate of 1 $MTCO_2e$ per hectare per year, or 0.3 $MTC0_2e$ per acre per year (Ryals and Silver 2013).

The MCP demonstrates and promotes the concept of *carbon farming* through an integrated planning and implementation process that includes agricultural practices that are known to improve the rate at which CO_2 is removed from the atmosphere and converted to plant material and/or soil organic matter. Carbon farming is successful when carbon gains exceed carbon losses. Figure 6-2 illustrates the carbon farming concept.

Figure 6-2. Carbon Farming



Source: Intergovernmental Panel on Climate Change through the Marin Carbon Project, 2013.

Table 6-1 describes the practices that the NRCS has approved for improving organic matter (aka "soil carbon") in agricultural and rangeland soils. As described below, these measures not only would increase soil carbon but also have a wide range of other environmental benefits, including reducing erosion, preventing compaction, managing nutrients, conserving water, improving water quality, managing plant pests (weeds, insects, diseases), providing food for domestic livestock, and providing food and cover for wildlife, among other benefits. The Marin RCD, which has been active for many years, has supported sustainable agricultural systems. It has also supported the implementation of many of these measures in Marin County.

Table 6-1. Approved Natural Resource Conservation Service Practices for Improved Organic Matter

Practice	NRCS Code	Description/Benefits
Conservation Crop Rotation	328	Growing crops in a recurring sequence on the same field. BENEFITS: Reduce sheet and rill erosion, reduce irrigation induced erosion, reduce soil erosion from wind, maintain or improve soil organic matter content, manage deficient or excess plant nutrients, improve water use efficiency, manage saline seeps, manage plant pests (weeds, insects, diseases), provide food for domestic livestock, and provide food and cover for wildlife.
Cover Crop	340	Grasses, legumes, forbs, or other herbaceous plants established for seasonal cover and conservation purposes. BENEFITS: Reduce erosion from wind and water, increase soil organic matter, manage excess nutrients in the soil profile, promote biological nitrogen fixation, increase biodiversity, provide weed suppression, provide supplemental forage, and manage soil moisture.
Access Control	472	The temporary or permanent exclusion of animals, people, vehicles, and/or equipment from an area. BENEFITS: Achieve and maintain desired resource conditions by monitoring and managing the intensity of use by animals, people, vehicles, and/or equipment in coordination with the application of the schedule of practices, measures, and activities specified in the conservation plan.
Conservation Cover	327	Establishing and maintaining permanent vegetative cover to protect soil and water resources. BENEFITS: Reduce soil erosion and sedimentation, improve water quality, and enhance wildlife habitat.
Critical Area Planting	342	Planting vegetation, such as trees, shrubs, vines grasses, or legumes, on highly erodible or critically eroding areas (does not include tree planting mainly for wood products). BENEFITS: To stabilize the soil, reduce damage from sediment and runoff to downstream areas, and improve wildlife habitat and visual resources.
Field Border	386	A strip of permanent vegetation established at the edge or around the perimeter of a field. PURPOSE: Reduce erosion from wind and water, protect soil and water quality, manage harmful insect populations, provide wildlife food and cover, increase carbon storage in biomass and soils, and improve air quality.
Filter Strip	393	A strip or area of vegetation for removing sediment, organic matter, and other pollutants from runoff and wastewater. This standard establishes the minimally acceptable requirements for design and operation and maintenance of filter strips for removing sediment, organic matter, and other pollutants from runoff or wastewater. BENEFITS: To remove sediment and other pollutants from runoff or wastewater by filtration, deposition, infiltration, absorption, adsorption, decomposition, and volatilization, thereby reducing pollution and protecting the environment.
Grassed Waterway	412	A natural or constructed channel that is shaped or graded to required dimensions and established in suitable vegetation for the stable conveyance of runoff. This standard applies to natural or constructed channels that are to be established in vegetation and used for water disposal. Grassed waterways with stone centers are also included. BENEFITS: To covey runoff from terraces, diversions, or other water concentrations without causing erosion or flooding and improve water quality.
Hedgerow Planting	422	Establishment of dense vegetation in a linear design to achieve a natural resource conservation purpose. BENEFITS: Food, cover, and corridors for terrestrial wildlife; food and cover for aquatic organisms that live in watercourses with full bank widths of less than 5 feet; living fences, boundary delineations, contour guidelines, screens, and barriers to noise, odors, and dust; and improvement of landscape appearance.
Mulching	484	Applying plant residues or other suitable materials to the soil surface. BENEFITS: To conserve moisture, prevent surface compaction or crusting, reduce runoff and erosion, modify surface temperatures, control weeds, help establish plant cover, and reduce particulate matter emissions into the air.

Practice	NRCS Code	Description/Benefits
Nutrient Management	590	Managing the amount, source, placement, form, and timing of the application of nutrients and soil amendments. BENEFITS: To budget and supply nutrients for plant production; properly use manure or organic by-products as a plant nutrient source; minimize agricultural nonpoint-source pollution of surface and groundwater resources; and maintain or improve the physical, chemical, and biological condition of soil.
Pasture and Hay Planting	512	Establishing native or introduced forage species. BENEFITS: Establish adapted and compatible species, varieties, or cultivars; improve or maintain livestock nutrition and/or health; extend the length of the grazing season; provide emergency forage production; and reduce soil erosion by wind and/or water.
Prescribed Grazing	528	The controlled harvest of vegetation with grazing or browsing animals, managed with the intent of achieving a specified objective. BENEFITS: Improve or maintain the health and vigor of selected plant(s) and maintain a stable and desired plant community; provide or maintain food, cover, and shelter for animals of concern; improve or maintain animal health and productivity; maintain or improve water quality and quantity; reduce accelerated soil erosion and maintain or improve soil conditions for the sustainability of the resource; and promote economic stability through grazing land sustainability.
Range Planting	550	Establishment of adapted perennial vegetation such as grasses, forbs, legumes, shrubs, and trees. BENEFITS: Restore a plant community similar to its historic climax or the desired plant community, provide or improve forages for livestock and/or browse or cover for wildlife, reduce erosion by wind and/ or water, improve water quality and quantity, and increase carbon sequestration.
Residue Management – Seasonal	344	Managing the amount, orientation, and distribution of crop and other plant residues on the soil surface during part of the year, while growing crops in a clean tilled seedbed. BENEFITS: Reduce sheet and rill erosion, reduce soil erosion from wind, and provide food and escape cover for wildlife. Allow timely cycling of high volumes of residue, and maintain or improve soil organic matter content and tilth.
Residue Management – Mulch Till	344	Managing the amount, orientation, and distribution of crop and other plant residue on the soil surface year-round while growing crops where the entire field surface is tilled prior to planting. BENEFITS: Reduce sheet and rill erosion, reduce wind erosion, maintain or improve soil organic matter content and tilth, conserve soil moisture, and provide food and escape cover for wildlife.
Riparian Forest Buffer	391	An area of predominantly trees and/or shrubs located adjacent to and up-gradient from watercourses or water bodies. BENEFITS: Create shade to lower water temperatures and improve habitat for fish and other aquatic organisms; provide a source of detritus and large woody debris for fish and other aquatic organisms as well as riparian habitat and corridors for wildlife; reduce excess amounts of sediment, organic materials, nutrients, pesticides, and other pollutants in surface runoff; reduce excess nutrients and other chemicals in shallow groundwater flow; provide protection against scour erosion within the floodplain; restore natural riparian plant communities; moderate winter temperatures to reduce freezing of aquatic over-wintering habitats; and increase carbon storage.
Riparian Herbaceous Cover	390	Riparian areas are ecosystems that occur along watercourses or at the fringe of water bodies. Riparian herbaceous cover consists of grasses, grasslike plants, and forbs. PURPOSE: Riparian areas provide habitat (food, shelter, and water) for aquatic and terrestrial organisms; intercept direct solar radiation, create shade, and increase the depth-to-width ratio to help maintain or restore suitable water temperatures for fish and other aquatic organisms while providing a milder microclimate for wildlife; improve and protect water quality by reducing the amount of sediment and other pollutants, such as pesticides, organic materials, and nutrients in surface runoff as well as nutrients and chemicals in shallow groundwater flow; provide food, in the form of plant detritus, for aquatic insects, which are important food items for fish; help stabilize the channel bed and streambank; serve as corridors to provide landscape linkages between existing habitats; provide room for watercourses to establish geomorphic stability; and manage existing riparian herbaceous habitat to improve or maintain desired plant communities.

Practice	NRCS Code	Description/Benefits
Tree and Shrub Establishment	612	Establishing woody plants by planting seedlings or cuttings, direct seeding, or natural regeneration. BENEFITS: Establish woody plants for forest products, provide erosion control, enhance energy conservation, reduce air pollution by uptake of soil- and water-borne chemicals and nutrients, beautify an area, protect a watershed, provide wildlife habitat, treat waste, sequester carbon, and increase species diversity.
Vegetation Treatment Area	635	An area of permanent vegetation used for agricultural wastewater treatment. BENEFITS: Improve water quality by reducing loading of nutrients, organics, pathogens, and other contaminants associated with livestock, poultry, and other agricultural operations.
Windbreak/ Shelterbelt	380	Linear plantings of single or multiple rows of trees or shrubs established for environmental benefits. BENEFITS: Reduce wind erosion, protect growing plants, provide shelter for structures and livestock, provide wildlife habitat, provide a tree or shrub product, provide living screens, improve aesthetics, improve irrigation efficiency.

The MCP launched a demonstration carbon farm program in the county, starting on three farms, and is securing the policy and economic support necessary for the adoption of carbon-beneficial practices at scale in Marin County. The farms have already applied nearly 4,000 cubic yards of compost to their rangelands and are working to complete the carbon farm planning process. Each of the demonstration farms is presently developing a comprehensive Carbon Farm Plan; these plans will include known climate-resilience and carbon-beneficial practices such as those shown in Table 6-2, including windbreaks, riparian and range management improvements, and grass, plant, and tree establishment. Figure 6-3 shows an example of a draft carbon farm plan that the MCP has been developing for local farmers. The three farms could reduce GHG emissions by approximately 1,000 $MTCO_2e$ per year if their draft carbon farm plans are implemented.

Figure 6-3. Example Draft Carbon Farm Plan

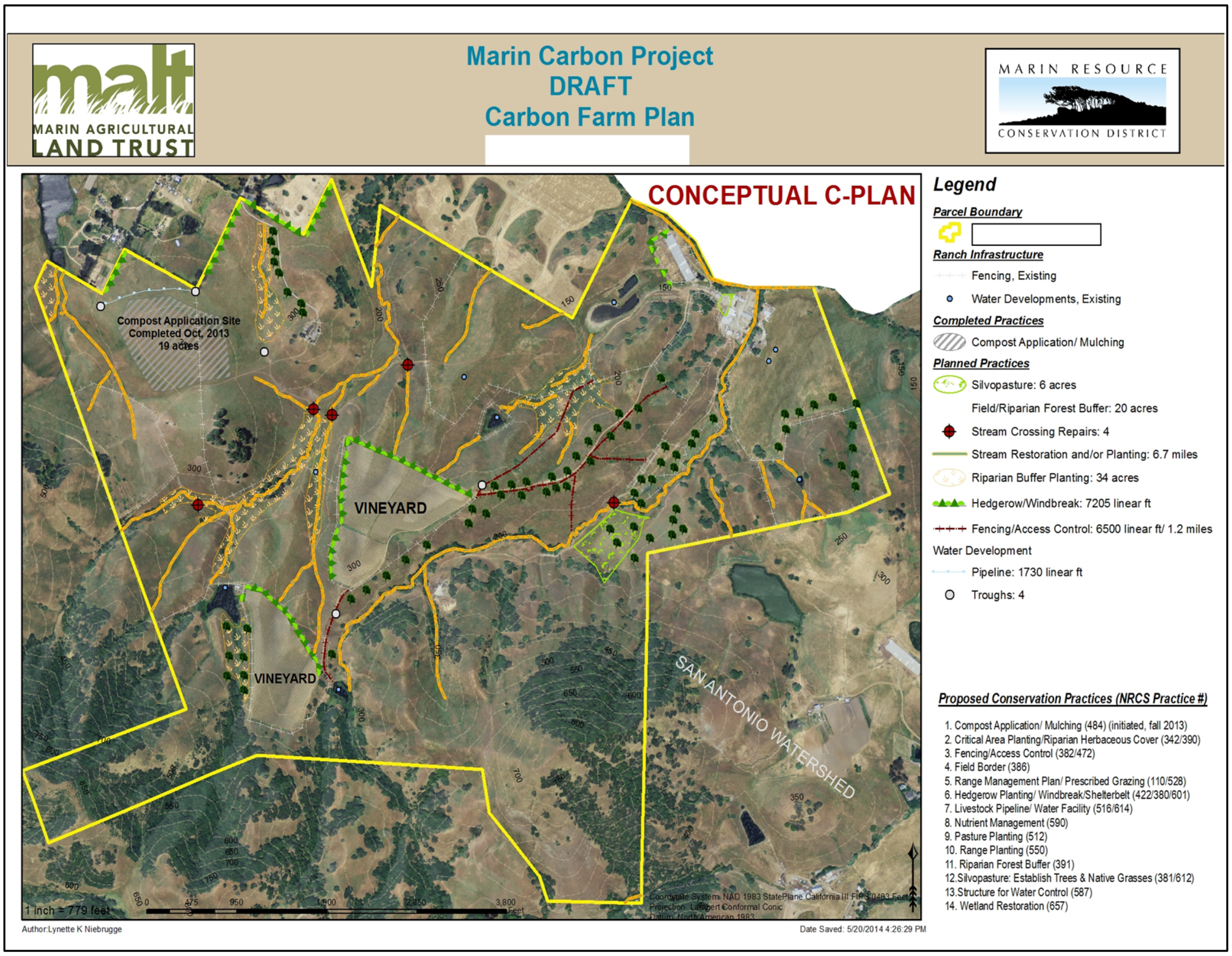


Table 6-2. GHG Reduction Potential of Carbon Farming on Three Marin County Farms ($MTCO_2e$)

Carbon Farming Practice	NRCS Code	Farm A		Farm B		Farm C	
		Annual	20 Year	Annual	20 Year	Annual	20 Year
Pasture Seeding	512			44	880	44	880
Pasture Planting	512					44	880
Windbreaks	380	4	73	17	347	11	213
Prescribed Grazing	528	56	1,120	42	840	42	840
Rangeland Compost	777	88	1,760	88	1,760	88	1,760
Silvopasture	381	49	991	18	357		
Riparian Restoration	391	77	1.555	37	739	10	197
Range Planting	550	44	880				
Riparian Herbaceous Cover	390	36	720			8	160
No Till	329	25	490				
Critical Area Planting	386	19	374			2	44
Field Border	386	12	991				
Nutrient Management	590					57	1,133
Total	NA	408	8,203	266	4,923	315	6,107

Source: Marin Carbon Project.

Notes: Estimates based on draft carbon farm plans for three farms in Marin County. Anaerobic digester measure excluded from this table because this measure is discussed separately in measure Agriculture-1, above.

The MCP is exploring the opportunity for agriculture to receive carbon offset credits through California cap-and-trade or other carbon markets for on-farm climate beneficial practice implementation in Marin. The MCP market protocol for compost application to grazed grasslands, for example, has been approved by the American Carbon Registry, effective October 2014, and CAPCOA in December 2014. It is also under review by BAAQMD as a local GHG credit. As described above, there are numerous other agricultural practices that are broadly recognized as GHG beneficial. These are also available and already often employed by Marin County farmers and ranchers. The GHG benefits of these practices can be quantified through the use of models, such as NRCS COMET-Farm or the less-complex Tier 1 practice-based methods, as shown by the preliminary estimates in Table 6-2.

The Potential Landscape Value of Soil Carbon Farming

Although the exact feasible extent of increases in soil carbon within Marin County may be uncertain, the following give an idea of the potential landscape value of improvements in agricultural soil and rangeland management in Marin County and California if soil carbon farming were to become more widespread. Using estimates from Delonge and Ryals (2013) that show that soil amendments that use composted manure and plant waste could result in GHG reductions over 3 years of approximately 9 $MTCO_2e$ per acre, potential landscape reductions were estimated as follows:

- If soil amendments were applied to 5% of rangeland in Marin County, this would represent an equivalent GHG emissions reduction of 73,000 $MTCO_2e$ over 3 years. Averaged annually, this would represent approximately 23,000 MT of $C0_2e$, which is equivalent to approximately 74% of the quantified local emissions reductions in this CAP.
- If soil amendments were applied to 5% of rangeland in California, this would represent an equivalent GHG emissions reduction of 28 million MT of CO_2e over 3 years. Averaged annually, this would represent over 9 million $MTCO_2e$, which is equivalent to approximately 2% of 2012 state GHG emissions.

The MCP will continue to work with local farmers and the local NRCS office to identify farm management practices that complement compost application by building soil carbon and soil health and improving productivity and forage quality.

6.3.2.2 The Role of the County

The Marin Countywide Plan includes policies and programs that are directly supportive of this measure, including Air-1.g, *Require Control Measures for Construction and Agricultural Activity*, Air-4.d, *Reduce Greenhouse Gas Emissions from Agriculture*, and Air-4.l, *Preserve Agricultural Lands*.

The County will work with local agricultural entities to develop and implement education and outreach programs about carbon farming practices that will enhance carbon sequestration, increase soil health, climate resilience, and crop productivity. The County will assist Marin County's agriculture community, with the support of agricultural entities, to implement and expand carbon-farming practices that have been adopted by local ranchers and farmers as well as practices that have been supported by local, regional, and national conservation efforts and peer-reviewed research.

This CAP does not include any specific reduction "credit" for specific practices associated with carbon farming for a number of important reasons:

- Although highly promising, the draft carbon farms being developed by local farmers, combined with the MCP, are still a work in progress, and the specific amount of GHG reductions over time that is likely to result from such actions has yet to be finalized.
- The extent to which carbon farming can be scaled up is not yet known and will depend on the success of the initial demonstration projects that are under way in the county, the financial performance of the implemented carbon farming practices, and the sustainability of such practices over time.
- Marin County has no desire to impose additional mandates on the county's farmers and ranchers. Instead, the County desires to support the ongoing efforts of farmers and ranchers to promote sustainable agricultural practices, including carbon farming efforts.

- As noted above, Marin County farmers and the MCP are hoping to support carbon farming, in part through sale of offset credits under the California cap-and-trade system (or other offset credit schemes). All offset credit systems explicitly require that the offsets be additional to other reduction requirements or actions that would happen without payment of the offset credit. Therefore, if this CAP were to rely on (or require) reductions from carbon farming formally, then carbon farming could not qualify for the financial incentive through sales of carbon offsets. Thus, to avoid any double counting of reductions and creating any impediment to the MCP and local farmer's effort to obtain economic incentives through the sale of offset credits, the MCP reductions are not presumed in this CAP or required to meet the GHG reduction target.

6.3.2.3 Establish Marin County Carbon Stock/Sequestration Baseline and Periodically Update Inventory

As discussed elsewhere in this CAP, the current estimates of carbon stock in county agricultural and natural lands are only a rough estimate and could benefit through the collection of local data to derive a better understanding of existing levels of carbon stock and sequestration. Developing a more detailed baseline inventory is feasible but requires more effort to collect data and complete estimates.

The County, working with other partners, including the UCCE, NRCS, academic researchers, the MCP, farmers, ranchers, and other parties, will complete an inventory of carbon stocks and an estimate of annual sequestration within 2 years from adoption of this CAP Update (by mid-2017). To the extent feasible, the baseline inventory will use local data. The baseline inventory will include estimates of aboveground and belowground carbon stocks in farmed lands, ranchlands, and the county's natural lands. Carbon stock within urbanized parts of the county (urban forests) may also be included if funding is adequate, although the focus will be on agricultural and natural lands.

After completion of the baseline inventory, the County shall periodically prepare an updated estimate of carbon stock at least every 5 years to estimate changes in the carbon stock over time. As part of the updated inventory, the County will collect data from local farmers and ranchers as well as natural land managers to identify changes in practices and conditions between inventory years to understand the contributions of changes in land management practice to the changes in carbon stocks over time.

The baseline inventory and periodic updates shall be used in any future updates of the Climate Action Plan.

6.3.2.4 Carbon Farming Local Carbon Offset Protocol and CEQA Mitigation[28]

The California cap-and-trade system and other offset program protocols to validate carbon offset credits are usually complicated and data-intensive, resulting in substantial effort by parties that seek to develop offset credits for sale. The Carbon Cycle Institute has estimated that the costs associated with developing composting-based carbon farming offsets breakdown as follows: applying compost to rangelands (51%); GHG offset assertion, securing credits, and validation (39%); and monitoring (10%). A streamlined, but effective, protocol could help to lower the 39% of costs that are not associated with the actual physical work and monitoring. To support Marin farmers and ranchers,

[28] There is already an established methane digester protocol; therefore, this measure is focused on other practices.

the County will explore the potential development of a local carbon farming offset protocol to streamline procedures and practices and validate offset credits for use as CEQA mitigation. The protocol will need to follow the basic rules of "additionality" that are applied in all offset schemes and have sufficient rigor to verify the credit rationale and guarantee over time. The County may develop this for use only within Marin County or may seek economy of scale by combining with other jurisdictions in the San Francisco Bay Area and/or the BAAQMD. Given the complexity of carbon offsets, it is unknown whether such an effort will succeed in lowering the regulatory burden for Marin farmers and ranchers, but Agriculture-2 requires the County to attempt to develop such a protocol within 2 years of adoption of this CAP Update (by early 2017). If successful, the protocol would enable credits for carbon farming to be used as CEQA mitigation within Marin County (and/or in other accepting jurisdictions).

6.3.3 Agriculture-3: Promote the Sale of Locally Grown Foods and/or Products

Under this measure, the County will continue to support local farmer's markets to provide community residents with a more local source of food, potentially resulting in a reduction in the number of trips and vehicle miles traveled by both the food producers and the consumers to grocery stores and supermarkets. Given the prevalence of sustainable practices in local agriculture in the county, the use of local produce can also displace carbon-intensive food production practices elsewhere. Also, as noted above, with local farming interest in carbon farming, the promotion of local agricultural products can indirectly support carbon farming.

The University of California Cooperative Extension Marin has been actively partnering to expand the number of school and community gardens and increase the production of existing gardens through garden education. Currently, the University of California Marin Master Gardeners are working directly with more than 33 school and community gardens and facilitating policy implementation to make community gardens a permitted use in Marin's cities. The production of additional local food through community gardening that relies on sustainable practices can, in addition to its educational value, have other benefits, such as displacing the consumption of food that was produced with less sustainable methods elsewhere.

Chapter 7
Greenhouse Gas Reduction Measure Implementation Program

Photo: Marin Community Development Agency

Chapter 7
Greenhouse Gas Reduction Measure Implementation Program

7.1 Introduction

This chapter describes the objectives, milestones, timeline, and processes for implementation of the GHG emissions reduction strategies (please refer to Chapter 8*, Climate Change Adaptation*, for implementation details related to climate change adaptation). Establishing a robust management program is necessary to ensure the CAP Update meets its emissions reduction objectives and is implemented in a timely and efficient manner. Details on specific implementation actions for each strategy are provided, as well as potential funding options and milestones. Plans for outreach and education, monitoring and evaluation of the emissions reduction strategies, and future document updates are also described.

7.2 Marin County Sustainability Team

The Marin County Sustainability Team, a division of the Community Development Agency, will be responsible for leading and coordinating the County's efforts on implementation, monitoring, and management of both the quantitative and the supporting emissions reduction strategies. The Sustainability Team will coordinate with and provide support to representatives from several County departments as they implement the measures of the Plan.

The Sustainability Team's main objective will be to maintain the strategy implementation schedules and ensure emissions reductions are achieved in a cost-effective manner. Sustainability Team representatives will provide guidance and support to County staff on financial, programmatic, and technical matters. The Sustainability Team will develop and manage protocols for monitoring, verifying, and reporting emissions reductions. The team will also be responsible for updating and adaptively managing the emissions reduction strategies based on real-time information collected through the monitoring and verification process. The Sustainability Team will serve as the external communication hub to climate change organizations and members of the community.

The Sustainability Team will coordinate with applicable department representatives to undertake the following general implementation steps to support implementation of the emissions reduction strategies.

- **Develop Implementation Plans for Each Emissions Reduction Strategy**. Implementation plans will include specific milestones, deadlines, funding opportunities, partners, programs, and other details, as necessary, to initiate implementation of the emissions reduction strategies.
- **Estimate Project-Specific Costs**. The estimated costs/savings for the emissions reduction strategies are provided in Appendix C, *Reduction Measure Methods*. During the implementation phase of each strategy, project-specific costs/savings will be prepared to provide a more accurate assessment of upfront investment needs, potential returns, and other financial planning needs.

- **Adopt or Update Ordinances and/or Codes**. The Sustainability Team will support efforts by specific County departments to prepare amendments to the Marin County Code that implement some emissions reduction strategies.
- **Establish Partnerships**. Some of the emissions reduction strategies will require new program partnerships, both internal to the County and with external agencies, to leverage staff expertise and agency resources and to maximize funding opportunities.
- **Pursue Funding Sources**. Funding from state and federal agencies can support the implementation of the emissions reduction strategies. The County will pursue these and other emerging funding sources as a part of implementation efforts. The County will also consider internal funding sources such as facility master plan programs and capital improvement programs.
- **Create Monitoring/Tracking Processes and Indicators**. All of the emissions reduction strategies will require tracking and monitoring of program progress, particularly to identify and remedy any shortfalls in a timely manner. For each strategy, the County will identify monitoring and tracking procedures.
- **Engage the Community and Stakeholders**. The County will engage and educate the public and stakeholder groups in the implementation of each emissions reduction strategy. The County will solicit input to design effective implementation programs for emissions reduction strategies. Community engagement activities may include ongoing outreach to relevant stakeholder groups, providing clear and topic-specific messages on emissions reduction strategies, soliciting feedback, holding public meetings, connecting through existing events and online media, and providing informational materials.
- **Lobby for State and Federal Action.** Consistent with its Legislative Plan, the County will continue to advocate for state and federal actions that are supportive of local and regional climate actions.

7.3 Implementation Actions

Successful implementation of the emissions reduction strategies requires the identification of key action items, known obstacles, and resources. While comprehensive implementation plans for each strategy will be developed over time, primary actions that the County will undertake to achieve the strategy objectives can be identified now. These actions are related to the general implementation steps listed above but are specific to individual strategies. Appendix C provides a list of these primary actions, and summarizes measures that will be implemented to support the primary action(s). These supporting measures are not exhaustive and may be modified during implementation of the emissions reductions strategies.

7.4 Implementation Schedule

Swift implementation of the emissions reduction strategies will occur following adoption of the CAP Update to ensure the County's community and municipal targets are achieved by 2020. The Sustainability Team will initially focus on developing key ordinances and programs, and then will shift to strategy implementation, program management, and emissions tracking. Specific timelines and milestone(s) for each strategy will be further developed based on the general schedule shown in Figure 7-1, with strategy implementation occurring in three phases:

- **Group 1** strategies are those that need to be developed early in order to achieve reduction targets by 2020 and/or that require long lead times;
- **Group 2** strategies are those that don't need to be online immediately but need time to develop in order to meet 2020 reduction targets;
- **Group 3** strategies are those that only need to be online by 2020 and which can be started later in the decade.

Beginning in 2015, strategies will begin to be implemented, and strategy prioritization will be based on several factors including cost effectiveness, emissions reduction efficacy, and general benefits to the community as well as timing necessary to support meeting the 2020 target. The three groups are meant to organize implementation based on the prioritization for each GHG reduction measure.

Figure 7-1. Implementation Timeline for the Greenhouse Gas Reduction Measures

2014-2015	2015	2016-2017	2018	2019-2020	Post-2020
• Adopt the CAP Update • Identify funding mechanisms	• Implement Group 1 strategies • Develop protocols for monitoring, reporting, and responding to CAP progress	• Implement Group 2 strategies • Update emissions inventories • Examine CAP progress	• Implement Group 3 strategies	• Update emissions inventories • Examine CAP Progress • Consider post-2020 targets	• Update emissions inventories • Report on CAP success • Adopt post-2020 targets

Implementation of the individual emissions reduction strategies will be led by the specific County divisions shown in Table 7-1 (community) and 7-2 (municipal), with support from the Sustainability Team. Private and other regional entities (e.g., Marin Transit) may be responsible for implementing specific projects under each strategy. The entity responsible for the primary implementation of each strategy is also shown in Tables 7-1 and 7-2. The County may adjust this initial grouping as more specific implementation timelines are developed for each strategy. Final strategy prioritization will be based on the following factors.

- **Expected Reductions**. How effective is the strategy at reducing GHG emissions, and how quickly must reductions be achieved to meet the 2020 Community and Municipal Emissions Reduction Targets?
- **Cost and Funding**. How much does the strategy cost? Is funding already in place?
- **Co-Benefits**. What community co-benefits does the strategy offer?
- **Community Impact**. What are the advantages and disadvantages of the strategy to the community as a whole?
- **Implementation Effort**. How difficult will it be to develop and implement the strategy? Are new ordinances and/or coordination with external organizations required?
- **Consistency with Existing Programs**. Does the strategy complement or extend existing programs?

These factors were used to develop the current measure prioritization presented in Table 7-1, below. For example, lower cost measures that result in large and immediate GHG emission reductions were placed in Group 1.

Table 7-1. Implementation Timeline for the Community GHG Reduction Measures

	Strategy	Implementation Group	Responsible Entity
ENERGY EFFICIENCY AND RENEWABLE ENERGY	Energy-1. Community Choice Aggregation	Group 1 (2015)	MCE
	Energy-2. Energy Efficiency	Group 1 (2015)	CDA, MCE
	Energy-3. Solar Energy	Group 1 (2015)	CDA, MCE
	Energy-4. Additional Renewable Energy	Group 2 (2017)	CDA, MCE
LAND USE AND TRANSPORTATION	Trans-1. Land Use Design and VMT Reduction	Group 1 (2015)	CDA, TAM
	Trans-2. Public Transportation	Group 2 (2017)	TAM
	Trans-3. Electric Vehicles	Group 2 (2017)	CDA, TAM, MCE
	Trans-4. Off-Road Equipment	Group 3 (2018)	CDA
WASTE REDUCTION, REUSE, AND RECYCLING	Waste-1. Zero Waste by 2025	Group 1 (2015)	DPW
WATER CONSERVATION AND WASTEWATER TREATMENT	Water/Wastewater-1. Water Conservation	Group 2 (2017)	CDA
	Water/Wastewater-2. Increase Pump Efficiency	Group 3 (2018)	CDA, MCE
	Wastewater/Wastewater-3. Reduce Wastewater Generation	Group 2 (2017)	CDA
AGRICULTURE	Agriculture-1. Methane Capture and Energy Generation at Dairies	Group 2 (2017)	Agriculture, CDA, MCE
	Agriculture-2. Carbon Farming	Group 1 (2015)	Agriculture, CDA
	Agriculture-3. Promote the Sale of Locally Grown Foods and/or Products	Existing ongoing action	Agriculture, CDA

MCE = Marin Clean Energy; CDA = Community Development Agency; TAM = Transportation Authority of Marin; DPW = Department of Public Works

Table 7-2. Implementation Timeline for the Municipal GHG Reduction Measures

	Strategy	Implementation Group	Responsible Entity
ENERGY EFFICIENCY AND RENEWABLE ENERGY	Energy-1. Energy Efficiency	Group 1 (2015)	DPW, CDA, IST, Parks
	Energy-2. Solar Power	Group 1 (2015)	CAO, DPW, CDA
LAND USE AND TRANSPORTATION	Trans-1. New Vehicles	Group 1 (2016)	DPW, Parks
	Trans-2. Alternative Transportation	Group 2 (2017)	DPW, DOF
	Trans-3. Trip Reduction	Group 1 (2016)	DPW, CAO, Board of Supervisors
WASTE REDUCTION, REUSE, AND RECYCLING	Waste-1. Increase Recycling at County Facilities	Group 1 (2016)	DPW, Cultural Services, Sheriff, H&HS
WATER CONSERVATION	Water-1. Water Conservation	Group 2 (2017)	DPW, Parks

IST = Information Services and Technology; CAO = County Administrator's Office; DPW = Department of Public Works; DOF = Department of Finance; H&HS = Health & Human Services

7.5 Funding Strategies

The County, public agencies, and community members will incur both costs and savings from implementation of the local emissions reduction strategies. Primary costs are related to capital improvements and other investments, as well as operations and maintenance. Despite these upfront and ongoing costs, some strategies will result in long-term cost savings from reduced energy use and maintenance. Furthermore, there are many rebates, incentives, and grant programs available to reduce upfront capital costs, alleviate overall project costs, and support long-term initiatives. The County will have a leadership role in identifying and pursuing relevant funding for some candidate strategies, but the private sector will also need to pursue different funding options, as discussed below. The County will also seek innovative funding solutions for the CAP Update measures and consider subsidizing existing climate action funds.

7.5.1 County and CAP-Level Financing

Implementation of the CAP Update will require considerable investment from multiple entities. The following overall financing approach will help ensure the emissions reduction strategies are funded and implemented efficiently and quickly. The County will develop a comprehensive funding program, including facility and capital improvement plans, over time.

- Pursue funding for strategies concurrently, whenever possible, to use funds most efficiently. Please refer to Appendix D for information on potential funding options that the County may explore.
- Leverage federal, state, and regional grants and other funding sources.
- Partner with other jurisdictions and regional entities to administer joint programs, and partner with the private sector on strategy implementation.

7.5.2 Community and Project-Level Financing

Implementation of the emissions reduction strategies will result in costs and saving for residents, businesses, and other members of the community (please refer to Appendix C). Since many of the strategies in the CAP Update are voluntary (such as energy efficiency and solar retrofits for existing buildings), the private sector will only incur associated costs and savings for those strategies they choose to implement. Some of the strategies, however, will be mandatory and require community action. It is also important to note that costs and savings associated with some strategies may not be borne by the same players. In other words, the entity making the upfront investment is not always the entity that experiences the reduction in utility bills or other savings. For example, developers may invest in energy efficiency measures during construction, but the homeowners will experience the reduction in utility bills. As another example, the water agencies may invest in water-conservation actions and education programs, but County residents will experience the reduction in water bills.

Various funding options are available to support the community with implementation of the emissions reduction strategies. These options can provide initial capital, reduce overall program costs, and support long-term strategy implementation. Table 7-3 provides an overview of potential funding sources for each of the five actions. Please refer to Appendix D for additional information on specific funding and financing options available to the community.

Table 7-3. Overview of Potential Community Funding Sources by Strategy Area

Strategy Area	Potential Community Funding Sources
Energy Efficiency and Renewable Energy	• Utility rebates (e.g., PG&E, MCE, California Solar Initiative) • Federal tax credits for energy efficiency • Energy efficient mortgages and PACE • Power purchase agreements • Private equity funding (e.g., PACE) • Cap-and-trade funding
Land Use, Transportation, and Off-Road Equipment	• Federal and state transportation funds • State alternative transportation assistance • BAAQMD programs (i.e., Carl Moyer Program, Lawn Mower Exchange) • Cap-and-trade funding
Waste Reduction, Reuse, and Recycling	• Private funds • Cap-and-trade funding
Water Conservation and Wastewater Treatment	• Water service provider rebates • Cap-and-trade funding
Land Conservation	• Federal or state grants, private funds • Cap-and-trade funding
Dairy Methane Digesters	• Marin Clean Energy • Cap-and-trade funding
Carbon Farming	• CalRecycle Waste Sector Plan (compost incentives) • Cap-and-trade funding • Other offset funding • Local CEQA mitigation
PACE = property assessed clean energy.	

Funding may also be available for the California cap-and-trade program. The County may be able to obtain funding from state grants resulting from the state's sale of cap-and-trade allowances to support the GHG reduction measures in this CAP Update. The County is currently monitoring the availability of these funds.

The private sector incentives and rebates identified in Appendix C can significantly improve the economics of individual projects. For example, incremental upfront costs for a new residential home to install rooftop solar under Energy-3, *Solar Energy*, are estimated to be $14,000 to $16,000 (for a 4-kilowatt solar system installed through direct purchase; upfront costs through a power purchase agreement would be $0). Assuming eligibility requirements are met and incentives are available at the time of application, residents (or developers) could recoup around 30% of that upfront cost through the federal investment tax credit (ITC).

7.6 Outreach and Education

Community involvement is essential to successful implementation of the emissions reduction strategies, especially considering that many strategies depend on voluntary commitment, creativity, and participation. The County will collaborate with local businesses, community groups, residents, developers, and property owners to establish partnerships and encourage active involvement in the CAP Update. Periodic meetings will be held to provide information and inform the community on progress toward attaining the 2020 Community and Municipal Emissions Reduction Targets. These meetings will provide an opportunity for collaboration and a mechanism for the County to receive feedback on potential improvements or changes to the emissions reduction strategies. Other outreach activities, including a public website and email flyers, will also be pursued to engage the public and solicit input, suggestions, and participation.

7.7 Evaluation and Monitoring

Regular monitoring is important to ensure programs are functioning as they were originally intended. Early identification of effective strategies and potential issues will enable the County to make informed decisions on future priorities, funding, and scheduling. Moreover, monitoring provides concrete data to document the County's progress in reducing GHG emissions.

Measuring current emissions levels will be an essential component of the monitoring and evaluation strategy. As shown in Figure 6-1, the County will update the Community and Municipal Inventories for comparison to the 2012 inventories and the 2020 Community and Municipal Emissions Reduction Targets. The first inventory update will be conducted in 2017 based on 2016 GHG emissions data, and the second update will be conducted in 2019 based on 2018 GHG emissions data. These inventory updates will provide information regarding overall trends in community and municipal emissions. The updated inventories will be submitted to the Board of Supervisors and distributed to the public for review. The assessments will report on emissions trends and indirect factors that may influence emissions, including temperature, changes in emissions factors (particularly for the power sector, whose sources may change due to drought and other conditions), employment, gross domestic product, and population.

Technologies, financing, regulations/policies, and behavior relevant to the emissions reduction strategies are constantly changing. Accordingly, the County will track the progress of each strategy on an annual basis. Effective monitoring of individual strategies will require regular data collection in each of the primary emissions sectors. For example, reports detailing annual building electricity usage and fuel consumption will be necessary. The Sustainability Team will coordinate with internal County departments, PG&E, Marin Clean Energy, and other stakeholders to obtain and consolidate information into a repository that can be used to evaluate the effectiveness of individual reduction measures. The Sustainability Team will also track the state's progress on implementing state-level actions. Close monitoring of actual reductions achieved by the state programs will allow the County to adjust the local emissions reduction strategies, if needed, to ensure the 2020 Community and Municipal Emissions Reduction Targets are achieved.

Progress achieved by the state and local emissions reduction strategies will be reported to the Board of Supervisors. Where program tracking, inventory updates, or other information indicates that the emissions reduction strategies are not as effective as originally anticipated, the County will adaptively manage the CAP Update. At a minimum, the County will conduct a 3-year review of overall CAP effectiveness as part of its annual reporting in 2017. This will allow for potential mid-course adjustments prior to 2020. The County will also monitor and track emission reduction progress using tools that will allow for easy communication with the public regarding the County's progress toward achieving the GHG reduction targets. For example, In January 2015, the Marin Climate and Energy Partnership launched a new website to help track the climate efforts of Marin County jurisdictions over time.[29] This website presents annual information for various

[29] For more information, please see: http://www.marintracker.org/

sectors for each community, including trends in household energy use, the amount of solar installed, the number of electric vehicle charging stations installed, and the amount of water consumed per-capita.

7.8 Regional Collaboration

There are several regional partners and collaboration opportunities that will enhance the effectiveness of the emissions reduction strategies in the CAP Update. The County will coordinate with the following partners to explore opportunities to leverage resources, support overall CAP management, and share information.

- **Bay Area Air Quality Management District (BAAQMD).** BAAQMD is the local agency responsible for developing and implementing air quality plans. BAAQMD also sponsors various air quality programs that may support implementation of several energy efficiency, transportation, and renewable energy strategies.
- **PG&E and Marin Clean Energy (MCE).** PG&E and MCE offer numerous incentives and rebate programs to encourage energy efficiency. Resources offered by PG&E and MCE may reduce program implementation and administration costs. MCE is a Community Choice Aggregation program which partners with PG&E to deliver additional renewable electricity to County homes and businesses. There may also be opportunities for cooperation on community-scale alternative energy installations (e.g., solar).
- **MTC, Golden Gate Transit, Marin Transit, and Sonoma-Marin Area Rail Transit (SMART).** To fully implement the local transportation strategies, collaboration with regional transportation agencies is necessary. It is essential that the County, MTC, Golden Gate Transit, Marin Transit, and SMART establish a shared vision for how transportation and land use planning can support sustainable growth, consistent with the goals of SB 375 and the sustainable communities strategy.
- **California Department of Transportation (Caltrans).** The County will work with Caltrans to adapt to the stresses that climate change will place on the County's transportation network, especially low-lying roads that are in danger of flooding due to sea level rise (such as Highway 101). Potential actions may include rerouting or elevating these roads, planning emergency evacuation routes and alternative entrances/exits to Highway 101, making public service announcements to let drivers know about closures, establishing redundant routes, and providing access to and updating marine facilities (e.g., ferry terminals) as necessary.
- **Marin Cities and Towns and Marin Climate and Energy Partnership (MCEP).** Cooperation with Marin County cities could help maximize efficiencies in implementing emissions reduction strategies. Staff from all cities, the County, water districts and MCE currently meet monthly and collaborate via MCEP. The County will continue coordinate with staff from these agencies to promote regional collaboration.
- **Domestic Water Providers**. The County is served by three domestic water providers—the Marin Municipal Water District, the North Marin Water District, and the Stinson Beach County Water District. The County will work with these water providers to promote reductions in indoor and outdoor water use from existing developments and achieve the goals set forth by SB X7-7.

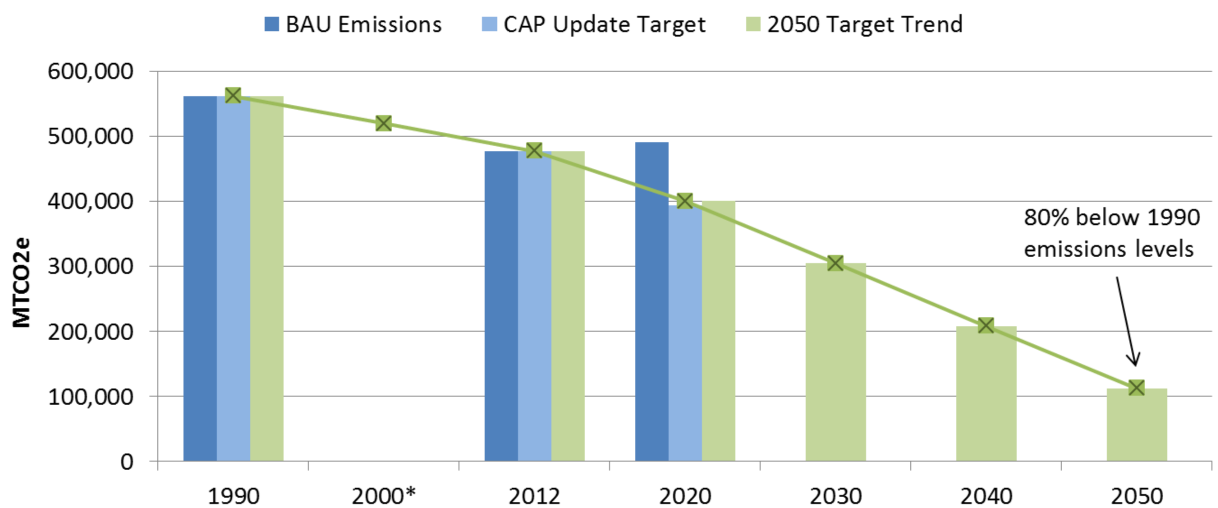
- **Wastewater Treatment Service Providers**. The County is served by eight wastewater treatment providers—Central Marin Sanitation Agency, Oceana Marin Sewer Service, Tomales Village Community Services District, Novato Sanitary District, Las Gallinas Valley Sanitary District, Sausalito-Marin City Sanitary District, Bolinas Sewage Services, and the Sewerage Agency of Southern Marin. The County is served by eight wastewater collection agencies as listed above. These agencies handle wastewater treatment and disposal in Marin County. Coordination among all agencies will be necessary to support implementation of community strategy Water/Wastewater-3 and municipal strategy Water-1.
- **Marin Hazardous and Solid Waste Joint Powers Authority.** The County contracts all solid waste collection and recycling services with the Marin Hazardous and Solid Waste JPA. The County will work with the collection agency to promote waste reduction, recycling, and composting, consistent with Waste-1. The County and the Marin Hazardous and Solid Waste JPA may also be able to share facilities, programs, and incentives to help ensure the 83% waste diversion goal is achieved by 2020, and the zero waste goal is achieved by 2025.
- **Agricultural Stakeholders:** There are numerous agricultural organizations and agencies in the county that can help design and implement strategies and actions to reduce GHG emissions from agriculture and increase the carbon sequestration capacity of county land. Organizations include the NRCS, the UCCE, the Marin Resource Conservation District, the Marin Carbon Project, Marin Organic, the Marin County Farm Bureau, the California Climate and Agriculture Network (CalCAN), the California Rangeland Coalition, the Community Alliance with Family Farmers (CAFF), and the U.S. Department of Agriculture (USDA).

7.9 Beyond 2020

The emissions reduction strategies presented in the CAP Update were developed to reduce community emissions by 30% below 1990 levels by 2020. This goal is consistent with (and exceeds) the goals and milestones outlined in AB 32. However, it is reasonably foreseeable that as California approaches 2020, statewide focus will shift to emissions reductions beyond 2020. This trend has been observed elsewhere through the United States, with New York City recently releasing a plan to reduce GHG emissions by 80% below 1990 levels by 2050. California Executive Order S-03-05, which was issued in 2005, articulates a similar long-term goal for the state. However, a detailed plan similar to the AB 32 Scoping Plan for how the state will meet this target has not been released.

In order to reach 80% below 1990 emissions levels by the year 2050, the County would need to reduce community emissions to 112,370 $MTCO_2e$, as illustrated in Figure 6-2. Based on population forecasts from ABAG, this is equivalent to 1.4 $MTCO_2e$ per capita or 1.1 $MTCO_2e$ per service population (population + employment). Current emissions in 2012 are 7.1 $MTCO_2e$ per capita and 5.7 $MTCO_2e$ per service population. This demonstrates the scale of the challenge to get to 2050 recommended levels. Because the County has adopted an aggressive target of 30% below 1990 levels by 2020, the County is currently on the right track to meet the 2050 target, and is ahead of the AB 32 goal for 2020 (1990 levels). The County's target is equivalent to 5.7 $MTCO_2e$ per capita, or 4.5 $MTCO_2e$ per service population, underscoring the challenge associated with meeting the 2050 goal of 1.4 $MTCO_2e$ per capita, or 1.1 $MTCO_2e$ per service population, and the need for an aggressive approach to GHG reduction moving forward.

Figure 7-2. Achieving the 2050 Emissions Target of 80% below 1990 Levels



** The GHG inventory for the year 2000 is not comparable to the 1990, 2012 inventories and 2020 forecast (the sectors, methods and data sources differ), so emissions for 2000 were not displayed on the chart. The year 2000 is included on the axis in order to show a consistent timescale of 10-year segments.*

The AB 32 Scoping Plan Update recommends a minimum 40% reduction in community emissions from 1990 levels by 2030 and a minimum 60% reduction from 1990 levels by 2040 in order to avoid 450 parts per million of CO_2e.[30] The goal specified in this CAP Update for community emissions, 30% reduction from 1990 levels by 2020, puts the County on track to meet ARB's recommended target for 2030 and 2040.

Moving forward, the County will consider any updates to these targets in future CAP updates and assess the latest scientific findings and recommendations for alternative and more aggressive targets.

As the year 2020 approaches, the County will need to develop reduction targets for years beyond 2020 to continue the commitment of reducing GHG emissions and providing a more sustainable future for Marin residents, businesses, and organizations. County staff will propose a 2030 target for both community and municipal operations for Board of Supervisor adoption sometime after 2020. The proposal will include an assessment of the potential impact on the community and of meeting this target (e.g., monetary costs; co-benefits), as well as on the County's internal resources. The strategies included in this CAP Update will help to put the County on a path to achieve more substantial reductions in the years after 2020. The County will also likely rely on further state and federal action to achieve post-2020 targets. In future CAP updates, the County will establish a 2050 reduction target and a timeline to achieve it, considering current climate change science and the context of state and federal reduction planning at the time.

[30] According to the IPCC, "an increase in the global average temperature of 2°C (3.6°F) above pre-industrial levels, which is only 1.1°C (2.0°F) above present levels, poses severe risks to natural systems and human health and well-being." In order to avoid temperatures above those levels, many parties have suggested the need to stabilize atmospheric GHG concentrations at 450 parts per million (ppm) (California Air Resources Board 2014b). The 450 ppm limit is not an emission target itself; it is a condition that the emission target is designed to avoid. Natural systems and human health and well-being are already at high risk, and GHG concentrations are already at or above 479 ppm, accounting for CO_2 (400 ppm), CH_4, NO_2, and other GHGs (National Oceanic and Atmospheric Administration 2014).

Chapter 8
Climate Change Adaptation

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Climate Change Adaptation

8.1 Introduction

Climate change planning includes at least two distinct response categories—mitigation and adaptation. *Mitigation* refers to minimizing the magnitude of climate change, primarily through adopting GHG reduction strategies. However, even with the adoption of aggressive mitigation actions, climate change is already under way and cannot be completely avoided. *Adaptation* refers to actions taken to minimize the disruption resulting from the impact of these unavoidable climate change effects.

Although Marin County currently enjoys a relatively mild climate, climate change may exacerbate existing climate-related hazards in the county (such as an increased number of flooding incidences) or introduce new challenges (such as erosion or coastal flooding due to sea level rise). These climate change effects could have wide-ranging impacts across the county's various economic sectors. It is important that Marin County considers potential climate change vulnerabilities as it moves forward with other planning activities.

Marin County is a leader in climate change adaptation and has already taken great strides to begin to prepare the County for increased resilience to the likely impacts of climate change. A number of studies have been completed that evaluate various potential climate change impacts on Marin County, and some stakeholders are beginning to consider strategies for preparing for climate change. Although significant work remains to be done, these efforts provide a strong foundation for making Marin County more resilient to climate change.

This section includes a discussion of the observed and anticipated effects of climate change in the county, a discussion of existing efforts and suggestions for how those efforts can be replicated in other sectors or expanded and what additional efforts are needed, and a review of the sectors where potential impacts warrant an extensive vulnerability assessment to understand fully how specific assets are vulnerable and could benefit from adaptation actions. It also provides the County with a summary of what is known about the anticipated future local climate, an overview of what is being done to address the impacts, and suggestions about next steps.

8.2 How the Climate May Be Changing in Marin County

8.2.1 Observed and Projected Changes in Temperature, Precipitation, and Sea Level Rise

Current research efforts have shown that Marin County and the North Bay region have already experienced some changes in climate, including increases in temperature and precipitation. For example, minimum temperatures increased by 1.7°F between 1911 and 2000, while average maximum temperatures have increased only 1.0°F over the same period (Flint et. al. 2011). Meanwhile, annual precipitation has also increased, with a 12% more rapid increase for the latter half of the century (Micheli, et al. 2012).[31]

Projections indicate that temperatures will continue to increase, and the region will most likely experience a shift to drier summers and wetter winters, characterized by heavier rain events. In addition, local sea levels will rise, as shown in Table 8-1. However, the North Bay region is situated in a transition zone between Washington and Oregon—where projections indicate a shift towards wetter and warmer conditions—and Southern California and Baja Mexico—where projections indicate a shift towards drier and warmer conditions. This geographic complexity increases the uncertainty regarding exactly how the county's climate may change in the future, particularly regarding precipitation projections, which are more sensitive to model assumptions than temperature projections. Precipitation projections for the region vary from decreases in precipitation to as much as a 15% shift towards a wetter climate (North Bay Climate Adaptation Initiative 2013a; Micheli, et al. 2012). Table 8-1 presents a summary of the projected shifts in ambient temperatures, changes in precipitation, and sea level rise for the North Bay, which includes Marin, Sonoma, and Napa Counties.

Table 8-1. Projected Climate Changes in the North Bay (including Marin County)

Climate Hazard	Projected Changes
Ambient Temperatures	• Average **maximum** temperatures are projected to increase between 2°F and 7°F by the end of the century (North Bay Climate Adaptation Initiative 2013a). • If current trends continue, the increase in **minimum** temperatures could exceed the increase in maximum temperatures.
Changes in Precipitation	• Precipitation projections vary between General Circulation Models (GCMs) and indicate that 21st-century precipitation projections indicate a 2–15% **increase** over the 20th-century average (Micheli et al. 2012). • Under some scenarios there could be a **decrease** in precipitation over the same period (North Bay Climate Adaptation Initiative 2013a). • Regardless of an overall increase or decrease, all scenarios project an increase in weather variability with a higher likelihood of an increase in frequency and intensity of extreme events, such as floods and droughts (Flint et al. 2012; North Bay Climate Adaptation Initiative 2013a) • Watershed models project **shorter wet winters** and **longer, drier summers** (North Bay Climate Adaptation Initiative 2013a). • Expect heavier rain events (North Bay Climate Adaptation Initiative 2013a).
Sea Level Rise	• Potential for a range of 1.4 to 5.5 foot increase by the end of the century (Cayan et al. 2008; Knowles 2010, State of California Ocean Protection Council 2013). • More frequent flood inundation of low-lying areas of the North San Francisco Bay Estuary (San Pablo Bay) shoreline and coastal regions (Cayan et al. 2008; Knowles 2010).

31 It should be noted that coastal marine influences and topographic variation result in high spatial variability within these shifts. Throughout the County, microclimates may experience different shifts, which should be considered during further studies that investigate the specific vulnerabilities of sector assets.

8.2.2 Potential Effects of Projected Climate Change on Marin County

Increases in temperature, changes in precipitation, and sea level rise could result in the increased frequency or intensity of certain climate hazards, including shifts in the water supply and demand, wildfires, extreme heat, and inland flooding. These changes have been highlighted in various efforts that are underway or recently completed as discussed below in Section 7.3. Shifts in the energy supply and demand and changes in the agricultural growing season present additional potential impacts in the county. Based on the geographic location and projected changes listed in Table 8-1, Marin County may be exposed to the following potential impacts from climate change.

8.2.2.1 Extreme Heat

Although Marin County has a mild Mediterranean climate, increases in the average maximum temperature may be coupled with increases in extreme heat. Efforts to project changes in temperature, such as the data shown in Cal-Adapt, indicate that the number of "extreme heat" days in Marin could increase more than ten-fold by the end of the century (Cal-Adapt 2014a)[32]. Extreme heat in this historically temperate climate may threaten human health, cause heat stress in animals, and shorten the expected lifespan or increase the need for repairs in the built environment.

8.2.2.2 Inland Flooding

Increased intensity of winter storm events combined with sea-level rise is likely to cause more frequent flooding, especially in low-lying areas. An increase in the variability of rainfall could contribute to an increase in the likelihood of the frequency and intensity of extreme events such as floods in the North Bay (Flint et al. 2012).

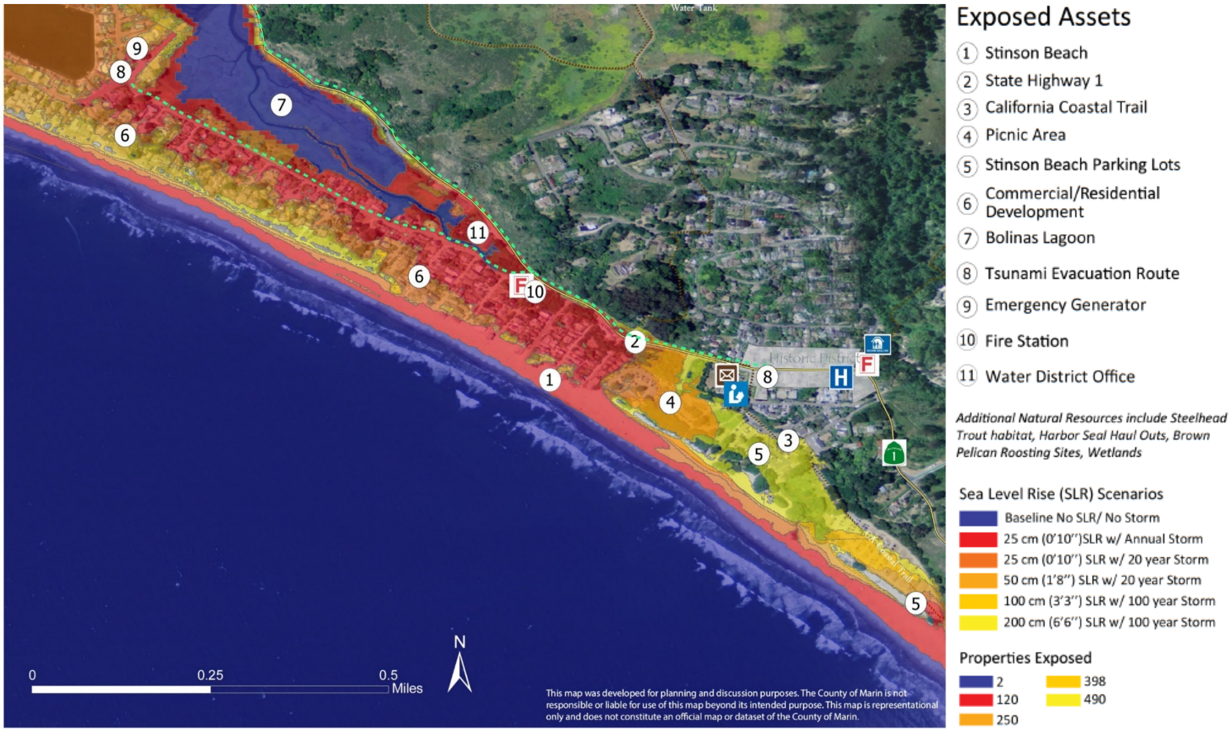
8.2.2.3 Sea Level Rise

Increased sea levels and elevations of storm surge could cause more area within the county to be temporarily or permanently inundated by salt and brackish waters. The exact amount of sea level rise to be experienced by Marin County will depend on many factors, but the State of California's *Sea Level Rise Guidance* document recommends that California agencies use a range of 4 to 30 centimeters (cm) by 2030, 12 to 61 cm by 2050, and 42 to 167 cm by 2100 (Ocean Protection Council [OPC] 2013). Local land subsidence and uplift will also influence the extent of inundation.

Land and structures in low-lying coastal areas may need to be reassessed to accommodate changes in the shoreline. Figure 8-1 shows potential sea level inundation for Stinson Beach under different sea level rise and storm scenarios For additional examples of sea level rise inundation maps, please see Appendix E.

[32] Data displayed in the Cal-Adapt Extreme Heat Tool have been provided by Scripps Institution of Oceanography.

Figure 8-1. Example Inundation Zone: Sea-Level Rise Exposure and Asset Identification Map for Stinson Beach, Marin County Under Different Scenarios



Source: Marin County, 2014

8.2.2.4 Shift in Water Demand and Supply

A shift in precipitation patterns and extended periods of drought would limit the available supply of water. By the end of the 21st century, under either high- or low-rainfall scenarios, warming is projected to amplify late-season climatic water deficit by 8%–21% (Micheli et al. 2012).[33] To compound the impact, increased temperatures and low soil moisture increase the demand for water as people require more water for their gardens, agriculture, and other uses. Simultaneously, an increase in heavy rainfall events may elevate turbidity resulting in freshwater resources that require additional processing for residential and industrial uses.

8.2.2.5 Wildfires

Increased temperatures and shifts in precipitation patterns, which may include extended dry spells, could create conditions that may increase the risk of wildfire danger in Marin County. As wildfire risk is projected to increase moderately in Marin County by the end of the century, wild-urban interface fires can cause major damage to the build environment and natural heritage, as seen in the 1991 Oakland Hills fire and the 2008 Santa Rosa fire (Cal-Adapt 2014c).

[33] Late-season climatic water deficit is a measure of drought stress on soils.

8.2.2.6 Change in Habitats and Ecosystems

Changes in habitats and ecosystems could result from changes in temperatures, precipitation, and the potential competition from colonizing species. The natural heritage and parks in the county may change. Projections suggest that future conditions may be more similar to the current conditions in Santa Barbara County, which could result in a significant transition in the local forests (North Bay Climate Adaptation Initiative 2013b).

Aquatic ecosystems may also be affected, through mechanisms such as ocean acidification, increased temperatures, changes in upwelling, and changes in nutrient loading. The response of the ecosystem to these changes is complex. Habitats for certain flora and fauna may shift geographically (or become less available), triggering impacts on the species that coexist or depend on those flora and fauna. The exact impact that climate change could have on Marin's marine ecosystems is unknown at this point, but species potentially at risk may include: the oysters farmed near Marin's coast, which are sensitive to ocean acidification due to their calcium carbonate shells; and seals, whose pups cannot swim nor climb on rocks and thus depend on sandy shores for survival—sandy shores that could be reduced as sea levels rise (Largier et. al. 2010).

8.2.2.7 Shift in Energy Demand and Supply

Increased temperatures and a decreased (or inconsistent) water supply could have a negative impact on the availability of energy. Some power plants require large amounts of water for cooling and higher temperatures could result in demand spikes that exceed production or available supply. Low-lying generation facilities and distribution equipment could be inundated with storm surges and sea level rise. Although there are no electric generation facilities in Marin County, changes in energy supply and demand could lead to higher energy prices, brownouts, or other impacts that affect Marin.

8.3 Status of Adaptation Efforts in Marin County

8.3.1 Efforts Under Way

There are many adaptation efforts already underway in Marin County. The County has proven to be a leader in thinking about adaptation and taking action to increase resiliency of local resources. The *Marin County Climate Adaptation/Resilience Snapshot* that was compiled by the Bay Area Climate & Energy Resilience Project (BACERP) in March 2014 provides a summary of the efforts that are completed or underway (Bay Area Climate & Energy Resilience Project 2014). Additionally, the *Climate Adaptation—Sea Level Rise White Paper* prepared by the City of San Rafael in January 2014 provides a review of federal, state, and regional level efforts and legislation that address sea level rise (City of San Rafael 2014). It reviews the current and recently completed studies and strategies in the county and region. These reports contain a more comprehensive list of adaptation initiatives in Marin County, but some example adaptation initiatives include those listed below.

- In November 2014, the **Marin County Board of Supervisors** allocated one-time funding of $250,000 to establish a countywide multi-jurisdictional partnership to complete a climate change vulnerability assessment and coordinate the various entities engaged in climate and sea level rise planning and education. The County is also seeking matching grant funding from the Coastal Conservancy to support this project.

- Marin County's **"Collaboration: Sea-level Marin Adaptation Response Team" (C-SMART)** is an intergovernmental/public-private partnership that is working to develop an understanding of how sea level rise (SLR) may affect coastal area homes, schools, roads, public facilities, natural resources and habitat areas, when these impacts might occur, how they might change over time, and how to prepare for them.
- The County's **Southern Marin Sea Level Rise Pilot Project** addresses how the climate change impacts of sea level rise will affect the future of Southern Marin communities, infrastructure, ecosystems and economy, and what strategies the County can pursue to reduce and manage these risks. The project area encompasses the Richardson Bay shoreline, from the Sewerage Agency of Southern Marin treatment plant in Mill Valley to Marin City.
- The **Bay Conservation and Development Commission (BCDC)** is tasked with providing regulatory authority over the San Francisco Bay. BCDC has produced maps of sea level rise for informational purposes that are intended to encourage further and more detailed local study. In 2011, BCDC prepared a vulnerability assessment, *Living with a Rising Bay: Vulnerability and Adaptation in San Francisco Bay and on the Shoreline* (San Francisco Bay Conservation and Development Commission 2011).
- **California Coastal Commission** is a state agency that provides planning and regulatory authority over the California coastline. The California Coastal Commission released *Draft Sea Level Guidance* in 2013 to provide local governments with recommendations on how to address sea level rise in Local Coastal Programs (California Coastal Commission 2013).
- The **Marin Municipal Water District is a partner in the North Bay Climate Ready project** aimed at developing a regional vulnerability assessment for selected Marin, Sonoma and Napa public agencies in order to help local government and agency staff implement informed and effective climate adaptation strategies and responses. The vulnerability assessment is scheduled for completion in 2016 and will examine potential changes in temperature and water supply, groundwater recharge, drought stress, and others variables for a range of climate scenarios. This project is coordinated by the **North Bay Climate Adaptation Initiative (NBCAI)**, a coalition of natural resource managers, policy makers and scientists working together to implement effective adaptation strategies for North Bay ecosystems and watersheds. The data products produced by North Bay Climate Ready will address a range of scenarios for the Marin landscape.
- The *Vegetation and Biodiversity Management Plan* (draft released in October 2013) is a prime example of how the County is incorporating climate change impacts and hazards into its long-range and comprehensive planning efforts (Marin County Parks and Marin County Open Space District 2013).
- The December 2012 publication of *San Francisco Estuary & Watershed Science* included a peer reviewed article by Elisabeth Micheli et al. (2012) titled, *Downscaling Future Climate Projections to the Watershed Scale: A North San Francisco Bay Case Study*. This study provides an in-depth discussion on the approaches and benefits of using downscaled data to predict temperature and precipitation changes.

8.3.2 Additional Efforts Needed

Marin County has been proactively addressing climate change on many fronts, but additional efforts are needed to understand the county's vulnerabilities and take action to address these vulnerabilities. Important additional efforts include a countywide vulnerability assessment, improved collaboration among stakeholders, and the establishment of additional funding sources to support adaptation initiatives.

8.3.2.1 Countywide Vulnerability Assessment

Although a large number of adaptation activities are under way, there has not been a consolidated look across sectors and climate change stressors at the vulnerabilities of Marin County. Vulnerability assessments thus far have been limited to certain geographic areas and/or specific climate stressors (e.g., sea level rise). A more comprehensive countywide vulnerability assessment would help highlight where resources should be focused under adaptation planning efforts. A countywide understanding of vulnerabilities will help ensure that adaptation resources are being deployed in an effective and efficient manner. Furthermore, effective adaptation requires coordination across many different stakeholders within a county, and a "big picture" understanding of the sectors and geographic locations that are most vulnerable would help demonstrate where coordination and collaboration are most needed.

A comprehensive vulnerability assessment is also an important resource for garnering public support for adaptation efforts. A countywide assessment would show, in clear terms, the locations that are particularly vulnerable, which could motivate communities to take action. They are less likely to take action if the threat of climate change is vague and not made specifically relevant to them.

8.3.2.2 Collaboration

Climate change has the potential to affect a wide variety of communities, stakeholders, and industries. Leaving each community or stakeholder group to address adaptation on its own would lead to inefficient and less effective adaptation strategies. It is better to address adaptation through a coordinated effort of communities and stakeholders.

To undertake this work, a broad range of groups that have an interest in the county will need to work together to identify and implement creative solutions. Under the discussion of each sector in Section 8.4, the key stakeholders and agencies are noted, highlighting the fact that there are many stakeholder groups with a vested interest in increasing the resiliency in each sector. In addition to developing an approach that reaches across agencies within the county, it may be essential to engage businesses, municipal governments, residents, and federal, state and regional agencies in developing a locally feasible implementation plan. Throughout the process of conducting a vulnerability analysis, assessing the sensitivity of systems, and developing an adaptation action plan, the relevant list of stakeholders should be reviewed and engaged.

As part of an effort to collaborate, the County and municipalities could benefit from agreeing to use the California sea level rise projections (as outlined in the *State of California Sea-Level Rise Guidance Document*) in long-range planning efforts (State of California Ocean Protection Council 2013). Although the state has not released similar guidance for temperature increases and precipitation changes, the County and municipalities could agree to adopt a set of local projections and commit to incorporating those projections into long-range planning efforts. In addition to selecting a set of projections, the government entities would also need to agree upon how to define "long-range" planning efforts.

8.3.2.3 Funding

Another significant challenge will be to identify funding sources for the vulnerability assessment, developing an adaptation plan, and implementing actions. By establishing buy-in across agencies, in the business community, and among residents, the County may be able to identify a broader range of funding sources. The County may seek opportunities for public-private partnerships, have enough buy-in to pass a ballot measure to collect revenue, or identify opportunities to integrate adaptation into existing efforts that have co-benefits such as turning an area with high risk of sea level rise–related inundation into a scenic trail or park. Creative approaches to funding may help engage a larger community and identify opportunities for additional co-benefits.

8.4 Potential Impacts of Climate Change on Marin County's Sectors and Potential Adaptation Actions

This section discusses the potential impacts of important sectors to the aforementioned climate hazards. Each sector is introduced by a brief overview of the relevant features of that sector in Marin County, highlights of the climate hazards with the highest potential to cause damage, a discussion of current activities, and which agencies or groups would be integral in developing and implementing specific adaptation actions. Table 8-2 provides a high-level list of potential adaptation actions for each sector; see Appendix A for additional detail. This list provides suggested actions to increase resiliency; however, this is not an exhaustive list and is only intended for guidance and to initiate a discussion with relevant stakeholders after a comprehensive vulnerability assessment is completed.

The review is intended to provide high level guidance for the County and not rate the relative potential impacts. The information does not state whether these impacts are likely to occur, and likelihood cannot be assessed given the inherent uncertainty of greenhouse gas projections, climate models, and the associated impacts on assets and services. The evaluation is based on research and professional expertise and provides a discussion of general sensitivities that may be a concern in the county. A detailed vulnerability assessment by sector would be required to identify where the county's specific vulnerabilities lay.

Table 8-2. Example Adaptation Actions by Sector[34]

Sector	Potential Adaptation Actions
Cross-Cutting	• Select set of climate projections upon which to base future planning decisions. • Conduct detailed vulnerability assessment by sector or geographic region within the County. • Evaluate vulnerability of planning decisions based on the selected climate projections. • Integrate adaptation actions into planning processes (i.e., wildfire preparedness, water management, hazard preparedness, comprehensive planning, etc.) and infrastructure decision-making (i.e., locating and designing roads). • Encourage zoning and planning decisions that limit building of infrastructure in areas at risk for sea level rise, flooding, or landslides. Also encourage planning decisions that increase redundancy of critical infrastructure types. • Work with other institutions to develop cost-effective, comprehensive arrangements for monitoring the changes in local climate factors such as precipitation, fog, heat patterns, storm frequency and severity, flood flows, areas inundated and sea level. • Begin monitoring climate- and weather-related damages and costs to help understand the costs of inaction. Monitoring is also critically important for determining the appropriate pace and timing of adaptation actions, especially for actions requiring long lead-time and high cost alternatives.
Water	• Implement water conservation measures to mitigate demand. • Anticipate higher water treatment costs. • Incorporate design standards to slow surface water runoff. • Review and update coastal flood protection measures. • Introduce erosion control measures. • Review and update forest management practices.
Natural Heritage	• Monitor existing and emerging species. • Increase habitat connectivity and establish habitat corridors. • Increase the availability of shade and water at recreational facilities. • Acquire and protect areas where marsh can migrate upland as inundation increases. • Create “no-wake zones” to reduce erosion. • Consider water needs of plants when landscaping.

[34] This table represents example adaptation measures that could be implemented by Marin County. A more complete list is presented in Appendix A. A more complete vulnerability and adaptation analysis is needed to determine which adaptation measures should be recommended.

Sector	Potential Adaptation Actions
Transportation	• Develop plan to address worker safety with regards to extreme heat. • Review guidelines for materials and equipment to ensure they can withstand increased maximum temperatures. • Protect sensitive equipment and update maintenance schedule to address more rapid deterioration of materials. • Make Public Service Announcements about closures and plan for detours. • Reroute or elevate roads and improve drainage on existing roads. • Establish redundant routes. • Adapt marine facilities (e.g., ferry terminals). • Conduct post-event evaluation and maintenance to ensure all facilities are up to standard for safe operations and use after extreme events (i.e., fire, flood, heat wave, etc.).
Agriculture	• Adjust growing season and planting methods or select varieties of plants that are heat resistant. • Grow different varieties of plants and crops that are more tolerant to variability or projected climate conditions. • Develop plan for animal safety in the event of an extreme event such as a flood, storm surge, or extreme heat. • Use buffers to modify and reduce fertilizer and pesticide application to address potential increases in polluted agricultural runoff from floods, inundation, and erosion. • Develop carbon farming and wetland restoration along Marin's bayshore to restore wetlands, sequester atmospheric carbon, and accrue significant quantities of carbon-rich soil to increase shoreline elevation and buffer storm surges.
Energy	• Add peak generation, power storage capacity, and distributed generation. • Implement improved cooling flow technologies and procedures to reduce water needs. • Institute technologies and procedures to increase reliability of the energy supply during heat waves and/or drought years. • Reduce energy demand through energy efficiency.
Human Health	• Early warning systems for heat waves and unsafe swimming conditions. • Make cooling facilities available for residents. • Stagger activities like construction to cooler times of day. • Monitor air quality concentrations. • Monitor coastal conditions and reduce discharge of warm water and fertilizers upstream. • Educate public on preparedness for hazards. • Develop contingency plan at hospitals and for patients that receive care at home for situations with loss of power.

Sector	Potential Adaptation Actions
Built Environment	• Update building codes to require structural adaptations to withstand flood inundation • Support use of adaptable building construction types for remodels and new construction • Increase setbacks/elevations for beach and bluff-top development in coastal communities. • Develop managed realignment/relocation plans which could include transfer of development credits, acquisition and conservation easements. • Create natural protection systems in coastal areas which could include beach/dune restoration (addition of sand and vegetation) and offshore bio-beds (kelp, sea grass, oyster beds, etc.) • Construct structural coastal protections including seawalls, groins, emergent breakwaters, artificial reefs and perched beaches.

This section also notes the general coordination and research activities, and the likely actors to oversee those activities, that would need to be conducted to begin preparing for these changes. It is important to understand that this high-level coordination and research are important first steps for effectively and efficiently adapting. Specific adaptation strategies that are common to each sector are highlighted in Table 8-2 and detailed in Appendix A; however, more detailed analyses on specific vulnerabilities of Marin County, and potential costs and benefits of each adaptation measure, are needed to determine which actions should be implemented in Marin.

8.4.1 Water

The Marin Municipal Water District provides drinking water to 186,000 customers in central and southern Marin County (including incorporated areas). Approximately 75% of the drinking water comes from the seven reservoirs that capture rainwater on 21,600 acres of protected watershed on Mt. Tamalpais. Additional water resources are imported from the Russian River in Sonoma County (Marin Municipal Water District 2014). The North Marin Water District provides service to approximately 61,000 customers in the city of Novato and several small improvement districts near the coast (North Marin Water District 2014). The Stinson Beach County Water District serves the residents of Stinson Beach. Additional small districts serve the communities along the Pacific coast.

Concerns regarding water are typically associated with three main and time-variable aspects: quantity, quality, and demand.

Increased temperatures and extreme heat could decrease water supplies as evapotranspiration and the demand for water increases. Secondary sources of water and conservation measures can help offset these impacts. Additionally, higher temperatures decrease dissolved oxygen levels in water, which can reduce water quality and require higher costs for treatment.

Flooding may cause shifts in peak water flows, shifting the quantity of water in streams and rivers. Water management practices that store water onsite (such as low-impact development) can help reduce these shifts in peak flows. Increased runoff and flooding may also move pollution into the waterways and require additional treatment costs. Similarly, sea level rise could impact quality of water and increase concerns related to saline intrusion and potential leach field impacts.

Increased erosion from wildfires in the watershed and the use of chemicals from fighting fires may directly impact the water quality. Additionally, as energy prices increase, the cost of pumping and delivering water could also increase.

An assessment of the existing facilities, distribution networks, and land uses will be necessary to understand the extent to which the water supply in Marin County will be impacted by climate change impacts. The **Marin Municipal Water District, North Marin Water District,** and **Marin County Flood Control and Water Conservation District** will likely be the primary group interested in fully understanding the risks associated with climate change.

8.4.2 Natural Heritage

Marin County has a rich natural heritage with regional and community parks, neighborhood parks, with 34 open space preserves that span 19,300 acres, 190 miles of unpaved public trails, 21,000 acres of protected watershed on Mt. Tamalpais and in west Marin owned by the Marin Municipal Water District, and federal and state parklands and preserves(Marin County 2008a). These lands provide vital ecosystem services that clean the air and water; contribute to the quality of life of residents, employees, and visitors; and provide critical habitat for native plants and animals (Marin County 2008b). Currently the County is home to a variety of forests that include oaks, Douglas fir, the iconic redwoods, and a diverse mix of hardwoods typical of the Coast Range mountains (North Bay Climate Adaptation Initiative 2013b). Although riparian areas, including streams, creeks, and rivers, account for a small portion of the land area in the county, these areas provide critical services for plant and animal species (North Bay Climate Adaptation Initiative 2013c).

Slight shifts in the growing season, ambient air temperature, and water temperatures can have dramatic impacts on natural resources. For example, one of the most significant shifts projected for the area is that much of the woody forest vegetation that is characteristic of the county may be replaced by chaparral shrub cover that is more characteristic of coastal climates further south, such as Santa Barbara (North Bay Climate Adaptation Initiative 2013b). Shifts in conditions may provide environments that are more favorable for heat-tolerant invasive species. Inundation from flooding and sea level rise may destroy or damage habitats, marshes, beaches, and recreational areas. Droughts may limit the water available in lakes or streams that can be used by aquatic species and may cause a shift towards more drought tolerant tree and plant species. Wildfires may destroy critical habitats for species and damage recreational facilities.

The first step in many of the adaptation actions, identified in Appendix A, is to begin (or continue) species monitoring to understand precisely how the changes are impacting the natural heritage. As concerns about wildfires increase in the area, it will be important for the departments responsible for preserving open space work in coordination with the fire department.

The preliminary draft of the *Vegetation and Biodiversity Management Plan* (released October 29, 2013) responded to guidance from the 2007 *Marin Countywide Plan*, which promoted the keeping the community safe from climate change (Marin County Parks and Marin County Open Space District 2013; Marin County Community Development Agency 2007). This current draft includes a section on management for climate change within chapter 3. The section on management of vegetation responses to climate change includes a plan to expand monitoring and adaptive management practices to respond to climate change and sea level rise (Marin County 2008b). The Marin County Watershed Program has identified tools such as Our Coast Our Futures' sea level rise visualization tool, which helps planners understand how changes will impact tidal marsh habitat and bird species over the next 100 years (Point Blue Conservation Science 2013).

Marin County Parks and Open Space District, Marin Municipal Water District, and **Marin County Watershed Program** will likely be the primary groups responsible for implementing the appropriate adaptation options, based on the vulnerability assessment presented in the 2013 *Vegetation and Biodiversity Management Plan* (Marin County Parks and Marin County Open Space District 2013). Countywide plans may also include coordination with the **Community Development Agency**, **Marin County Fire Department, Marin Audubon Society, Marin County Flood Control and Water Conservation District,** and other groups including National and State Park agencies that are active in preserving the county's natural heritage**.**

8.4.3 Transportation

The Marin County transportation network consists primarily of roads and bicycle and pedestrian facilities. Highway 101 is the main thoroughfare that runs North-South through the eastern portion of the County. Highway 1 is a scenic road that follows the Pacific Coast. In 2003 the Sonoma-Marin Area Rail Transit (SMART) district was established and will provide 70 miles of passenger rail service that will run from Cloverdale in Sonoma County to Larkspur Landing in Marin County. Phase 1 is scheduled to begin service in late 2016 (Sonoma Marin Area Rail Transit 2014). In addition to terrestrial transportation services, there are three ferry services that transport pedestrians (and cyclists) by boat. The Blue and Gold Fleet provide service between Tiburon, Sausalito, Angel Island, and San Francisco. Golden Gate Transit transports people between Larkspur, Sausalito, and San Francisco. The Angel Island Ferry operates between Tiburon and the state park on Angel Island (Marin County 2014).

The transportation network in Marin County could be affected by several climate impacts. Transportation infrastructure, such as roads, bridges, and rail, require significant capital investments and generally has long life expectancies; it is likely that these systems will be impacted by climate hazards. Extreme heat events, wildfires, flooding, and sea level rise may cause direct damage or destruction to the transportation network or temporarily disrupt services. Such extreme events may also introduce personal risk to workers or increase the need for maintenance and repairs. Changes in the cost of fuel may increase the demand for public transportation or alternative transportation options, such as walking and biking. Certain sections of Highway 101 are extremely vulnerable to sea level rise, and many communities have only one entrance/exit in case of emergency.

Transportation Authority of Marin (TAM) and **Transportation Planning (a division of Public Works)** will likely be the primary groups in the county that are most interested in understanding the specific vulnerabilities for transportation assets in the county. Countywide plans may also include coordination with the **Community Development Agency**, **Bicycle Advisory Group, SMART, Marin County Flood Control and Water Conservation District,** and **the ferry service providers.** Beyond the County, regional agencies, including the **Association of Bay Area Governments (ABAG)** and **Metropolitan Transportation Commission (MTC)** will likely be involved in the vulnerability assessment and resulting adaptation recommendations to understand how risks in Marin County's network will impact surrounding municipalities.

8.4.4 Agriculture

Livestock and dairy are the primary agricultural products in Marin County. The vast majority of the 167,000 acres of land that are zoned "Agricultural" (about 50% of the land area in the county) are used for seasonal grazing of dairy, cattle, and sheep (University of California Cooperative Extension, no date). There are 255 agricultural operations in the county, of which 191 are considered small or mini-farms (University of California Cooperative Extension, no date). Over 75% of the agricultural gross value comes from livestock-related production. The remaining production comes from approximately 12% in field crops, 5% in fruit and vegetable crops, 6% in aquaculture, and the remaining 1% in nursery crops (Marin County 2013).

Since the majority of agricultural activity in the county is related to livestock production, it will be particularly important to understand how climate hazards may impact the health and safety of cattle and sheep. Extreme heat may cause animals to experience heat exhaustion, stress, or death; increase their vulnerability to disease; reduce fertility; and limit milk production. Impacts on grazing crops could require ranchers to provide animals with more imported feed. To combat the impacts of extreme heat, individual farmers and ranchers may benefit from increasing ventilation in barns, expanding animal access to water, and providing additional areas that can provide shade and cooling. As temperatures and precipitation patterns change, new disease vectors may be introduced that further threaten the health of livestock. Monitoring and developing plans for addressing outbreaks could help halt the spread of any such diseases.

Flooding, sea level rise, and wildfires may cause direct impacts on cattle, agricultural lands, equipment, and water quality. While it may be possible to move cattle and equipment in the event of temporary inundation or a wildfire, these hazards could also result in permanent damage or destruction that could result in more permanent disruptions in the industry. Physical barriers and flood mitigation strategies can be used to minimize the impacts of extreme events. A plan to prevent and contain wildfires could help avoid the potential impacts of wildfires on agriculture.

Agricultural uses require large amounts of water that could be limited during a drought. During periods of limited resources, the cost of water may increase. A lack of access to water can result in dehydration for animals and reduced yields or plant death for crops.

To understand the specific vulnerabilities associated with climate impacts in Marin County, a comprehensive vulnerability assessment is necessary. The **County Department of Agriculture** and **independent farmers and ranchers** could take a lead on conducting a vulnerability assessment and identifying the appropriate adaptation options that are appropriate for the region. Collaboration with the **Marin Municipal Water District**, **Marin County Fire,** the **Community Development Agency,** and **Marin County Flood Control and Water Conservation District** could help to develop plans that are integrated into the countywide plans.

8.4.5 Energy

While wildfires, sea level rise, and flooding in Marin County have the potential to disrupt energy distribution, significant changes in temperature and extreme heat events across the region could result in larger systematic problems such as brownouts. A significant increase in energy demand could decrease efficiency, increase overall costs, and disrupt service. Backup power generation, redundancy, and distributed energy production (i.e., solar panel installation) could help minimize peak loads.

PG&E and **Marin Clean Energy (MCE)** along with **independent energy consumers** may be the primary groups interested in understanding the local vulnerabilities and potential options for implementing adaptation actions. Countywide plans may also include coordination with the **Community Development Agency** and the **Marin Builders Association** who may play a significant role in influencing local energy efficiency standards and design requirements**. PG&E, MCE and the Marin Energy Watch Partnership** currently provide assistance and incentive funding to help residents and businesses reduce energy needs.

8.4.6 Human Health

Overall, County residents have generally good health (Marin County Health & Human Services 2014). The population in the county is aging, with approximately 18% being 65 years of age or older, compared to about 12% for the rest of California (U.S. Census Bureau 2014). More than 23% of the population over 5 years old speaks a language other than English at home, and the median household income exceeds that of the state (U.S. Census Bureau 2014). During the 2008–2012 reporting period, about 7.5% of the population lived below the poverty level, compared to a 15.3% statewide average (U.S. Census Bureau 2014). The human health risks associated with climate change in the county are consistent with those in other areas of the country.

Although the residents of Marin County experience generally good health, extreme heat events could put additional stress on the healthcare network. Wildfires, flooding, sea level rise, and the availability of water may cause increases in physical injury and mental health stress. Local changes in the temperature and precipitation patterns are unlikely to have a major impact on the availability of food for the general public, since most food is imported from areas beyond the County. However, a statewide shift in the growing season could impact the cost and availability of some food in the county. Adaptation efforts may focus on ensuring that adequate services would be delivered if an extreme event were to occur in the county.

Currently Marin Grassroots is working with vulnerable communities to understand their primary concerns with regards to sea level rise. Across California, health advocates and the CalBRACE program[35] are quantifying the climate benefits of various health strategies by forecasting exposures and population vulnerabilities at a local/regional level, conducting a health risk assessment, assessing interventions, and developing an implementation plan. These efforts will contribute to making the public health system more prepared for the impacts of climate change.

Marin Health and Human Services, local hospitals (including Marin General and Kaiser Permanente), and **health centers** could be the primary groups that may lead the implementation of the CalBRACE model in the county. Countywide plans may also include coordination with the **Community Development Agency**, **senior living facilities, community service centers,** and the **California Department of Public Health.**

[35] CalBRACE (Building Resilience Against Climate Effects) is a program of the California Department of Public Health with funding from the Centers for Disease Control (CDC). The program provides resources and technical assistance for the state and local public health departments to build climate adaptation capacity and enhance resilience at the local and regional levels.

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Photo: Marin Cultural Services Department

Chapter 9
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Appendix A

Summary of Adaptation Actions

Appendix A
Summary of Adaptation Actions

Introduction

The following series of tables offer potential adaptation actions that could be applicable to the various impacts that may be a threat to sectors in Marin County. The sectors reflect those of importance in the county and the potential impacts are tailored to the climate hazards that may pose a risk to the county, based on the changes in temperature, precipitation, and sea level rise discussed in Chapter 7. This list provides suggested actions to increase resiliency; however, this is not an exhaustive list and is only intended for guidance and to initiate a discussion with relevant stakeholders after a comprehensive vulnerability assessment is completed.

Water

Climate Hazard	Potential Impacts	Adaptation Options
Extreme Heat	• Decrease in water supplies as evapotranspiration increases • Depletion of groundwater	• Invest in secondary sources of water • Consider desalination as an option for potable water supply, while balancing environmental resource protection and water quality concerns.
	• Decreased quality because higher temperature can exacerbate eutrophication (algae growth) which can result in low dissolved oxygen • Higher water temperatures can also increase pathogen levels • Higher pollutant concentrations from larger evaporation losses	• Anticipate higher water treatment costs
	• Increase in demand for water e.g., cooling water for industry, irrigation, watering lawns, etc.	• Implement water conservation measures to mitigate demand
Riverine Flooding	• Increase in peak water flows	• Establish water management practices • Incorporate low-impact development (LID), best management practices, and other design standards that promote on-site water retention that slows surface water runoff
	• May dilute pollutant concentrations or increase pollutant concentrations by introducing pollutants from land surface	• Anticipate higher water treatment costs

Climate Hazard	Potential Impacts	Adaptation Options
Sea Level Rise (permanent inundation and episodic **flooding)**	• Reduction in quality of groundwater by seawater intrusion, reducing the quantity available for consumption	• Review coastal flood protection measures • Install groundwater barriers
	• Increase in demand on other water resource supplies not affected by saline intrusion	• Develop alternative water supply resources
Wildfires	• Increased land erosion related to rainfall on denuded soils (sedimentation, suspended solids); increase of pollutants (chemicals from firefighting, nitrates from fire) • Disruption to reforestation/ revegetation	• Consider erosion control measures, including replanting and non-vegetative measures (e.g., geotextiles)
	• Increase of water pollutants (i.e., chemicals from firefighting, nitrates from fire)	• Enhance water treatment
	• May result in changes of water flows (e.g., peak-flow increases related to denuded and hydrophobic soils)	• Implement water catchment features • Implement erosion protection measures
	• Decreased sub surface flow and evapotranspiration given denuded land and hydrophobic soils	• Review forest management practices
Shift in Energy Demand and Supply	• Increase in costs of pumping and delivering water as demand for energy increases	• Anticipate higher water treatment costs

Natural Heritage

Climate Hazard	Potential Impacts	Adaptation Options
Extreme Heat	• Stress on threatened and endangered species (or any species)	• Consider species monitoring
	• Shifts in species habitat ranges with the possibility of increased human-wildlife interactions and increased stress on species who have nowhere to migrate	• Increase habitat connectivity or ensure habitat corridors established

Climate Hazard	Potential Impacts	Adaptation Options
	• Decline in number of days (or hours in the day) that visitors can comfortably and safely visit parks	• Increase the availability of shade and water • Consider offering alternative recreational activities
	• Emergence of new plant and animal communities	• Monitor to track emergence and spread of new species (and determine if management interventions are necessary)
	• Rising water temperatures may stress species	• Implement cooling techniques (e.g., planting shade trees around streams and small water bodies)
	• Increased threat from heat-tolerant invasive species	• Deploy best management practices to control and prevent spread of invasive species
Riverine Flooding	• Destruction of habitats due to flooding and landslides • Destruction of recreational areas due to flooding and landslides	• Consider BMPs to improve flood protection • Review/revise land management plans and development codes • Provide public education to address preparedness for climate hazards and habitat restoration
Sea Level Rise (permanent inundation and episodic flooding)	• Decreasing extent of marsh habitat, affecting ability of species to feed, nest, etc. • Cliff and shoreline erosion • Combined flooding: where riverine flooding (flowing off the land) can be additive to increased water run-up from the sea (significant problem at Stinson Beach)	• Acquire and protect areas where marsh can migrate upland as inundation increases • Create "no-wake zones" to reduce erosion • Ensure adequate sediment supply to promote marsh accretion • Establish new setback requirements to reduce susceptibility to erosion risks and combined flooding impacts • Consider proactive wetland enhancement
	• Damage to or destruction of beaches used for recreation	• Consider offering alternative recreational activities
Shift in Water Demand/Supply	• Decreased lake levels, impacting species health	• Consider species monitoring
	• Decreased lake levels, decreasing recreational opportunities (e.g., boating, rafting)	• Consider offering alternative recreational activities • Consider lake and reservoir management
	• Shift toward more drought-tolerant species	• Consider water needs of plants when choosing new plants
	• Increased disease in trees due to droughts	• Consider measures to control the outbreak and spread of disease

Climate Hazard	Potential Impacts	Adaptation Options
Wildfires	• Destruction of habitat for threatened and endangered species (or any species) • Increased opportunities for establishment and spread of invasive species	• Consider species monitoring • Establish good plan to prevent fires from starting (e.g. fire management zones) • Deploy best management practices to control and prevent spread of invasive species
Change in Growing Season	• Changes in the timing of flowering • Mismatch in timing between blooms and pollinators or availability of food and species that rely upon it	• Consider shifts in growing season and likely survivability when selecting and planting new vegetation • Consider species monitoring

Transportation

Climate Hazard	Potential Impacts	Adaptation Options
Extreme Heat	• Transportation workers may be at risk of overheating during maintenance and operations of equipment. Interruptions in service may occur if unsafe conditions prevent workers from performing duties	• Develop plan to address worker safety with regards to extreme heat
	• May cause concrete pavement buckling and loss of non-concrete pavement integrity (e.g., asphalt melt) for roads and sidewalks. • Can lead to rail damage	• Review guidelines for materials to ensure those used can withstand increased maximum temperatures.
	• Increases in lightning activity poses threat to electronic equipment and interferes with operations	• Protect electronic equipment
	• Many types of vehicles can overheat, and tires will deteriorate more quickly	• Shorten maintenance schedule • Select equipment that can withstand higher temperatures
Riverine Flooding	• Heaving rain can cause standing water on runways, sidewalks, and roads, causing transportation delays	• Make Public Service Announcements to let drivers know about closures • Reroute or elevate roads • Improve drainage on existing roads • Establish redundant routes

Climate Hazard	Potential Impacts	Adaptation Options
Sea Level Rise (permanent inundation and episodic flooding)	• Sea level rise in combination with tidal actions and/or subsidence can inundate low-lying transportation systems in coastal areas (such as Highway 101) • May disrupt marine transportation facilities	• Make Public Service Announcements to let drivers know about closures • Reroute or elevate roads • Establish redundant routes • Adapt marine facilities (e.g., ferry terminals) • Plan emergency evacuation routes and alternative entrances/exits to Highway 101
Wildfires	• Post-wildfire debris flow can cause damage to bridge abutments and roads • Rail ties and tracks are susceptible to damage from wildfire heat. Wooden ties can combust when exposed to fire. Metal components can warp or melt if exposed to high temperatures. • Typical asphalt mixtures have the potential to ignite during tunnel fires	• Establish good plan to prevent fires from starting (keep underbrush levels low, establish buffer between wild areas and transportation facilities to starve fire) • Provide water resources to put out fires • Conduct post-event evaluation and maintenance to ensure all facilities are up to standard for safe operations and use
Shift in Energy Demand and Supply	• Rising costs of transportation due to increase in fuel and energy prices, could place additional demand on public transportation services	• Monitor public transit ridership and shifts in demand

Agriculture

Climate Hazard	Potential Impacts	Adaptation Options
Extreme Heat	• Cattle and sheep may experience heat exhaustion, stress, or death that could result in increased vulnerability to disease, reduced fertility, and reduced milk production	• Identify and establish areas that can provide shade (e.g., trees and manmade structures) for animals to get out of the sun • Ensure that animals have consistent access to water to cool off • Increase ventilation in barns
	• Extreme heat may reduce yields or cause complete crop loss, depending on the timing of the heat spell during the growing season	• Adjust growing season or select varieties of plants that are heat resistant • Use innovative growing methods that reduce heat locally

Climate Hazard	Potential Impacts	Adaptation Options
Riverine Flooding	• Contamination of cattle drinking water may result in animal sickness	• Develop a plan for where to move animals in the event of a flood • Remove manure from areas that are likely to flood • Monitor animals for sickness • Monitor drinking water
	• Damage to barns, other infrastructure, and machinery	• Move buildings and critical infrastructure out of the floodplain and other low lying areas • Keep only movable machinery or structures that can withstand temporary inundation in the floodplain
	• Can result in oxidative stress of plants, which may reduce yields or kill plants, depending on extent and duration	• Develop a drainage system that can quickly move water away from crops (may want to move water into a location for future use to address flood-drought cycles)
	• All sensitivities mentioned above for animals and crops.	• Develop a watershed plan to mitigate flooding that is built off existing floodplains and takes into account potential for changes in precipitation patterns (e.g., heavier rainfall events) • Use buffers to modify and reduce fertilizer and pesticide application to address potential increases in polluted agricultural runoff
Sea Level Rise (permanent inundation and episodic flooding)	• Salinization of soils from coastal inundation may create parcels that are no longer appropriate for growing plants for grazing or other types of food production. • Loss of land due to erosion	• Construct physical barriers or modify the landscape to protect land from inundation and erosion • Develop carbon farming and wetland restoration along Marin's bayshore to restore wetlands, sequester atmospheric carbon, and accrue significant quantities of carbon-rich soil to increase shoreline elevation and buffer storm surges
Shift in Water Demand/Supply	• Lack of access to water can result in dehydration and/or death of animals.	• Construct water reservoirs for animals to use if naturally occurring water sources are not as reliable as in past • Develop methods to collect water during times of drought (e.g., rain barrels, water storage ponds, etc.) • Enhance water-holding capacity of Marin's agricultural soils through use of compost and other organic carbon enhancement strategies per Marin Carbon Project Carbon Farm Planning Protocol

Climate Hazard	Potential Impacts	Adaptation Options
	• Lack of access to water can result in reduced yields or plant death depending on timing and duration.	• Add irrigation system for crops • Plant drought tolerant varieties of crops • Develop methods to collect water during times of drought (e.g., rain barrels, water storage ponds, etc.)
Wildfires	• Wildfires can burn/damage/kill cattle and agricultural equipment/ barns/etc. • Ruin grazing land for short to long term (depending on level of damage). • Damage farmland and fruit trees for production.	• Establish good plan to prevent fires from starting (keep underbrush levels low, establish buffer between wild areas and agricultural areas to starve fire) • Provide water resources to put out fires • Establish plan to keep animals safe during a fire
Change in Growing Season	• Increased temperatures and shifts in the precipitation and fog patterns could result in periods with insufficient plants for grazing. • Temperatures and water availability may reduce or eliminate crop yields depending on length and intensity of shift.	• Add new plants to the grazing fields that are seasonally insensitive, supplement cattle other food sources • Shift planting timing based on weather forecasts and longer term trends in seasonality changes. • Grow different varieties that are more tolerant to variability or grow new types of plants that are more tolerant
Warming, acidification of Bay and coastal waters	• Fishing and Mariculture: Warming waters may shift the distribution of target species in the ocean, affect the spawning and rearing of anadromous and stream species such as salmon, and potentially affect shellfish production.	• Monitor research developments and potential adaptation strategies • Consider the potential for shellfish production options within the county to enhance countywide resilience against potential warming/acidification impacts in specific shellfish production waters while balancing environmental resource protection and water quality issues.

Energy

Climate Hazard	Potential Impacts	Adaptation Options
Extreme Heat	• Decreased energy system efficiency, due to increase in frequency of severity of very hot days and heat waves	• Diversify energy supply chain (e.g., a new solar farm project capable of powering 500 Marin homes is currently being installed an old quarry in Novato) • Build redundancy into facilities • Add peak generation, power storage capacity, and distributed generation • Add backup power supply for grid interruptions • Insulate equipment for temperature extremes
	• Overall increases in cost due to reduced oil, gas, and coal processes efficiency • Increased fuel extraction and processing costs	• Diversify supply chain • Increase energy system efficiency
	• Increased temperatures affect the transmission and distribution of energy (e.g., can lead to failure of power transformers; increased stress on transmission infrastructure and grid, leading to disruption of supply; increased sag of overhead line conductors) • Heat waves and higher temperatures reduce the longevity of production equipment through reductions in material strength or warping	• Utilities: o Improve reliability of grid systems through backup power supply, intelligent controls, and distributed generation o Increase transmission capacity between regions o Conduct annual review of network loadings to ensure adequate headroom on network o Provide annual review of network loadings to ensure adequate headroom on network o Institute proactive program replacement driven by monitoring the condition of assets; condition information gathered through combination of thermal imaging, hi-res imaging, and periodic foot and helicopter patrols • County/Utilities: Monitor vegetation and review vegetation management in place to maintain statutory clearances to overhead assets. This includes resilience against falling vegetation

Climate Hazard	Potential Impacts	Adaptation Options
	• Increased energy demand for AC, refrigeration, and water	• Improve water distribution/reuse efficiency • Allow flexible work schedules to transfer energy use to off-peak hours • Expand capacity and encourage conservation • Set higher temperatures in buildings • Improve building energy use • Upgrade cooling system and manufacturing efficiencies • Employ demand-response capabilities (e.g., smart grid) • Enhance urban forestry to reduce the heat-island effect in built-up portions of the County
Riverine Flooding	• Can damage power lines and electricity distribution	• Move critical infrastructure out of the floodplain • Elevate or protect infrastructure that cannot be moved
	• Disruptions in railway, truck, and marine transportation that transport oil, gas, and coal	• Provide backup power generation for critical systems that rely on the grid.
Sea Level Rise (permanent inundation and episodic flooding)	• Energy infrastructure located in low-lying coastal areas may be temporarily or permanently inundated. • Increased energy use for additional pumping requirements related to retention of runoff behind expanded levees.	• Move critical infrastructure out of low-lying coastal areas • Develop land use plans to reduce need for expanded levees
Shift in Water Demand/ Supply	• Drought may increase the need for energy-intensive methods of providing drinking and irrigation water that is pumped, transported, and treated.	• Seek alternative technology that requires less energy to pump, transport, and treat water. • Promote water conservation
Wildfires	• Energy infrastructure located in high wildfire risk areas may suffer disruptions or damage.	• Expand fire prevention plan to include climate projections.

Human Health

Climate Hazard	Potential Impacts	Adaptation Options
Extreme Heat	• Extreme heat may cause stress, heat stroke, and mortality.	• Provide early-warning systems • Provide cooling facilities • Reduce outdoor activities • Stagger activities such as construction to cooler times of day
	• Extreme heat degrades air quality with tropospheric ozone and particulate matter, including risks of cardiovascular disease, chronic and acute respiratory disease, lung cancer and preterm birth	• Early warning systems • Monitor air quality concentrations • Reduce exposure to outdoors, especially for children, elderly, and other sensitive populations
	• Algae growth along coastlines (e.g., red tide) due to warmer sea surface temperatures	• Monitor coastal conditions • Reduce discharge of warmer waters/fertilizers upstream if applicable • Make announcements to alert public when the water is and is not safe for swimming and fishing
Riverine Flooding	• Mortality and injury due to flooding • Mental health and stress disorders due to geographic displacement and loss of loved ones	• Provide public education to address preparedness for climate hazards • Update building codes to require structural adaptations to withstand flood inundation • Develop managed realignment/relocation plans, which could include transfer of development credits, simple acquisition, and conservation easements • Develop structural and non-structural adaptations to increased risk of flooding • Update zoning to discourage construction in flood-prone areas
Sea Level Rise (permanent inundation and episodic flooding)	• Mortality and injury due to bigger waves, storm surges, and wave run-up • Mental health and stress disorders due to geographic displacement and loss of loved ones	• Provide public education to address preparedness for climate hazards • Update building codes to require structural adaptations to withstand flood inundation • Develop managed realignment/relocation plans, which could include transfer of development credits, simple acquisition, and conservation easements • Develop structural and non-structural adaptations to increased risk of flooding • Update zoning to discourage construction in areas that are prone to inundation from sea level rise

Climate Hazard	Potential Impacts	Adaptation Options
Wildfires	• Mortality and morbid impacts • Mental health and stress disorders due to geographic displacement and loss of loved ones	• Provide public education to address preparedness for climate hazards • Establish good plan to prevent fires from starting (e.g. fire management zones)
Change in Growing Season	• Food security as availability and costs may change	• Diversify food supply chain; ensure that multiple food source options exist, including local sources
	• Shift in the timing of outdoor allergens such as pollen	• Provide public announcements to alert the public
Shift in Energy Demand/Supply	• Brownouts could impact the availability of energy for critical health needs, such as air conditioning for sensitive populations during extreme heat events.	• Develop contingency plan at hospitals and for patients that receive care at home for situations with loss of power

Appendix B

Inventory and Forecast Details

Appendix B
Inventory and Forecast Details

Introduction

This appendix summarizes the data sources and general methods that were used to develop the community and municipal greenhouse gas (GHG) inventory and forecast updates for the unincorporated Marin County Climate Action Plan 2014 Update (CAP Update). This will be referred to as the "inventory" in this appendix.

This appendix describes the general methods for developing the community and municipal GHG emissions for each emissions sector. It also provides the approach used to develop the "business as usual" (BAU) forecast for 2020 for both community and municipal emissions.

GHG Inventory Structure and Definitions

Community Inventory. The Community Inventory includes GHG emissions associated with community activities occurring within the geographic or jurisdictional boundaries of the county and generally consist of sources of emissions that the County's community can influence or control. It is an activity-based inventory (as opposed to a consumption-based inventory). The boundaries of the community inventory are geographic; emissions included, or activities that result in emissions, must occur inside of the jurisdictional boundary of the county. Marin's cities/towns are separately responsible for calculating the emissions from their own jurisdictions.

Municipal Inventory. The Municipal Inventory includes GHG emissions associated with municipal activities and Marin County (County) government operations as it provides services to the public. It is an activity-based inventory (as opposed to a consumption-based inventory). This inventory includes emissions associated with municipal facilities and municipal activities. The boundaries of the municipal inventory are organizational; emissions included, or activities associated with emissions, must be under the control of the County.

Direct/Indirect Emissions. For direct emissions (such as natural gas combustion in buildings), if the County can have a substantial effect on those emissions by influencing energy use (such as through green building codes), then the direct emissions are included in the inventory. For indirect emissions (such as solid waste disposed outside of the county), if the County can have a substantial effect on those indirect emissions by influencing demand (such as waste minimization and diversion programs), then they are included in the inventory. By including emissions that are controlled by or subject to the influence of the County, the inventory can form the basis for local climate action planning.

GHG Emission Sectors. Community emissions are divided into the following ten sectors: building energy use, on-road transportation, off-road vehicles and equipment, water conveyance, wastewater generation, waste generation, stationary sources, agriculture, forestry, and carbon stock. Municipal emissions are divided into the following nine sectors: building energy use, vehicle fleet, employee commute, off-road vehicles and equipment, water conveyance, wastewater generation, solid waste generation, stationary sources, and refrigerants. The following table maps the community and municipal sectors:

Community Sector	Municipal Sector
Building Energy Use	Building Energy Use
	Streetlights and Traffic Signals
On-Road Transportation	Vehicle Fleet
	Employee Commute
Off-Road Vehicles and Equipment	Off-Road Vehicles and Equipment
Solid Waste Generation	Solid Waste Generation
Water Conveyance	Water Conveyance
Wastewater Generation	Wastewater Generation
Stationary Sources	Stationary Sources
Agriculture	N/A
Forestry	N/A
Rangeland Soil Carbon Stock	N/A
Aboveground Carbon Stock	N/A
N/A	Refrigerants

As noted above, the inventories are activity-based inventories, not consumption-based inventories. Consumption-based inventories include the global emissions associated with satisfying the purchase and use of products and services. These include fuels that are used in buildings and transportation as well as the production of food, other goods, and services. It is a lifecycle emissions approach that estimates total supply chain emissions. Typically, this method is applied at the household level, not at the community or municipal level. The ICLEI—Local Governments for Sustainability (ICLEI) *U.S. Community Protocol for Accounting and Reporting Greenhouse Gas Emissions* (2012) and the *Local Government Operations Protocol for the Quantification and Reporting of Greenhouse Gas Emissions Inventories* (LGOP) (2010) (used here) are both activity-based inventory protocols which do not require the preparation of lifecycle inventories for community or municipal inventories.[1] Consumption-based inventory protocols are currently under development. For these reasons, the community and municipal inventories for Marin County are activity-based inventories.

Municipal emissions are largely, but not exclusively, a subset of community emissions. For example, emissions related to natural gas and electricity consumption in municipal buildings are contained within the community building energy use sector, because this energy use was included in the utility data for the community. Because the municipal inventory uses an operational boundary as opposed to a geographic boundary, it may sometimes include emissions outside or not completely aligned with the community's boundary. For example, emissions from County vehicles (such as police cars or fire trucks) traveling outside of county boundaries (such as within an incorporated city) would be included in the municipal inventory. As another example, vehicle emissions from employees commuting from outside the county to work at a municipal office within the county would also be included in the municipal inventory. Caution should be taken when examining the two inventories as they are related but the municipal inventory is not always a complete subset, and should therefore never be added to or subtracted from community emissions.

[1] The ICLEI U.S. Community Protocol (2012) states the following: "Consumption - based accounting of greenhouse gas emissions at the community scale is a relatively young field. Methods are still being tested, evaluated and compared and "best practices" have not yet been identified. Additional new methods and variations on those methods may still be developed."

Previous Inventories

Marin County assessed community and municipal GHG emissions for a number of years as part of its 2006 GHG Reduction Plan. Emissions were estimated for the years 1990, 1995, 2000, and 2005. Community emissions included emissions for the entire county, including both the cities and the unincorporated areas. The municipal emissions included activities associated with local government operations. These inventories used slightly different methods and data sources from those used in the inventory for this CAP Update, as data sources have expanded and improved, and methods for calculating emissions have grown more robust.

The previous community inventories included emissions for building energy (residential, commercial, and industrial), transportation, waste, and agriculture. The previous municipal inventories included emissions for buildings, streetlights, vehicle fleet, employee commute, and waste. The new inventories contained in this CAP Update include additional emissions sectors to encompass more sources of emissions and provide a more comprehensive picture of emissions associated with the county.

Inventory Update Year – 2012

The inventory update year for the GHG inventory is 2012. The year 2012 was chosen because complete or nearly complete activity data was available for the year 2012 for all sectors to support inventory preparation. Socioeconomic data for 2012 (including population, employment, and housing) was derived from a combination of data from the Association of Bay Area Governments (ABAG) and the U.S. Census. For sectors where 2012 data is not available, appropriate scaling methodologies were developed to project activity data to the year 2012. Any measures or programs (such as those designed to reduce emissions) implemented prior to the base year (2012) are accounted for in the inventory.

2020 Business as Usual Forecast

The inventory also supports development of the 2020 BAU Community Forecast, which is a prediction of how community emissions may change in the future, in absence of State and local actions to reduce GHG emissions. A BAU projection is an estimate of future emissions; it does not include the effects of *any* new federal, State, or local measures. The CAP Update 2020 BAU Community Forecast is similar to a BAU projection but differs slightly because 1) the data used to forecast 2020 emissions include General Plan socioeconomic assumptions and 2) the transportation emissions forecast accounts for future planned highway and transit network improvements (including the launch of SMART). Local actions and all other State regulations (e.g., AB 32) are not included in the forecast.

The BAU forecasts for 2020 used socioeconomic metrics, which scaled the base-year data. A unified set of socioeconomic data (population, jobs, and households) was developed through coordination with ABAG and the Metropolitan Transportation Commission (MTC).

Additional methods of forecasting 2012 activity and emissions data to 2020 were used depending on the sector and availability of data. For example, some water consumption projections were already available in Urban Water Management Plans (UWMPs) for the County's water suppliers.

Updated Community GHG Emissions for 1990

To facilitate comparison to 2012 and 2020 emissions, and to provide a more accurate GHG reduction target for community emissions, a revised GHG emissions inventory for the year 1990 was conducted for the community (1990 municipal emissions were not updated as part of this effort). The data sources used for 1990 are consistent with the data sources used for 2012. The revised 1990 community emissions inventory is consistent with the latest GHG protocols and the 2012 Community GHG inventory and 2020 Community BAU forecast. This is important because the 2020 GHG reduction target is based on 1990 emissions, so consistent GHG accounting across all years of analysis is necessary.

The 1990 municipal emissions are not completely consistent with the 2012 emissions in terms of sectors, data, and methods. There were some significant data gaps in the 1990 Municipal Inventory, which makes comparisons between years difficult. These data gaps include missing utility data for certain buildings (including some fire stations and the fairgrounds), missing electricity consumption data for some streetlights and traffic signals, over-reported solid waste diversion, fuel sold to other agencies not controlled by the County in the vehicle fleet sector, and a lack of data for water use, wastewater treatment, stationary sources, and refrigerants. Because of these data gaps, comparing municipal emissions in 1990 with emissions in 2012 (or 2020) should be done with care.

Inventory Protocol

The ICLEI - Local Governments for Sustainability (ICLEI) *U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions* (October 2012) was used to quantify community emissions for 2012 wherever applicable and appropriate. For some sectors, like land use sequestration, the ICLEI 2012 Community Protocol provides no guidance and alternative protocols were consulted including the Association of Environmental Professionals white paper on baseline community inventories and IPCC methodologies. The California Air Resources Board's *Local Governments Operations Protocol* (LGOP) was used to develop the municipal inventory for 2012 (California Air Resources Board et. al. 2010).

Emission Sectors

The following section includes detailed methods and supporting information for the inventory. This section is organized by sector. For each sector, the following information is provided:

- <u>Overview</u>: a brief description of the emission calculation(s).
- <u>Methods Used in Previous Inventory</u>: a brief description of the methods used in the County's 2005 GHG inventory (Marin County Community Development Agency 2007).
- <u>Data and Models</u>: a list of data and models that were used to calculate emissions.

- Inventory Methods: the detailed methodology for calculating emissions for both the community and municipal inventories for 2012.
- Forecast Methods: the detailed methodology for forecasting emissions for the community and municipal inventories to 2020.

Building Energy (Community and Municipal) and Streetlights and Traffic Signals (Municipal)

Overview

This sector includes GHG emissions from electricity and natural gas consumption for residential, commercial, industrial, institutional, and municipal buildings in the county.

Methods Used in Previous Inventory

The County's previous inventory for 2005 included four building energy sectors: two community sectors (Residential and Commercial/Industrial) and two municipal sectors (Street lighting/traffic signals and buildings). Residential, commercial, and industrial building energy emissions were determined using ICLEI's Cities for Climate Protection (CCP) software, which incorporates energy consumption data (electricity and natural gas) from Pacific Gas and Electric (PG&E) and electricity GHG emission factors based on California's fuel mix. Similarly, municipal building energy emissions from 20 County-owned buildings were determined using PG&E data and the California energy generation emission factors. Emissions from municipal street lighting and traffic signals were determined using the same methods as described above. 1990 emissions only included traffic signals and not streetlights.

Data and Models

- Electricity consumption (kWh) provided by PG&E for residential, commercial, industrial, institutional, and municipal buildings and by Marin Clean Energy (MCE) for customers they serve (Armanino pers. comm.; Kudo pers. comm.).
- Natural Gas consumption (therms) provided by PG&E for residential, commercial, industrial, institutional, and municipal buildings (Armanino pers. comm.).
- Utility specific electricity GHG emission factors for PG&E (year 2012 data) and regional average emission factors from the U.S. Environmental Protection Agency (USEPA) for methane (CH_4) and nitrous oxide (N_2O) (year 2010 data) (Pacific Gas and Electric 2014; USEPA 2014). Marin Clean Energy emission factor for 2012 (Kudo pers. comm.).
- GHG emission factors for natural gas for 2012 (Pacific Gas and Electric 2013).
- Socioeconomic data for 2012 and 2020, including population, square footage of commercial and industrial establishments, employment by sector, and number of households (Wong pers. comm.).
- Municipal building construction information.
- Municipal employment data and projections for 2012 and 2020.

Inventory Methods

Community and Municipal: The County estimated CO_2 emissions from electricity provided by PG&E by multiplying electricity use by the utility-specific CO_2 emission factor for PG&E-delivered electricity for 2012. The 2012 emission factor (445 pounds of carbon dioxide equivalent per megawatt hour) represents all emissions related to electricity deliveries in 2012, including owned and purchased power. Methane (CH_4) and nitrous oxide (N_2O) emissions for both utilities were calculated using USEPA eGRID year 2010 emission factors for the CAMX/WECC region (this region represents electricity primarily generated in California; 2010 is the latest year available). Similarly, emissions associated with power provided by MCE were estimated using emissions factors. The inventory update includes community emissions for residential, commercial, and industrial buildings and municipal emissions for municipal buildings and street lighting/traffic signals. Water-related energy use was subtracted from the building energy sector to avoid double counting.

Transmission and distribution (T&D) electricity losses, which occur between the points of generation and the points of consumption, were also included in the building energy sector. The T&D loss value used in the inventory was 6.84% (USEPA 2014). The CAMX/WECC emission factors cited above were used to estimate GHG emissions for this electricity.

GHG emissions from natural gas consumption were calculated by multiplying the natural gas consumption statistics by emission factors from PG&E and ICLEI (Armanino pers. comm.; ICLEI – Local Governments for Sustainability USA 2012).

Forecast Method

Community: 2020 BAU building energy consumption was estimated by projecting 2012 data using the socioeconomic forecasts. Residential energy use was forecasted using the projected number of single-family and multi-family homes in 2020 and commercial and industrial energy use was forecasted using employment projections. The State's renewable portfolio standard will impact electricity emissions in future years, however, the impact of the State's goals is quantified under the reduction measures and is not counted toward BAU estimates.

A future PG&E emission factor was calculated by taking a running average of emission factors for the past five years (2008–2012) to partially neutralize the large annual variability in utility emission factors. PG&E has published future emissions factors out to 2020 but those take into account Renewable Portfolio Standard (RPS) advancement, whereas the BAU forecast will not take into account future activities. For MCE power, usage was held constant; increases in MCE participation is part of the CAP strategies to reduce GHG emissions.

Municipal – Building energy emissions resulting from energy consumption in County-owned facilities and equipment in 2020 was estimated by projecting the 2012 municipal building energy emissions using building expansion/construction projections provided by the County.

On-Road Transportation (Community); Vehicle Fleet and Employee Commute (Municipal)

Overview

This sector includes GHG emissions from fuel combusted by on-road vehicles. For the municipal inventory, this includes County vehicle fleet emissions and employee commutes.

Methods Used in Previous Inventory

Community: The County's previous GHG inventory estimated transportation emissions by using county vehicle miles traveled (VMT) data from the Caltrans Highway Inventory and Performance Branch database (HPMS Database), the Caltrans Motor Vehicle Stock, Travel, and Fuel Forecast (MVSTAFF) reports for 2005, and transportation GHG- emission factors embedded in the ICLEI Cities for Climate Protection (CCP) software.

Municipal: The County's municipal on-road transportation emissions, which includes employee commute and vehicle fleet emissions, were determined using employee commute survey data from the Employee Transportation Survey and vehicle fleet fuel consumption data from the Department of Public Works' fleet accounting software. Emissions were likely estimated using the ICLEI CCP software, but the County's Inventory Report does not specify.

Data and Models

- Traffic model results provided by MTC for 2012 and 2020. The MTC model was run for the years 2010 and 2020. 2012 VMT values were interpolated using methods from MTC. The MTC outputs will include VMT for the county aggregated by origin/destination (inbound, outbound, or intra-city) and speed increments ("speed bins") of 5 miles per hour from 0 to 65 mph) (Brazil pers. comm.).
- EMFAC2011 model emission factors.
- Employee commute survey data for 2012.
- Fuel consumption for County-owned vehicles for 2012.
- Municipal employment data and projections for 2012 and 2020.

Inventory Methods

Community: Quantification of on-road transportation emissions followed the 2012 ICLEI Community Protocol. Community VMT data was provided by MTC for 2012 (interpolated using an MTC-derived interpolation factor). The MTC model uses the latest Association of Bay Area Governments (ABAG) (Plan Bay Area) forecasts.

To determine passenger VMT for the county, MTC apportioned one-half of the trip distance for any trip with an origin or destination within the county. This eliminates apportioning through-trips on freeways or major arterials to the county, while adding regional traffic burden to land uses generating trips on a 50/50 split. This is the current recommended approach of the State's Regional Targets Advisory Committee (RTAC) and provides a better accounting of VMT associated with land use jurisdiction than approaches that apportion VMT on a pro-rata share or on the basis of VMT that occurs within the boundaries of a jurisdiction. This approach can also help to reveal potential differences in VMT generation that can be useful during future land use and GHG reduction planning. VMT by speed bin and the corresponding speeds were used as inputs into the EMFAC2011[2] model to determine emission factors that were used to quantify the GHG emissions for passenger vehicles.

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[2] The Emissions Factor (EMFAC) model is a transportation model issued by the California Air Resources Board. It includes a set of emission factors that represent the local vehicle fleet, speeds, and environmental conditions that can be useful in performing project-level air quality modeling.

VMT and GHG emissions for commercial and other vehicles was supplied at the countywide level and apportioned to the unincorporated county using apportionment factors developed by MTC.

Municipal: Municipal GHG emissions include employee commute and vehicle fleet emissions. Employee commute emissions were estimated using the most recent employee commute survey data from the County. Employee commute VMT were then multiplied by the appropriate emission factors from the EMFAC model.

Vehicle fleet emissions were estimated using the County's most recent fuel consumption data, mileage data, and other vehicle fleet data, provided by the County. Fuel consumption data was multiplied by the appropriate emission factors from the Climate Registry (Climate Registry 2014).

Forecast Methods

Community: VMT data was provided by MTC for 2020. Similar to the inventory methods, the forecast methods used the 2020 VMT data and corresponding emission factors from the EMFAC model to determine community on-road GHG emissions in 2020.

Municipal: The County's 2020 employee commute emissions were projected using the 2012 employee commute emissions and municipal employment projections provided by the County. Municipal vehicle fleet emissions were projected using municipal employment projections provided by the County.

Off-Road Vehicles and Equipment (Community and Municipal)

Overview

This sector includes GHG emissions from small off-road equipment (e.g., recreational, harbor craft, rail yard, private airport, lawn and garden, agricultural, commercial, and industrial equipment), and County-owned off-road equipment.

Methods Used in Previous Inventory

Off-road vehicles and equipment emissions were not included in the County's previous GHG inventory.

Data and Models

- The California Air Resources Board (CARB) OFFROAD model.
- CARB's Diesel Off-road On-line Reporting System.
- Socioeconomic data for 2012 and 2020, including population, employment by sector, and number of households (Wong pers. comm.).
- Municipal employment data and projections for 2012 and 2020.

Inventory Methods

Community: For quantification of off-road emissions, The County used the 2012 ICLEI Community Protocol as a guide. The 2012 ICLEI Community Protocol recommends using the USEPA's NONROAD model, but this analysis will use CARB's OFFROAD model because it is more specific to California communities than the NONROAD model.

CARB's OFFROAD model provides estimates for emissions at the county level for a variety of off-road equipment types, including construction equipment, lawn and garden equipment, airport ground support equipment, and recreational equipment. The County obtained county-level data from the OFFROAD model or CARB's Diesel Off-road On-line Reporting System (DOORS). This analysis was based on the model's default assumption of annual hours of operation for all equipment in the county.

Emissions resulting from the use of agricultural equipment were included under this sector.

Municipal: A list of County-owned off-road equipment and fuel consumption data for 2012 was used. The fuel consumption data and fuel-GHG emissions factors from the Climate Registry were used to estimate emissions from the County-owned equipment (Climate Registry 2014).

Forecast Methods

Community - 2020 BAU off-road emissions were estimated using 2012 off-road emissions and socioeconomic forecast data (population, housing and jobs). The type of socioeconomic data that was used depends on the off-road equipment type (e.g. landscaping equipment was projected using housing forecast projections for 2020; industrial equipment was projected using employment projections for 2020).

Municipal – Off-road emissions resulting from County-owned equipment in 2020 were estimated by projecting the 2012 municipal off-road emissions using municipal employment projections provided by the County.

Solid Waste Generation (Community and Municipal)

Overview

This sector includes GHG emissions associated with the decomposition of waste generated by the County.

Methods Used in Previous Inventory

Community: The County's previous community GHG inventory used waste disposal data from the California Integrated Waste Management Board (CalRecycle) and ICLEI's Cities for Climate Protection software.

Municipal: The County's previous municipal GHG inventory used data provided by the Department of Public Works and the ICLEI software.

Data and Models

- Tons of waste sent to landfills in 2012 from the California Department of Resources Recycling and Recovery (CalRecycle) (CalRecycle 2013).
- Landfill characteristics for the Redwood Landfill (Waste Management 2014).
- Waste emission factors from the 2012 ICLEI Community Protocol (ICLEI – Local Governments for Sustainability USA 2012).
- Municipal employment data and projections for 2012 and 2020.

- Socioeconomic data for 2012 and 2020, including population, and employment by sector (Wong pers. comm.).
- Municipal waste generation from the County's Department of Public Works.

Inventory Methods

Community: Consistent with the 2012 ICLEI Community Protocol solid waste emissions calculation methods, the County evaluated emissions from solid waste management by considering future indirect emissions resulting from solid waste deposited in the inventory year, as reported by CalRecycle,[3] regardless of where that waste is disposed.

Per the 2012 ICLEI Community Protocol for indirect future emissions from community-generated waste during the inventory year, total tons of waste (residential and commercial) sent to landfills in 2012 and waste profile data was combined with equations from ICLEI. Redwood Landfill accepts county waste and has a 90% methane collection rate, which is higher than the industry standard 75% rate (Waste Management 2014). This capture rate was used in place of the default ICLEI capture value to calculate emissions for the county. The ICLEI emission factors for waste cover a variety of waste types (glass, plastic, wood, etc.). These emission factors were multiplied by the corresponding waste amounts (by waste type) generated in the county in 2012 to calculate future indirect emissions. The generation-based estimates can help identify opportunities for waste reduction measures through source reduction, recycling, or composting. As such, the generation-based emissions method was used in the inventory.

Total site-based emissions from the Redwood Landfill (which are associated with *all* waste deposited in the landfill, not just the waste deposited by unincorporated Marin County) were not included because these emissions would be double-counted with the generation-based emissions that were included. Emissions from composting and combustion of solid waste were not included in the inventory due to data availability issues, as CalRecycle does not provide this data. These sources are likely minor emissions sources. Emissions from waste hauling (trucks) are not included in this sector. These emissions are included in the On-Road Transportation sector for trucks (waste trucks are part of the aggregate countywide VMT data provided by MTC).

Municipal: The County's municipal waste emissions were estimated using waste generation data from County facilities provided by the Department of Public Works and the ICLEI equations described above for the Community inventory (Marin County Civil Grand Jury 2014). The County does not own and operate any landfills, so direct site-based landfill emissions were not included.

Forecast Methods

Community: 2020 community solid waste emissions were estimated by projecting 2012 waste generation using population and employment forecast data for residential and commercial waste, respectively.

Municipal: Solid waste emissions resulting from municipal operations in 2020 were estimated by projecting 2012 municipal waste generation using municipal employment projections provided by the County.

[3] CalRecycle is California's leading authority on recycling, waste reduction, and product reuse. Officially known as the Department of Resources Recycling and Recovery, CalRecycle plays an important role in the stewardship of California's vast resources and promotes innovation in technology to encourage economic and environmental sustainability.

Water Conveyance (Community and Municipal)

Water consumption-related emissions originate from energy used to transport, treat, and pump water to the county, including water consumed at County-owned facilities. Emissions from water conveyance were estimated for the following sources: 1) the energy associated with water usage *inside* the county (such as local pumps distributing water within the county) and 2) energy associated with water transport from *outside* the county (such as regional pumps delivering water from the Russian River in Sonoma County to the county's borders). Electricity used to treat and distribute water locally is captured within the building energy sector; all attempts were made to avoid any double counting of this energy use and resulting emissions.

Overview

This sector includes GHG emissions associated with water consumption in the county.

Methods Used in Previous Inventory

Water consumption emissions were not included in the County's previous GHG inventory.

Data and Models

- Water consumption (gallons) in (2012) provided by MMWD, NMWD and Stinson Beach County Water District (Armanino pers. comm.).
- Electricity and natural gas use for water treatment and pumping in 2012 provided by MMWD, NMWD and Stinson Beach County Water District (Armanino pers. comm.).
- Water consumption at County-owned facilities in 2012 provided by MMWD and NMWD (Armanino pers. comm.).
- Water supply sources for the county.
- Utility specific electricity GHG emission factors for PG&E (year 2012 data) and regional average emission factors from the U.S. EPA for methane (CH_4) and nitrous oxide (N_2O) (year 2010 data) (USEPA 2014). Marin Clean Energy emission factor for 2012 (Kudo pers. comm.).
- GHG emission factors for natural gas for 2012 (Pacific Gas and Electric 2013).
- Socioeconomic data for 2012 and 2020, including population and jobs (Wong pers. comm.).
- Municipal employment data and projections for 2012 and 2020.

Inventory Methods

Community: Water is provided to the county by the Marin Municipal Water District (MMWD), the North Marin Water District (NMWD), and the Stinson Beach County Water District (SBWD). Actual electricity and natural gas use for water treatment and pumping in the county (provided by MMWD, NMWD, and SBWD) was used to develop emissions. Countywide energy use was apportioned to the unincorporated county using service population figures. Water-related energy use was subtracted from the building energy sector to avoid double counting. T&D losses associated with water-related electricity were also included in this sector (details provided in the building energy sector section). Emissions calculations were based on electricity emission factors as described in the building energy sector.

Municipal: Municipal water consumption was provided by the water districts. Total gallons of water were multiplied by energy intensity factors derived from the community-level data provided by the water districts, as listed above (on a per gallon basis). T&D losses associated with water-related electricity were also included in this sector (details provided in the building energy sector section). Emissions calculations were based on electricity emission factors as described in the building energy sector.

Forecast Methods

Community: 2020 BAU water consumption estimates were developed using population growth.

Municipal: 2020 BAU municipal water consumption emissions were projected from 2012 municipal water consumption emissions using municipal employment projections provided by the County.

Wastewater Treatment (Community and Municipal)

Overview

This sector includes GHG emissions from the treatment of industrial, residential, commercial, and municipal wastewater produced within the county.

Methods Used in Previous Inventory

Wastewater treatment emissions were not included in the County's previous GHG inventory.

Data and Models

- 2012 ICLEI Community Protocol equations for emissions calculations (ICLEI – Local Governments for Sustainability USA 2012).
- Wastewater treatment data from the sanitation districts who operate wastewater treatment plants (WWTPs) in the county (Armanino pers. comm.).
- Wastewater flow projections for 2020 from the sanitation districts (Armanino pers. comm.).
- Urban Water Management Plans for the county (MMWD 2010; NMWD 2010).
- Socioeconomic data for 2012 and 2020, including population and jobs (Wong pers. comm.).
- Municipal employment data and projections for 2012 and 2020.

Inventory Methods

Community: The county is served by the following wastewater treatment plants:

- Bolinas Community Public Utility District
- Central Marin Sanitary Agency
- Las Gallinas Valley Sanitary District
- North Marin Water District (provides treatment services to Dillon Beach area)
- Novato Sanitary District
- Sausalito-Marin City Sanitary District

- Sewerage Agency of Southern Marin
- Tomales Village Community Services District

The energy consumed to operate any WWTP that is located within the county's borders was included in the building energy sector. GHG emissions from electricity and natural gas consumption at wastewater treatment plants were calculated according to the 2012 ICLEI Community Protocol, as described above in the building energy sector.

Fugitive emissions from wastewater treatment were calculated following the 2012 ICLEI Community Protocol based on actual WWTP characteristics, provided by the wastewater treatment agencies. This information includes population served, cubic feet of digester gas produced and combusted per day, fraction of methane in digester gas, BOD5 load,[4] the fraction of BOD5 removed during treatment, gallons of wastewater treated per day, and information regarding any existing methane capture, combustion, or energy conversion programs. GHG emissions from septic systems were estimated and based on the County's inventory of septic tanks and general septic tank characteristics.

Municipal: To estimate wastewater emissions resulting from municipal operations, the 2012 ICLEI Community Protocol as described above was used to calculate emissions from wastewater generated by municipal facilities. This sector only includes emissions resulting from municipal wastewater generation.

Forecast Methods

Community: The 2020 BAU wastewater emissions were estimated by collecting wastewater projection estimates (including projected wastewater flows) from the WWTPs serving the county, where available. Where these data were not available, 2012 data were projected using population forecasts.

Municipal: The 2020 BAU municipal wastewater emissions were projected from 2012 municipal wastewater emissions using municipal employment projections provided by the County.

Stationary Sources (Community and Municipal)

Industrial/Commercial/Municipal

Overview

This sector includes GHG emissions from nonresidential stationary (typically industrial) combustion of fossil fuels of any type *except* natural gas (accounted for in the building energy use sector) and fugitive emissions from industrial processes in the county.

Methods Used in Previous Inventory

Stationary Sources emissions were not included in the County's previous GHG inventory.

[4] Biochemical oxygen demand of wastewater during decomposition occurring over a 5-day period

Data and Models

- GHG emissions for fuel consumption from the Bay Area Air Quality Management District (BAAQMD) by facility.
- GHG emissions data from USEPA MRR database and CARB's online GHG Emissions Reporting Tool.
- Emission factors from the CalEEMod model (South Coast Air Quality Management District 2013).
- Emission factors from the USEPA, CARB, the 2012 ICLEI Community Protocol, and Climate Registry protocols.
- Fuel consumption in 2012 for all County-owned stationary sources from the County Department of Public Works (e.g. emergency generators) (Armanino pers. comm.).
- Socioeconomic data for 2012 and 2020, including square footage of commercial and industrial establishments, and employment by sector (Wong pers. comm.).
- Municipal employment data and projections for 2012 and 2020.

Inventory Methods

Community: The methods used to quantify GHG emission from stationary sources were consistent with the 2012 ICLEI Community Protocol. GHG emissions data for all facilities in Marin County under BAAQMD's jurisdiction was provided by the BAAQMD. This data was supplemented by emissions data from the USEPA MRR database and from CARB's online GHG Emissions Reporting Tool for large facilities, as necessary.

Municipal: Characteristics for all stationary sources owned by the County (such as Emergency Stand-By Generator, and diesel pumps), including horsepower, engine type, fuel type, and hours of operation were used to develop emissions. Emission factors from the CalEEMod model for the appropriate equipment type were used to calculate GHG emissions from municipal stationary source equipment (South Coast Air Quality Management District 2013).

Forecast Methods

Community: 2020 BAU stationary source emissions were estimated by projecting 2012 year data using total employment estimated in 2020.

Municipal: 2020 BAU municipal stationary source emissions were projected from 2012 municipal stationary source emissions using municipal employment projections provided by the County.

Residential (Community)

Overview

Calculation of GHG emissions from residential combustion of fossil fuels of any type *except* natural gas (accounted for in the building energy use sector). This includes fuel oil, propane, kerosene, and wood.

Data and Models

- U.S. Census data from the American Community Survey (ACS) (U.S. Census. 2012).
- Energy Information Administration's (EIA) Residential Energy Consumption Survey dataset (Energy Information Administration 2013a).
- EIA State Energy Data System (SEDS) (Energy Information Administration 2013b).
- Emission factors from the USEPA, CARB, the 2012 ICLEI Community Protocol, and Climate Registry protocols.
- Socioeconomic data for 2012 and 2020, including population, employment by sector, and number of households (Wong pers. comm.).

Inventory Methods

The County used quantification methods consistent with the 2012 ICLEI Community Protocol to quantify GHG emissions from residential fuel combustion. The number of households in the county that use each type of fuel was determined using information from the EIA and the ACS. Fuel consumption for each fuel type was calculated using state-level fuel use from the EIA SEDS. This fuel use was multiplied by emission factors from the USEPA, CARB, the 2012 ICLEI Community Protocol, and Climate Registry protocols (as appropriate) to determine emissions.

Forecast Methods

The 2020 BAU residential fuel use emissions were estimated by projecting 2012 data using housing forecasts.

Refrigerants (Municipal)

Overview

This sector includes GHG emissions from the leakage of refrigerants that contain or consist of HFC compounds that contribute to global warming. These chemicals are used in refrigeration, fire suppression equipment, air conditioners, and chillers. Through the installation, use, and disposal of these systems and products, leaks are likely to occur. Although the leaks are generally small, emissions may be significant because these chemicals typically have high GWPs.

Methods Used in Previous Inventory

Refrigerant emissions were not included in the County's previous GHG inventory.

Data and Models

- Refrigerant purchases and usage.
- GPWs from the LGOP and the IPCC (California Air Resources Board et. al. 2010; Intergovernmental Panel on Climate Change 2013).
- Municipal building construction information.

Inventory Methods

The 2012 ICLEI Community Protocol and the LGOP were used to quantify emissions from refrigerant use. Total refrigerant purchases by refrigerant type and by weight from 2011–2013 were used to estimate refrigerant emissions. Refrigerant replacement and leakage values were not available, so it was assumed that the purchases roughly equal the amount of refrigerant leakage. Three years of refrigerant purchase data was used to calculate an average annual refrigerant usage rate, which was assumed to be equal to the refrigerant leakage rate.

The County uses the following refrigerants: R-22, R-410A (GWP = 1,725), R-407C (GWP = 1,526), R-134a (GWP = 1,300), and R-404 (GWP = 3,620). R-22 is currently being phased out under the Montreal Protocol and is not classified as GHG under the Kyoto Protocol; as such, the LGOP recommends that R-22 should not be included in any emissions inventory and R-22 was therefore not included in the inventory for the county.

Total annual purchases of each refrigerant were multiplied by the corresponding GWPs to estimate emissions from refrigerants.

Forecast Methods

2020 BAU refrigerant emissions were projected using the growth in municipal building energy use (see building energy sector above). Building energy use represents a reasonable proxy for the amount of refrigerants used in buildings.

Agriculture (Community Only)

Overview

This sector includes GHG emissions from manure management (fugitive emissions of methane and nitrous oxide), enteric fermentation (fugitive emissions of methane and nitrous oxide), and fertilizer use (fugitive emissions of nitrous oxide). Other emission sources from agriculture were excluded because they are not covered in the ICLEI U.S. Community Protocol.

Data and Models

- Marin County Crop Report for 2012 (Marin County Department of Agriculture 2013)
- U.S. Department of Agriculture (USDA) Census of Agriculture (U.S. Department of Agriculture n.d.).
- Standard emissions factors from USEPA, CARB, and ICLEI (USEPA 2014; CARB 2011; ICLEI – Local Governments for Sustainability USA 2012).
- *A Low-Cost, High-Benefit Approach to Climate Change Mitigation* (Silver and Ryals 2009)
- CropScape GIS database from the National Agricultural Statistics Service (NASS) (U.S. Department of Agriculture 2013).

Methods Used in Previous Inventory

The County's previous inventory calculated livestock-related agricultural emissions using livestock population data from the U.S. Department of Agriculture's National Agriculture Statistics Service. Methane and N_2O emissions from livestock were calculated using the EPA's 1999 Emission Inventory Improvement Program handbook. Only livestock-related emissions were estimated for this sector.

Inventory Methods

Emissions from agricultural vehicles were based on countywide activity levels of these vehicles, based on the OFFROAD model outputs (these emissions were included in the Off-Road Transportation and Equipment sector). It should be noted that the 2012 ICLEI Community Protocol does not include agricultural vehicle-related emissions with other agricultural emissions.

Manure management emissions were calculated using livestock population numbers from the Agriculture Commissioner and the United States Department of Agriculture (USDA) agriculture census. Standard emissions factors from USEPA and CARB, and 2012 ICLEI Community Protocol equations specific to manure management were used. Similarly, emissions resulting from enteric fermentation were calculated using livestock population numbers from the Agriculture Commissioner or USDA's agriculture census, standard emissions factors from CARB and USEPA, and 2012 ICLEI Community Protocol equations specific to enteric fermentation.

Emissions resulting from fertilizer use were calculated using the number of acres treated with fertilizers from the USDA's agriculture census for the years 2000 through 2010 (U.S. Department of Agriculture n.d.). The following standard fertilizer use emission factors from CARB were used in estimating fertilizer emissions.

Crop Type	Fertilizer Application (lbs/acre)
Grapes (wine)	44
Miscellaneous Fruits and Nuts	94.68
Miscellaneous Veggies	191.76
Hay, Oat	64
Silage, Corn	78
Pasture, Irrigated	5
Rangeland	0

Forecast Methods

Manure management and enteric fermentation emissions were not forecast due to uncertainty regarding future change in land cover types and livestock numbers in the county.

Fertilizer emissions were forecast using an estimate of acres by crop type in 2020 by using historical trends from 2008 to 2012. Fertilizer rates from the 2009 USDA survey data were applied to the 2020 forecasted crop acreages.

Community Emissions Sectors for Informational Purposes Only

The following sectors are presented as informational items but were not added to the emissions total for the community inventory or forecast.

Forestry Carbon Sequestration

Overview

Calculation of annual carbon sequestration from outside the agricultural sector in forest, timberland, and urban forests.

Data and Models

- CropScape GIS database from NASS (U.S. Department of Agriculture 2013)
- Carbon sequestration rates from the California Energy Commission (CEC) (Brown et. al. 2004)

Methods Used in Previous Inventory

Forestry emissions were not included in the County's previous GHG inventory.

Inventory Methods

Urban forests and rural non-agricultural land covers (such as forests) can be long-term emissions sinks, depending on management since these natural areas actively sequester atmospheric carbon dioxide during their growth cycle. Rural lands that are not developed or used for agriculture can include conservation areas, state and national forests, private forests and timberland,[5] scrubland, grassland, wetlands, and other covers. "Urban forests" refers to trees planted within developed areas, including residential trees, urban city parks, median trees, etc.

Calculating sequestration from rural forest covers and urban forestry can be challenging due to lack of data and the inherent uncertainties associated with vegetation-based carbon accounting.

This inventory only quantified annual carbon sequestration from forest cover. Annual sequestration rates from the CEC for deciduous forest, mixed forest, and evergreen forest were used to calculate emission sinks (Brown et. al. 2004). Annual sequestration for other non-agricultural land covers (such as scrubland, grassland, wetlands, etc.) was not estimated due to data limitations.

Acreage data by land cover type for the unincorporated county was obtained from the National Agricultural Statistics Service (NASS), which has broad land cover data based on aerial photography for 2012; see Table B-1, below. Acres for each land type were multiplied by the sequestration values to determine GHG emission sinks in the forestry sector.

Table B-1. Acres by Land Type for Unincorporated Marin County for 2012

Land Type	2012 Acres
Deciduous Forest	3,617
Mixed Forest	23,081
Evergreen Forest	67,792
Total	*94,489*

[5] Timberland may or may not be a long-term sink, at least in terms of woody biomass. Depending on the harvesting schedule, timberland can be a source of net emissions (if there is a declining amount of biomass) or a net sink of emissions (if there is an increasing amount of biomass).

Forecast Methods

A forecast of forestry sequestration was not conducted due to uncertainty regarding future change in land cover types in the county.

Rangeland Soil Carbon Stock

Overview

Carbon storage in rangeland soils represents total storage and not sequestration or GHG flux. Units presented in the inventory and forecast are in metric tons of carbon, not carbon dioxide equivalent (note: carbon storage in non-rangeland soils was not included due to lack of data).

Data and Models

- *A Low-Cost, High-Benefit Approach to Climate Change Mitigation* (Silver and Ryals 2009)
- Acreage values from the Marin County 2012 Crop Report (Marin County Department of Agriculture 2013).

Methods Used in Previous Inventory

Rangeland soil carbon was not included in the County's previous GHG inventory.

Inventory Methods

Rangeland acreage for 2012 as defined in the Marin County Crop Report for 2012 was multiplied by Marin/Sonoma soil carbon values to determine the amount of carbon stored in county rangelands. The soil carbon value of 180 megagrams of carbon per hectare for a depth of 1 meter was obtained from the report *Soil Carbon Sequestration: A Low-Cost, High-Benefit Approach to Climate Change Mitigation* (Silver and Ryals 2009).

Forecast Methods

A forecast of soil carbon stock was not conducted due to uncertainty regarding future change in land cover types in the county.

Aboveground Carbon Stock

Overview

This sector represents carbon stock in aboveground biomass in the county. This is not a source or sink of GHG emissions; it represents the total amount of carbon storage in biomass in 2012. Units presented are in metric tons of carbon, not carbon dioxide equivalent.

Data and Models

- CropScape GIS database from NASS (U.S. Department of Agriculture 2013)
- Carbon stock values from the USEPA and the CEC (USEPA 2010; Brown et. al. 2004)

Methods Used in Previous Inventory

Aboveground carbon stock was not included in the County's previous GHG inventory.

Inventory Methods

Acreage data by land cover type for the unincorporated county in 2012 was obtained from NASS. Land cover types used in this analysis include coniferous forest, croplands (not vineyards or rangeland/pastureland), rangeland/pasture, oak woodlands/riparian woodlands, shrublands, and vineyards. Acres for each land type were multiplied by carbon stock factors from the USEPA and the CEC to determine total aboveground carbon stock (USEPA 2010; Brown et. al. 2004).

Forecast Methods

A forecast of aboveground carbon stock was not conducted due to uncertainty regarding future change in land cover types in the county.

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Appendix C

Reduction Strategy Details and Analysis Methods

Reduction Strategy Details and Analysis Methods

Introduction

This appendix summarizes the calculations and assumptions used to quantify greenhouse gas (GHG) reductions and monetary costs and savings for the local and state strategies included in the Unincorporated Marin County (County) Climate Action Plan 2014 Update (CAP Update). Both community and municipal reduction measures are detailed in this appendix. The primary objective for each strategy is also provided. The appendix begins with a general overview of the GHG and economic analysis, followed by specific details regarding each of the local and state emissions reduction strategies.

Overview of Analysis Methods

Emissions reductions achieved by local and state strategies were quantified using guidance provided by the California Air Resources Board (ARB), California Air Pollution Control Officers Association (CAPCOA), California Energy Commission (CEC), and professional experience obtained from preparing CAPs for other jurisdictions in California. The majority of calculations were performed using standard factors and references, rather than through a specific analysis of individual technologies. GHG savings attributed to the individual strategies exclude emissions reductions achieved by other overlapping actions. This avoids double counting emissions benefits and enables a cumulative assessment of emissions reductions achieved by the CAP. All reductions were quantified in terms of metric tons of carbon dioxide equivalent ($MTCO_2e$) and represent the annual emissions saving in 2020.

Monetary costs and savings were estimated using information specific to the county, when available, or for similar cities in the region, California, or United States, prioritized in that order. The majority of data was from public sources, including the California Public Utilities Commission (CPUC), Pacific Gas & Electric (PG&E), United States Department of Energy (DOE), CEC, and EPA. Some cost data were also based on price quotes provided from suppliers serving the northern California region. Costs estimated include initial capital cost and programmatic costs, whereas savings include reduced costs associated with electricity, natural gas, fuel usage, and required maintenance. Ranges were provided for most strategies due to the uncertainties and variability associated with estimating project costs. In general, ranges reflect differences in price estimates for technologies, based on the use of multiple data sources.

Summary of Community GHG Reductions and Costs

Table C-1 summarizes community GHG reductions, costs, and savings, as available. Estimated costs and savings would be incurred by the private sector (e.g., county residents and businesses). County costs associated with CAP implementation are not included in the analysis, but are discussed qualitatively in Chapter 6, *Greenhouse Gas Reduction Measure Implementation Program*.

Table C-1. Summary of GHG Reductions, Costs, Savings, and Benefits Associated with Local Community Emissions Reduction Strategies

Strategy Area	Local Strategy	2020 GHG Reduction	Saving (cost) per MT Reduced	Net Present Value (cost)[a]	Payback (years)
ENERGY EFFICIENCY & RENEWABLE ENERGY	Energy-1. Community Choice Aggregation	2,744	Not estimated	Not estimated	Not estimated
	Energy-2. Energy Efficiency				
	Energy-2.1. Community Energy Efficiency Retrofits	1,925	Not estimated	Not estimated	Not estimated
	Energy-2.2. Expand Community Energy Efficiency Retrofits Program	5,601	\$300–\$500	\$20,000,000–\$30,000,000	2–5
	Energy-2.3. Tree Planting	23	Not estimated	Not estimated	Not estimated
	Energy-3. Solar Energy				
	Energy-3.1. Solar Installations for New Residential Development[b]	34	\$20–\$200 (DP); \$200 (PPA)	\$10,000–\$100,000 (DP); \$70,000 (PPA)	13-15 (DP); NA (PPA)
	Energy-3.2. Solar Installations for New Nonresidential Development[b]	23	\$30–\$300 (DP); \$200 (PPA)	\$9,000–\$100,000 (DP); \$50,000 (PPA)	11-15 (DP) NA (PPA)
	Energy-3.3. Solar Installations for Existing Residential Development[b]	3,950	\$20–\$200(DP); \$100 (PPA)	\$1,000,000–\$10,000,000 (DP); \$8,000,000 (PPA)	13-15 (DP); NA(PPA)
	Energy-3.4. Solar Installations for Existing Nonresidential Development[b]	3,086	\$30–\$300 (DP); \$100 (PPA)	\$1,000,000–\$10,000,000 (DP); \$5,000,000 (PPA)	11-15 (DP); NA(PPA)
LAND USE & TRANSPORTATION	Trans-1. Land Use Design and VMT Reduction				
	Trans-1.1 Promote Mixed-Use, Infill, and Transit-Oriented Developments	44	Not estimated	Not estimated	Not estimated
	Trans-1.2. VMT Reduction Monitoring and Implementation and Transportation Demand Management Program	152	Not estimated	Not estimated	Not estimated
	Trans-1.3. Transportation Marketing	1,358	Not estimated	Not estimated	Not estimated
	Trans-2. Expand Transit Service	116	Not estimated	Not estimated	Not estimated
	Trans-3. Electric Vehicle Charging Stations	15	(\$400)–\$100	(\$60,000)–\$10,000	8–> lifetime
	Trans-4. Electric-Powered Electric Landscaping Equipment	84	Not estimated	Net Saving[c]	Not estimated[d]

Strategy Area	Local Strategy	2020 GHG Reduction	Saving (cost) per MT Reduced	Net Present Value (cost)[a]	Payback (years)
WASTE REDUCTION, REUSE, AND RECYCLING	Waste-1. Zero Waste by 2025	2,995	Not estimated	Not estimated	Not estimated
WATER CONSERVATION AND WASTEWATER TREATMENT	Water/Wastewater-1. Water Conservation				
	Water/Wastewater-1.1. Senate Bill X7-7	946	Not estimated	Not estimated	Not estimated
	Water/Wastewater-1.2. Additional Water Conservation for New Construction	79	($400)–$300	($500,000)–($40,000)	10-20
	Water/Wastewater-1.3. Additional Water Conservation for Existing Buildings	162	($400)–$200	($1,000,000)–($100,000)	10-21
	Water/Wastewater-2. Increase Pump Efficiency	105	$400–$900	$700,000-–$1,000,000	2-3
	Water/Wastewater-3. Reduce Wastewater Generation	1,964	Not estimated	Not estimated	Not estimated
AGRICULTURE	Agriculture-1. Methane Capture and Energy Generation at Dairies	3,691	($10)	($900,000)–($300,000)	>Lifetime
	Agriculture-2. Carbon Farming	Not estimated			
	Agriculture-3. Promote the Sale of Locally Grown Foods and/or Products	Not estimated			

Notes:

DP = direct purchase; Not estimated = strategies that do not currently support a quantitative cost and savings analysis, even though the strategy has been evaluated from an emissions reduction standpoint; PPA = power purchase agreement.

All cost values in this table are rounded.

[a] Net Present Value is defined as the difference between the present value of cash inflows and the present value of cash outflows. A positive NPV means the reduction measure will save money over the project lifetime, and a negative NPV means the measure will have a cost.

[b] The cost analysis considered two financing scenarios:

Direct Purchase: The purchasing entity (e.g., homeowner for Energy-3.1, business owner for Energy-3.2) is assumed to directly purchase, install, and maintain the solar photovoltaic (PV) system.

Power Purchase Agreement: The purchasing entity enters into a PPA with a local company who owns and maintains the solar panels.

[c] Lifetime savings associated with an electric leaf blower or chainsaw estimated at between $3,000 and $4,000 per unit.

[d] Payback is not estimated since upfront equipment costs vary significantly based on features other than the energy source. Electric-powered construction and landscaping equipment are expected to provide annual savings relative to the operating costs for gas or diesel-powered equipment.

Table C-2 summarizes the total upfront costs, annual savings/costs, and entities incurring the costs/savings for all quantified strategies. While Table C-1 above presents metrics of cost-effectiveness (e.g., cost per $MTCO_2e$, net present value, and payback periods), Table C-2 reflects the total upfront and annual costs and savings that would be incurred to achieve the community emissions reduction target.

Table C-2. Total Upfront Costs and Annual Savings/Costs Associated with CAP Implementation

Strategy Area	Local Strategy	Upfront (One-Time Cost)		Annual	
		Cost[a]	Incurring Entity	Saving (Cost)[a]	Incurring Entity
ENERGY EFFICIENCY & RENEWABLE ENERGY	Energy-1. Community Choice Aggregation	Not estimated	• Marin Clean Energy	Not estimated	• Homeowners • Tenants
	Energy-2. Energy Efficiency				
	Energy-2.1. Community Energy Efficiency Retrofits	Not estimated	• Building Owners	Not estimated	• Building Owners • Tenants
	Energy-2.2. Expand Community Energy Efficiency Retrofits Program	$6,000,000–$15,000,000	• Building Owners	$3,000,000	• Building Owners • Tenants
	Energy-2.3. Tree Planting	Not estimated	• Marin County • Developers (due to tree planting requirements for new development)	Not estimated	
	Energy-3. Solar Energy				
	Energy-3.1. Solar Installations for New Residential Development[b]	$600,000–700,000	• Building Owners • Developers	$50,000 (DP); $5,000 (PPA)	• Building Owners • Tenants
	Energy-3.2. Solar Installations for New Nonresidential Development[b]	$300,000–$400,000	• Building Owners • Developers	$30,000 (DP); $3,000 (PPA)	• Building Owners • Tenants
	Energy-3.3. Solar Installations for Existing Residential Development[b]	$60,000,000–$70,000,000	• Building Owners	$5,000,000 (DP); $500,000 (PPA)	• Building Owners • Tenants
	Energy-3.4. Solar Installations for Existing Nonresidential Development[b]	$40,000,000–$50,000,000	• Building Owners	$4,000,000 (DP); $400,000 (PPA)	• Building Owners • Tenants
LAND USE & TRANSPORTATION	Trans-1. Land Use Design and VMT Reduction				
	Trans-1.1 Promote Mixed-Use, Infill, and Transit-Oriented Developments	Not estimated	• Marin County • Developers	Not estimated	• Developers • Residents • Business owners
	Trans-1.2. VMT Reduction Monitoring and Implementation and Transportation Demand Management Program	Not estimated	• Marin County • Businesses	Not estimated	• Marin County • Vehicle owners • Businesses

Strategy Area	Local Strategy	Upfront (One-Time Cost)		Annual	
		Cost[a]	Incurring Entity	Saving (Cost)[a]	Incurring Entity
	Trans-1.3. Transportation Marketing	Not estimated	• Marin County • Businesses	Not estimated	• Vehicle owners • Businesses
	Trans-2. Expand Transit Service	Not estimated	• Marin County • Marin Transit	Not estimated	• Residents • Business owners
	Trans-3. Electric Vehicle Charging Stations	$20,000-$50,000 (Private); $20,000–$50,000 (Government); $0 (Consumer)	• Private company operating the EV charging stations • Marin County	($5,000) (Private); $0 (Government); $10,000 (Consumer)	• Private company operating the EV charging stations • Plug-in electric vehicle driver
	Trans-4. Electric-Powered Electric Landscaping Equipment	Upfront cost assumed to be negligible; equipment costs vary significantly based on other features besides energy source.	• Equipment owners	Annual cost savings associated with an electric leaf blower or chainsaw estimated at between $500 and $600 per unit, assuming 960 hours of operation.	• Equipment owners/renters
WASTE REDUCTION, REUSE, AND RECYCLING	Waste-1. Zero Waste by 2025	Not estimated	N/A	Not estimated	• Marin County • Waste haulers
WATER CONSERVATION AND WASTEWATER TREATMENT	Water/Wastewater-1. Water Conservation				
	Water/Wastewater-1.1. Senate Bill X7-7	Not estimated	• Water Agencies • Homeowners • Building owners	Not estimated	• Homeowners, • Building owners • Tenants
	Water/Wastewater-1.2. Additional Water Conservation for New Construction	$500,000-$900,000	• Homeowners • Developers	$50,000	• Homeowners, • Building owners • Tenants
	Water/Wastewater-1.3. Additional Water Conservation for Existing Buildings	$1,000,000-$2,000,000	• Homeowners • Building owners	$100,000	• Homeowners, • Building owners • Tenants

Strategy Area	Local Strategy	Upfront (One-Time Cost)		Annual	
		Cost[a]	Incurring Entity	Saving (Cost)[a]	Incurring Entity
	Water/Wastewater-2. Increase Pump Efficiency	$200,000-$300,000	• Water Agencies	$100,000	• Water Agencies
	Water/Wastewater-3. Reduce Wastewater Generation	Not estimated	• Water Agencies • Homeowners • Building owners	Not estimated	• Homeowners, • Building owners • Tenants
AGRICULTURE	Agriculture-1. Methane Capture and Energy Generation at Dairies	$700,000-$1,000,000	• Dairies and Livestock facility operators	$30,000	• Dairies and Livestock facility operators
	Agriculture-2. Carbon Farming	Not estimated	• Farmers/Ranchers	Not estimated	• Farmers and Ranchers
	Agriculture-3. Promote the Sale of Locally Grown Foods and/or Products	Not estimated	• County • Farmer's Market proponents	Not estimated	• Product providers

Notes:

All cost values in this table are rounded.

[a] Staff time to prepare ordinances, develop new programs, or other staff costs associated with strategy development or implementation are not quantified in this analysis.

[b] The cost analysis considered two financing scenarios:
Direct Purchase (DP)**:** The purchasing entity (e.g., homeowner for Energy-3.1, business owner for Energy-3.2) is assumed to directly purchase and install the solar photovoltaic (PV) system. Power Purchase Agreement (PPA): The purchasing entity enters into a PPA with a local company who owns and maintains the solar panels.

Table C-3 highlights costs and savings at the project-level for several community emissions reduction strategies. All projects would require upfront costs, but ultimately result in cost savings over the lifetime of the improvement. Energy efficiency retrofits for an average existing multi-family home are anticipated to be one of the most cost-effective strategies, with a payback period of just 5 years.

Table C-3. Example Project-Level Costs and Savings for Community Measures

Measure	Action	Project Details	Upfront Cost	Annual Costs/Savings	Net Lifetime Costs/Savings[a]	Payback (years)
Energy-2.3. Expand Community Energy Efficiency Retrofits Program	Achieve the following residential energy efficiency retrofit goals by 2020 for a four-unit, Multi-Family Home	Will vary on a case-by-case basis. Retrofits should reduce energy consumption (electricity and natural gas) by at least 15%, relative to existing conditions.	$10,000	$2,000	$16,000	5
Energy-3.1. Solar Installations for New Residential Development	Direct Purchase Solar Installation on Residential Homes	Install a 4 kW solar photovoltaic system on residential roof-top, fixed tilt.	$14,000–$16,000[b]	$1,000	$300–$3,000[c]	13–15
	Power Purchase Agreement (PPA) Solar Installation on Residential Homes	Install a 4 kW solar photovoltaic system on residential rooftop, fixed tilt.	–[d]	$100	$2,000[c]	0
Energy-3.2. Solar Installations for New Nonresidential Development	Direct Purchase Solar Installation on Nonresidential buildings	Install a 40 kW solar photovoltaic system on an existing commercial building rooftop, fixed tilt.	$120,000–$148,000[b]	$10,000–$11,000	$3,000–$40,000[c]	11–15
	Power Purchase Agreement (PPA) Solar Installation on Nonresidential buildings	Install a 40 kW solar photovoltaic system on an existing commercial building rooftop, fixed tilt.	–[d]	$1,000	$16,000[c]	0
Energy-3.3. Solar Installations for Existing Residential Development	Direct Purchase Solar Installation on Residential Homes	Install a 4 kW solar photovoltaic system on residential rooftop, fixed tilt.	$14,000-$16,000[b]	$1,000	$300–$3,000	13–15
	Power Purchase Agreement (PPA) Solar Installation on Residential Homes	Install a 4 kW solar photovoltaic system on residential rooftop, fixed tilt.	–[d]	$100	$2,000	0
Energy-3.4. Solar Installations	Direct Purchase Solar Installation on Nonresidential buildings	Install a 40 kW solar photovoltaic system on an existing commercial building rooftop, fixed tilt.	$120,000–$148,000[b]	$10,000–$11,000	$3,000–$40,000	11–15

Measure	Action	Project Details	Upfront Cost	Annual Costs/Savings	Net Lifetime Costs/Savings[a]	Payback (years)
for Existing Nonresidential Development	Power Purchase Agreement (PPA) Solar Installation on Nonresidential buildings	Install a 40 kW solar photovoltaic system on an existing commercial building rooftop, fixed tilt.	–[d]	$1,000	$16,000[c]	0

Notes:

DP = direct purchase; kW = kilowatt; kWh = kilowatt-hour; PV = photovoltaic; PPA = power purchase agreement.

All values in this table are rounded.

[a] Equal to the net present value of the project.

[b] These upfront costs are net of the 30% Investment Tax Credit.

[c] Lifetime savings are presented as a discounted value (a net present value). For example, when the $1,000 savings each year over the lifetime of the system for Energy 3.1 (direct purchase) is discounted back to today at a rate of 5%, the present day equivalent is much less than the annual net savings multiplied by 25. See below for additional detail.

[d] Upfront cost paid by the solar provider.

Summary of Municipal GHG Reductions and Costs

Table C-4 summarizes municipal GHG reductions, costs, and savings, as available for each local measure. Estimated costs and savings would be incurred by the County. County costs associated with CAP implementation, including staff time to prepare ordinances, develop new programs, or other staff costs associated with strategy development or implementation are not included in the analysis, but are discussed qualitatively in Chapter 6, *Greenhouse Gas Reduction Measure Implementation Program*.

Table C-4. Summary of GHG Reductions, Costs, Savings, and Benefits Associated with Local Municipal Emissions Reduction Strategies

Strategy Area	Local Strategy	2020 GHG Reduction	Saving (cost) per MT Reduced	Net Present Value (cost)[a]	Payback (years)
ENERGY EFFICIENCY AND RENEWABLE ENERGY	Energy-1. Energy Efficiency				
	Energy-1.1. Energy Efficiency Measures for the new Emergency Operations Facility	222	Not estimated	Not estimated	Not estimated
	Energy-1.2. Existing Building Retrofit Program	55	($2,000)–($1,000)	($1,000,000)–($800,000)	30–44
	Energy-1.3. Energy Efficiency Measures for County-Owned Computers and Printers	6	$300–$2,000	$9,000–$60,000	Net saving
	Energy-1.4. Computer Energy Management	46	$1,000	$500,000	1
	Energy-1.5. Shade Tree Planting	1	$900–$2,000	($30,00)–($12,000)	Net cost
	Energy-1.6. Install energy-efficient street lights	11	Not estimated	Not estimated	Not estimated
	Energy-2. Solar Energy				
	Energy-2.1. Install solar panels on municipal facilities	42	($500)–($200) (DP); $100–$200 (PPA)	($300,000)–($100,000) (DP); $70,000-$100,000 (PPA)	17–20 (DP); 0 (PPA)
	Energy-2.2. Solar Panel Carports and Parking Areas[b]	68	($500)–($200) (DP); $100 (PPA)	($400,000)–($200,000) (DP); $100,000 (PPA)	17–20 (DP); 0 (PPA)
VEHICLE FLEET AND EMPLOYEE COMMUTE	Trans-1. New Vehicles				
	Trans-1.1. Purchase fuel-efficient (e.g., hybrid) and/or smaller fleet vehicles to replace existing fleet vehicles	17	Not estimated	Not estimated	Not estimated
	Trans-1.2. Electric Vehicles	42	Not estimated	Not estimated	Not estimated
	Trans-1.3. Electric Landscaping Equipment	3	Not estimated	Not estimated	Net Saving
	Trans-2. Alternative Transportation				
	Trans-2.1. Guaranteed Ride Home	1	Not estimated	Not estimated	Not estimated
	Trans-2.2. Green Commute Program	342	Not estimated	Not estimated	Not estimated
	Trans-2.3. Electric Vehicle Charging Stations	7	($400)–$100	($30,000)–$10,000	7–> lifetime
	Trans-3. Trip Reduction				

Strategy Area	Local Strategy	2020 GHG Reduction	Saving (cost) per MT Reduced	Net Present Value (cost)[a]	Payback (years)
	Trans-3.1. Encourage telecommuting by municipal employees	51	Not estimated	Not estimated	Not estimated
	Trans-3.2. Municipal Parking Management	388	Not estimated	Not estimated	Not estimated
WASTE REDUCTION, REUSE, AND RECYCLING	Waste-1. Increase Recycling at County Facilities	34	Not estimated	Not estimated	Not estimated
WATER CONSERVATION AND WASTEWATER TREATMENT	Water/Wastewater-1. Water Conservation				
	Water/Wastewater-1.1. Water Conservation for Existing Buildings	100	Not estimated	Not estimated	Not estimated
	Water/Wastewater-1.2. Irrigation Monitoring and Management System	1	Not estimated	Not estimated	Not estimated

Notes:

DP = direst purchase; Not estimated = strategies that do not currently support a quantitative cost and savings analysis, even though the strategy has been evaluated from an emissions reduction standpoint; PPA = power purchase agreement.

All cost values in this table are rounded.

[a] Net Present Value is defined as the difference between the present value of cash inflows and the present value of cash outflows. A positive NPV means the reduction measure will save money, and a negative NPV means the measure will have a cost.

[b] The cost analysis considered two financing scenarios:

Direct Purchase (DP)**:** The purchasing entity (the County) is assumed to directly purchase and install the solar photovoltaic (PV) system.

Power Purchase Agreement (PPA): The purchasing entity enters into a PPA with a local company who owns and maintains the solar panels.

Table C-5 summarizes the total upfront costs, annual savings/costs, and entities incurring the costs/savings for all quantified strategies. While Table C-4 above presents metrics of cost-effectiveness (e.g., cost per $MTCO_2e$, net present value, and payback periods), Table C-5 reflects the total upfront and annual costs and savings that would be incurred to achieve the municipal emissions reduction target.

Table C-5. Total Upfront Costs and Annual Savings/Costs Associated with CAP Implementation

Strategy Area	Local Strategy	Upfront (One-Time Cost)		Annual	
		Cost	Incurring Entity	Saving (Cost)[a]	Incurring Entity
ENERGY EFFICIENCY AND RENEWABLE ENERGY	Energy-1. Energy Efficiency				
	Energy-1.1. Energy Efficiency Measures for the New Emergency Operations Facility	Not estimated	Marin County	Not estimated	Marin County
	Energy-1.2. Existing Building Retrofit Program	$1,000,000–$2,000,000	Marin County	$40,000	Marin County
	Energy-1.3. Energy Efficiency Measures for County-Owned Computers and Printers	$20,000–$70,000	Marin County	$7,000	Marin County
	Energy-1.4. Computer Energy Management	$50,000	Marin County	$60,000	Marin County
	Energy-1.5. Shade Tree Planting	$8,000	Marin County	($2,000)–($800)	Marin County
	Energy-1.6. Install energy-efficient street lights	Not estimated	Marin County	Not estimated	Marin County
	Energy-2. Solar Energy				
	Energy-2.1. Install solar panels on municipal facilities	$900,000–$700,000 (DP); $0 (PPA)	Marin County	$40,000 (DP); $5,000 (PPA)	Marin County
	Energy-2.2. Solar Panel Carports and Parking Areas[b]	$1,000,000 (DP); $0 (PPA)	Marin County	$70,000 (DP); $8,000 (PPA)	Marin County
VEHICLE FLEET AND EMPLOYEE COMMUTE	Trans-1. New Vehicles				
	Trans-1.1. Purchase fuel-efficient (e.g., hybrid) and/or smaller fleet vehicles to replace existing fleet vehicles	Not estimated	Marin County	Not estimated	Marin County
	Trans-1.2. Electric Vehicles	Not estimated	Marin County	Not estimated	Marin County
	Trans-1.3. Electric Landscaping Equipment	Total costs not quantified. Upfront cost assumed to be negligible; equipment costs vary significantly based on other features besides energy source.	Marin County	Annual cost savings associated with an electric leaf blower or chainsaw estimated at between $500–$600 per unit, assuming 960 hours of operation.	Marin County
	Trans-2. Alternative Transportation				
	Trans-2.1. Guaranteed Ride Home	Not estimated	Marin County	Not estimated	Marin County

Strategy Area	Local Strategy	Upfront (One-Time Cost)		Annual	
		Cost	Incurring Entity	Saving (Cost)[a]	Incurring Entity
	Trans-2.2. Green Commute Program	Not estimated	Marin County	Not estimated	Marin County
	Trans-2.3. Electric Vehicle Charging Stations	$20,000–$60,000	Marin County	($2,000) (Government); $5,000 (Consumer)	Marin County Plug-in electric vehicle driver
	Trans-3. Trip Reduction				
	Trans-3.1. Encourage telecommuting by municipal employees	Not estimated	Marin County	Not estimated	Marin County
	Trans-3.2. Municipal Parking Management	Not estimated	Marin County	Not estimated	Marin County
 WASTE REDUCTION, REUSE, AND RECYCLING	Waste-1. Increase Recycling at County Facilities	Not estimated	Marin County	Not estimated	Marin County
 WATER CONSERVATION AND WASTEWATER TREATMENT	Water/Wastewater-1. Water Conservation				
	Water/Wastewater-1.1. Water Conservation for Existing Buildings	Not estimated	Marin County	Not estimated	Marin County
	Water/Wastewater-1.2. Irrigation Monitoring and Management System	Not estimated	Marin County	Not estimated	Marin County

Notes:

All cost values in this table are rounded.

[a] Staff time to prepare ordinances, develop new programs, or other staff costs associated with strategy development or implementation are not quantified in this analysis.

[b] The cost analysis considered two financing scenarios:
Direct Purchase (DP): The purchasing entity (the County) is assumed to directly purchase and install the solar photovoltaic (PV) system. Power Purchase Agreement (PPA): The purchasing entity enters into a PPA with a local company who owns and maintains the solar panels.

Table C-6 highlights costs and savings at the project-level for several municipal emissions reduction strategies. All projects would require upfront costs, but some projects result in cost savings over the lifetime of the improvement. Solar Installations on Carports and Parking Areas is anticipated to be one of the most cost-effective strategies, with a payback period of 0 years.

Table C-6. Example Project-Level Costs and Savings for Municipal Measures

Measure	Action	Project Details	Upfront Cost	Annual Costs/Savings	Net Lifetime Costs/Savings[a]	Payback (years)
Energy-1.2. Existing Building Retrofit Program	Conduct energy efficiency retrofits of existing County buildings. 2012 electricity use will be reduced by 5% by 2020 through retrofits of existing County buildings. Require these retrofits to improve building-wide energy efficiency by 20%. Retrofits should target lighting, heating, and air-conditioning units and overall building energy use. In addition, the County will require that newly leased buildings improve energy consumption by 20% over 2012 levels.	Existing municipal building of 10,000 sf (one-story office building) improves building-wide energy efficiency by 20%.	$5,000	$200	($3,000)	> Lifetime
Energy-2.2. Solar Panel Carports and Parking Areas	Direct Purchase Solar Installation on Carports and Parking Areas	Install a 1.4 kW solar photovoltaic system over each parking space in existing parking lots	$6,000–$7,000	$400	($2,000)–($800)[c]	17–20
	Power Purchase Agreement (PPA) Solar Installation on Carports and Parking Areas	Install a 1.4 kW solar photovoltaic system over each parking space in existing parking lots	–[b]	$40	$600[c]	0

Notes:

DP = direct purchase; kW = kilowatt; kWh = kilowatt-hour; PV = photovoltaic; PPA = power purchase agreement.

All cost values in this table are rounded.

[a] Equal to the net present value of the project.

[b] Upfront cost paid by the solar provider.

[c] Lifetime savings are presented as a discounted value (a net present value). For example, when the $400 savings each year over the lifetime of the system is discounted back to today at a rate of 5%, the present day equivalent is less than the annual net savings multiplied by 25.

Presentation Framework and Common Assumptions

The following sections present a detailed overview of the emissions reduction strategies and analysis procedures. Local strategies are summarized by the six community action areas discussed in Chapter 4 and by the four municipal action areas discussed in Chapter 5. The Following information is provided for all strategies, as available:

1. Objective: Describes the intent and overall goal for each strategy.
2. Summary Metrics: Summarizes the GHG reductions, costs, savings, and/or other quantified metrics.
3. Assumptions: Identifies assumptions used in calculating emission reductions and cost. Table C-7 includes a master list of assumptions for reference.
4. Analysis Method: Provides an overview of the methods for calculating GHG reductions and costs. A reasonable amount of detail is presented to provide a basic overview of the approach, as opposed to an exhaustive list of all calculations and steps.
5. Implementation Information: Provides a summary of implementation actions that are associated with each strategy.
6. Supporting Marin Countywide Plan Policies: Identifies policies in the Marin Countywide Plan that support the strategy.

As noted in Table C-7 below, many of the same assumptions are used to evaluate emissions reductions and costs for multiple strategies.

Table C-7. Master List of Quantification Assumptions for the Marin County CAP Update

Parameter	Value	Unit	Source
GWPs			
CO_2	1	-	IPCC 2013
CH_4	28	-	IPCC 2013
N_2O	265	-	IPCC 2013
CONVERSIONS			
Days per year	365	days/year	Standard conversion
Pounds per metric ton	2,204.62	pounds/MT	Standard conversion
Kilograms per metric ton	1,000	kilograms/MT	Standard conversion
Grams per metric ton	1,000,000	grams/MT	Standard conversion
Grams per kilogram	1,000	grams/kilograms	Standard conversion
Therms per million British thermal units (MMBtu)	10	therms/MMBtu	Standard conversion
Energy use ratio: Single Family: Multi-family housing—Electricity	1.97	-	EIA 2009
Energy use ratio: Single Family: Multi-family housing—Natural gas	2.27	-	EIA 2009
Kilowatt-hour (kWh) per megawatt-hour (MWh)	1,000.00	kWh/MWh	Standard conversion
Minutes per hour	60.00	minutes/hour	Standard conversion
metric ton per ton	0.91	MT/ton	Standard conversion
Million gallons per gallon	0.0000010	million gallons/gallon	Standard conversion
watts per kilowatt	1,000	W/kW	Standard conversion
Energy Ratio for gasoline	33.4	kWh/gallon-gasoline	CAPCOA 2010, VT-3, Page 310
Energy Ratio for diesel	37.7	kWh/gallon-gasoline	CAPCOA 2010, VT-3, Page 310
gallons per acre-foot	325,851	gal/ac-ft	Standard conversion
ENERGY			
2012 Community			
Residential Electricity - PG&E Regular	98,116,686	Kilowatt-hours	Armanino pers. comm.
Estimated Single Family	89,941,155	Kilowatt-hours	Scaled based on EIA data
Estimated Multi Family	8,175,531	Kilowatt-hours	Scaled based on EIA data
Residential Electricity - MCE Light Green	83,465,980	Kilowatt-hours	Kudo pers. comm.

Parameter	Value	Unit	Source
Estimated Single Family	76,511,213	Kilowatt-hours	Scaled based on EIA data
Estimated Multi Family	6,954,767	Kilowatt-hours	Scaled based on EIA data
Residential Electricity - MCE Deep Green	2,291,069	Kilowatt-hours	Kudo pers. comm.
Estimated Single Family	2,100,167	Kilowatt-hours	Scaled based on EIA data
Estimated Multi Family	190,902	Kilowatt-hours	Scaled based on EIA data
Commercial/Industrial Electricity - PG&E Regular	61,400,824	Kilowatt-hours	Armanino pers. comm.
Commercial/Industrial Electricity - MCE Light Green	63,340,839	Kilowatt-hours	Kudo pers. comm.
Commercial/Industrial Electricity - MCE Deep Green	2,395,977	Kilowatt-hours	Kudo pers. comm.
Commercial/Industrial Electricity - MCE Unspecified	821,307	Kilowatt-hours	Kudo pers. comm.
Commercial/Industrial Electricity - Direct Access	13,912,478	Kilowatt-hours	Armanino pers. comm.
Water Electricity - MCE Light Green	5,799,073	Kilowatt-hours	Armanino pers. comm.
Total PG&E Delivered Electricity	159,517,510	*kWh*	Calculated from Above
Total DA Delivered Electricity	13,912,478	*kWh*	Calculated from Above
Total MCE Light Green Delivered Electricity	152,605,892	*kWh*	Calculated from Above
Total MCE Deep Green Delivered Electricity	4,687,046	*kWh*	Calculated from Above
Total MCE Unspecified Delivered Electricity	821,307	*kWh*	Calculated from Above
Residential Natural Gas	13,841,199	therms	Armanino pers. comm.
Estimated Single Family	12,829,789	therms	Scaled based on EIA data
Estimated Multi Family	1,011,410	therms	Scaled based on EIA data
Commercial/Industrial Natural Gas	4,716,296	therms	Armanino pers. comm.
Water Natural Gas	7,591	therms	Armanino pers. comm.
Marin County Total Energy Use (all jurisdictions)			
Residential Electricity - PG&E	377,226,628	*kWh*	Calculated from Above
Nonresidential Electricity - PG&E	344,000,478	*kWh*	Calculated from Above
Nonresidential Electricity - Direct Access	31,548,026	*kWh*	Calculated from Above
Residential Natural Gas	55,460,031	*therms*	Calculated from Above
Non Residential Natural Gas	21,065,818	*therms*	Calculated from Above
2012 Municipal			
Municipal Building Energy - PG&E	4,223,088	kWh	Armanino pers. comm.
Municipal Building Energy - MCE Light Green	12,403,836	kWh	Armanino pers. comm.
Municipal Building Energy - MCE Deep Green	71,400	kWh	Armanino pers. comm.

Parameter	Value	Unit	Source
Municipal Building Energy - Natural Gas	410,642	therms	Armanino pers. comm.
Municipal Streetlights - PG&E	11,043	kWh	Armanino pers. comm.
Municipal Streetlights - MCE Light Green	454,346	kWh	Armanino pers. comm.
Municipal Traffic Signals - PG&E	4,853	kWh	Armanino pers. comm.
Municipal Traffic Signals - MCE Light Green	34,119	kWh	Armanino pers. comm.
2020 Community			
Residential Electricity - PG&E Regular	100,906,731	kWh	Calculated by ICF
Estimated Single Family	92,498,722	kWh	Scaled based on EIA data
Estimated Multi Family	8,408,010	kWh	Scaled based on EIA data
Residential Electricity - MCE Light Green	83,465,980	kWh	Calculated by ICF
Estimated Single Family	76,511,213	kWh	Scaled based on EIA data
Estimated Multi Family	6,954,767	kWh	Scaled based on EIA data
Residential Electricity - MCE Deep Green	2,291,069	kWh	Calculated by ICF
Estimated Single Family	2,100,167	kWh	Scaled based on EIA data
Estimated Multi Family	190,902	kWh	Scaled based on EIA data
Residential Electricity - MCE Unspecified	-	kWh	Calculated by ICF
Estimated Single Family	-	kWh	Scaled based on EIA data
Estimated Multi Family	-	kWh	Scaled based on EIA data
Commercial/Industrial Electricity - PG&E Regular	71,196,172	kWh	Calculated by ICF
Commercial/Industrial Electricity - MCE Light Green	63,175,309	kWh	Calculated by ICF
Commercial/Industrial Electricity - MCE Deep Green	2,395,977	kWh	Calculated by ICF
Commercial/Industrial Electricity - MCE Unspecified	821,307	kWh	Calculated by ICF
Commercial/Industrial Electricity - Direct Access	14,920,532	kWh	Calculated by ICF
Water Electricity - MCE Light Green	5,990,138	kWh	Calculated by ICF
Total PG&E Delivered Electricity	172,102,904	*kWh*	Calculated by ICF
Total DA Delivered Electricity	14,920,532	*kWh*	Calculated by ICF
Total MCE Light Green Delivered Electricity	152,631,427	*kWh*	Calculated by ICF
Total MCE Deep Green Delivered Electricity	4,687,046	*kWh*	Calculated by ICF
Total MCE Unspecified Delivered Electricity	821,307	*kWh*	Calculated by ICF
Residential Natural Gas	14,048,167	therms	Calculated by ICF
Estimated Single Family	13,021,323	MMBtu	Calculated by ICF

Parameter	Value	Unit	Source
Estimated Multi Family	1,026,509	MMBtu	Calculated by ICF
Commercial/Industrial Natural Gas	5,058,056	therms	Calculated by ICF
Water Natural Gas	7,841	therms	Calculated by ICF
2020 Municipal			
Municipal Building Energy - PG&E	4,223,088	kWh	Calculated by ICF
Municipal Building Energy - MCE Light Green	17,302,971	kWh	Calculated by ICF
Municipal Building Energy - MCE Deep Green	71,400	kWh	Calculated by ICF
Municipal Building Energy - Natural Gas	440,571	therms	Calculated by ICF
Municipal Streetlights - PG&E	11,043	kWh	Calculated by ICF
Municipal Streetlights - MCE Light Green	457,053	kWh	Calculated by ICF
Municipal Traffic Signals - PG&E	4,853	kWh	Calculated by ICF
Municipal Traffic Signals - MCE Light Green	35,891	kWh	Calculated by ICF
ON-ROAD TRANSPORTATION			
2012 Passenger VMT	349,061,299	annual VMT	Brazil pers. comm.
2012 Commercial VMT	21,181,227	annual VMT	Brazil pers. comm.
2012 Other VMT	11,402,411	annual VMT	Brazil pers. comm.
2020 Passenger VMT	346,165,126	annual VMT	Brazil pers. comm.
2020 Passenger VMT	23,485,423	annual VMT	Brazil pers. comm.
2020 Other VMT	11,785,886	annual VMT	Brazil pers. comm.
2012 Percent VMT due to commuting	70.7%	percent	Brazil pers. comm.
2020 Percent VMT due to commuting	74.2%	percent	Brazil pers. comm.
WASTE			
Community			
Waste disposal 2012	46,231	tons	Calculated by ICF
Waste disposal 2020	47,754	tons	Calculated by ICF
Municipal			
Waste disposal 2012	623	tons	Armanino pers. comm.
Waste disposal 2020	669	tons	Calculated by ICF

Parameter	Value	Unit	Source
WATER			
Community			
2012 Water Use	3,297,582,139	gallons/year	Calculated by ICF
2020 Water Use	3,406,229,102	gallons/year	Calculated by ICF
Growth	1.03	-	Calculated by ICF
2012 Water Use (unincorporated county)			
MMWD	2,322,952,455	gallons/year	Calculated by ICF
NMWD	929,629,684	gallons/year	Calculated by ICF
SBWD	45,000,000	gallons/year	Calculated by ICF
2012 Water Use (agency-wide)			
MMWD	8,830,247,089	gallons/year	Armanino pers. comm.
NMWD	3,533,804,486	gallons/year	Armanino pers. comm.
SBWD	45,000,000	gallons/year	Armanino pers. comm.
2020 Water Use (unincorporated county)			
MMWD	2,399,487,843	gallons/year	Calculated by ICF
NMWD	960,258,622	gallons/year	Calculated by ICF
SBWD	46,482,636	gallons/year	Calculated by ICF
2020 Water Use (agency-wide)			
MMWD	9,121,181,321	gallons/year	Calculated by ICF
NMWD	3,650,234,376	gallons/year	Calculated by ICF
SBWD	46,482,636	gallons/year	Calculated by ICF
2012 Service Area Population			
MMWD	190,600	persons	MMWD 2010
NMWD	60,423	persons	NMWD 2010
SBWD	632	persons	City-Data 2014
2020 Electricity Use by Agency (unincorporated county)			
MMWD	5,189,576	kWh	Armanino pers. comm.
NMWD	621,356	kWh	Armanino pers. comm.
SBWD	179,206	kWh	Armanino pers. comm.
2020 Natural Gas Use by Agency (unincorporated county)			
MMWD	6,888	therms	Armanino pers. comm.

Parameter	Value	Unit	Source
NMWD	953	therms	Armanino pers. comm.
SBWD	-	therms	Armanino pers. comm.
Percentage of Residential Outdoor Water Use	57%	-	ConSol 2010
Percentage of Residential Indoor Water Use	43%	-	ConSol 2010
Percentage of Nonresidential Outdoor Water Use	35%	-	Yudelson 2010
Percentage of Nonresidential Indoor Water Use	65%	-	Yudelson 2010
Percent Hot Water Heating (residential)	33%	-	AquaCraft 2014
Percent Hot Water Heating (commercial)	22%	-	Calculated from Yudelson, 2010 and AquaCraft 2014
Electricity Use to Heat Gallon of Hot Water	0.18	kWh/gallon	U.S. EPA 2010
Percent of Commercial Buildings with Electric Water Heaters	39.89%	-	EIA 2003 (Pacific Region, table B32)
Natural Gas Use to Heat Gallon of Hot Water (therms)	0.009	therm/gallon	U.S. EPA 2010
Percent of Commercial Buildings with Nat Gas Water Heaters	60.11%	-	EIA 2003 (Pacific Region, table B32)
Residential Indoor Water Use by End Use			
Toilet	33%	percent	CAPCOA 2010 (Table WUW-1.1)
Showerhead	22%	percent	CAPCOA 2010 (Table WUW-1.1)
Bathroom / Kitchen Faucet	18%	percent	CAPCOA 2010 (Table WUW-1.1)
Standard /Compact Dishwasher	1%	percent	CAPCOA 2010 (Table WUW-1.1)
Top/Front-Loading Clothes Washer	14%	percent	CAPCOA 2010 (Table WUW-1.1)
Leaks, other	12%	percent	CAPCOA 2010 (Table WUW-1.1)
Nonresidential Indoor Water Use by End Use			
Toilet	48%		CAPCOA 2010 (Table WUW-1.2 – Office)
Urinals	11%		CAPCOA 2010 (Table WUW-1.2 – Office)
Bathroom Faucet	3%		CAPCOA 2010 (Table WUW-1.2 – Office)
Showers	5%		CAPCOA 2010 (Table WUW-1.2 – Office)
Kitchen Faucet	4%		CAPCOA 2010 (Table WUW-1.2 – Office)
Dishwashers	2%		CAPCOA 2010 (Table WUW-1.2 – Office)
Ice	1%		CAPCOA 2010 (Table WUW-1.2 – Office)
Laundry	0%		CAPCOA 2010 (Table WUW-1.2 – Office)
Other	26%		CAPCOA 2010 (Table WUW-1.2 – Office)
CALGreen Fixture Flow Rates			

Parameter	Value	Unit	Source
Residential Fixtures			
Lavatory and Kitchen Faucets			
2013 CALGreen Code Flow Rate – Mandatory	1.8	gal/min	CBSC 2013a
2013 CALGreen Code Flow Rate – Voluntary	1.5	gal/min	CBSC 2013b
Dishwashers			
Standard			
2013 CALGreen Code Flow Rate – Mandatory	6.5	gal/cycle	CBSC 2013a
2013 CALGreen Code Flow Rate – Voluntary	4.25	gal/cycle	CBSC 2013b
Compact			
2013 CALGreen Code Flow Rate – Mandatory	4.5	gal/cycle	CBSC 2013a
2013 CALGreen Code Flow Rate – Voluntary	3.5	gal/cycle	CBSC 2013b
Toilets			
2013 CALGreen Code Flow Rate – Mandatory	1.28	gal/flush	CBSC 2013b
2013 CALGreen Code Flow Rate – Voluntary (waterless/composting)	0	gal/flush	CBSC 2013b
Unit Water Consumption			
Lavatory faucets	1,319	gal/fixture/year	Guy et al. 2013
Kitchen faucets	11,944	gal/fixture/year	Guy et al. 2013
Dishwashers	215	cycles/year	Little 2011
Toilets	5	flushes per person per day	Hauenstein 2013
Nonresidential Fixtures			
Lavatory Faucets			
2013 CALGreen Code Flow Rate – Mandatory	0.50	gal/min	CBSC 2013c
2013 CALGreen Code Flow Rate – Voluntary	0.35	gal/min	CBSC 2013c
Kitchen Faucets			
2013 CALGreen Code Flow Rate – Mandatory	2.20	gal/min	CBSC 2013c
2013 CALGreen Code Flow Rate – Voluntary	1.60	gal/min	CBSC 2013c
Toilets			
2013 CALGreen Code Flow Rate – Mandatory	1.28	gal/min	CBSC 2013c
2013 CALGreen Code Flow Rate – Voluntary	1.12	gal/min	CBSC 2013c

Parameter	Value	Unit	Source
<u>Municipal</u>			
2012 Water Use			
MMWD	64,696,016	gallons/year	Armanino pers. comm.
Dedicated Landscaping	15,147,748	gallons/year	Armanino pers. comm.
Potable, Mixed Use	17,350,608	gallons/year	Armanino pers. comm.
Recycled Water	32,197,660	gallons/year	Armanino pers. comm.
NMWD	13,961,420	gallons/year	Armanino pers. comm.
Unknown	258,060	gallons/year	Armanino pers. comm.
Irrigation	12,816,232	gallons/year	Armanino pers. comm.
Park Facilities	422,620	gallons/year	Armanino pers. comm.
Airport Facilities	80,036	gallons/year	Armanino pers. comm.
Temp Hydrant	22,440	gallons/year	Armanino pers. comm.
Fire Station	175,780	gallons/year	Armanino pers. comm.
Medical Clinic	186,252	gallons/year	Armanino pers. comm.
SBWD	0	gallons/year	Armanino pers. comm.
2012-2020 growth factor	1.07		
2020 Water Use			
MMWD	69,479,455	gallons/year	Calculated by ICF
Dedicated Landscaping	16,267,729	gallons/year	Calculated by ICF
Potable, Mixed Use	18,633,463	gallons/year	Calculated by ICF
Recycled Water	34,578,263	gallons/year	Calculated by ICF
NMWD	14,993,688	gallons/year	Calculated by ICF
Unknown	277,140	gallons/year	Calculated by ICF
Irrigation	13,763,828	gallons/year	Calculated by ICF
Park Facilities	453,867	gallons/year	Calculated by ICF
Airport Facilities	85,954	gallons/year	Calculated by ICF
Temp Hydrant	24,099	gallons/year	Calculated by ICF
Fire Station	188,777	gallons/year	Calculated by ICF
Medical Clinic	200,023	gallons/year	Calculated by ICF
SBWD	0	gallons/year	Calculated by ICF

Parameter	Value	Unit	Source
AGRICULTURE			
2012 and 2020 Community			
Acres of Pasture, Irrigated/Rangeland – Countywide	122,775	acres	U.S. Department of Agriculture 2013
Acres of Pasture, Irrigated/Rangeland – Unincorporated	118,015	acres	U.S. Department of Agriculture 2013
Livestock Counts - Unincorporated			
Milk cows and heifers (2 years and older)	8,663	head	Calculated values using the Marin County 2012 Crop Report (Marin County Department of Agriculture 2013) and the percentage of rangeland acres located in the unincorporated county
Beef cows and heifers (2 years and older)	5,894	head	
Beef calves	6,355	head	
Dairy calves	4,324	head	
Laying hens and pullets	155,095	head	
Sheep and lambs	8,767	head	
Hogs	4,013	head	
Goats	4,013	head	
Manure Management Emissions			
Cattle	45,639	$MTCO_2e$	Calculated value
Other livestock	6,270	$MTCO_2e$	Calculated value
EMISSION FACTORS			
2012 Energy			
CO_2 (PG&E)	0.445	Pounds/kilowatt-hour	PG&E 2014a
CO_2e (MCE Light Green)	0.380	Pounds/ kilowatt -hour	Kudo pers. comm.
CO_2e (MCE Deep Green)	0	Pounds/ kilowatt -hour	Kudo pers. comm.
CO_2e (MCE Unspecified)	0.190	Pounds/ kilowatt -hour	Calculated by ICF (average of light and deep green)
CO_2 (eGRID – Direct Access)	0.611	Pounds/kilowatt-hour	U.S. EPA 2014
CH_4	0.0000285	Pounds/kilowatt-hour	U.S. EPA 2014
N_2O	0.0000060	Pounds/kilowatt-hour	U.S. EPA 2014

Parameter	Value	Unit	Source
CO_2 (natural gas)	11.7	Pounds/therm	PG&E 2014a
CH_4 (natural gas)	0.005	Kilograms/MMBtu	ICLEI – Local Governments for Sustainability USA. 2012 (Table B.3)
N_2O (natural gas)	0.0001	Kilograms/MMBtu	ICLEI – Local Governments for Sustainability USA. 2012 (Table B.3)
2020 Energy			
CO_2 (PG&E BAU)	0.4998	Pounds/kilowatt-hour	Calculated by ICF
CO_2 (PG&E RPS-adjusted)	0.290	Pounds/kilowatt-hour	PG&E 2013
CO_2 (eGRID RPS-adjusted)	0.451	Pounds/kilowatt-hour	Calculated by ICF
CH_4 (PG&E and eGRID RPS-adjusted)	0.000021	Pounds/kilowatt-hour	Calculated by ICF
N_2O (PG&E and eGRID RPS-adjusted)	0.0000045	Pounds/kilowatt-hour	Calculated by ICF
T&D losses	6.84%	per kilowatt-hour	U.S. EPA 2014
OFF-ROAD			
CO_2 (gasoline)	8.78	Kilograms/gallons	Climate Registry 2014
CO_2 (diesel)	10.21	Kilograms/gallons	Climate Registry 2014
SOCIOECONOMIC DATA			
Population			
2012 Marin Unincorporated	67,380	persons	California DOF 2014
2012 Marin County Total	253,374	persons	California DOF 2014
2020 Marin Unincorporated	69,600	persons	Wong pers. comm.
2020 Marin County Total	261,100	persons	Wong pers. comm.
Households			
2012 Marin Unincorporated	26,258	Occupied dwellings	California DOF 2014
2012 Marin County Total	103,336	Occupied dwellings	California DOF 2014
Single Family Homes - 2012	21,848	Occupied dwellings	California DOF 2014
Multi Family Homes - 2012	3,906	Occupied dwellings	California DOF 2014
Mobile Homes - 2012	504	Occupied dwellings	California DOF 2014

Parameter	Value	Unit	Source
2020 Marin Unincorporated	26,650	Occupied dwellings	Wong pers. comm.
2020 Marin County Total	106,170	Occupied dwellings	Wong pers. comm.
Single Family Homes – 2020	22,174	Occupied dwellings	Calculated by ICF
Multi Family Homes – 2020	3,964	Occupied dwellings	Calculated by ICF
Mobile Homes – 2020	512	Occupied dwellings	Calculated by ICF
Persons per Household – 2012	2.57	Persons per household	
Persons per Household – 2020	2.61	Persons per household	
Employment			
2012 Marin Unincorporated	16,672	jobs	California DOF 2014
2012 Marin County Total	112,526	jobs	California DOF 2014
2020 Marin Unincorporated	17,880	jobs	Wong pers. comm.
2020 Marin County Total	119,990	jobs	Wong pers. comm.
Marin County Total Employees – 2012	2,164	employees	Armanino pers. comm.
Marin County Full Time Employees – 2012	1,964	employees	Armanino pers. comm.
Marin County Total Employees – 2020	2,324	employees	Armanino pers. comm.
Marin County Full Time Employees – 2020	2,109	employees	Armanino pers. comm.
OTHER			
Percentage GHG reduction from electrified G4 equipment by horsepower			
Less than 25	64.1%	-	CAPCOA 2010
25–50	80.3%	-	CAPCOA 2010
50–120	80.1%	-	CAPCOA 2010
120–175	79.5%	-	CAPCOA 2010
Greater than 175	78.9%	-	CAPCOA 2010
Diesel	72.9%	-	CAPCOA 2010
Gasoline (G2)	64.1%	-	CAPCOA 2010
PG&E and MCE average bundled residential electricity: • 53.4% PGE residential electricity rate ($0.2097) • 45.4% Light Green residential electricity rate ($0.2088) • 1.3% Deep Green residential electricity rate ($0.2190)	$0.20942	$ per kWh in 2016	CEC 2014 and Marin Clean Energy 2014

Parameter	Value	Unit	Source
PG&E and MCE average bundled commercial small- and medium-sized business electricity rate, which includes: • 53.1% PGE commercial small- and medium-sized business electricity rate ($0.1993) • 45.2% Light Green commercial small- and medium-sized business electricity rate ($0.1927) • 1.7% Deep Green commercial small- and medium-sized business electricity rate ($0.2029)	$0.1964	$ per kWh in 2016	CEC 2014 and Marin Clean Energy 2014
PG&E and MCE average bundled large industrial and commercial electricity rate, which includes: • 53.1% PGE large industrial and commercial electricity rate ($0.1683) • 45.2% Light Green large industrial and commercial electricity rate ($0.1549) • 1.7% Deep Green large industrial and commercial electricity rate ($0.1650)	$0.1622	$ per kWh in 2016	CEC 2014 and Pacific Gas & Electric 2015
PG&E average bundled residential natural gas rate	$1.0907	$ per therm in 2016	CEC 2014
PG&E average bundled commercial/municipal natural gas rate	$1.1056	$ per therm in 2016	CEC 2014
PG&E and MCE average bundled municipal rate, which includes: • 24.6% PGE commercial electricity rate ($0.1993) • 74.9% Light Green commercial electricity rate ($0.1927) • 0.4% Deep Green commercial electricity rate ($0.2029)	$0.19436	$ per kWh in 2016	CEC 2014 and Marin Clean Energy 2014
Utility rate escalator	1%	Each year	CEC 2014
Potable water rate	$0.003	$ per gallon	California Water Service Company 2011

Notes:

CAPCOA = California Air Pollution Control Officers; CEC = California Energy Commission; CBSC = California Building Standards Commission; DOE = U.S. Department of Energy; DOF = California Department of Finance; EDD = California Employment Development Division; EIA = Energy Information Administration; EPA = U.S. Environmental Protection Agency; IPCC = Intergovernmental Panel on Climate Change; PG&E = Pacific Gas & Electric.

State Emissions Reduction Strategies

State-1. Renewables Portfolio Standard

Objective: The Renewables Portfolio Standard (RPS) obligates investor-owned utilities (IOUs), energy service providers (ESPs), and Community Choice Aggregators (CCAs) to procure an increasing amount of their electricity from eligible renewable sources. Senate Bill X1-2 was signed by Governor Brown in April 2011 and requires regulated entities to meet RPS goals of 20% of retail sales from renewables by the end of 2013, 25% by the end of 2016, and the 33% by the end of 2020.

Summary Metrics:

Community or Municipal	2020 GHG Reduction[a]	% of All Reductions[b]	% of State Reductions	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
Community	17,512	17.5%	24.6%	-[c]	-[c]	-[c]
Municipal	403	8.6%	12.4%	-[c]	-[c]	-[c]

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Cost analysis not prepared for state-level strategies.

Assumptions: All assumptions utilized for the analysis of this strategy are identified in Table C-7.

Analysis Method: Both PG&E and Marin Clean Energy (MCE) provide electricity to county residents. GHG emissions generated by PG&E-delivered electricity in the 2020 business-as-usual (BAU) community emissions forecast (2020 BAU Community Forecast) and the 2020 BAU Municipal Forecast were quantified using the utility's BAU CO_2e intensity. MCE already meets the requirements of the RPS, so no additional reductions were attributed for MCE-provided electricity relative to the RPS. Some electricity is provided through direct-access service; GHG emissions generated by direct-access electricity were quantified using the statewide average emissions intensities (using the EPA eGRID CAMX region factors). Achievement of the RPS will reduce PG&E's and statewide average BAU carbon intensities. GHG emissions that would be generated by community and municipal electricity consumption in 2020 will therefore be lower as a result of the RPS-adjusted emission factors. These reductions were calculated by multiplying the forecasted 2020 community-wide electricity consumption by the RPS-adjusted emissions factors for PG&E and direct-access. The difference in emissions between the 2020 BAU and 2020 RPS scenarios represents the emissions reductions achieved by this state action.

State-2. Title 24 Standards for Commercial and Residential Buildings

Objective: Title 24 requires that building shells and building components be designed to conserve energy and water. CALGreen mandatory and voluntary measures became effective on January 1, 2011, and the guidelines will be periodically updated. The current energy efficiency standards in Title 24 were last adopted in 2013 and took effect on January 1, 2014. The standards are planned to be updated periodically in the future.

Summary Metrics:

Community or Municipal	2020 GHG Reduction[a]	% of All Reductions[b]	% of State Reductions	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
Community	1,362	1.4%	1.9%	-[c]	-[c]	-[c]
Municipal	-[d]	- [d]	- [d]	-[c]	-[c]	-[c]

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Cost analysis not prepared for state-level strategies.
[d] The only new municipal facility is the Emergency Operations Facility, which will already comply with Title 24 standards.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- State action would apply to new buildings constructed between 2012 and 2020.
- Stringency of the single-family and multi-family residential 2013 Title 24 Standards (effective 2014) increased by 25% and 18%, respectively, relative to the 2008 Standard (California Energy Commission 2012). Stringency of the residential standards is assumed to increase by 17% every three years after 2014.
- Stringency of the nonresidential 2013 Title 24 Standard (effective 2014) increased by 30%, relative to the 2008 Standard (California Energy Commission 2012). Stringency of the nonresidential standards is assumed to increase by 7% every three years after 2014.

Analysis Method: Revisions to the single-family, multi-family, and nonresidential Title 24 standards in 2013 increased the stringency by 25%, 14%, and 30%, respectively, relative to the 2008 standards, which were in place at the time of the 2012 community emissions inventory (2012 Community Inventory). It was assumed that Title 24 will be revised again in 2017[1] to include a 17% and 7% stringency increase in the residential and nonresidential standards, respectively, relative to the 2013 standard. Community-wide energy reductions in 2020 were calculated based on the assumed stringency increases in the Title 24 standards and the annual fraction of electricity subject to each code revision (14% of electricity subject to the 2008 code [year 2013], 43% of electricity subject to the 2014 code [years 2014-2016], and 43% of electricity subject to the 2017 code [years 2017-2019]). Emissions reductions achieved by the strategy were quantified by multiplying the energy reductions by the appropriate RPS-adjusted utility emission factors.

State-3. Lighting Efficiency and Toxics Reduction Act

Objective: Assembly Bill 1109 (AB 1109), Lighting Efficiency and Toxics Reduction Act, is structured to reduce statewide electricity consumption by at least 50% from 2007 levels for indoor residential lighting, and by at least 25% from 2007 levels for indoor commercial and outdoor lighting, by 2018.

[1] The Title 24 standards will likely be revised again in 2020, but the code revision will not take effect until 2021. Accordingly, energy and emissions benefits achieved by the 2020 code update have not been included in the 2020 reduction calculation.

Summary Metrics:

Community or Municipal	2020 GHG Reduction[a]	% of All Reductions[b]	% of State Reductions	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
Community	6,419	6.4%	9.0%	-[c]	-[c]	-[c]
Municipal	-[d]	-[d]	-[d]	-[c]	-[c]	-[c]

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Cost analysis not prepared for state-level strategies.
[d] All municipal facilities already comply with AB 1109.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- State action would apply to buildings constructed before 2012.
- 5.20% of nonresidential electricity is used for outdoor lighting (California Energy Commission 2006).
- 28.9% of nonresidential electricity is used for indoor lighting (California Energy Commission 2006).
- 29.3% of residential electricity is used for indoor lighting (Energy Information Administration 2009).

Analysis Method: Electricity usage from lighting in existing residential and nonresidential developments was estimated by multiplying energy use in 2012 by the fraction of energy that is used for outdoor and indoor lighting. Energy reductions achieved by AB 1109 were calculated by multiplying the estimated lighting consumption by the state goals for residential and nonresidential developments. GHG emissions reductions achieved by the strategy were quantified by multiplying the energy reductions by the appropriate RPS-adjusted utility emission factors.

State-4. Residential Solar Water Heaters

Objective: The Residential Solar Water Heater Program (AB 1470) creates a $25 million per year, 10-year incentive program to encourage the installation of solar water heating systems that offset natural gas and electricity use in homes and businesses throughout the state.

Summary Metrics:

Community or Municipal	2020 GHG Reduction[a]	% of All Reductions[b]	% of State Reductions	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
Community	178	0.2%	0.3%	-[c]	-[c]	-[c]
Municipal	-[d]	-[d]	-[d]	-[c]	-[c]	-[c]

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Cost analysis not prepared for state-level strategies.
[d] This measure does not apply to municipal facilities.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- State action would apply to buildings constructed before 2020.
- Natural gas solar water heaters reduce natural gas use by 130 therms (California Air Resources Board 2008).
- Electric solar water heaters reduce electricity use by 2,195 kilowatt-hours (kWh) (U.S. Department of Energy 2012a).
- An average of 0.013 water heaters per home will be replaced as a result of the strategy in 2020 (California Air Resources Board 2008).

Analysis Method: The ARB estimates that implementation of AB 1470 would result in the installation of 200,000 solar water heaters by 2020. The solar water heaters will reduce either natural gas use by 130 therms or electricity use by 2,195 kWh, depending on the type of auxiliary tank system. Natural gas and electricity reductions were calculated by multiplying the expected energy reductions by the percentage of homes with each system type and estimated number of water heaters in the county. GHG emissions reductions achieved by the strategy were quantified by multiplying the energy reductions by the appropriate RPS-adjusted utility emission factors.

State-5. Pavley Emissions Standards for Passenger Vehicles and the Low Carbon Fuel Standard

Objective: Pavley will reduce GHG emissions from automobiles and light-duty trucks (2009 model years and newer) by 30% from 2002 levels by the year 2016. The state's vehicle efficiency standards have been harmonized with federal vehicle efficiency standards. The low carbon fuel standard (LCFS) would reduce GHG emissions by requiring a low carbon intensity of transportation fuels sold in California by at least 10% by the year 2020.

Summary Metrics:

Community or Municipal	2020 GHG Reduction[a]	% of All Reductions[b]	% of State Reductions	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
Community	42,920	42.8%	60.3%	-[c]	-[c]	-[c]
Municipal	2,653	56.6%	81.7%	-[c]	-[c]	-[c]

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Cost analysis not prepared for State-level strategies.

Assumptions: All assumptions utilized for the analysis of this strategy are identified in Table C-7 and contained within the EMFAC2011 model.

Analysis Method: The ARB's EMFAC2011 model provides GHG emission factors that account for the statewide impact of Pavley and LCFS. The 2020 VMT forecast for the county were multiplied by the EMFAC2011 emission factors to obtain GHG emissions assuming implementation of Pavley and LCFS. Local GHG emissions reductions achieved by Pavley and LCFS were calculated by subtracting the Pavley and LCFS adjusted emissions from the 2020 BAU emissions for the transportation sector.

State-6. Advanced Clean Cars

Objective: The Advanced Clean Car (ACC) rule will further reduce GHG emissions from automobiles and light-duty trucks for 2017–2025 vehicle model years. The state's vehicle efficiency standards have been harmonized with federal vehicle efficiency standards.

Summary Metrics:

Community or Municipal	2020 GHG Reduction[a]	% of All Reductions[b]	% of State Reductions	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
Community	2,226	2.2%	3.1%	-[c]	-[c]	-[c]
Municipal	161	3.4%	4.9%	-[c]	-[c]	-[c]

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Cost analysis not prepared for state-level strategies.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- The ACC rule will reduce statewide emissions from passenger vehicles by 3.8 million $MTCO_2e$ in 2020 (California Air Resources Board 2013).

Analysis Method: The EMFAC2011 model does not include emissions benefits from the ACC rule. Local reductions achieved by the ACC rule were therefore obtained by apportioning expected statewide reductions to the county level. The ARB estimates that implementation of the ACC rule will reduce statewide emissions from light-duty vehicles by 3.8 million $MTCO_2e$ in 2020, or by approximately 2.5% (California Air Resources Board 2013). Emissions reductions achieved by the ACC rule within Marin were therefore quantified by multiplying GHG emissions from light-duty vehicles by 0.025. Reductions achieved by Pavley and LCFS were removed from the light-duty emissions forecast to avoid double counting.

S-6. Assembly Bill 32 Vehicle Efficiency Measures

Objective: The AB 32 scoping plan includes several vehicle efficiency measures that focus on maintenance practices. The Tire Pressure Program will increase vehicle efficiency by assuring properly inflated automobile tires to reduce rolling resistance. The Heavy-Duty Vehicle Aerodynamic Efficiency Program will increase heavy-duty vehicle (long-haul trucks) efficiency by requiring installation of best available technology and/or ARB approved technology to reduce aerodynamic drag and rolling resistance. Finally, the Heavy-Duty Vehicle Hybridization Program will reduce GHG emissions through the use of hybrid and zero-emission technology.

Summary Metrics:

Community or Municipal	2020 GHG Reduction[a]	% of All Reductions[b]	% of State Reductions	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
Community	574	0.6%	0.8%	-[c]	-[c]	-[c]
Municipal	29	0.6%	0.9%	-[c]	-[c]	-[c]

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Cost analysis not prepared for state-level strategies.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- The Tire Pressure Program will reduce statewide emissions from passenger vehicles by 0.6 million $MTCO_2e$ (California Air Resources Board 2013).
- The Heavy-Duty Vehicle Aerodynamic Efficiency Program will reduce statewide emissions from heavy-duty vehicles by 0.7 million $MTCO_2e$ (California Air Resources Board 2013).
- The Heavy-Duty Vehicle Hybridization Program will reduce statewide emissions from heavy-duty vehicles by 0.1 million $MTCO_2e$ (California Air Resources Board 2013).

Analysis Method: The ARB estimates that implementation of the Tire Pressure Program will reduce statewide emissions from light-duty vehicles by 0.6 million $MTCO_2e$, or by approximately 0.39%. Implementation of the Heavy-Duty Vehicle Programs (Aerodynamic Efficiency and Hybridization) will reduce statewide emissions from heavy-duty vehicles by 0.8 million $MTCO_2e$, or by approximately 1.9%. Emissions reductions achieved by the Tire Pressure and Heavy-Duty Vehicle Programs were therefore quantified by multiplying GHG emissions from light-duty vehicles and heavy-duty vehicles, respectively, by 0.0039 and 0.019. Reductions achieved by Pavley, LCFS, and ACC were removed from the light-duty emissions forecast to avoid double counting.

Local Emissions Reduction Strategies – Community

Energy Efficiency and Renewable Energy

Energy-1. Community Choice Aggregation

Objective: Marin Clean Energy (MCE), launched in 2010, is a community choice aggregation program and electricity provider that works with PG&E to provide their customers between 50-100% renewable energy. This measure includes the potential to increase participation in the Deep Green program from 1% to 5% by 2020.

Assembly Bill 117 (2002) enables California cities and counties, either individually or collectively, to supply electricity to customers within their jurisdiction by establishing a CCA program. Unlike a municipal utility, a CCA does not own transmission and delivery systems, but is responsible for providing electricity to residents and businesses. The CCA may own electric generating facilities, but more often, it purchases electricity from private electricity generators.

It should be noted that MCE is not the County of Marin's program; MCE is a separate, independent entity that operates the CCA program that serves Marin residents and businesses. However, the County will work with MCE to increase participation in the Deep Green program and support MCE's long-term aim for all-renewable electricity. The County will encourage MCE to focus on distributed renewable systems as opposed to Renewable Energy Certificates. As Deep Green gathers momentum and capacity, the County will urge MCE to fund local energy efficiency programs as well as local renewables using Deep Green revenue.

The County will work with MCE to promote, advocate, incentivize, and enable the "new energy paradigm," the suite of emerging new technologies that will make distributed renewable power feasible and affordable. Such technologies include robust energy efficiency, conservation and behavior changes, battery energy storage, "prosumerism" (consumers become producers), "wise grid" management and advanced community-level controls, wireless technology, demand response, microgrids, nanogrids, combined heat and power (co-generation), and rooftop technologies.

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of BE Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
2,744	2.7%	9.4%	15.8%	-[d]	-[d]	-[d]

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for Building Energy (BE) including energy efficiency and renewable energy strategies.
[d] Cost analysis not prepared for this measure.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- The participation rate in MCE's Deep Green energy service would increase from 1% in 2012 to 5% in 2020 (MCE 2013).

Analysis Method: New MCE Deep Green customers were assumed to be previous PG&E customers (not MCE Light Green customers). The increase in participation from 1% to 5% represents a fivefold increase in Deep Green customers, and an associated fivefold increase in Deep Green electricity service. The increase in Deep Green electricity is equal to a decrease in PG&E electricity. GHG emission reductions were calculated by multiplying the new Deep Green electricity use by the 2020 RPS-adjusted emission factors for PG&E.

Energy-2. Energy Efficiency

The following sub-measures are part of the County's Energy Efficiency action strategy.

Energy-2.1. Community Energy Efficiency Retrofits

Objective: This measure encompasses all existing programs to improve the energy efficiency of community buildings (including homes and businesses) through retrofits, which occurred from 2013 to 2014. Existing energy retrofit programs include the Marin Energy Watch Partnership and MCE Clean Energy retrofits[2].

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of BE Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
1,925	1.9%	6.6%	11.1%	-[d]	-[d]	-[d]

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for Building Energy (BE) including energy efficiency and renewable energy strategies.
[d] Cost analysis not prepared for this measure.

[2] The Bay Area Regional Energy Network (BayREN) program also resulted in energy savings in Marin County, but the data available was only for the 9-county Bay Area region and it was too speculative to apportion these savings to unincorporated Marin County.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- The proportion of energy consumption in the unincorporated county compared to the county as a whole is: 48.7% of residential electricity, 37.8% of nonresidential electricity, 25.0% of residential natural gas, and 22.4% of nonresidential natural gas.
- Marin Energy Watch Partnership energy savings goals for the 2013-2014 program cycle for the entire county (including the incorporated cities) were 250,000 kWh for residential and 4,800,000 kWh for nonresidential.
- MCE Clean Energy savings goals for the 2013-2014 program cycle for the entire county (including the incorporated cities) were 7,006,181 kWh and 42,239 therms for residential and 6,080,000 kWh and 520,364 therms for nonresidential.

Analysis Method: Energy savings goals associated with the Marin Energy Watch Partnership and MCE Clean Energy retrofits for the entire county (including the incorporated cities) for the years 2013 and 2014 was apportioned to the unincorporated county using the proportion of energy consumed in the unincorporated county compared to the county as a whole. GHG emissions reductions achieved by the strategy were quantified by multiplying the energy reductions by the appropriate RPS-adjusted utility emission factors.

Implementation Information: N/A

Supporting Marin Countywide Plan policies: EN-1.d Explore energy efficiency standards for existing buildings, EN-1.h Support low income weatherization, EN-1.i Reduce energy use in processing operations.

Energy-2.2. Expand Community Energy Efficiency Retrofits Program

Objective: Promote energy efficiency in existing residential buildings and commercial buildings, and remove funding barriers for energy efficiency improvements. Achieve the voluntary residential and nonresidential energy efficiency retrofit goals outlined in Table C-8 by 2020. Providing a variety of retrofit packages allows homeowners to select and customize retrofit options that meet their needs.

The County is also exploring an update to its Green Building Ordinance (see Supporting Measure Energy-5) which would require, at minimum that remodels and additions achieve energy efficiency savings greater than minimum state code requirements. The County will also conduct an all-Marin “Energy Efficiency Homes and Businesses” campaign to rally community buy-in for large-scale energy efficiency gains. The County will also help businesses and consumers implement retrofits and provide information about costs, savings and co-benefits associated with the efficiency retrofits.

Energy efficiency upgrades at residential, commercial and industrial buildings will reduce energy consumption and could provide a variety of co-benefits for the workforce. For example, a well-built energy-efficient structure is more durable and directly reduces certain health risks (e.g., mold, dust mites). Energy efficient buildings also improve general comfort by equalizing room temperatures and reducing indoor humidity.

Table C-8. Voluntary Residential Energy Efficiency Retrofit Goals

Retrofit Level	Implementation Goal	Minimum Retrofits
Basic	12% of existing single-family homes	• Replace interior high use incandescent lamps with LEDs • Seal air leaks
Advanced	5% of existing single-family homes	• All *basic* retrofits • Seal duct leaks • Install a programmable thermostat • Replace windows with double-pane, solar-control low E-argon gas wood frame windows
Premium	3% of existing single-family homes	• All *advanced* retrofits • Insulate the attic • Replace electric clothes dryers with natural gas dryers • Replace natural gas furnaces with ENERGY STAR labeled models
Multi-family	20% of existing multi-family homes	• Will vary on a case-by-case basis. Retrofits should reduce energy consumption (electricity and natural gas) by at least 15%, relative to existing conditions.
Nonresidential	15% of existing nonresidential buildings	• Will vary on a case-by-case basis. Retrofits should reduce energy consumption (electricity and natural gas) by at least 20%, relative to existing conditions.

The participation rates listed in the table above are based on the past success of County retrofit programs. For example, the BayREN program completed 521 single-family energy efficiency upgrades between July 2013 and June 2014 (Bay Area Regional Network 2014). Many of these homes were in Marin County. The California Youth Energy Services (CYES) program has a demonstrated track record of assisting homeowners with retrofit measures. Since 2006, this program has retrofitted nearly 5,000 homes, replaced more than 40,000 incandescent bulbs with CFLs and LEDs, replaced more than 5,000 water devices (such as faucets aerators and showerheads), and saved more than 2 million kWh of electricity and 5,000 therms of natural gas (Armanino pers. comm.). In 2014 alone, the CYES program installed (at no cost) more than 3,000 CFLs, more than 2,000 LEDs, and more than 100 efficient-flow showerheads and aerators, among other items, in Marin homes and saved more than 100,000 kWh of electricity, 600 therms of natural gas, and 180 gallons of water per minute (California Youth Energy Services 2014). Given the proven track record of successful home energy retrofits in Marin County, the County believes that the implementation goals listed in Table C-2, above, are realistic for this measure.

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of BE Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
5,601	5.6%	19.3%	32.2%	\$300–\$500	\$6,000,000–\$15,000,000	\$3,000,000

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for Building Energy (BE) including energy efficiency and renewable energy strategies.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- Strategy goals would apply to residential and nonresidential buildings constructed before 2015.
- Energy reductions achieved by the basic retrofit level would be 997 kWh and 91 therms per single-family house (U.S. Department of Energy 2013a).
- Energy reductions achieved by the advanced retrofit level would be 1,143 kWh and 171 therms per single-family house (U.S. Department of Energy 2013a).
- Energy reductions achieved by the premium retrofit level would be 2,106 kWh and 268 therms per single-family house (U.S. Department of Energy 2013a).
- Initial costs per single-family retrofits are $880 to $1,900 for the basic level, $2,600 to $4,800 for advanced, and $5,200 to $8,400 for premium (U.S. Department of Energy 2013a).
- The cost per square foot for building energy audits ranges from $0.18 to $0.50 for a comprehensive energy audit (AECOM 2010).
- The cost per square foot for building energy retrofits (5% to 20% energy efficiency improvement) are $0.30 to $1.01 (Pike Research 2010; AECOM 2010).

Analysis Method: Energy savings associated with the single-family retrofit levels were estimated using the DOE's Home Energy Saver™ (HES). Electricity and natural gas savings provided by the HES were multiplied by the implementation goals (see Table C-8) and the estimated number of homes in 2015 to obtain total energy reductions for single-family residences. Energy reductions achieved by multi-family retrofits were quantified assuming the upgrades would reduce energy consumption by 15%, relative to BAU conditions. GHG emissions reductions achieved by the strategy were quantified by multiplying the energy reductions by the appropriate RPS-adjusted utility emission factors.

Energy reductions achieved by nonresidential retrofits were quantified assuming the upgrades would reduce facility-wide energy use by 20%. This reduction was multiplied by the forecasted electricity and natural gas consumption for participating buildings constructed before 2015. Energy savings from overlapping state and local strategies were removed from the energy forecast to avoid double counting. GHG emissions reductions achieved by the strategy were quantified by multiplying the energy reductions by the appropriate RPS-adjusted utility emission factors.

Upfront retrofit costs for single-family homes were estimated using the HES. For most upgrades, costs reflect the assumption that updates will be made at the end of the useful life of the currently-installed appliance or furnace (and thus represent the incremental cost of the more energy efficient unit). Upfront retrofit costs for multi-family homes were based on costs and energy savings reported by the California Home Energy Retrofit Coordinating Committee (2011). These costs were scaled for the county based on total energy reductions. Annual cost savings for both single- and multi-family homes were calculated by multiplying electricity and natural gas reductions by the appropriate PG&E utility rates.

Upfront costs for nonresidential buildings would be incurred to conduct an energy audit and perform the physical retrofits. Costs of conducting building energy audits were estimated based on the total square footage of participating nonresidential buildings and the cost per square foot for energy audits. A similar method was used to estimate upfront costs associated with the physical retrofit. Annual energy cost savings were calculated by multiplying the electricity and natural gas reductions by the appropriate PG&E utility rates.

Implementation Actions: Actions may include: Implementing a low-income weatherization program, expanding energy efficiency outreach/education campaigns targeted at residents and businesses, promoting the smart grid, funding and scheduling energy efficiency tune-ups, promoting energy efficiency management services for large energy users and promoting energy efficiency financing tools.

Supporting Marin Countywide Plan policies: EN-1.d Explore energy efficiency standards for existing buildings, EN-1.h Support low income weatherization, EN-1.i Reduce energy use in processing operations.

Energy-2.3. Tree Planting

Objective: Plant at least 310 shade trees per year within the county beginning in 2015. This measure will reduce energy consumption and associated GHG emissions in the building energy sector by reducing the heat island effect.

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of BE Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
23	0.02%	0.1%	0.1%	-[d]	-[d]	-[d]

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for Building Energy (BE) including energy efficiency and renewable energy strategies.
[d] Cost analysis not prepared for this measure.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- Strategy requirements would take effect in 2015.
- 310 shade trees per year would be planted by developers and the County adjacent to buildings, to provide shade for those buildings.
- Average tree planting age is 1 year and 96% of planted trees would survive.
- Trees would be a mix of maple, ash, pine, oak, and redwood.

Analysis Method: Energy savings from reduced building cooling and heating were obtained from the U.S. Forest Service's (2011) Tree Carbon Calculator for each tree species. The values were multiplied by the expected number of trees planted per year. All 310 trees planted per year were assumed to be planted adjacent to private property were included in the calculations; trees planted in the public right of way were not assumed to provide building shade. GHG emissions reductions achieved by the strategy were quantified by multiplying the total energy reductions by the appropriate RPS-adjusted utility emission factors. Carbon sequestration benefits were not evaluated as they are outside the scope of the CAP.

Although a cost analysis was not performed for this measure, the County or developers would incur upfront costs to plant, stake, and mulch trees. Maintenance costs would also occur. Cost savings for benefits such as air quality, health, property value, or intrinsic value improvements would likely occur; some studies show a net benefit for trees when these co-benefits are monetized.

Implementation Information: The County already requires accounting for trees removed and planted as part of new construction. Additional implementation mechanisms might include establishing goals and funding sources for new trees planted on County property.

Supporting Marin Countywide Plan policies: Air-4.j Acquire and restore natural resource systems, Air-4.k Encourage the planting of trees and the following implementing programs, AIR-4.k - Encourage the Planting of Trees, BIO-4.I - Preserve Agricultural Lands, DES-3.e - Encourage Small-Scale Green Spaces.

Energy-3. Solar Energy

The following sub-measures are part of the County's Solar Energy action strategy.

Energy-3.1. Solar Installations for New Residential Development

Objective: Implement solar energy installation requirements for new residential buildings to increase renewable energy generation. This is a mandatory measure to install solar on 20% of new single-family residential buildings. Under this measure, the County will also work to install solar on as many new multi-family homes as feasible.

As part of the County's green building ordinance update planned for 2015, the County will explore the feasibility of continuing a net-zero-energy requirement for new construction projects. The County will also explore approaches being used by other jurisdictions such as the Town of Tiburon, City of Sebastapol and City of Lancaster to mandate the use of solar energy as part of its green building ordinance update process.

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of BE Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
34	0.03%	0.1%	0.2%	\$20–\$200 (DP); \$200–\$300 (PPA)	\$600,000–700,000	\$50,000 (DP); \$5,000–\$10,000 (PPA)

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for Building Energy (BE) including energy efficiency and renewable energy strategies.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- There would be an estimated 204 new single-family homes constructed between 2015 and 2020, based on a linear interpolation of 21,848 homes in 2012 and 22,174 homes 2020.
- 20% of new single-family housing units would participate in this measure, for a total of 41 single-family houses.
- The County will also work to install solar on as many new multi-family homes as feasible. However, the County does not currently have a target for the number of systems to install on new multi-family buildings by 2020, and therefore, GHG reductions from multi-family solar are not currently included in this measure.
- Each 4 kW residential solar system would generate 5,606 kWh per year, which represents a typical residential system (U.S. Department of Energy 2013b).

- Initial costs for a residential system (4 kW, roof-mounted) range from $4.90 to $5.70 per watt (Lawrence Berkeley National Laboratory and U.S. Department of Energy 2013).
- Solar systems would have a 25-year lifetime (U.S. Department of Energy 2013b).

Analysis Method: The PVWatts model was used to calculate the energy potential of each residential solar installation. This value was multiplied by forecasted number of participating homes constructed between 2015 and 2020 to determine total residential energy reductions achieved by the strategy. GHG emissions reductions were then quantified by multiplying the total energy reductions by the appropriate RPS-adjusted utility emission factors.

The cost analysis considered two financing scenarios:

- **Direct Purchase**: The building owner is assumed to directly purchase, install and maintain the solar panels
- **Power Purchase Agreement**: The building owner enters into a power purchase agreement (PPA) with a local company who owns and maintains the solar panels.

Total capital costs under the direct purchase scenario were calculated on a per-project basis based on an initial cost of $4.90 to $5.70 per watt installed. The lower residential cost includes a federal investment tax credit (ITC) of 30% of the system cost. Annual operating costs of $0.02 per watt were assumed, based on the PVWatts model. Annual energy cost savings were based on electricity production (which decreases slightly each year due to system degradation), multiplied by the appropriate PG&E utility rates (assumes an annual utility rate escalator of 1%).

No upfront costs were assumed under the PPA scenario. Annual costs savings were estimated to be 10% off the retail value of the electricity generated (GreenZU 2014).

Implementation Information: This could be implemented through discretionary approvals and permitting for new projects. Form partnerships with PG&E and other private sector funding sources including SunRun, SolarCity, and other solar lease or PPA companies to encourage solar installations. Funds may be provided through the Marin Clean Energy Solar Rebate program or the Property Assessed Clean Energy (PACE) financing program. The County will work to streamline the permitting of local solar and storage installations.

The County will also explore approaches that are being used by other jurisdictions, such as the Town of Tiburon, City of Sebastapol and City of Lancaster, to mandate the use of solar energy as part of its green building ordinance update process.

Supporting Marin Countywide Plan Policies: N/A

Energy-3.2. Solar Installations for New Nonresidential Development

Objective: Implement solar energy installation requirements for new nonresidential buildings to increase renewable energy generation. This is a mandatory measure to install solar on 20% of new nonresidential buildings.

As part of the green building ordinance update planned for 2015, the County will explore the feasibility of continuing a net-zero-energy requirement for new construction projects. As noted above, the County will also explore approaches that are being used by other jurisdictions to mandate the use of solar energy as part of its green building ordinance update process.

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of BE Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
23	0.02%	0.1%	0.1%	\$30–\$300 (DP); \$200–\$300 (PPA)	\$300,000–\$400,000	\$30,000 (DP); \$3,000–\$6,000 (PPA)

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for Building Energy (BE) including energy efficiency and renewable energy strategies.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- 20% of nonresidential buildings constructed between 2015 and 2020 would be required to incorporate onsite solar energy generation to provide 100% of the project's energy needs.
- Electricity use for nonresidential buildings constructed between 2015 and 2020 was estimated using a linear interpolation of 2012 electricity use and 2020 electricity use.
- Initial costs for a nonresidential system (40 kW roof-mounted) ranges from \$4.30 to \$5.30 per watt (Lawrence Berkeley National Laboratory and U.S. Department of Energy 2013).

Analysis Method:

Nonresidential energy reductions were calculated by multiplying the forecasted electricity consumption for buildings constructed after 2015 by a 10% participation rate. Electricity savings from overlapping state and local strategies were removed from the nonresidential energy forecast to avoid double counting. GHG emissions reductions were then quantified by multiplying the total energy reductions by the appropriate RPS-adjusted utility emission factors.

The cost analysis considered two financing scenarios:

- **Direct Purchase**: The building owner is assumed to directly purchase and install the solar panels
- **Power Purchase Agreement**: The building owner enters into a power purchase agreement (PPA) with a local company who owns and maintains the solar panels.

Total capital costs under the direct purchase scenario were calculated on a per-project basis based on an initial cost of \$4.30 to \$5.30 per watt installed. The lower nonresidential cost scenario includes solar renewable energy certificate (SREC) valued at \$10 per MWh. The higher cost scenarios also include the ITC. Annual operating costs of \$0.02 per watt were assumed, based on the PVWatts model. Annual energy cost savings were based on electricity production (which decreases slightly each year due to system degradation), multiplied by the appropriate PG&E utility rates (assumes an annual utility rate escalator of 1%).

No upfront costs were assumed under the PPA scenario. Annual costs savings were estimated to be 10% off the retail value of the electricity generated.

Implementation Information: This could be implemented through discretionary approvals and permitting for new projects. Form partnerships with PG&E and other private sector funding sources including SunRun, SolarCity, and other solar lease or PPA companies to encourage solar installations. Funds may be provided through the Marin Clean Energy Solar Rebate program. The County will work to streamline the permitting of local solar and storage installations.

MCE has designed a feed-in tariff that provides renewable energy system owners with long-term contracts. System owners are obligated to sign a contract for a 20-year term. This program incentivizes homeowners and business owners to install solar systems, even if they have no need for all of the electricity that those systems produce (Marin Clean Energy 2014).

As noted above, the County will also explore approaches that are being used by other jurisdictions to mandate the use of solar energy as part of its green building ordinance update process.

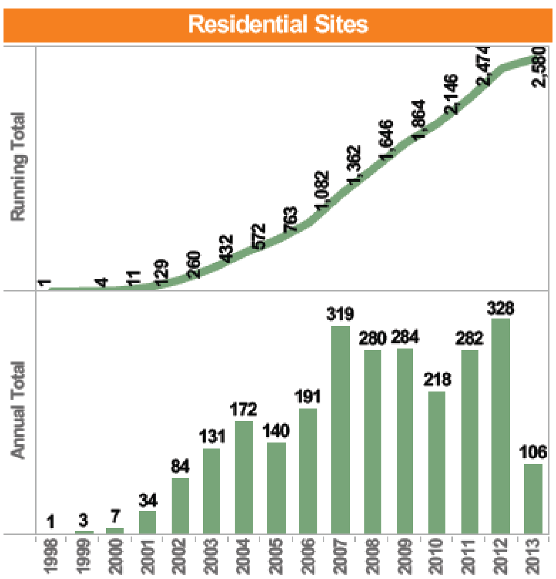
Supporting Marin Countywide Plan Policies: N/A

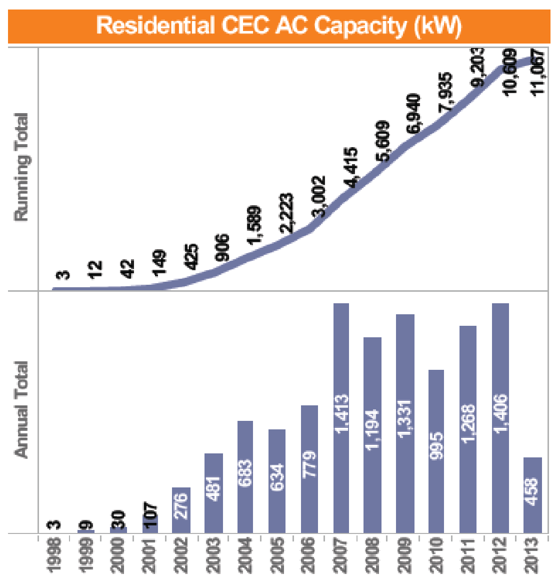
Energy-3.3. Solar Installations for Existing Residential Development

Objective: Achieve the following voluntary solar installation goals for existing development.

- 20% of existing single-family residences install solar photovoltaic (PV).

The estimated 20% participation rate was based on the current and past success of County residential solar programs. As of March 2015, Marin County was ranked 10th in PG&E's territory for the number of projects completed via the California Solar Initiative (CSI). The number of residential solar installations in the county is growing rapidly, as shown in the following figures (Pacific Gas & Electric 2014b):





The County rolled out the CaliforniaFIRST program in the fall of 2014, is considering adding additional PACE program offerings and currently supports solar by offering free technical assistance to residents and businesses that are interested in going solar.

Under this measure, the County will also work to install solar on as many existing multi-family homes as feasible.

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of BE Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
3,950	3.9%	13.6%	22.7%	\$20–\$200(DP); \$100–\$300 (PPA)	\$60,000,000–\$70,000,000	\$5,000,000 (DP); \$500,000–\$1,000,000 (PPA)

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for Building Energy (BE) including energy efficiency and renewable energy strategies.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- Strategy goals would apply to residential buildings constructed before 2015. This is estimated to be 21,970 single family homes, based on a linear interpolation of 21,848 homes in 2012 and 22,174 homes 2020.
- The County will also work to install solar on as many existing multi-family homes as feasible. However, the County does not currently have a target for the number of systems to install on existing multi-family buildings by 2020, and therefore, GHG reductions from multi-family solar are not currently included in this measure.
- Each 4 kW single-family residential solar system would generate 5,606 kWh per year, which represents a typical residential system (U.S. Department of Energy 2013b).
- 20% of existing homes = 4,394 homes installing solar, for a total of approximately 17,576 kW of solar installed.

Analysis Method: The approach for calculating electricity, emissions reductions, and costs is similar to what is described for Energy-3.1, *Solar Installations for New Residential Development*. However, the strategy was assumed to apply to existing developments constructed before 2015, as specified in the strategy objective.

Implementation Information: This could be implemented through permitting for major remodels. The County could form partnerships with PG&E and other private sector funding sources, including SunRun, SolarCity, and other solar lease or PPA companies, to encourage solar installations. Funds may be provided through the Marin Clean Energy Solar Rebate program or the PACE financing program. The County will work to streamline the permitting of local solar and storage installations.

MCE has designed a feed-in tariff that provides renewable energy system owners with long-term contracts. System owners are obligated to sign a contract for a 20-year term. This program incentivizes homeowners and business owners to install solar systems, even if they have no need for all of the electricity that those systems produce (Marin Clean Energy 2014).

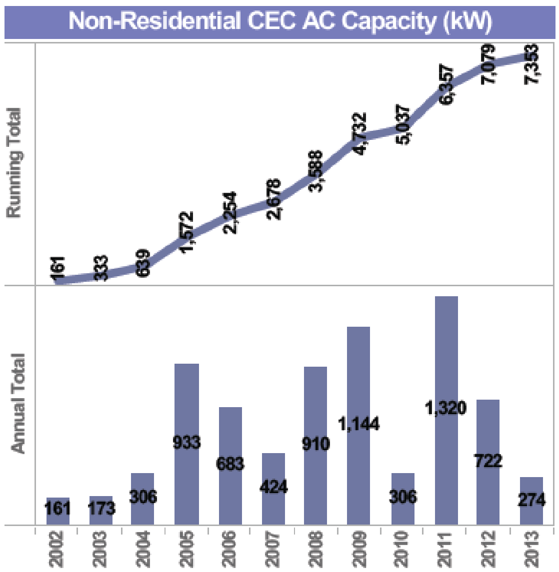
Supporting Marin Countywide Plan Policies: N/A

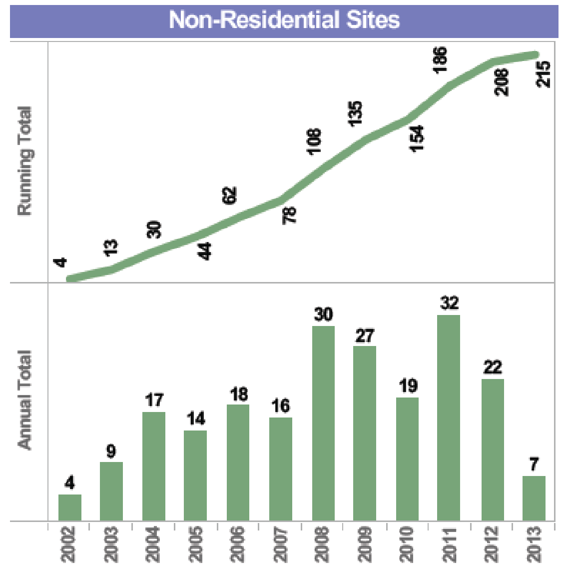
Energy-3.4. Solar Installations for Existing Nonresidential Development

Objective: Achieve the following voluntary solar installation goals for existing development.

- 15% of existing nonresidential developments install solar PV to provide 100% of the building's energy needs.

The estimated 15% participation rate was based on the current and past success of County solar programs. The number of non-residential solar installations in the county is growing rapidly, as shown in the following figures (Pacific Gas & Electric 2014b):





Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of BE Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
3,086	3.1%	10.6%	17.8%	$30–$300 (DP); $100–$200 (PPA)	$40,000,000–$50,000,000	$4,000,000 (DP); $400,000–$800,000 (PPA)

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for Building Energy (BE) including energy efficiency and renewable energy strategies.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- Strategy goals (see above) would apply to nonresidential buildings constructed before 2015.
- Electricity use for nonresidential buildings constructed before 2015 was estimated using a linear interpolation of 2012 electricity use and 2020 electricity use.
- The average system size is 40 kW.
- 15% of existing nonresidential developments equals approximately 13,371 kW of solar installed.

Analysis Method: The approach for calculating electricity, emissions reductions, and costs is similar to what is described for Energy-3.2, *Solar Installations for New Nonresidential Development*. However, the strategy was assumed to apply to existing developments constructed before 2015, as specified in the strategy objective.

Implementation Information: This could be implemented through discretionary approvals and permitting for existing projects.. Form partnerships with PG&E and other private sector funding sources including SunRun, SolarCity, and other solar lease or PPA companies to encourage solar installations. Funds may be provided through the Marin Clean Energy Solar Rebate program. The County will work to streamline the permitting of local solar and storage installations.

MCE has designed a feed-in tariff that provides renewable energy system owners with long-term contracts. System owners are obligated to sign a contract for a 20-year term. This program incentivizes homeowners and business owners to install solar systems, even if they have no need for all of the electricity that those systems produce (Marin Clean Energy 2014).

Supporting Marin Countywide Plan policies: N/A

Supporting Strategies for Energy Efficiency & Renewable Energy Measures

The following community strategies were not quantified for GHG emission reductions or costs and savings, but they support and strengthen the quantified measures listed above and are an important part of the CAP Update.

SP Energy-1. District Financing Program for Energy Efficiency and Renewables

Objective: Participate in a PACE financing program for energy efficiency and renewables for commercial and residential properties.

SP Energy-2. Update Code to Encourage Small-Scale Solar

Objective: Update County codes to encourage responsible development of small-scale (< 1 MW) solar generation facilities. Clarify and streamline County permitting of small units of wholesale solar PV in appropriately sited in environmentally appropriate locations.

SP Energy-3. Promote MCE's Deep Green Program

Objective: Promote residential and commercial participation in MCE's Deep Green program. Goal of 10% to 15% opt-in.

SP Energy-4. Public Education on Zero Net Energy Buildings

Objective: Provide educational material to the public about zero net energy (ZNE) buildings. The County will host training sessions for the public and contractors on new technologies (e.g., thermal heat pumps to replace natural gas heaters). The County hosted a well-attended ZNE forum in 2013 and could host more in the future. The County would encourage new buildings not to use natural gas, propane, or any other fossil fuels and instead use highly efficient electric heat pump systems for heating and cooling, electric heat pump water heaters, and very efficient induction cook tops.

SP Energy-5. Update to County Green Building Ordinance

Objective: In 2015, the Community Development Agency will explore an amendment to the County green building ordinance that includes energy efficiency and green building requirements more stringent than State code for new construction projects as well as substantial additions and remodels. The County will investigate the cost effectiveness of energy budget requirements based on project size, including net-zero requirements, and will also consider the inclusion of requirements for additional green building measures through a third-party rating system (e.g., Build It Green or LEED) or CALGreen (e.g.., Tier 1 or 2).

The County will also explore approaches that are being used by other jurisdictions, such as the Town of Tiburon, City of Sebastapol and City of Lancaster, to mandate the use of solar energy as part of its green building ordinance update process.

Land Use, Transportation, and Off-Road

Trans-1. Land Use Design and VMT Reduction

The following sub-measures are part of the County's Land Use Design and VMT Reduction action strategy. The CAP Update does not propose any new land use strategies or programs. All land use strategies are adapted from the approved Marin Countywide Plan. The CAP Update just quantifies these strategies (as feasible) in terms of GHG reductions.

Trans-1.1. Promote Mixed-Use, Infill, and Transit-Oriented Developments

Objective: The County would promote longstanding Countywide Plan growth control strategy of focusing new development in the city center corridor via mixed-use, infill, and transit-oriented developments in downtown neighborhoods, transit-hubs, and existing and planned transit corridors for the unincorporated county. Development with multiple uses and in infill locations would improve the diversity of nearby land uses and facilitate easy access to retail and commercial destinations. Improving the county's jobs/housing balance would also increase access to work destinations. Locating these diverse uses in proximity to each other would encourage walking or bicycling, reducing VMT. New development near existing and planned high-quality transit[3] and other transit lines would facilitate the use of transit by people traveling to or from the project site, resulting in reduced VMT.

Mixed use development produces less vehicle miles traveled (VMT) on a per capita basis as compared to traditional development. Geographically proximate land uses can decrease VMT since trips between land use types are shorter and may be accommodated by non-auto modes of transport. For example, when residential areas are in the same neighborhood as retail and office buildings, a resident does not need to travel outside of the neighborhood to meet his/her trip needs.

The CAPCOA report states the following about mixed-use development (CAPCOA 2010): "Having different types of land uses near one another can decrease VMT since trips between land use types are shorter and may be accommodated by non-auto modes of transport. For example, when residential areas are in the same neighborhood as retail and office buildings, a resident does not need to travel outside of the neighborhood to meet his/her trip needs."

The CAPCOA report indicates that mixed-use development can result in a 9-30% reduction in VMT, based on two reports: *Travel and the Built Environment - A Meta-Analysis* (Ewing and Cervero 2010) and *Measuring the effects of mixed land uses on housing values* (Song and Knaap 2004). Additional literature cited by CAPCOA that supports VMT reductions from mixed-use developments include *Crediting Low-Traffic Developments* (Nelson\Nygaard 2005) and *A Quick-Response Method of Estimating Travel Impacts from Land-Use Changes* (Criteron Planner/Engineers and Fehr & Peers Associates 2001).

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[3] High-quality transit is defined as fixed-route bus service with intervals no longer than 15 minutes during peak commute hours. The only stops in the unincorporated county that qualify as high-quality transit stops are those in Strawberry (Mill Valley area) and Marin City.

Mixed-use development is widely considered an effective means of reducing traffic impacts. Ranking in the EPA top-ten Smart Growth planning principles, and achieving higher levels of support from planners, policy makers and elected officials and developers, mixing a variety of land uses is generally considered a strategy that optimizes use of transportation infrastructure, improves community quality-of-life, and reduces vehicle travel and related concerns over global warming. Mixed-use developments come in a wide range of sizes, mixes, and configurations. One common characteristic is that such development can reduce off-site traffic impacts by satisfying travel needs within the development site and reducing external travel (Fehr & Peers 2014a).

Fehr & Peers estimates that this measure will increase transit ridership in the county by 11% (Chan pers. comm.). This estimate is based on a study by the Transit Cooperative Research Program (TCRP), which was sponsored by the Federal Transit Administration, titled *Traveler Response to Transportation System Changes Handbook* (Transportation Research Board 2004a). Various chapters from this handbook specifically identify effects on transit ridership after incorporating new strategies, such as Trans 1.1. The total increase in ridership from the study was applied to ridership data from Marin Transit's Short-Range Transit Plan (Marin Transit 2012). This new increase in ridership was then used to provide the baseline modal split (25% for each mode, including transit, carpool, walking, and bicycling). The baseline modal splits were then adjusted according to the individual strategy's effect on ridership. Based on Marin Transit's Short-Range Transit Plan, existing peak-period bus service in Marin has the capacity to support this 11% increase in ridership. Therefore, no additional bus routes or services are needed to support Trans 1.3.

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of TRANS Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
44	0.04%	0.2%	2.5%	-[d]	-[d]	-[d]

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for land use, transportation, and off-road strategies.
[d] Cost analysis not prepared for this measure.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- 38% of projected new units are applicable to this measure assuming 125 new single family units and 75 multi-family units are developed by 2020. Estimates are based on historical permit data/current trends (the County receives permit applications for approximately 25 new single-family homes each year), existing approved but unbuilt projects like the Oakview Master Plan (which is projected to include 75 senior housing units) and existing policies and regulations governing mixed-use development.
- Applicable project characteristics include (based on the approved Oakview Master Plan): density of 8 housing units per acre; 50% multifamily and 50% institutional; 4-mile distance to downtown or major job center; 0.25 mile distance to transit node/route; and 20% of units are deed-restricted below market rate housing (Fehr & Peers 2014b)
- In the event that more projects move forward by 2020, these initial savings estimates would be revisited and revised accordingly.
- Pedestrian network enhancement will occur within the applicable projects and connect off-site (Fehr & Peers 2014b).

- The applicable project, the Oakview Senior Facility, will include access to a car-sharing program
- This strategy would reduce VMT growth in new residential developments by 5.76% to 5.86% (Fehr & Peers 2014b, 2014c). This value was calculated as follows:
    - The equation *1- (1-5%)*(1-0.9%)* was used, where:
        - 5% = VMT credit from land use strategies (including increased density, land use diversity, destination accessibility, transit accessibility, and below market rate housing). Land use strategies in a suburban setting have a maximum/cap on the amount of effectiveness that can be achieved. This is explained in more detail in the CAPCOA report (2010) (Chapter 6, page 61) and essentially utilizes a Holtzclaw report on location efficiency to conduct reasonableness checks to prevent over-estimation of effectiveness of land use strategies.
        - 0.9% = VMT credit from neighborhood site enhancement strategies, including pedestrian access network and a carshare program. The pedestrian network strategy provided 0.8% VMT credit. The calculations are detailed in the CAPCOA report (2010) (Chapter 7, page 186), and are based on two literature resources (Center for Clean Air Policy n.d.; 1000 Friends of Oregon 1997). These literature sources provide a 2% VMT credit for pedestrian accommodations within a project site and connecting off-site. This 2% is reduced by a 38% applicability input (see below) and thus results in a 0.8% VMT credit. The car share strategy provided a 0.1% VMT credit. The calculations are detailed in the CAPCOA report (2010) (Chapter 7, page 245) and are based on two literature resources (Millard-Ball et. al. 2005; Cambridge Systematics 2009). These literature provide a 0.37% VMT credit, and it is reduced by a 38% applicability input (see below) and thus results in a 0.1% VMT credit.
    - The equation *1- (1-5%)*(1-0.9%)* is very similar to simply adding the credit of 5% to 0.8% but instead of adding, "multiplicative dampening" was used to take into account that if one strategy is already reducing VMT, then the additional strategies would be reducing VMT from a smaller base (because the first strategy has already reduced some of the VMT). It is negligible here since 5.0%+0.9% = 5.8% which is very close to 5.86%.
- 38% of new units are applicable to this measure (Fehr & Peers 2014b, 2014c)
- Resulting VMT reductions are 168,084.

Analysis Method: Based on modeling conducted by Fehr & Peers, Trans-1.1 was assumed to result in a light-duty VMT reduction of 168,084 annual miles. Implementation of the strategy is not anticipated to significantly affect the distribution vehicle speeds within the county. Consequently, the percentage reduction in VMT was assumed to be commensurate with the percentage reduction in GHGs. Emissions reductions associated with the strategy were therefore calculated by multiplying the percentage reduction in VMT by emission factors produced by EMFAC2011 for light-duty vehicles.

A moderate level of cost associated with additional staff time to develop policies guidelines, and incentives is anticipated. Developing these guidelines might require as much as ¼ of an FTE for one year.

Implementation Information: The County would promote and apply existing policies and incentives to encourage mixed-use, infill, and transit-oriented development for the unincorporated county. Potential incentives could include parking variances, reductions in building and permit fees, and other related items.

Supporting Marin Countywide Plan policies: HS-3.o - Conduct a Survey of Potential Mixed-Use Sites, HS-3.q - Establish Mixed-Use Development Standards and Incentives, CD-2.c Enact Zoning Changes, CD-2.g - Identify and Plan Mixed-Use Sites, CD-5.b - Develop Highway 101 Corridor–Specific Plans, DES-2.a - Designate Target Nodes, DES-2.b - Encourage Flexible-Use Building Types, DES-2.c - Allow Mixed Use in Commercial Districts, DES-3.a - Encourage Mixed-Use Projects, HS-3.o - Conduct a Survey of Potential Mixed-Use Sites, HS-3.p - Prepare a White Paper on Mixed-Use Housing Development Feasibility, TR-3.f - Promote Transit-Oriented Development, TR-3.f Promote Transit-Oriented Development, DES-2.a - Designate Target Nodes, CD-5.b - Develop Highway 101 Corridor–Specific Plans, HS-3m - Establish Transit-Oriented Development (TOD) Zoning Standards, EC-1.h - Encourage Transit-Oriented Development.

Trans-1.2. VMT Reduction Monitoring and Implementation and Transportation Demand Management Program

Objective: Identify and require in new developments VMT performance thresholds for reducing the VMT 20% below levels that would otherwise occur without implementation of strategies outlined below. Provide developments with a suite of strategies, including, but not limited to, those listed below, as a menu of options to apply to eligible sites or projects. Require that strategy outcomes be monitored on a regular basis.

Potential strategies may include:

- Reduced parking requirements for affordable or senior housing projects
- Reduced cost transit passes
- Unbundled parking costs
- Bicycle amenities
- Car-share pods
- Support alternative work schedules
- Parking cash-out
- Ride-matching services
- Participation in vanpool program
- Emergency ride home

The existing Bay Area Commuter Benefits Program, developed by BAAQMD and MTC, currently requires employers with at least 50 employees to offer commuter benefits to their employees. The program gives employers the flexibility to offer one or more of the following benefits to employees:

- Option 1: Pre-Tax Benefit – Allow employees to exclude up to $130 of their transit or vanpooling expenses each month from taxable income.
- Option 2: Employer-Provided Subsidy – Provide a subsidy to reduce or cover employees' monthly transit or vanpool costs, up to $75 per month.

- Option 3: Employer-Provided Transit – Provide a free or low-cost transit service for employees, such as a bus, shuttle, or vanpool service.
- Option 4: Alternative Commuter Benefit – Provide an alternative commuter benefit that is as effective in reducing single-occupancy commute trips as Options 1, 2, or 3.

The program is a pilot program that will remain in effect through 2016. Measure Trans 1.3 will extend commuter benefits similar to these past 2016 and to at least 2020.

Fehr & Peers estimates that this measure will increase transit ridership in the county by 7.3% (Chan pers. comm.). This estimate is based on the TCRP study, which identifies effects on transit ridership after incorporating new strategies, such as Trans 1.2 (Transportation Research Board 2004a). The total increase in ridership from the study was applied to ridership data from Marin Transit's Short-Range Transit Plan (Marin Transit 2012). This new increase in ridership was then used to provide the baseline modal split (25% for each mode, including transit, carpool, walking, and bicycling). The baseline modal splits were then adjusted according to the individual strategy's effect on ridership. Based on Marin Transit's Short-Range Transit Plan, existing peak-period bus service in Marin has the capacity to support this 7.3% increase in ridership. Therefore, no additional bus routes or services are needed to support Trans 1.3.

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of TRANS Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
152	0.15%	0.5%	8.6%	-[d]	-[d]	-[d]

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for land use, transportation, and off-road strategies.
[d] Cost analysis not prepared for this measure.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- 100% of employees in the county are eligible for this program (Fehr & Peers 2014b)
- This strategy would reduce VMT growth in new residential and commercial developments by 10.4% (Fehr & Peers 2014b, 2014c)
- 50% of growth is applicable to this measure (Fehr & Peers 2014b, 2014c)
- Resulting VMT reductions are 574,157.

Analysis Method: Based on modeling conducted by Fehr & Peers, Trans-1.2 was assumed to result in a light-duty VMT reduction of 574,157 annual miles. Implementation of the strategy is not anticipated to significantly affect the distribution vehicle speeds within the County. Consequently, the percentage reduction in VMT was assumed to be commensurate with the percentage reduction in GHGs. Emissions reductions associated with the strategy were therefore calculated by multiplying the percentage reduction in VMT by emission factors produced by EMFAC2011 for light-duty vehicles.

This cost estimate is only for the mandatory VMT reduction and monitoring program. The efforts for the bundled strategies are described in their respective sections.

This commute trip reduction program would require a moderate amount of ongoing effort to develop the general program, create required strategies on a project basis, and administer the regular monitoring. The number of new projects per year as well as the total number of active projects would figure into the effort. As such, ¼ of an FTE may be required for up to one year to develop the program, one FTE to intake ten projects per year, and one FTE to administer 30 projects per year.

Implementation Information: The County may mandate that certain TDM strategies be implemented for all new residential projects consisting of 25 or more units and new or expanded projects with 50 or more employees. The TDM strategies may be agreed upon with the project sponsor dependent on the appropriateness of the strategy to the site and its location within the county. Incentives may also be used to implement measures, such as parking variances, reductions in building and permit fees, and other related items. Fees and penalties may be issued for non-compliance.

Supporting Marin Countywide Plan policies: TR-1.s - VMT Reduction Monitoring and Implementation and Transportation Demand Management Program.

Trans-1.3. Transportation Marketing

Objective: Conduct countywide efforts to implement marketing strategies to reduce commute trips. Marketing available strategies to employees, employers, residents, and developers is an important component to successful VMT reduction. Marketing efforts may encourage or mandate dissemination of information to the above groups on specific strategies or alternate travel means in general.

Fehr & Peers estimates that this measure will increase transit ridership in the county by 11.0% (Chan pers. comm.). This estimate is based on the TCRP study, which identifies effects on transit ridership after incorporating new strategies, such as Trans 1.3. (Transportation Research Board 2004b). The total increase in ridership from the study was applied to ridership data from Marin Transit's Short-Range Transit Plan (Marin Transit 2012). This new increase in ridership was then used to provide the baseline modal split (25% for each mode, including transit, carpool, walking, and bicycling). The baseline modal splits were then adjusted according to the individual strategy's effect on ridership. Based on Marin Transit's Short-Range Transit Plan, existing peak-period bus service in Marin has the capacity to support this 11% increase in ridership. Therefore, no additional bus routes or services are needed to support Trans 1.3.

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of TRANS Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
1,358	1.4%	4.7%	76.8%	-[d]	-[d]	-[d]

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for land use, transportation, and off-road strategies.
[d] Cost analysis not prepared for this measure.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- 100% of employees in the county are eligible for this program (Fehr & Peers 2014b)
- 50% of employees will be exposed to the marketing materials

- This strategy would reduce total residential and commercial work-related VMT by 4% (CAPCOA 2010; Fehr & Peers 2014b, 2014c)
- 74.2% of total VMT is work related (commute VMT), which applicable to this measure (Brazil pers. comm.)
- Resulting VMT reductions are 5,140,265.

Analysis Method: Based on modeling conducted by Fehr & Peers, Trans-1.3 was assumed to result in a light-duty VMT reduction of 5,140,265 annual miles. Implementation of the strategy is not anticipated to significantly affect the distribution vehicle speeds within the County. Consequently, the percentage reduction in VMT was assumed to be commensurate with the percentage reduction in GHGs. Emissions reductions associated with the strategy were therefore calculated by multiplying the percentage reduction in VMT by emission factors produced by EMFAC2011 for light-duty vehicles.

The cost of implementation would consist of developing and administering the program. The amount of effort to develop may be ¼ of an FTE for one year. Regular updates to the marketing material and online presence would require a minimal annual effort, approximately 1/8 of an FTE per year.

Implementation Information: This strategy involves providing targeted marketing in both print and online formats to employees, employers, residents, and developers. Materials should provide accurate and timely information regarding commute reduction strategies. Information sharing could be rolled into HR policies for new employee orientation. Real time transit data should be made available online with trip planning tools, with mobile phone apps as a future development. The marketing could be made mandatory for new residential projects consisting of 25 units or more, and new or expanded commercial projects with 50 employees or more, as is consistent with Trans-1.2.

Supporting Marin Countywide Plan policies: N/A

Trans-2. Expand Transit Service

Objective: Expand local and regional bus service in range and/or frequency where service expansion would result in higher bus occupancy and would result in lower GHG emissions per passenger mile than for average passenger vehicles. Expanding the geographical reach of the transit system would provide transit access to a higher number of residents and workers. Increasing transit frequency would make transit a more attractive and convenient option for travel. Both of these strategies would shift the mode choice of travelers toward transit, reducing VMT but also potentially reducing bicycle and walk trips. However, expansion of transit service should be prioritized to locations where bus occupancy can be maximized. Successful implementation of this measure will result in transit vehicle occupancies that are higher than present levels. Although rural transit routes may be important for providing transit service to less served populations and communities, low-occupancy routes that use diesel buses may not be effective in reducing GHGs compared to passenger vehicles. Thus, the focus on expanding transit service should be on locations where the bus occupancy can be high enough to result in lower GHG emissions per passenger mile than individual vehicles. In addition, existing congestion in Marin increases the co-benefit value of transit service, especially where buses operate in HOV lanes.

This measure will also reduce transit-passenger travel time through more reduced headways and increased speed and reliability. This makes transit service more attractive and may result in a mode shift from auto to transit, which reduces VMT.

Fehr & Peers estimates that this measure will increase transit ridership in the county by 2.7% (Chan pers. comm.). This estimate is based on the TCRP study, which identifies effects on transit ridership after incorporating new strategies, such as Trans 1.2. (Transportation Research Board 2004a). The total increase in ridership from the study was applied to ridership data from Marin Transit's Short-Range Transit Plan (Marin Transit 2012). This new increase in ridership was then used to provide the baseline modal split (25% for each mode, including transit, carpool, walking, and bicycling). The baseline modal splits were then adjusted according to the individual strategy's effect on ridership.

Summary Metrics:

2020 GHG Reduction[a]	**% of All Reductions**[b]	**% of Local Reductions**	**% of TRANS Reductions**[c]	**Savings (Cost)/MT**	**Initial Capital Cost**	**Annual Savings (Cost)**
116	0.1%	0.4%	6.6%	-[d]	-[d]	-[d]

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for land use, transportation, and off-road strategies.
[d] Cost analysis not prepared for this measure.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- 2.5% increase of transit network coverage (Fehr & Peers 2014b)
- 2.5% reduction in headways (increase in frequency) (Fehr & Peers 2014b)
- The existing transit mode share is 9.4% (as a % of total daily trips) (Fehr & Peers 2014b)
- Strategy would reduce countywide passenger VMT by 0.2% (Fehr & Peers 2014b, 2014c)
- Resulting passenger vehicle VMT reductions are 692,330/year.
- Strategy would increase bus VMT by 55,767/year. This estimate is based on the fixed-route service miles projected by the Marin Transit Short Range Transit Plan and deadhead miles from the National Transit Database (Marin Transit 2012; National Transit Database 2012).
- The average Marin Transit bus would emit 1,177 grams of CO_2 per mile, 0.0249 grams of CH_4 per mile, and 0.0453 grams of N_2O per mile (Reebs pers. comm.; New Flyer n.d.) (see additional discussion of GHG emission changes from transit service expansion below).

Analysis Method: Methods from CAPCOA (2010) were used to calculate passenger vehicle VMT reductions for this measure. CAPCOA presents the following equation for estimating passenger vehicle VMT reductions:

$$\%\,VMT\ Reduction = Coverage * B * Mode * D$$

Where:

- Coverage = % increase in transit network coverage (2.5%)
- B = elasticity of transit ridership with respect to service coverage (1.01) (Transportation Research Board 2004c).

- Mode = existing transit mode share (9.4%)
- D = adjustments from transit ridership increase to VMT (0.67) (CAPCOA 2010)

Based on the equation listed above, this measure was assumed to result in a light-duty VMT reduction of 0.2% or 692,330 annual miles.

Implementation of the strategy is not anticipated to significantly affect the distribution vehicle speeds within the County. Consequently, the percentage reduction in VMT was assumed to be commensurate with the percentage reduction in GHGs. Emissions reductions associated with the strategy were therefore calculated by multiplying the percentage reduction in VMT by emission factors produced by EMFAC2011 for light-duty vehicles.

Increased emissions from additional bus service were also estimated for this measure. As noted above, Trans 2.1 would increase bus revenue VMT by 47,455/year and total VMT (including deadhead VMT) by 55,767/year.[4] Increased emissions from additional bus VMT were based on bus fleet information from Marin Transit and emission factors produced by EMFAC2011 for urban buses.

This strategy would require some staff time to develop policies, guidelines, and pursue funding opportunities. We estimate that the level of effort required would be about 1 FTE for one year. Cost of implementing actual transit expansion would be medium to high, depending on capital and operating expenses of the proposed expansions.

Additional Discussion of GHG Emission Changes from Transit Service Expansion

As noted above, switching from automobile travel to transit travel can reduce GHG emissions but may not always reduce GHG emissions. GHG emissions are dependent on a number of factors, including the fuel efficiency of the automobile, the fuel type and fuel efficiency of the transit vehicle, and occupancy rates for both.

For Marin Transit vehicles, the average revenue-mile weighted daily passenger load during peak and midday (AM peak, midday, and PM peak periods) is **9.21 passengers per bus** and the average revenue-mile weighted daily passenger load including nighttime is **8.57 passengers per bus** (Reebs pers. comm.). Marin Transit has a variety of bus makes, models, and years. In 2012, 50% of the bus fleet was model year 2007 or newer (including some 2012 and 2013 model year diesel hybrid buses) and 50% of the bus fleet is model year 2000-2006 (Reebs pers. comm.). Marin Transit anticipates replacing the majority of buses in the current fleet, and the 2020 bus fleet is anticipated to be 30% diesel, 51% diesel hybrid, and 20% gasoline. Of these new buses, the majority will be model year 2015 or newer (Reebs pers. comm.). Diesel hybrid buses are anticipated to improve fuel economy over non-hybrid diesel buses by up to 50% (New Flyer n.d.).

The likely timing of any transit service increases per this measure would be commuter routes during peak periods and possible mid-day periods as opposed to the more lightly used other routes. According to EMFAC2014 for 2012, taking Pavley I and the Advanced Clean Cars regulation (Pavley II) into account,[5] along with deadhead miles in addition to revenue miles for buses, the average

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[4] Based on data from the National Transit Database, Golden Gate Transit buses had 5,170,584 total revenue miles and 905,591 total deadhead miles in 2012, for a total of 6,076,175 bus miles. Therefore, to estimate total bus VMT, revenue miles were scaled by the ratio of revenue miles to total miles (1.75) (National Transit Database 2012).

[5] EMFAC2014 does not take into account the effect of the Low-Carbon Fuel Standard (LCFS). However, it is estimated that the LCFS will reduce tailpipe emissions from gasoline vehicles by 1% and from diesel vehicles by

emission rate for a Marin Transit bus traveling at 35 mph (the average weighted speed of urban buses provided by MTC) at an occupancy of 9.2 passengers per bus is **0.50** pounds of CO_2 per passenger mile traveled, and the average emission rate for a Marin County passenger vehicle traveling at 35 mph (the average weighted speed of passenger vehicles provided by MTC) using the FHWA 2009 NHTS commute occupancy of 1.14 passengers per vehicle (USDOT/FHWA 2011) is **0.67** pounds of CO_2 per passenger mile traveled. For 2020, incorporating Marin Transit's anticipated fleet turnover, and assuming no change in vehicle occupancy or average speed, the average emission rate for a Marin Transit bus for peak and mid-day routes is **0.33** pounds of CO_2 per passenger mile traveled and the average emission rate for a Marin County passenger vehicle for commute trip purposes is **0.54** pounds of CO_2 per passenger mile traveled. Consequently, switching from auto travel to transit travel for commuter transit service (and for other high-occupancy transit service) is anticipated to reduce GHG emissions in Marin County.

When considering transit service for all purposes (not just commuter purposes), the conclusions will be similar to the peak/mid-day analysis above but GHG benefits would be lower. According to EMFAC2014 for 2012, using the same assumptions noted above, the average emission rate for a Marin Transit bus at an occupancy of 8.57 passengers per bus is **0.54** pounds of CO_2 per passenger mile traveled. For 2020, incorporating Marin Transit's anticipated fleet turnover, and assuming no change in vehicle occupancy or average speed, the average emission rate for a Marin Transit bus is **0.35** pounds of CO_2 per passenger mile traveled. Although national averages for vehicle occupancy for all purposes in 2009 was **1.67** person/vehicle (USDOT/FHWA 2011), this does not reflect Bay Area trip characteristics. To use a more accurate factor for vehicle occupancy appropriate to the Bay area, the national occupancy factors for different types of trips (commute, shopping/other family, and social/entertainment) were weighted by the percent of Bay Area VMT for these different trips using data from the MTC/BAAQMD (MTC/BAAQMD no date). The resultant all-purpose vehicle occupancy factor would be **1.42** persons/vehicle. Using this factor, passenger vehicle emissions for 2012 would be **0.53** pounds of CO_2 per passenger mile and for 2020 would be **0.43** pounds of CO_2 per passenger mile. The 2012 passenger vehicle value is slightly lower than the transit all-purpose value, but 2020 passenger vehicle emissions per passenger mile are still higher than the transit value for 2020. Use of the all-purpose trip factor would likely substantially understate the targeted benefits of focused transit expansion on commuter and high-occupancy transit routes/service, which would yield greater ridership and GHG reductions.

Under the LCFS, future Marin Transit buses may be using blended fuels (biodiesel blends). If these buses use B5 or B20 instead of standard diesel, then lifecycle emissions from buses would be even lower than the estimates above, and the benefit of buses compared with automobiles would be even greater.

The following table presents a summary of this analysis.

16% between 2014 and 2020. This would make buses even more GHG efficient when compared with passenger vehicles.

Comparison of Emissions by Transit Mode: Bus and Auto

Time of Day / Vehicle Type	Emission Rate by Year (lbs CO_2/passenger mile) 2012	2020
Peak/Midday		
Bus	0.50	0.33
Auto	0.67	0.54
All Periods		
Bus	0.54	0.35
Auto	0.53	0.43

Financial Discussion

A review of the MTC summaries of transit operations from 1994 to 2013 indicates the following for services that operate in Marin County (Metropolitan Transportation Commission 1999–2014):

- From Fiscal Year 1994/5 to 2012/13, Golden Gate Transit fixed bus revenue miles have declined by 34% and passengers by 23%.
- From Fiscal Year 1994/5 to 2012/13, Golden Gate Transit ferry revenue miles increased by 27%, and ferry ridership increased by 75%.

The best measure of investment in transit service is the revenue miles provided by a service. For Golden Gate Transit fixed bus service, the data show a trend of declining investment (as reflected by the decline in revenue miles) as well as a decline in passengers. For Golden Gate Transit ferry service, the data show a trend of an increase in investment (as reflected by an increase in revenue miles), with an increase in ridership that is three times the increase in revenue miles on a percentage basis.

The modeling of VMT in the inventory supporting the CAP uses MTC's model, which is a financially constrained model that takes into account funded improvements to the roadway and transit systems. Because financial constraints are taken into account in the modeling, the CAP estimates of future VMT take into account financial considerations. However, it should be noted that all investments in transit will not necessarily yield increases in transit usage; transit service must be responsive to and targeted at transit demand. That is the intent of this measure.

SMART Train, Golden Gate Transit Ferry, and Other Modes

The GHG inventory includes emissions associated with on-road transportation, including passenger vehicles and transit buses. The inventory does not include the emissions associated with the SMART Train or the Golden Gate Transit (GGT) ferries because of the lack of data by which to apportion ridership to the unincorporated county area. The SMART Train and GGT ferries serve the cities and unincorporated parts of Marin County as well as surrounding areas, but the available data for the future train service and the existing ferry service do not distinguish between users from the cities in Marin County and the unincorporated area of Marin County.

As shown in the table below, buses and the SMART Train have lower GHG emissions per passenger mile than passenger cars, but ferries have much higher GHG emissions than all other travel modes (presuming no change in the GGT ferries by 2020). Thus, at present, bus and train strategies are viable GHG emissions reduction strategies, but increasing ferry service is not a GHG emissions reduction strategy based on the current GGT ferry fleet. If in the future the ferry fleet is upgraded with more efficient engines or alternative fuels, ferry expansion may perform better in terms of GHG emissions. Although ferries are not efficient concerning GHG emissions, other reasons for ferry service remain, including on-road vehicle congestion relief, mobility, and diversification of the travel options, but these purposes are beyond those being addressed in the CAP Update.

Comparison of Emissions by Transit Mode

	Emission Rate by Year (grams CO_2/passenger mile)	
Mode	**2012**	**2020**
Passenger Car	302	245
SMART Train	219	189
Marin Transit Bus	228	149
Golden Gate Transit Ferry	707	707

Source: Passenger car emission rates and transit bus emission rates from the analysis of transit vs. passenger car emissions above. SMART train emissions estimated based on analysis below this table. GGT Ferry GHG emissions based on National Transportation Data (NTD) for vessel miles, diesel gallons consumed, and passenger miles.

The rough estimate of potential SMART GHG emissions included in the table above was prepared as follows:

- Data used included the latest available estimate of ridership for the 2015 Initial Operating Segment (IOS) of 2,900 trips/weekday[6] (Dowling 2011), 330,000 miles/year of rail operations and 375,000 gallons/year of fuel consumption (SMART 2013), and assumed 260 weekdays/year of operations (ICF assumption). Using these assumptions, SMART would have daily GHG emissions of 15 $MTCO_2$. Assuming the average commute trip is 23 miles (Dowling, 2011) the equivalent passenger car travel using the model year 2012 average of 23.6 mpg (U.S. Environmental Protection Agency 2013) and a 1.14 passenger occupancy for commuting (Federal Transit Administration 2010) would result in daily GHG emissions of 19 $MTCO_2$. The table above shows these emissions on a per-passenger mile basis.
- Federal CAFÉ standards require the fleet average for new 2025 passenger vehicles to be 54.5 mpg,[7] but it would take a number of years after 2025 for the on-road fleet average to reach 54.5 mpg.[8] At the forecast 2035 IOS ridership level of 4,800 trips/weekday (Dowling 2011) and still assuming the average commute trip is 23 miles (Dowling 2011), the SMART GHG emissions would still be 15 MT (due to no change in number of trains, just increased ridership), but the equivalent passenger vehicle GHG emissions (using 54.5 mpg fleet average) would be 16 MT.
- This comparison does not take into account any potential effect of the low-carbon fuel standard on train emissions or any improvements in train technology over time. This is evidence that, for the next few decades, SMART daily GHG emissions should be slightly less than equivalent passenger vehicle emissions.

[6] This is the lowest ridership number in the Dowling 2011 study. The study estimates that ridership will rise to 4,800 trips/weekday in 2035 for the IOS and 5,050 to 6,550 trips in 2020 with the full project.

[7] NHTSA estimates that actual CAFÉ performance levels will be lower than the target values in the standards (U.S. Environmental Protection Agency/National Highway Traffic Safety Administration 2010, 2012).

[8] For example, the 2013 CAFÉ requirements for new vehicles is a fleet average of 31.1, but the on-road average mpg is 23.6.

Implementation Information: The County would support Marin Transit as it continues to make service plan improvements outlined in the Marin Transit Short Range Transit Plan (Marin Transit 2012). Search for funding opportunities from grants or other sources to finance unfunded service needs. Continue to assess other service plan needs. The County will promote the widespread use of transit, including SMART, by providing special service for large community events such as the county fair and major concerts.

Supporting Marin Countywide Plan policies: TR-3.a Increase Bus and Ferry Services, AIR-4.b - Reduce Greenhouse Gas Emissions Resulting from Transportation.

Trans-3. Electric Vehicle Charging Stations

Objective: Expand public charging facilities to promote electric vehicle (EV) usage within the county by installing 20 new charging stations throughout the county. Install five Level I charging stations and 15 Level II charging stations by 2020.

This strategy would support plug-in hybrid electric vehicle (PHEV) purchase by the general public by enabling charging stations in key locations throughout Marin to allow PHEV use for shorter trips in and around the county. Cooperative planning with the cities could increase the potential for PHEV trips within the county and among the cities. The County is also in the process of updating its green building code and hopes to include a requirement that new residential and commercial construction include pre-wiring for EV chargers.

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of Trans Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
15	0.01%	0.1%	0.8%	($400)–$100	$20,000–$50,000 (Private); $20,000–$50,000 (Government); $0 (Consumer)	($5,000) (Private); $0 (Government); $10,000 (Consumer)

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for land use, transportation, and off-road strategies.

Assumptions: In addition to assumptions listed in Table C-1, the following were also considered:

- Installation of five Level I and 15 Level II charging stations would serve four PHEV and/or BEV per day, resulting in a 13 electric-VMT (eVMT) increase per vehicle per day.
- Anticipated mix of PHEV (10-mile range, 20-mile range, and 40-mile range) and BEV is based on the ARB's projections under the Zero-Emission Vehicle (ZEV) "Most Likely Compliance Scenario" (ARB 2010, 2011).
- Charging PHEV and BEV would consume the following quantities of electricity:
  - PHEV 10-mile range: 4.1 kWh per charge
  - PHEV 20-mile range: 4.8 kWh per charge
  - PHEV 40-mile range and BEV 75-mile range: 5.8 kWh per charge

- PHEV and BEV would replace new vehicles with an average fuel economy of 34 miles per gallon.
- On average, PHEV and BEV travel 41 miles per day.
- The Energy Efficiency Ratio (EER) of EVs is 3.4 (ARB 2014).
- The energy density of reformulated gasoline is 115.63 mega joules per gallon (California Code of Regulations, Title 17 Section 95485(a)(1)).
- On average, four vehicles would use each charging station per day (weekdays and weekends).
- 20% of total vehicle charging occurs at the charging stations (80% occurs in the home). Consequently, to be conservative in attributing emission reductions to the County's action of installing charging stations, only 20% of total displaced emission reductions from EVs are attributed to this measure (ECOtality 2013).
- The charging stations will not be funded by LCFS credits and are additional to the state's plan for EVs under LCFS.
- Systems are assumed to be installed in bundles of one Level I EV charging station and three Level II EV charging stations to reduce upfront costs.
- One-time hardware costs per EV charging bundle range from $1,700 to $6,500 (ICF International 2013a).
- One-time permitting costs per EV charging station bundle range from $100 to $1,000 (ICF International 2013a).
- One-time installation/labor costs per EV charging station bundle range from $2,500 to $6,000 (ICF International 2013a).
- One-time trenching/concrete costs per EV charging station bundle range from $3,000 to $8,000 (ICF International 2013a).
- Assumes the County and a private company split the upfront costs (i.e., a public buy down of 50%).
- Annual maintenance and networking costs per bundle paid by private sector of $1,000 (ICF International 2013a).

Analysis Method: GHG emissions generated by EVs are attributed to VMT in all-electric mode (i.e., e-VMT) and gasoline mode. The E-VMT calculation was based on the anticipated future fleet mix, vehicle range, and charging times required for Level I and Level II charging stations. Miles traveled in all-electric mode were assumed to displace miles traveled using a gasoline-engine with an average fuel economy of 34 miles per gallon. Emissions reductions were therefore determined as the difference between the emissions attributable to the EV and the emissions that would have otherwise occurred using an average conventional gasoline vehicle. Total GHG reductions for these new EVs were multiplied by 20% to account for only the percentage of charging that occurs at public stations (versus the 80% of charging that occurs in the home).

Upfront costs include hardware, permitting, installation, and trenching/concrete for the Level I and Level II charging stations (ICF International 2013a). The cost analysis assumed a public-private partnership arrangement in which the County covered 50% of upfront costs and then transferred ownership and operations to a private third party. The private third party incurs annual maintenance and networking costs, while the drivers of plug-in electric vehicle realize fuel savings.

Implementation Information: The County would work with MCE to identify grants and other funding sources to help finance the installation of charging stations throughout the county. The County could also work with PG&E to fund and install charging stations.

Supporting Marin Countywide Plan Policies: N/A

Trans-4. Electric-Powered Landscaping Equipment

Objective: Reduce gasoline-powered landscaping equipment use and/or reduce the number and operating time of such equipment. Pursue a voluntary goal for 10% of landscaping equipment operating in the county to be electric- or battery-powered by 2020. The County will adopt an ordinance requiring exterior electrical outlets on all new development to support the use of electric-powered landscaping equipment.

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of TRANS Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
84	0.08%	0.3%	4.7%	-[d]	-[e]	-[f]

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for land use, transportation, and off-road strategies.
[d] Not estimated.
[e] Upfront cost assumed to be negligible; equipment costs vary significantly based on other features besides energy source.
[f] Annual cost savings associated with an electric leaf blower or chainsaw estimated at between $500 and $600 per unit, assuming 960 hours of operation.

Assumptions: All assumptions utilized for the analysis of this strategy are identified in Table C-7.

Analysis Method: The OFFROAD2007 model calculates vehicle operating emissions by fuel type (e.g., diesel, gasoline) and average horsepower. Emissions reductions achieved by the strategy were calculated by multiplying the model outputs by vehicle class by CAPCOA's (2010) anticipated percentage reduction in GHG emissions for switching to electric power.

Total costs not quantified. Upfront cost is assumed to be negligible; equipment costs vary significantly based on other features besides energy source. As an example, the annual cost savings associated with an electric leaf blower or chainsaw is estimated at between $500-$600 per unit, assuming 960 annual hours of operation.

Implementation Information: The County would work in close cooperation with the air district in drafting an ordinance and developing outreach programs to be consistent with current air district rules and CEQA guidelines. The ordinance will also include the following provisions for community landscaping equipment:

- Sponsor a lawnmower exchange program that allows residents to trade in their gasoline powered mower for an electric mower at a low or discounted price.
- Require exterior electrical outlets on all new building developments.

Supporting Marin Countywide Plan policies: N/A

Supporting Strategies for Land Use, Transportation, and Off-Road Measures

The following community strategies were not quantified for GHG emission reductions or costs and savings, but they support and strengthen the quantified measures listed above and are an important part of the CAP Update.

SP Trans-1. Support Regional Carpool and Vanpool Programs

Objective: Enhance the existing Vanpool Incentive Program to attract and retain participants. Vanpools usually service an employee's commute to work. The program provides financial incentive for purchasing or leasing of vans. These vans would then be used to provide rides to multiple commuters with similar commute times, origins, destinations, or destinations along the route.

This measure is a supporting measure for Trans-1.2, V*MT Reduction Monitoring and Implementation and Transportation Demand Management Program*, and the GHG reductions are therefore included in Trans-1.2.

Because this strategy would require staff time to develop guidelines and policies for the program, the level of effort is likely to be about one-fourth that of an FTE for 1 year. The cost of the program itself would most likely be low but would depend on the level of participation.

Implementation Information: County staff would develop enhancements to the existing Vanpool Incentive Program to attract and retain participants. The current Vanpool Incentive Program offers $3,600 over a 2-year period for vanpools that carry at least seven passengers and have an origin, destination, or at least three pick-up points in Marin County. It has had moderate success, with 34 registered vanpools as of 2013.

Possible strategies to increase participation in the program include making the requirements less restrictive to reduce the barrier to entry. Connecting vanpool organizers with commuters would also be beneficial. The County should consider using 511 ridesharing forums, dynamic rideshare apps (the County recently launched a pilot project app called "Carma"), or facilitate communication among employers in the same geographic area. To retain vanpool participants, the County should consider extending the benefits beyond the first 2 years.

Supporting Marin Countywide Plan Policies: N/A

SP Trans-2. Support Alternate Work Schedules and Telecommute Programs

Objective: Encouraging alternate work schedules and telecommuting to reduce the number of commute trips and therefore VMT by employees. Alternative work schedules could take the form of staggered starting times, flexible schedules, or compressed work weeks.

This measure is a supporting measure for Trans-1.2, V*MT Reduction Monitoring and Implementation and Transportation Demand Management Program*, and the GHG reductions are therefore included in Trans-1.2.

The cost of implementation would consist of developing and administering the program. The amount of effort to develop may be one-fourth that of an FTE for 1 year.

Implementation Information: This strategy involves providing incentives for employers to allow and promote alternate work schedules for employees and telecommuting. This strategy would be provided as a suite of options for employers to use under Trans 1.2.

Supporting Marin Countywide Plan Policies: TR-1.a - Support Alternate Work Schedules.

SP Trans-3. Improve the county's jobs/housing balance

Objective: Measure from the 2006 Marin County GHG Reduction Plan.

Supporting Marin Countywide Plan Policies and Programs: CD-5.f – Redefine Countywide Planning Functions, HS-3.a – Complete a Nonresidential Job/Housing Linkage Study, HS-3.b – Adopt a Job/Housing Linkage Ordinance.

SP Trans-4. Institute growth boundaries, ordinances, or programs to limit suburban sprawl

Objective: Measure from the 2006 Marin County GHG Reduction Plan.

Supporting Marin Countywide Plan Policies and Programs: AIR-4.l – Preserve Agricultural Lands, AIR-4.m – Focus Development in Urban Corridors, OS-2.b – Coordinate Open Space Planning, OS-2.c – Acquire and Protect Lands Pursuant to the Open Space District's Mission Statement, OS-2.g – Apply County Zoning, OS-2.h – Require Clustered Development, CD-1.a – Keep Urban Uses in the City-Centered Corridor[9], CD-1.b – Preserve Resources in the Baylands Corridor, CD-1.c – Reduce Potential Impacts.

SP Trans-5. Implement Housing Overlay Zone focused on city-centered corridor

Objective: Measure from the 2006 Marin County GHG Reduction Plan.

Supporting Marin Countywide Plan Policies and Programs: CD-2.d – Implement the Housing Overlay Designation Program, HS-3.v – Evaluate the Feasibility of an "Affordable Housing Overlay Designation" Zoning Designation (includes below-market-rate housing requirements), CD-1.a Keep Urban Uses in the City-Centered Corridor.

SP Trans-6. Senior Mobility Action Plan

Objective: Support/Implement recommendations in the Senior Mobility Action Plan.

SP Trans-7. Implement Marin County Unincorporated Area Bike/Ped Master Plan

Objective: Expand community bicycle infrastructure (e.g., dedicated bicycle lanes, additional bicycle parking spaces).

AB 1193, by Assemblymember Phil Ting (D-San Francisco), will require Caltrans to create engineering standards for protected bike lanes, which, until now, have been discouraged by a complex approval processes and a lack of state guidance. This new class of lane will be separated from motor traffic by using a physical barrier, such as curbs, planters, or parked cars (Streetsblog LA 2014). AB 1193, which was adopted in September 2014, will help the County implement this measure.

[9] The Marin Countywide Plan describes the City-Centered Corridor as follows: The area along Highway 101, in the eastern part of the county near San Francisco and San Pablo bays, is designated primarily for urban development and for protection of environmental resources. This corridor is divided into six planning areas, generally based on watersheds.

Supporting Marin Countywide Plan Policies and Programs: TR-2.a – Encourage Bicycling and Walking, TR-2.b – Adopt Standards for Pedestrian and Bicycle Access, TR-2c – Support Bicycle Stations and Consider Attended Parking, TR-2d – Fund Projects (Marin County Unincorporated Bicycle and Pedestrian Master Plan), TR-2e – Prioritize Completion of the North-South and East-West Bikeways, TR-2g – Add Bicycle Lanes, TR-2h – Encourage Innovative Bicycle Lane Design, TR-2i – Renovate Tunnels Along the Planned North-South Bikeway into Multi-Use Pathways, TR-2l – Complete Streets.

SP Trans-8. Expand the "Safe Routes to School" Program

Objective: Measure from the 2006 Marin County GHG Reduction Plan.

Supporting Marin Countywide Plan policies and programs: TR-2.b – Adopt Standards for Pedestrian and Bicycle Access, TR-2.j – Ensure Safe Routes to Schools, TR-2.k – Consider Pedestrian Needs.

SP Trans-9. Employer-Based Trip Reduction

Objective: Support voluntary employer-based trip reduction.

Supporting Marin Countywide Plan Policies: Countywide Plan – Air-3.a).

SP Trans-10. Traffic Signal Synchronization

Objective: Measure from the 2006 Marin County GHG Reduction Plan.

Supporting Marin Countywide Plan Policies and Programs: TR-2.k – Consider Pedestrian Needs.

SP Trans-11. Support Alternative-Fuel Vehicles

Objective: Actively support infrastructure needed for alternative fuel vehicles, including fueling and charging stations. Review and consider revising applicable codes applying to refueling and recharging infrastructure. Support state, federal, and local efforts to increase fuel efficiency and reduce greenhouse gas emissions.

Supporting Marin Countywide Plan Policies: Countywide Plan TR-4.e.

SP Trans-12. Support Alternate Work Schedules and Telecommute Programs

Objective: Encourage employers to allow alternate work schedules for employees, telecommuting, and use of satellite work centers.

Supporting Marin Countywide Plan Policies and Programs: TR-1.a

SP Trans-13. Transit Agency Coordination

Objective: Encourage coordination amongst transit agencies to conduct a countywide transit study to identify opportunities for efficiencies, improve transfers/connections, and identify service gaps. Work with transit agencies to increase bike storage on buses, at bus stops, and at transit hubs and ferry terminals.

SP Trans-14. Parking Requirements

Objective: Consider lowering minimum parking requirements, encourage shared use parking (work with County to define boundaries where this may be feasible).

Supporting Marin Countywide Plan Policies and Programs: DES-1.a, DES-2.a, HS-3.11, HS-3.12, HS-3.l, HS-3.m, HS-3.q, TR-1.q.

SP Trans-15. Adopt Flexible Parking Standards

Objective: Amend the Development Code and work with cities and towns to allow reduced automobile parking requirements for projects that participate in subsidy programs for transit riders or provide direct access to (or are located within 0.5 mile of) transit hubs, participate in a TDM program, provide shared parking.

Supporting Marin Countywide Plan Policies and Programs: TR-1.i.

SP Trans-16. Promote Transportation Choices

Objective: Work with local, state, and federal governments; businesses; schools; seniors; and environmental groups to encourage use of transit, vanpools, carpools, car sharing, bicycles, and walking, including providing incentives to employers, commuters, and recreational users to support these transportation alternatives.

Supporting Marin Countywide Plan Policies and Programs: TR-1.c.

SP Trans-17. Coordinate with Local Agencies

Objective: Work with a proposed City-County Planning Committee, Department of Public Works, Transportation Authority of Marin, Metropolitan Transportation Commission, and other Bay Area counties to coordinate transportation system planning, including updating the County Congestion Management Program and the Capital Improvement Program to prioritize the projects that will meet the goals of the County Transportation Vision. Work with the Transportation Authority of Marin to develop transportation system performance goals in line with the goals of the CAP.

Supporting Marin Countywide Plan Policies and Programs: TR-1.d.

SP Trans-18. West Marin Traffic Reduction Program

Objective: Implement a Traffic Reduction Program for Recreational Traffic to West Marin.

Supporting Marin Countywide Plan Policies and Programs: TR-3.h.

Waste Reduction, Reuse, and Recycling

Waste-1. Zero Waste by 2025

Objective: The Marin Hazardous and Solid Waste JPA (Waste JPA) seeks to send zero tons of waste to landfills by the year 2025. This program is supported by the County's existing recycling programs, the food waste collection program, the Construction and Demolition (C&D) waste ordinance, the plastic bag ban, and the polystyrene ban. To support the 2025 zero waste goal, the County must divert from landfills at least 83% of waste generated in the county overall by 2020. The 83% target is based on a straight line extrapolation from 74% diversion in 2013 to 94% in 2025, which is the overall target of the Waste JPA for 2025.

Existing waste management programs collectively diverted 74% of waste generated in the county to recycling centers and other end uses in 2013. Implementation of this strategy will further the amount of diverted waste to at least 83% by 2020. The County will work with the Marin Hazardous and Solid Waste JPA to expand existing services and support or organize education and outreach programs (see Implementation Information below).

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of WR Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
2.995	3%	10.3%	100%	-[d]	-[d]	-[d]

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for waste reduction, reuse, and recycling strategies.
[d] Cost analysis not prepared for this measure.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- Marin County would have a BAU waste diversion rate of 75% (Marin County Civil Grand Jury, 2014).
- The county would generate 191,016 tons of solid waste in 2020, of which, 47,754 tons would be landfilled under BAU conditions.
- One ton of landfilled waste generates 0.196 $MTCO_2e$ (ICLEI – Local Governments for Sustainability USA. 2012).

Analysis Method: Waste-1 would increase the waste diversion rate from 75% under BAU conditions to 83%. The 83% target is based on a straight-line extrapolation from 74% in 2013 to 94% in 2025 (the overall target of the Waste JPA for 2025). Landfilled waste in 2020 was recalculated assuming an 83% diversion rate and subtracted from the BAU scenario to calculate the volume of additional diverted waste achieved by the strategy. Avoided GHG emissions from increased diversion were quantified by multiplying the additional diverted waste by the average landfill emissions per ton of waste landfilled.

Lifecycle emissions from waste diversion were not calculated for this measure. However, the Marin Sanitary Service (MSS) has calculated its avoided indirect emissions benefits from recycling, composting, biomass to energy, and avoided landfill emissions as well as emissions from beneficial reuse, alternative daily cover (ADC), and landfill following the best practices of a modified federal EPA WARM model. MSS has calculated that the avoided indirect emissions benefits in 2012 from these programs total 122,384 $MTCO_2e$ (Marin Sanitary Service 2014). These reductions are associated with all recycling conducted by MSS for its entire service area, not just the unincorporated county. Because these emissions are considered lifecycle emissions and calculated with a different approach than that used to estimate waste emissions in the inventory, these reductions cannot be counted toward the CAP target. This information is presented for informational purposes only.

Although a cost analysis was not performed for this measure, potential costs would include incremental costs for new and expanded policies, programs, and infrastructure to increase diversion.

Implementation Information: The Marin Hazardous and Solid Waste JPA has planned some key activities that will help the county achieve the zero waste goal:

- Expanded food waste composting;
- Expanded use of construction and demolition debris recycling services;
- Outreach to promote higher participation rates and higher diversion rates among residential, commercial, and industrial generators; and
- Promotion of Extended Producer Responsibility for product take back by industry at the local, state, and national level.

The Waste JPA was planning to achieve 80% diversion in 2013 (to be on track for the 94% 2025 target) but managed to achieve only 74%, as noted above. The Waste JPA took three actions this past year to address this shortfall:

1. The board funded a contact to help cities/towns and the County implement C&D programs. This contract ensures that each municipality has a C&D ordinance and helps cities/towns set up enforcement at each location and provide outreach materials.
2. $50,000 was set aside to perform an evaluation of zero waste outreach/programs in schools and provide recommendations moving forward. The County hopes to increase or improve school outreach in the coming years.
3. The County added a staff position with the Waste JPA, to be filled in January. The position will focus on outreach and zero waste programs.

Supporting Strategies for Waste Reduction, Reuse, and Recycling Measures

The following community strategies were not quantified for GHG emission reductions or costs and savings, but they support and strengthen the quantified measures listed above and are an important part of the CAP Update.

SP Waste-1. Landfill Gas to Energy Projects

Objective: As appropriate, install methane capture technology and associated monitoring systems on all landfills without methane capture and are not required to install or upgrade equipment under the state rule, with a goal of increasing the facility level methane capture rate to the highest extent feasible (i.e., approaching 100%).

SP Waste-2. Construction and Demolition Reuse and Recycling Ordinance

Objective: All building and demolition permits must demonstrate a 50% minimum of reused or recycled C&D materials. This ordinance was passed in September 2003. Increase the C&D diversion rate of 65% for all new construction projects.

SP Waste-3. Waste Education Program

Objective: Provide education and publicity about commercial and residential recycling, reuse, waste reduction, composting, grass cycling, and waste prevention to the public. Encourage local recycling and composting initiatives at the neighborhood level.

Water Conservation and Wastewater Treatment

Water/Wastewater-1. Water Conservation

The following sub-measures are part of the County's Water Conservation action strategy.

Water/Wastewater-1.1. Senate Bill X7-7

Objective: Meet (or exceed) the state-established per capita water use reduction goal[10] as identified by Senate Bill (SB) X7-7 for 2020. SB X7-7 was enacted in November 2009 and requires urban water agencies throughout California to increase conservation to achieve a statewide goal of a 20% reduction in urban per capita use (compared to nominal 2005 levels) by December 31, 2020 (referred to as the "20X2020 goal"). Each urban water retailer in the county subject to the law has established a 2020 per-capita urban water use target to meet this goal. These water retailers are the Marin Municipal Water District (MMWD) and the North Marin Water District (NMWD). As a rural water retailer, the Stinson Beach Water District (SBWD), which supplies water to some county residents, is not required to comply with SB X7-7.

This strategy will reduce embodied energy use associated with water conveyance and treatment, along with fugitive emissions associated with wastewater treatment processes resulting from treatment of wastewater generated within the county. Specific per capita water use reduction goals vary by water agency.

University of California Marin Master Gardeners, in partnership with the Marin Municipal Water District, has provided individual home consultations on gardening choices and irrigation management to reduce water use for 6 years in a row. The Marin Friendly Garden Walks program has served more than 1,000 homeowners, resulting in a total of 23 million gallons of water saved to date. Programs and actions like these will help support and implement this measure.

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of WW Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
946	0.9%	3.3%	29.4%	-[d]	-[d]	-[d]

[a] Presented in terms of $MTCO_2e$. Water efficiency improvements will reduce water consumption, which will likewise contribute to reductions in building energy use. For example, efficient faucets that use less water will require less electricity and natural gas for hot water heating. Approximately 84% (799 $MTCO_2e$) of the GHG emissions reductions achieved by Water-1.1 are associated with reduced hot water heating. The remaining reductions (148 $MTCO_2e$) are related to reduction in energy use required to transport, distribute, and treat water, and reductions in wastewater treatment fugitive emissions.

[b] State and local reductions for all sectors.

[c] Local reductions for water conservation and wastewater strategies.

[d] Cost analysis not prepared for this measure.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- Water energy intensities were based on the 2012 Community Inventory and are 2,163 and 647 kWh per million gallons for MMWD and NMWD, respectively.

[10] The State goal is a 20% reduction in per capita water use compared to baseline levels.

- BAU water consumption rates were assumed to be 127 gallons per capita per day (gpcd) for MMWD and 160 for NMWD
- SB X7-7 targets were assumed to be 124 gpcd for MMWD and 123 gpcd for NMWD (Marin Municipal Water District 2010; North Marin Water District 2010).

Analysis Method: Implementation of SB X7-7 will reduce per capita water use, relative to BAU conditions. Water reductions achieved by SB X7-7 were calculated by multiplying the percentage reduction in per capita water use for each water agency by the amount of water they are forecasted to provide to the county in 2020. Electricity savings from reduced water movement and treatment were quantified by multiplying the estimated water reductions by the appropriate agency-specific energy intensities. Reductions in building energy consumption were calculated by multiplying the water reductions by the percentage of hot water used in buildings, an assumed proportion of gas and electric water heaters, and the amount of energy it takes to heat a gallon of water for both heater types. Total energy reductions from water movement and hot water heating were multiplied by RPS-adjusted utility emission factors to estimate emissions reductions. Reductions in fugitive emissions from wastewater treatment were also quantified by multiplying the water reduction by the average treatment emissions per ton of gallon of processed water.

Although costs were not quantified for this measure, costs would include up-front costs of installing low-flow fixtures and other water saving appliances in homes and businesses, and savings would include reduced water bills.

Implementation Information: The urban water retailers (MMWD and NMWD) are responsible for implementing this measure.

Supporting Marin Countywide Plan policies: N/A

Water/Wastewater-1.2. Additional Water Conservation for New Construction

Objective: Implement a countywide water reduction target for new development that exceeds the SB X7-7 20% reduction target, such as a 30% reduction in water use. To satisfy this goal, require Adoption of the Voluntary CALGreen Tier 1 water efficiency measures for new residential and nonresidential construction. CALGreen voluntary measures recommend use of certain water-efficient appliances, and plumbing and irrigation systems, as well as more aggressive water savings targets.

This measure goes beyond Water/Wastewater-1.1 to reduce water use and wastewater generation further, beyond the 20% requirement of SB X7-7.

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of WW Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
79	0.1%	0.3%	2.5%	($400)–$300	$500,000–$900,000	$50,000

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for water conservation and wastewater strategies.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- All new residential and nonresidential buildings would comply with CALGreen Voluntary Tier 1 measures.
- Water energy intensities were based on the 2012 Community Inventory and are 2,163, 647, and 3,855 kWh per million gallons for MMWD, NMWD, and SBWD, respectively.
- Residential upfront costs assumed for water conservation fixtures. Assuming fixtures are replaced at the end of their useful life, the incremental cost of low-flow faucets is zero, the Energy Star–certified dishwasher is $12, and the waterless toilet is $1,500 (California Energy 2013a and 2013b; Lowes 2015).
- Commercial upfront costs assumed to be zero because of the variability in the types of fixtures and strategies available.

Analysis Method: Water savings were calculated on a per-fixture basis for residential and nonresidential water use using the difference between the mandatory CALGreen flow requirements for fixtures and the voluntary Tier 1 requirements for fixtures. Fixtures included lavatory and kitchen faucets, dishwashers, clothes washers and toilets/urinals. Electricity savings from reduced water movement and treatment were quantified by multiplying the estimated water reductions by the appropriate agency-specific energy intensities. Reductions in building energy consumption were calculated by multiplying the water reductions by the percentage of hot water used in buildings, an assumed proportion of gas and electric water heaters, and the amount of energy it takes to heat a gallon of water for both heater types. Water savings from overlapping state and local strategies were removed from the energy forecast to avoid double counting. Total energy reductions from water movement and hot water heating were multiplied by RPS-adjusted utility emission factors to estimate emissions reductions. Reductions in fugitive emissions from wastewater treatment were also quantified by multiplying the water reduction by the average treatment emissions per ton of gallon of processed water.

Upfront costs were quantified only for the residential sector because of the inherent variability in the types of fixtures and strategies available to the nonresidential sector. Homes were assumed to install waterless toilets, "very low-flow" plumbing fixtures for faucets, and Energy Star–certified dishwashers. Cost savings are due to the annual reduction in electricity, natural gas, and water use.

Implementation Information: The County would update building standards and codes for new buildings to require adoption of these voluntary measures, including:

- Use of low-water irrigation systems
- Installation of rainwater and graywater systems
- Installation of water-efficient appliances and plumbing fixtures, as well as composting toilets
- A 30% to 40% reduction over baseline in indoor water use, and a 55% to 60% reduction in outdoor potable water use (CALGreen Tier 1 or 2).

The county will coordinate with the water districts and will use the Energy Watch Partnership and work with MCE and PG&E to help implement this measure. The County will also promote the use of PACE financing for water conservation measures and encourage "pay as you save" programs for energy and water efficiency.

Apply for State Water Board's grant money for the water-energy "standard offer" pilot project.

Supporting Marin Countywide Plan policies: N/A

Water/Wastewater-1.3. Additional Water Conservation for Existing Buildings

Objective: Implement a countywide water reduction target for existing buildings that exceeds the SB X7-7 20% reduction target, such as a 30% reduction in water use. To satisfy this goal, implement a program to renovate existing buildings to achieve higher levels of water efficiency. Encourage existing buildings (constructed before 2015) to adopt voluntary water efficiency and conservation measures that exceed the standards included in the California Building Standards Code i.e. Plumbing and Green Building Standards Code.. The County will continuously monitor updates to the California Building Standards code and will explore requiring water efficiency upgrades, beyond State minimum requirements, for all new construction projects including additions and remodels.

This measure goes beyond Water/Wastewater-1.1 to reduce water use and wastewater generation further, beyond the 20% requirement of SB X7-7.

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of WW Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
162	0.2%	0.6%	5%	($400)–$200	$1,000,000–$2,000,000	$100,000

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for water conservation and wastewater strategies.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- 2% of existing residential and nonresidential buildings would comply with CALGreen Voluntary Tier 1 measures by 2020.
- Water energy intensities were based on the 2012 Community Inventory and are 2,163, 647, and 3,855 kWh per million gallons for MMWD, NMWD, and SBWD, respectively.
- Residential upfront costs assumed for water conservation fixtures. Assuming fixtures are replaced at the end of their useful life, the incremental cost of low-flow faucets is zero, the Energy Star–certified dishwasher is $12, and the waterless toilet is $1,500 (California Energy 2013a, 2013b; Lowes 2015).

Analysis Method: The approach for calculating water and emissions reductions is similar to what is described for Water/Wastewater-1.2, *Additional Water Conservation for New Construction*. However, the strategy was assumed to apply to existing developments constructed before 2015, as specified in the strategy objective.

Upfront costs were quantified only for the residential sector because of the inherent variability in the types of fixtures and strategies available to the nonresidential sector. Homes were assumed to install waterless toilets, "very low-flow" plumbing fixtures for faucets, and Energy Star–certified dishwashers. Cost savings are due to the annual reduction in electricity, natural gas, and water use.

Implementation Information: The County will continuously monitor updates to the State code and will explore requiring water efficiency upgrades, beyond State minimum requirements, for all new construction projects including additions and remodels. Education and outreach programs will help educate individuals on the importance of water efficiency and how to reduce water use. Rebate programs will help promote installation of water-efficient plumbing fixtures. The program will include:

- A Water Audit Program in collaboration with efforts by local water purveyors that offer free water audits.
- Development plans to ensure water conservation techniques are used (e.g. rain catchment systems, drought tolerant landscape, etc.).
- Water efficiency upgrades as a condition of issuing permits for renovations or additions of existing buildings.
- Water conservation pricing, such as tiered rate structures, to encourage efficient water use.
- Incentives for projects that demonstrate significant water conservation through use of innovative water consumption technologies.

The County will coordinate with the water districts and will use the Energy Watch Partnership and work with MCE and PG&E to help implement this measure. The County will also promote the use of PACE financing for water conservation measures and encourage "pay as you save" programs for energy and water efficiency.

Supporting Marin Countywide Plan policies: N/A

Water/Wastewater-2. Increase Pump Efficiency

Objective: Work with water agencies to maximize water pump efficiency to achieve a 10% reduction in energy use by 2020. Major energy efficiency savings can help avoid major capital expenses for water agencies and drive large GHG emissions reductions.

The County's role will be that of a facilitator and technical service provider. Through the County's Energy Watch Partnership with PG&E, the County currently offers the Marin Energy Management Team for Public Facilities. The County provides technical assistance and project planning assistance to Marin's cities, towns, schools, and special districts. In this role in the past, the County has assisted water districts with energy efficiency and solar projects at offices, corporate yards, and treatment plants.

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of WW Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
105	0.1%	0.4%	3.3%	$400–$900	$200,000–$300,000	$100,000

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for water conservation and wastewater strategies.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- Energy use for water pumping was reduced by 10%
- Upfront implantation costs range from $0.50 to $0.38 per kWh saved (California Energy Commission and the U.S. Department of Energy 2002; U.S. Department of Energy 2012b).
- Annual maintenance savings estimated for the lower cost savings scenario of $0.04 per kWh saved (California Energy Commission and the U.S. Department of Energy 2002; U.S. Department of Energy 2012b).

Analysis Method: Electricity savings were calculated by multiplying the 2020 BAU electricity use for water pumping by 10%. Electricity savings from overlapping state and local strategies were removed from the energy forecast to avoid double counting. Total electricity reductions from water movement were multiplied by RPS-adjusted utility emission factors to estimate emissions reductions.

Although costs were not quantified for this measure, costs would include up-front costs of installing more efficient pumps, and savings would include reduced utility bills for the water districts.

The wastewater treatment plant would incur upfront costs to improve pump efficiency. In the low-cost scenario, annual maintenance savings are assumed. In both the low- and high-end scenarios, increased pump efficiency results in annual electricity savings.

Implementation Information: The County, in partnership with PG&E and MCE, will work with MMWD, NMWD, and SBWD to improve the water pumping efficiency by at least 10% by 2020. Primary responsibility for the implementation of this measure rests with the water districts.

Supporting Marin Countywide Plan policies: N/A

Water/Wastewater-3. Reduce Wastewater Generation

Objective: Reduce residential wastewater generation by at least 15% and nonresidential wastewater generation by at least 10% by 2020. This would be supported by water conservation measures that seek to reduce indoor water use in buildings along with the County's existing graywater ordinance.

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of WW Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
1,964	2%	6.8%	61%	-[d]	-[d]	-[d]

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for water conservation and wastewater strategies.
[d] Cost analysis not prepared for this measure.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- Residential wastewater generation was reduced by 15%; nonresidential wastewater generation was reduced by 10%
- Water energy intensities were based on the 2012 Community Inventory and are 2,163, 647, and 3,855 kWh per million gallons for MMWD, NMWD, and SBWD, respectively.

Analysis Method: 2020 indoor water use, after taking into consideration other previous measures that reduce water use, was multiplied by a 15% reduction factor for residential water use and a 10% reduction factor for nonresidential water use. Total energy reductions from water movement and hot water heating were multiplied by RPS-adjusted utility emission factors to estimate emissions reductions. Reductions in fugitive emissions from wastewater treatment were also quantified by multiplying the water reduction by the average treatment emissions per ton of gallon of processed water.

Implementation Information: Implementation actions will be similar to those listed for Water/Wastewater-1.2 and Water/Wastewater-1.3 and will include promotion of the County's graywater ordinance.

Supporting Marin Countywide Plan policies: PFS-3.a Reduce wastewater volume, PFS-3.e Explore wastewater disposal alternatives, PFS-3.f Develop appropriate wastewater treatment technologies.Supporting Strategies for Water Conservation and Wastewater Treatment Measures

The following community strategies were not quantified for GHG emission reductions or costs and savings, but they support and strengthen the quantified measures listed above and are an important part of the CAP Update.

SP Water/Wastewater-1. Encourage Water Conservation

Objective: Encourage water conservation in the county.

Supporting Marin Countywide Plan Policies and Programs: PFS-2.b – Minimize the demand for water in new development, PFS-2.i – Promote water saving irrigation, PFS-2.l – Reduce energy use from water facilities, WR-3.a – Support Water Conservation Efforts, WR-3.b – Support and Integrate Water District Conservation Efforts, AG-1.p – Evaluate Small-Scale Water Development, AG-1.q – Support Irrigation Alternatives.

SP Water/Wastewater-2. Equipment Upgrades

Objective: Assist local wastewater treatment providers with their energy efficiency efforts through the Energy Watch Partnership with PG&E. Encourage providers to upgrade and replace wastewater treatment and pumping equipment with more energy-efficient equipment, as financially feasible, at existing facilities by 2020. Encourage the use of best management practices for the treatment of wastewater.

SP Water/Wastewater-3. Offer Low-Interest Loan Program

Objective: Encourage local sanitary districts to offer low-interest loan programs to homeowners to repair sewer laterals.

Agriculture

Agriculture-1. Methane Capture and Energy Generation at Dairies

Objective: This is a voluntary measure to be undertaken by dairies. The measure encourages the installation of methane digesters to capture methane emissions from the decomposition of manure.

The methane could be used as on-site as an alternative to natural gas in combustion, power production, or as a transportation fuel. Using captured biogas could potentially offset natural gas use or off-road fuel use in the county (reductions may be achieved in the building energy sector and/or the off-road sector). Further, individual project proponents can sell GHG credits associated with these installations on the voluntary carbon market.[11]

Under this measure, it is assumed that 20% of dairies and other livestock facilities will install methane digesters.

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of AG Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
3,691	3.7%	12.7%	100%	($10)	$700,000–$1,000,000	$30,000

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for agriculture strategies.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- Participating dairies will capture at least 50% of methane emissions from manure management.
- 20% of dairy cows in the county will feed the methane digesters
- 75% of captured methane would be combusted to produce electricity.
- Four farms are assumed to implement digesters.
- Upfront cost of implementation for a 360-cow farm is estimated to be $180,000 to $330,000 (Straus Family Creamery 2015).
- Assumes annual operational and maintenance costs of $50,000 (i.e., 4% the total implementation cost for the high-end scenario) (ICF International 2013b).

Analysis Method: 2020 BAU Manure management emissions from dairy cows were multiplied by 10% (20% participation rate and 50% capture rate) to determine GHG emission reductions from this measure. Total captured methane was multiplied by 75% to calculate the amount of methane combusted for electricity generation. Using the conversion factors in Table C-1, the electricity generation potential from this methane was estimated. This electricity was assumed to offset PG&E electricity. GHG emissions reductions achieved through this electricity generation were quantified by multiplying the energy reductions by the appropriate RPS-adjusted utility emission factors.

Implementation Information: As a voluntary measure, the County would support dairies to consider existing and new technologies to control emissions from enteric fermentation and manure management and assess the feasibility and cost effectiveness of these technologies. Dairies would be

[11] Individual project proponents could also sell GHG credits associated with these installations on the voluntary carbon market to offset GHG emissions due to other activities. To the extent that project proponents sell GHG offset credits, these same credits may not be applied to local GHG emission reductions. Thus, even though there might be reductions in local emissions, there would be no net reduction in emissions globally. Nevertheless, carbon markets offer opportunities for agriculture to provide offsets and be financially compensated for doing so, including the sale of offsets that could be credited to local GHG reduction and then retired rather than being sold as offsets for other projects.

encouraged to explore new technologies and implement feasible and cost-effective manure digestion projects based on their own local conditions and operations. The County would assist in seeking local, regional, state, and/or federal grants to help offset capital costs, linking dairies to new research opportunities, and working with local partners to help assess the feasibility of reduction projects and implement cost-effective options where available. The County would also work with MCE, the Marin County Agricultural Commissioner, and the Marin County Farm Bureau to implement this measure.

Centralized digester systems are designed to gain economies in digester operation by using the manure from a cluster of dairy farms (Lee and Sumner 2014), but new and emerging biogas recovery technologies suggest this approach may be applicable even to Marin's smaller dairy operations (Greer 2010). To be economically feasible, digesters in California must be designed per regulatory constraints, maximize operational efficiency through the use of recovered heat and co-digestion where possible, capture all potential revenue streams, and secure power purchase agreements or offset their own energy use at favorable prices (Lee and Sumner 2014). Achieving these conditions is extremely challenging but could be made less so by the active engagement of County regulatory agencies in support of such projects and by the use of Marin dairy digester projects for CEQA mitigation at a CO_2e value high enough to render projects economically viable.

Large dairy owners would incur upfront costs from installing the digester and annual operational and maintenance costs. The methane capture produces electricity and results and annual electricity savings to the dairy owners.

Supporting Marin Countywide Plan Policies: N/A

Agriculture-2. Carbon Farming

Reductions for this measure were not quantified, and a cost-effectiveness analysis was not conducted. See discussion in Chapter 6.

Agriculture-3. Promote the Sale of Locally Grown Foods and/or Products

Reductions for this measure were not quantified, and a cost-effectiveness analysis was not conducted. See discussion in Chapter 6.

Land Conservation

Supporting Strategies

The following community strategies were not quantified for GHG emission reductions or costs and savings, but they support and strengthen the quantified measures listed above and are an important part of the CAP Update.

SP Land Conservation-1. Protect Conservation Areas

Objective: Encourage the preservation of existing land conservation areas, especially forested, oak woodland, hillside, ridgeline, and wetland areas that provide carbon sink benefits. Preserve existing oak woodland and seek no net loss of oak woodland areas. The County will increase its work with the Marin Resource Conservation District and the Marin Agricultural Land Trust to promote conservation, assist them in seeking funding opportunities, and integrating climate mitigation and adaptation into their programs.

SP Land Conservation-2. Create New Vegetated Open Space

Objective: Encourage the restoration and revegetation of 40 acres of previously settled land to promote carbon sequestration in the unincorporated county. Also encourage the conversion of 40 acres of unused urban and suburban areas into parks and forests.

Local Emissions Reduction Strategies – Municipal

Energy Efficiency and Renewable Energy

Energy-1. Energy Efficiency

The following sub-measures are part of the County's Energy Efficiency action strategy.

Energy-1.1. Energy Efficiency Measures for the new Emergency Operations Facility

Objective: Energy efficient designs and a solar photovoltaic system at the Emergency Operations Facility (EOF) are anticipated to save 1.17 million kWh and 812 therms (solar hot water system) a year (over base Title 24 requirements).

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of BE Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
222	4.7%	15.5%	49.3%	-[d]	-[d]	-[d]

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for Building Energy (BE) including energy efficiency and renewable energy strategies.
[d] Cost analysis not prepared for this measure.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- 1.17 million kWh and 812 therms will be saved through implementation of this measure

Analysis Method: This measure would result in 1.17 million kWh of electricity savings and 812 therms of natural gas savings. GHG emissions reductions achieved by the strategy were quantified by multiplying the energy reductions by the appropriate RPS-adjusted utility emission factors.

Implementation Information: The County completed construction of the EOF in 2014 and implemented the energy efficiency measures.

Energy-1.2. Existing Building Retrofit Program

Objective: Conduct energy efficiency retrofits of existing County buildings. 2012 electricity use will be reduced by 5% by 2020 through retrofits of existing County buildings. Require these retrofits to improve building-wide energy efficiency by 20%. Retrofits should target lighting, heating and air conditioning units, and overall building energy use. In addition, the County will require that newly leased buildings improve energy consumption by 20% over 2012 levels.

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of BE Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
55	1.2%	3.8%	12.2%	($2,000)–($1,000)	$1,000,000–$2,000,000	$40,000

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for Building Energy (BE) including energy efficiency and renewable energy strategies.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- 2012 electricity use will be reduced by 5% by 2020 through retrofits of existing County buildings
- Retrofits will reduce energy consumption by 20% compared to baseline
- The cost per square foot for building energy audits ranges from $0.18 to $0.50 for a comprehensive energy audit (AECOM 2010).
- The lower cost per square foot for building energy retrofits (16-30% energy efficiency improvement) is $9.55 (AECOM 2010).
- The higher cost per square foot for building energy retrofits is $13.57, which includes lighting and HVAC measures (Benson et al. 2011).

Analysis Method: Total energy use (electricity and natural gas) in 2012 was multiplied by 5% to determine the amount of energy subject to retrofits. The resulting number was multiplied by 20% to determine energy reductions. GHG emissions reductions achieved by the strategy were quantified by multiplying the energy reductions by the appropriate RPS-adjusted utility emission factors.

Upfront costs would be incurred to conduct an energy audit and perform the physical retrofits. Costs of conducting building energy audits were estimated based on the total square footage of participating nonresidential buildings and the cost per square foot for energy audits. A similar method was used to estimate upfront costs associated with the physical retrofit. Annual energy cost savings were calculated by multiplying the electricity and natural gas reductions by the appropriate utility rates.

Implementation Information: These retrofits could be accomplished by a variety of actions, including:

- Energy inspections and audits
- Active Lighting Management System (including LED lighting retrofits, lighting controls, etc.)
- Major Equipment Procurement Standards: Require all major equipment purchases be more energy-efficient than the equipment it replaces.
- Building energy management system (such as requiring all occupied rooms maintain an ambient temperature of 71 degrees during the summer months)

Energy-1.3. Energy Efficiency Measures for County-Owned Computers and Printers

Objective: This measure includes two separate actions to improve energy efficiency at County facilities: 1) replace 100 traditional desktop or laptop computers with tablets; and 2) replace 50 printers with Energy Star printers.

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of BE Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
6	0.1%	0.4%	1.4%	$300–$2,000	$20,000–$70,000	$7,000

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for Building Energy (BE) including energy efficiency and renewable energy strategies.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- Each tablet computer will save 234 kWh annually compared with a standard desktop computer (Electric Power Research Institute 2012)
- Each Energy Star printer computer will save 229 kWh annually compared with a standard printer (ICLEI – Local Governments for Sustainability USA 2010)
- The incremental costs of Energy Star printers are zero.
- Incremental costs of tablets are assumed to range from $150-$700, depending on quality (Dell 2014).
- Assumed lifetime for printers and tablets is 5 years.

Analysis Method: Electricity savings for computers were estimated by multiplying the number of tablet computers (100) by the annual energy savings for each (234 kWh). Electricity savings for printers were estimated by multiplying the number of Energy Star printers (50) by the annual energy savings for each (229 kWh). GHG emissions reductions achieved by the strategy were quantified by multiplying the energy reductions by the appropriate RPS-adjusted utility emission factors.

The county would incur upfront costs from the purchase of tablets. Incremental costs of tablets are assumed to range from $150–$700, based on a review of tablet and desktop prices on dell.com (Dell 2014). Little price difference is found between higher and lower efficiency printers. Assuming printers are replaced at the end of their useful life, incremental costs of Energy Star printers are zero. Annual cost savings are based on electricity reductions, multiplied by the appropriate utility rates.

Implementation Information: N/A

Energy-1.4. Computer Energy Management

Objective: The County will use Verdiem software (or other similar software) to reduce energy consumption in computers. The County will also require that computers be turned off every night before County employees go home and before weekends. Explore and/or pilot programs that turn off PCs after hours when not in use. Require all PCs to be set at the highest energy-saving mode for regular use.

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of BE Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
46	1%	3.2%	10.2%	$1,000	$50,000	60,000

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for Building Energy (BE) including energy efficiency and renewable energy strategies.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- This measure will reduce baseline computer energy use by 15%
- 8.2% of total municipal electricity use is for office equipment (California Energy Commission 2006).
- Assumed capital costs of Verdiem software are $52,081 (Verdiem 2014).

Analysis Method: Total 2020 BAU municipal electricity use, after taking into account energy savings from other overlapping state and local strategies, was multiplied by 8.2% to determine the amount of electricity subject to this measure. This was then multiplied by 15% to determine electricity savings. GHG emissions reductions achieved by the strategy were quantified by multiplying the energy reductions by the appropriate RPS-adjusted utility emission factors.

Verdiem advertises a “less than one year payback” for their software (Verdiem 2014). Consequently, capital costs are conservatively assumed to be equal to one year of energy savings. Annual cost savings are based on electricity reductions, multiplied by the appropriate utility rates.

Implementation Information: N/A

Energy-1.5. Shade Tree Planting

Objective: Promote the planting of shade trees around County facilities. Plant 10 new shade trees each year as part of this goal. Promote California natives or low water trees and include irrigation upgrades to support tree health until established. Promote use of compost and mulch in all planting projects where feasible.

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of BE Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
1	0.02%	0.1%	0.2%	$900–$2,000	$8,000	($800)–($2,000)

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for Building Energy (BE) including energy efficiency and renewable energy strategies.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- Strategy requirements would take effect in 2015.
- 10 trees per year would be planted by the County adjacent to buildings.

- Average tree planting age is 1 year and 96% of planted trees would survive.
- For modeling purposes, new trees would be a mix of maple, ash, pine, oak, and redwood. The County Parks department may plant different tree species because soils and water conditions will dictate the species planted and there are many tree options. Average upfront cost to plant a tree is $170, with a range of $142 to $197 per tree based on whether root barriers are present (ICF International 2014).
- Annual maintenance costs were assumed to range from $34-$69 per tree (City of Goleta 2009; McPherson et al. 2005).

Analysis Method: Energy savings from reduced building cooling and heating were obtained from the U.S. Forest Service's (2011) Tree Carbon Calculator for each tree species. The values were multiplied by the expected number of trees planted per year. All 10 trees planted per year were assumed to be planted adjacent to buildings were included in the calculations; trees planted in the public right of way were not assumed to provide building shade. GHG emissions reductions achieved by the strategy were quantified by multiplying the total energy reductions by the appropriate RPS-adjusted utility emission factors. Carbon sequestration benefits were not evaluated as they are outside the scope of the CAP.

The county would incur upfront costs to plant, stake, and mulch trees. Maintenance costs were estimated based on a study conducted by the City of Goleta (2009) and McPherson et al. (2005). Cost savings were not calculated for benefits such as air quality, health, property value, or intrinsic value improvements; some studies show a net benefit for trees when these co-benefits are monetized. A lifetime of 40 years for each tree was assumed (McPherson et al. 1999).

Implementation Information: N/A

Energy-1.6. Install energy-efficient street lights

Objective: Require that all streetlights use LED bulbs. There are currently 213 high-pressure sodium and 3 Incandescent streetlights owned and operated by the County; the rest are all LED. Install lighting meters on streetlights at key distribution points.

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of BE Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
11	0.2%	0.7%	2.4%	-[d]	-[d]	-[d]

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for Building Energy (BE) including energy efficiency and renewable energy strategies.
[d] Cost analysis not prepared for this measure.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- High pressure sodium lights operate at 0.192 kW (U.S. Department of Energy 2012c).
- Incandescent lights operate at 0.15 kW (U.S. Department of Energy 2012c).
- LED lights operate at 0.12 kW (U.S. Department of Energy 2012c).
- Streetlights operate 11 hours per day, 365 days per year (ICLEI 2010).

Analysis Method: Electricity reductions achieved by energy-efficient streetlights were calculated based on the difference in electricity usage between the existing streetlight profile and an all LED-streetlight profile. Existing electricity consumption was estimated assuming 213 high-pressure sodium cutoff fixtures and 3 incandescent fixtures. GHG emissions reductions achieved by replacing all streetlights with LED bulbs were quantified by multiplying the difference in electricity consumption by the appropriate RPS-adjusted utility emission factors.

Implementation Information: N/A

Energy-2. Solar Energy

The following sub-measures are part of the County's Solar Energy action strategy.

Energy-2.1. Install solar panels on municipal facilities

Objective: Install solar on municipal facilities by aiming to provide 1.1% of all 2012 electricity consumed by County buildings and properties by 2020 to be from solar photovoltaic (PV) panels. Require that, where feasible, new or major rehabilitation of County-owned buildings are constructed to allow for easy, cost effective installation of solar energy systems in the future.

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of BE Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
42	0.9%	2.9%	9.4%	($500)–($200) (DP); $100–$200 (PPA)	$900,000–$700,000 (DP); $0 (PPA)	$40,000 (DP); $5,000–$10,000 (PPA)

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for Building Energy (BE), including energy efficiency and renewable energy strategies.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered:

- Does not include existing County-installed PV arrays located on Emergency Operations Facility, Fairgrounds, Throckmorton Fire Station, 120 N. Redwood, Health and Wellness Campus and General Services Buildings. These systems are already incorporated into the 2012 Municipal GHG Inventory and 2020 BAU forecast, and will therefore not contribute to reductions from 2020 BAU emissions.
- Does not include electricity offsets from Energy-2.2 *Solar Panel Carports and Parking Areas*
- Initial costs for a nonresidential system range from $4.3 to $5.3 per watt (Burbose et. al 2013).

- The average system size is 40 kW.
- Solar systems would have a 25-year lifetime (U.S. Department of Energy 2013b).

Analysis Method: Total 2020 BAU municipal electricity use, after taking into account energy savings from other overlapping state and local strategies, was multiplied by 1.1% to determine the amount of electricity supplied by solar PV under this measure. GHG emissions reductions achieved by the strategy were quantified by multiplying the energy reductions by the appropriate RPS-adjusted utility emission factors.

The cost analysis considered two financing scenarios:

- **Direct Purchase**: The building owner is assumed to directly purchase and install the solar panels.
- **Power Purchase Agreement**: The building owner enters into a power purchase agreement (PPA) with a local company who owns and maintains the solar panels.

Total capital costs under the direct purchase scenario were calculated on a per-system basis, based on an initial cost of $4.30 to $5.30 per watt for a 40 kW system. . Annual operating costs of $0.02 per watt were assumed, based on the PVWatts model. Annual energy cost savings were based on electricity production (which decreases slightly each year due to system degradation), multiplied by the appropriate utility rates (assumes an annual utility rate escalator of 1%).

No upfront costs were assumed under the PPA scenario. Annual costs savings were estimated to be 10% off the retail value of the electricity generated.

Implementation Information: N/A

Energy-2.2. Solar Panel Carports and Parking Areas

Objective: Install solar panels over carports and parking areas by 2020. The County will install solar PV over the equivalent of 200 parking spaces. If carports include plug-in-electric stations, the County should install enough PV panels to offset 80% of the electric station's expected energy use. Renewable energy generated by carport PV panels can be sold as an offset or used to power adjacent buildings or stand-alone plug-in charging stations.

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of BE Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
68	1.5%	4.7%	15.1%	($500)–($200) (DP); $100–$200 (PPA)	$1,000,000 (DP); $0 (PPA)	$70,000 (DP); $7,000–$20,000 (PPA)

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for Building Energy (BE) including energy efficiency and renewable energy strategies.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- Each parking space is 171 square feet (9' x 9'); for each parking space, 171 square feet of solar PV will be installed.

- Solar PV generation is approximately 8 watts per square foot of panel, producing 11.2 kWh per square foot of panel annually based on 5,606 kWh per year for a typical 4 kW solar system (National Renewable Energy Laboratory 2005; U.S. Department of Energy 2013b).
- Initial costs for a nonresidential system range from $4.30 to $5.30 per watt (Burbose et. al 2013).
- Installed system size assumed to be 1.4 kW per parking space.
- Solar systems would have a 25-year lifetime (U.S. Department of Energy 2013b).

Analysis Method: For each parking space, 171 square feet of solar PV panels would be installed. The County will install solar PV over 200 parking spaces, or 34,200 square feet of solar PV panels. This value was multiplied by 11.2 kWh solar electricity generation per square foot of PV to determine total annual electricity production. GHG emissions reductions were then quantified by multiplying the total energy reductions by the appropriate RPS-adjusted utility emission factors.

The cost analysis considered two financing scenarios:

- **Direct Purchase**: The building owner is assumed to directly purchase and install the solar panels.
- **Power Purchase Agreement**: The building owner enters into a power purchase agreement (PPA) with a local company who owns and maintains the solar panels.

Total capital costs under the direct purchase scenario were calculated on a per-system basis, based on an initial cost of $4.30 to $5.30 per watt for a 280 kW system. Annual operating costs of $0.02 per watt were assumed, based on the PVWatts model. Annual energy cost savings were based on electricity production (which decreases slightly each year due to system degradation), multiplied by the appropriate utility rates (assumes an annual utility rate escalator of 1%).

No upfront costs were assumed under the PPA scenario. Annual costs savings were estimated to be 10% off the retail value of the electricity generated.

Implementation Information: N/A

Supporting Strategies for Energy Efficiency and Renewable Energy Measures

The following municipal strategies were not quantified for GHG emission reductions or costs and savings, but they support and strengthen the quantified measures listed above and are an important part of the CAP Update.

SP Energy-1. Employee Outreach and Education

Objective: Institute an employee awareness program to educate personnel on energy-efficiency steps, such as indoor temperature controls.

SP Energy-2. Encourage Paperless Billing

Objective: Encourage online paperless billing as an option for revenue such as traffic tickets and other fines. Make a goal of reducing the number of payments by mail by 45% by 2020. This will reduce printing energy use as well as energy required to handle physical payments. This measure will also reduce paper waste generated by County facilities.

SP Energy-3. Data Center Virtualization

Objective: Install virtualization technology in data centers where feasible.

SP Energy-4. New Aeration Blowers at the Central Marin Sanitary Agency

Objective: Two of the four original single-speed aeration blowers at the Central Marin Sanitary Agency (CMSA) were replaced with high-speed, variable-output turbo blowers this past year. These new blowers are more energy efficient because of their ability to change motor speeds to match microorganism air demand fluctuations rather than throttling down the air supply of the single-speed blowers. The aeration system optimization phase of the project is under way and, when completed, the agency should realize a projected 20% to 30% energy savings. The following information is available for this measure:

- 2012 annual electricity use at the CSMA was 697,028 kWh, provided by MCE.
- The new aeration blowers would reduce this energy use by 20%
- The system has the potential to reduce GHG emissions by 26 $MTCO_2e$. However, these emission reductions will occur at the facility itself, which is located in the city of San Rafael. Consequently, emission reductions were not counted toward the CAP Update.

SP Energy-5. Food Waste-to Energy System at the Central Marin Sanitation Agency

Objective: The CSMA currently plans to use its existing wastewater treatment plant's anaerobic digesters to process local commercial food waste to produce renewable, non-fossil-fuel energy (City of San Rafael and Central Marin Sanitation Agency 2008). The following information is available for this measure:

- The potential renewable energy generation from the Food Waste-to-Energy System is 230 kW
- The system would operate 8 hours per day and 260 days per year, generating 478,400 kWh annually.
- The system would require 242,320 kWh annually for the separation facility and the processing facility.
- Net annual energy generation would be 236,080 kWh.
- This electricity would offset MCE Light Green electricity, the current electricity type used at the CMSA.
- The system has the potential to reduce GHG emissions by 44 $MTCO_2e$. However, these emission reductions will occur at the facility itself, which is located in the city of San Rafael. Consequently, emission reductions were not counted toward the CAP Update.

Vehicle Fleet and Employee Commute

Trans-1. New Vehicles

The following sub-measures are part of the County's New Vehicles action strategy.

Trans-1.1.Purchase fuel efficient (e.g., hybrid) and/or smaller fleet vehicles to replace existing fleet vehicles

Objective: Expand on the fuel-efficient fleet vehicles program by replacing 25 of County-owned traditional-fueled vehicles (passenger/light-duty, medium-duty, and heavy-duty) with the most efficient vehicles (hybrid, compressed natural gas, or diesel) available by the year 2020.

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of TRANS Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
17	0.4%	1.2%	2.0%	-[d]	-[d]	-[d]

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for energy Vehicle Fleet and Employee Commute strategies.
[d] Cost analysis not prepared for this measure.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- Standard vehicle fuel economy is 34 miles per gallon (average from the 2012 Municipal Inventory)
- Hybrid vehicle fuel economy is 46 miles per gallon (provided by County). The actual hybrid fuel economy will likely be higher.
- Average annual VMT is 10,000

Analysis Method: Hybrids will achieve 12 mpg beyond standard vehicles, resulting in 78 gallons of gasoline saved per year per vehicle (10,000 miles ÷ 34 mpg - 10,000 miles ÷ 46 mpg). This value was multiplied by 25 vehicles to determine total annual fuel savings. Total fuel savings were multiplied by the emission factors presented in Table C-1 to determine GHG emission reductions.

Implementation Information: N/A

Trans-1.2. Electric Vehicles

Objective: Require the replacement of 20 non-emergency gasoline powered sedans with electric vehicles by 2020.

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of TRANS Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
42	0.9%	2.9%	4.9%	-[d]	-[d]	-[d]

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for energy Vehicle Fleet and Employee Commute strategies.
[d] Cost analysis not prepared for this measure.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- Standard vehicle fuel economy is 34 miles per gallon (average from the 2012 Municipal Inventory)
- EVs require 32 kWh per 100 miles, using the 2014 Ford Focus Electric vehicle as a proxy (U.S. Department of Energy 2014)
- Average annual VMT is 10,000

Analysis Method: Gasoline savings were calculated by dividing average annual VMT for each vehicle (10,000) by the fuel efficiency of standard vehicles (34 mpg). Increased electricity use to power the new EVs was estimated by multiplying average annual VMT by 32 kWh per 100 miles. These values were multiplied by 20 vehicles to determine total annual fuel savings and electricity use. Total fuel savings were multiplied by the emission factors presented in Table C-1 to determine GHG emission reductions from reduced fuel use. Total increased electricity emissions were calculated by multiplying new electricity use for EVs by the appropriate RPS-adjusted utility emission factors.

Implementation Information: N/A

Trans-1.3.Electric Landscaping Equipment

Objective: Require the replacement of 10 pieces of County landscaping equipment with electric equipment by 2020. Install outdoor electrical outlets on County buildings as appropriate.

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of TRANS Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
3	0.1%	0.2%	0.4%	-[d]	-[e]	-[f]

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for energy Vehicle Fleet and Employee Commute strategies.
[d] Not estimated.
[e] Upfront cost assumed to be negligible; equipment costs vary significantly based on other features besides energy source.
[f] Annual cost savings associated with an electric leaf blower or chainsaw estimated at between $500 and $600 per unit, assuming 960 hours of operation.

Assumptions: All assumptions utilized for the analysis of this strategy are identified in Table C-7.

Analysis Method: The OFFROAD2007 model calculates vehicle operating emissions by fuel type (e.g., diesel, gasoline) and average horsepower. Emissions reductions achieved by the strategy were calculated by multiplying the model outputs by vehicle class by CAPCOA's (2010) anticipated percentage reduction in GHG emissions for switching to electric power.

Total costs not quantified. Upfront cost is assumed to be negligible; equipment costs vary significantly based on other features besides energy source. As an example, the annual cost savings associated with an electric leafblower or chainsaw is estimated at between $500-$600 per unit, assuming 960 annual hours of operation.

Implementation Information: N/A

Trans-2. Alternative Transportation

The following sub-measures are part of the County's Alternative Transportation action strategy.

Trans-2.1. Guaranteed Ride Home

Objective: Provide a free shuttle or taxi ride home to employees in case of an emergency (illness, family crisis, unscheduled overtime). Would apply to any employee who uses any alternative to driving alone to work (public transit, carpooling, vanpooling, biking, or walking) on the day of the emergency.

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of TRANS Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
1	0.02%	0.1%	0.1%	-[d]	-[d]	-[d]

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for energy Vehicle Fleet and Employee Commute strategies.
[d] Cost analysis not prepared for this measure.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- 13% of eligible employees will use this program once each year
- In 2020, 674 employees would be eligible for this program (average number of daily employees using an alternative mode of transportation to commute to work)

Analysis Method: 88 guaranteed ride home trips would occur as a result of this measure (13% * 674), offsetting 88 commute trips. The change in VMT by mode was estimated by distributing these trips based on the new commute mode share after the implementation of this strategy and any other overlapping local employee commute measures. GHG emission reductions were then estimated by multiplying VMT reductions for each mode by the associated emission factors used in the 2012 Municipal Inventory.

Implementation Information: N/A

Trans-2.2. Green Commute Program

Objective: Reestablish the County's Green Commute Program which could include measures that allow County employees to purchase public transit fares with pre-tax dollars up to IRS limits, provide employees with low-cost monthly transit passes, and/or provide direct incentives to employees that take commute alternatives. The County will also encourage car-pooling or van-pooling by municipal employees by providing ride-matching assistance, preferential carpool parking, flexible work schedules for carpools, and vanpool assistance.

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of TRANS Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
342	7.3%	23.9%	40.2%	-[d]	-[d]	-[d]

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for energy Vehicle Fleet and Employee Commute strategies.
[d] Cost analysis not prepared for this measure.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- The previous Marin County Green Commute Program (implemented in 2008 but subsequently canceled) was used as a proxy for estimating reduced trips and VMT for this measure. The change in mode share from this program was: -10% for drive alone, +6% for carpool, +2% for transit, and +2% for bike trips (Marin County Department of Public Works 2009).
- The County would also provide a daily alternative transportation incentive to employees.

Analysis Method: The daily number of reduced drive alone trips was calculated by multiplying the baseline number of trips (after the implementation of other overlapping local employee commute measures) by -10% as indicated above. The increase in carpool, transit, and bike trips was then calculated by multiplying the baseline number of trips (after the implementation of other overlapping local employee commute measures) by +6% for carpool, +2% for transit, and +2% for bike trips as indicated above. GHG emission reductions were estimated by multiplying VMT reductions and VMT increases for each mode by the associated emission factors used in the 2012 Municipal Inventory.

A moderate level of cost associated with additional staff time to manage the program and incentives are anticipated. Developing, marketing and managing the program might require as much as ½ of an FTE per year and a materials budget.

Implementation Information: N/A

Supporting Marin Countywide Plan policies: TR-1.c - Promote Transportation Alternatives, AIR-4.b - Reduce Greenhouse Gas Emissions Resulting from Transportation, AIR-4.e - Reduce County Government Contributions to Greenhouse Gas Emissions.

The following sub-measures are part of the County's electric vehicles action strategy.

Trans-2.3. Electric Vehicle Charging Stations

Objective: Encourage the use of electric vehicles (EVs) by County employees by installing 10 new 120-volt EV charging at County facilities by 2020. Install three Level I charging stations and seven Level II charging stations by 2020. The Department Of Public Works is currently investigating the potential of adding four 120-volt stations in the Civic Center lot in 2015.

This strategy would support plug-in hybrid electric vehicle (PHEV) purchase by County employees by enabling charging stations at County facilities.

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of TRANS Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
7	0.2%	0.5%	0.9%	($400)–$100	$20,000–$60,000	($2,000) (Government); $5,000 (Consumer)

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for land use, transportation, and off-road strategies.

Assumptions: In addition to assumptions listed in Table C-1, the following were also considered:

- Installation of three Level I and seven Level II charging stations would serve four PHEV and/or BEV per day, resulting in an electric-VMT (eVMT) increase of 13 per vehicle per day.
- Anticipated mix of PHEV (10-mile range, 20-mile range, and 40-mile range) and BEV is based on the ARB's projections under the Zero Emission Vehicle (ZEV) "Most Likely Compliance Scenario" (ARB 2010, 2011).
- Charging PHEV and BEV would consume the following quantities of electricity:
    - PHEV 10-mile range: 4.1 kWh per charge
    - PHEV 20-mile range: 4.8 kWh per charge
    - PHEV 40-mile range and BEV 75-mile range: 5.8 kWh per charge
- PHEV and BEV would replace new vehicles with an average fuel economy of 34 miles per gallon.
- On average, PHEV and BEV travel 41 miles per day.
- The Energy Efficiency Ratio (EER) of EVs is 3.4 (ARB 2014).
- The energy density of reformulated gasoline is 115.63 mega joules per gallon (California Code of Regulations, Title 17 Section 95485(a)(1)).
- On average, four vehicles would use each charging station per day (weekdays and weekends).
- 20% of total vehicle charging occurs at the charging stations (80% occurs in the home). Consequently, to be conservative in attributing emission reductions to the County's action of installing charging stations, only 20% of total displaced emission reductions from EVs are attributed to this measure (ECOtality 2013).
- The charging stations will not be funded by LCFS credits and are additional to the state's plan for EVs under LCFS.
- Systems are assumed to be installed in bundles of one Level I EV charging station and 2.3 Level II EV charging stations, on average, to reduce upfront costs.
- One-time hardware costs per EV charging bundle range from $1,700 to $6,500 (ICF International 2013a).
- One-time permitting costs per EV charging station bundle range from $100 to $1,000 (ICF International 2013a).

- One-time installation/labor costs per EV charging station bundle range from $2,500 to $6,000 (ICF International 2013a).
- One-time trenching/concrete costs per EV charging station bundle range from $3,000 to $8,000 (ICF International 2013a).
- Annual maintenance and networking costs per bundle paid by the county of $1,000 (ICF International 2013a).

Analysis Method: GHG emissions generated by EVs are attributed to VMT in all-electric mode (i.e., e-VMT) and gasoline mode. The E-VMT calculation was based on the anticipated future fleet mix, vehicle range, and charging times required for Level I and Level II charging stations. Miles traveled in all-electric mode were assumed to displace miles traveled using a gasoline engine with an average fuel economy of 34 miles per gallon. Emissions reductions were therefore determined as the difference between the emissions attributable to the EV versus the emissions that would have otherwise occurred using an average conventional gasoline vehicle. Total GHG reductions for these new EVs were multiplied by 20% to account for only the percentage of charging that occurs at public stations (versus the 80% of charging that occurs in the home).

Upfront costs include hardware, permitting, installation, and trenching/concrete for the Level II and DC charging stations (ICF International 2013a). The County covers the upfront costs and annual maintenance and networking costs. The drivers of plug-in electric vehicle realize savings.

Implementation Information: The County would work with MCE to identify grants and other funding sources to help finance the installation of charging stations. The County could also work with PG&E to fund and install charging stations.

Supporting Marin Countywide Plan Policies: N/A.

Trans-3. Trip Reduction

The following sub-measures are part of the County's Trip Reduction action strategy.

Trans-3.1. Encourage telecommuting by municipal employees

Objective: The County would update telework policies and practices for employees. The policy should specify the following (Victoria Transport Policy Institute 2011a):

- Which job categories are suitable for telework.
- What is required of employees to qualify for the program.
- What equipment, support and benefits the County will provide to telecommuting employees.
- What criteria are to be used to evaluate the performance of employees when they telecommute.
- How telecommuting schedules are determined, and what is required to change schedules.
- Periodic review of the arrangement.
- Model contracts and forms for establishing and tracking telecommuting.

Supporting Marin Countywide Plan policies: AIR-4.b - Reduce Greenhouse Gas Emissions Resulting from Transportation, TR-1.a - Support Alternate Work Schedules.

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of TRANS Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
51	1.1%	3.5%	5.9%	-[d]	-[d]	-[d]

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for energy Vehicle Fleet and Employee Commute strategies.
[d] Cost analysis not prepared for this measure.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- 2% of total employees will be working from home on any given day under this measure; in the 2020 BAU scenario, 1% of total employees are be working from home on any given day.
- The average one-way commute trip distance is 19.3 miles (511 Rideshare & Bicycling 2012).

Analysis Method: The daily number of avoided VMT was estimated by calculating the number of additional employees working from home (1% of total employees) by the average one-way trip distance (19.3). The change in VMT by mode was estimated by distributing these trips based on the new commute mode share after the implementation of this strategy and any other overlapping local employee commute measures. GHG emission reductions were then estimated by multiplying VMT reductions for each mode by the associated emission factors used in the 2012 Municipal Inventory.

Implementation Information: N/A

Trans-3.2.Municipal Parking Management

Objective: Implement a Municipal Parking Management Program to discourage private vehicle use. This may include the use of parking pricing for employees. The County will study where a parking management program will produce the greatest benefits in the most cost-effective manner and where impacts on street parking for surrounding communities will be the smallest.

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of TRANS Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
388	8.3%	27%	45.6%	-[d]	-[d]	-[d]

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for energy Vehicle Fleet and Employee Commute strategies.
[d] Cost analysis not prepared for this measure.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- The County would implement a $1.00 parking price for employees at selected County facilities. A $1.00 parking price was used to be conservative, but studies show increased savings from increased fees. This results in a 0.9% trip reduction for drive alone (Victoria Transport Policy Institute 2011b).

Analysis Method: The daily number of reduced drive alone trips was calculated by multiplying the baseline number of trips (after the implementation of other overlapping local employee commute measures) by 0.9%. The change in VMT by mode was estimated by distributing these reduced trips based on the new commute mode share. GHG emission reductions were estimated by multiplying VMT reductions for each mode by the associated emission factors used in the 2012 Municipal Inventory.

Implementation Information: The County would conduct an updated study of the financial, employee and neighborhood impacts of adding a parking fee to selected County facilities including the Civic Center to design a fee program for appropriate sites. A $1.00 parking price was used in this analysis to be conservative, but studies show increased savings from increased fees. The County would study the impact of different parking fees further in the development of the program. The financial impact to employees could be reduced by allocating surplus revenue from the fees to incentives to encourage the use of commute alternatives and/or by allowing employees to pay the parking fee using pre-tax dollars.

The study would require the participation of the Human Resources Department and will ensure that it complies with all bargaining obligations.

Supporting Strategies for Vehicle Fleet and Employee Commute Measures

The following municipal strategies were not quantified for GHG emission reductions or costs and savings, but they support and strengthen the quantified measures listed above and are an important part of the CAP Update.

SP Trans-1. Vehicle Idling

Objective: Limit idling of municipal vehicles to 3 minutes.

SP Trans-2. Clean Energy Fuels Program Infrastructure

Objective: Provide/encourage construction of refueling infrastructure for electric and alternative-fuel vehicles. This measure will support Trans-1.

SP Trans-3. Smart Global Positioning Systems

Objective: Participate in a pilot program to install smart global positioning systems (GPS) on County vehicles. Smart GPS supports trip planning actions by mapping optimal routes that reduce VMT. Through this measure, the County will continue to seek funding to install additional GPS units. This measure will support the measures above.

SP Trans-4. Fuel Tracking System

Objective: Provide an up-to-date fuel tracking system for the County fleet. This measure will support the measures above.

SP Trans-5. Vehicle Maintenance Program

Objective: Evaluate and enhance the County's current vehicle maintenance program to reduce fuel consumption. This measure will support the measures above.

SP Trans-6. Bicycle Safety Program

Objective: Provide a bicycle safety program and information about safe routes to work.

Waste Reduction, Reuse, and Recycling

Waste-1. Increase Recycling at County Facilities

Objective: Increase the recycling rate at County facilities. This could be implemented by additional recycling and composting efforts and through education and outreach programs for County employees.

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of WR Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
34	0.7%	2.4%	100%	-[d]	-[d]	-[d]

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for energy Waste Reduction, Reuse, and Recycling strategies.
[d] Cost analysis not prepared for this measure.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- The 2020 BAU diversion rates for the following facilities and events were used: Civic Center – 43%; County Jail – 15%; 120 North Redwood – 89%; Kerner Campus – 88%; Marin County Fair – 91%; Marin Home Show – 87%
- The county would generate 623 tons of solid waste from these facilities and events in 2020, of which, 310 tons would be landfilled under BAU conditions.
- Under this measure, the new diversion rates for the following facilities and events were used: Civic Center – 83%; County Jail – 83%; 120 North Redwood – 83%; Kerner Campus – 83%; Marin County Fair – 95%; Marin Home Show – 95%
- One ton of landfilled mixed municipal solid waste (MSW) generates 0 0.1512 $MTCO_2e$ (ICLEI – Local Governments for Sustainability USA. 2012).

Analysis Method: Waste-1 would increase the waste diversion rate under BAU conditions as listed above. Landfilled waste in 2020 for each facility and event was recalculated assuming the new diversion rates listed above. These tonnages were subtracted from the BAU scenario to calculate the volume of additional diverted waste achieved by the strategy. Avoided GHG emissions from increased diversion were quantified by multiplying the additional diverted waste by the average landfill emissions per ton of waste landfilled.

Implementation Information: N/A

Supporting Strategies for Waste Reduction, Reuse, and Recycling Measures

The following municipal strategies were not quantified for GHG emission reductions or costs and savings, but they support and strengthen the quantified measures listed above and are an important part of the CAP Update.

SP Waste-1. Electronic and Universal Waste Recycling

Objective: Require that all electronic and universal waste from County buildings and facilities be diverted from landfills and recycled instead. Universal waste includes batteries, pesticides, mercury-containing equipment, and bulbs (lamps).

SP Waste-2. Recycled Paper Purchasing

Objective: Continue to require departments to purchase paper with a minimum of 30% recycled content. All paper should be multi-purpose rather than copier-quality paper.

Water Conservation and Wastewater

Water/Wastewater-1. Water Conservation

The following sub-measures are part of the County's Water Conservation action strategy.

Water/Wastewater-1.1. Water Conservation for Existing Buildings

Objective: Implement a program to renovate existing buildings to require a higher level of water efficiency. At a minimum, require a 10% savings in indoor and outdoor water use. Develop a master plan of County facilities to address water efficient landscape, irrigation and maintenance practices.

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of WW Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
100	2.1%	7.0%	98.7%	-[d]	-[d]	-[d]

[a] Presented in terms of $MTCO_2e$.
[b] State and local reductions for all sectors.
[c] Local reductions for energy Water Conservation and Wastewater strategies.
[d] Cost analysis not prepared for this measure.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- Water energy intensities were based on the 2012 Municipal Inventory and are 2,163, 647, and 3,855 kWh per million gallons for MMWD, NMWD, and SBWD, respectively.

Analysis Method: Estimated indoor and outdoor water use in existing municipal facilities (for the year 2015) were multiplied by 10% to determine water use reductions associated with this measure. Electricity savings from reduced water movement and treatment were quantified by multiplying the estimated water reductions by the appropriate agency-specific energy intensities. Reductions in building energy consumption were calculated by multiplying the water reductions by the percentage of hot water used in buildings, an assumed proportion of gas and electric water heaters, and the amount of energy it takes to heat a gallon of water for both heater types. Water savings from overlapping state and local strategies were removed from the energy forecast to avoid double counting. Total energy reductions from water movement and hot water heating were multiplied by RPS-adjusted utility emission factors to estimate emissions reductions. Reductions in fugitive emissions from wastewater treatment were also quantified by multiplying the water reduction by the average treatment emissions per ton of gallon of processed water.

Although costs were not quantified for this measure, costs would include up-front costs of installing low-flow fixtures and other water saving appliances in County facilities, and savings would include reduced water bills.

Implementation Information: This measure could be implemented by complying with part or all of CALGreen Tier 1 standards for nonresidential development, which would achieve a 30% reduction in water use. The County would also conduct water audits on County facilities and expedite repairs, create development plans to ensure water conservation techniques are used, and perform water efficiency upgrades where feasible and effective.

Water/Wastewater-1.2. Irrigation Monitoring and Management System

Objective: Install a water monitoring and management system for all of the County's irrigation needs.

Summary Metrics:

2020 GHG Reduction[a]	% of All Reductions[b]	% of Local Reductions	% of WW Reductions[c]	Savings (Cost)/MT	Initial Capital Cost	Annual Savings (Cost)
1	0.03%	0.1%	1.2%	-[d]	-[d]	-[d]

a Presented in terms of $MTCO_2e$.
b State and local reductions for all sectors.
c Local reductions for energy Water Conservation and Wastewater strategies.
d Cost analysis not prepared for this measure.

Assumptions: In addition to assumptions listed in Table C-7, the following were also considered.

- The expected percent reduction in outdoor water use after installation of smart landscape irrigation controllers is 6.1% (CAPCOA 2010).

Analysis Method: Estimated 2020 BAU outdoor water use was multiplied by 6.1% to determine water use reductions associated with this measure. Water savings from overlapping state and local strategies were removed from the energy forecast to avoid double counting. Electricity savings from reduced water movement and treatment were quantified by multiplying the estimated water reductions by the appropriate agency-specific energy intensities. Total energy reductions from water movement were multiplied by RPS-adjusted utility emission factors to estimate emissions reductions.

Although costs were not quantified for this measure, costs would include up-front costs of installing monitoring and irrigation management tools, and savings would include reduced water bills.

Implementation Information: This measure could be accomplished by participation in the California Irrigation Management Information System (CIMIS), such as by installation of a climate station in the county or by using CIMIS irrigation scheduling tools. Other monitoring and irrigation management tools should be considered, as appropriate, to best meet the county's specific needs.

Refrigerants

Supporting Strategies for Refrigerants Measures

The following municipal strategies were not quantified for GHG emission reductions or costs and savings, but they support and strengthen the quantified measures listed above and are an important part of the CAP Update.

SP Refrig-1. Refrigerant Best Management Practices

Objective: Implement best management practices, including frequent appliance inspections and responsible appliance disposal, for the handling and use of refrigerants.

SP Refrig-2. Vending Machine Replacements

Objective: Reduce the total number of vending machines at County-owned facilities by 2020.

SP Refrig-3. Purchasing Requirements

Objective: Industry experts are currently conducting research to develop refrigerants that are not as a potent a GHG as their existing counterparts. The County will to monitor the availability of these refrigerants.

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Appendix D

Funding Strategies

Appendix D
Funding and Financing Options

This appendix provides information on funding and financing options available to support implementation of the emissions reduction strategies. The funding options may be available to Marin County (County), public agencies, community members, or a combination of entities, as noted below. The County will pursue a number of financing strategies to support overall management of the Climate Action Plan Update (CAP Update). The County may also promote several of the community-oriented funding options described below as part of CAP Update incentives, outreach, and education.

Federal and State Funding Options

California Air Resources Board Programs

The California Air Resources Board (ARB) manages a variety of air pollution incentives, grants, and credit programs that could be used to help fund local transportation strategies. The following programs offer grant opportunities over the next several years. Residents, businesses, and fleet operators may be eligible to receive funds or incentives, depending on the program rules.[1]

- Air Quality Improvement Program (Assembly Bill 118).
- Enhanced Fleet Modernization Program (Assembly Bill 118).
- Carl Moyer Program—Voucher Incentive Program (administered by California Air Pollution Control Officers Association).
- Goods Movement Emission Reduction Program.
- Loan Incentives Program.
- Lower-Emission School Bus Program/School Bus Retrofit and Replacement Account.
- Providing Loan Assistance for California Equipment (PLACE) Program.
- Clean Vehicle Rebate Project (CVRP)
- California Capital Access Program (CalCAP)

California Department of Resources Recycling and Recovery Grant Program

California Department of Resources Recycling and Recovery (CalRecycle) grants are authorized by state legislation to assist public entities in the safe and effective management of the waste stream. Funds are intended to reduce, reuse, and recycle all waste; encourage development of recycled-content products and markets; protect public health; and foster environmental sustainability.[2]

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[1] For more information on the ARB incentive programs, please visit: http://www.arb.ca.gov/ba/fininfo.htm.

[2] For more information on the CalRecycle Recycling and Recovery grants, please visit: http://www.calrecycle.ca.gov/grants/

California Solar Initiative

Pacific Gas and Electric (PG&E) is one of three utilities participating in the state's Go Solar Initiative. This program provides a variety of rebates, incentives, and other types of support for both existing and new homeowners. Program rebates apply to solar photovoltaics (PVs), thermal technologies, and solar hot water projects. The program is designed to accommodate single-family homes, commercial development, and affordable housing. The initiative has a total budget of $2.2 billion between 2007 and 2016 for solar generation and $250 million between 2010 and 2017 for thermal systems (i.e., new solar hot water systems). Most of the project funding for PG&E customers has been expended but as of December 2014, there were still funds available for eligible affordable housing projects.[3]

Energy Upgrade California

Energy Upgrade California is funded by the American Recovery and Reinvestment Act, California utility ratepayers, and private contributions. It is administered by participating utilities, like PG&E. Under this program, a homeowner selects one of two energy upgrade packages, basic or advanced, with each offering different enhanced options. The program connects homeowners with home energy professionals, including participating contractors and Whole-House Home Energy Raters. It also offers rebates, incentives, and financing. For instance, homeowners can get up to $6,500 back on an upgrade through a local utility.[4]

Energy Efficient Mortgage

Energy Efficiency Mortgages (EEMs) may be available to some county residents. An EEM credits a home's energy efficiency upgrades and gives borrowers the opportunity to finance cost-effective, energy-saving measures as part of a single mortgage. Borrowers typically need to have a home energy rater conduct a home energy assessment before financing is approved. This rating verifies that the home is energy-efficient. EEMs are typically used to purchase a new home that is already energy efficient, such as an ENERGY STAR–qualified home.[5]

Federal Tax Credits for Energy Efficiency

Federal government tax credits are available to county residents through 2016. The tax credits provide a discount of 30% of cost with no upper limit for geothermal heat pumps, small wind turbines (residential), and solar energy systems. The 2016 tax credits also include 30% of the cost up to $500 per 0.5 kilowatt (kW) of power capacity for fuel cells in a principal residence.[6]

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[3] For more information on the California Solar Initiative, please visit: http://www.gosolarcalifornia.ca.gov/

[4] For more information on Energy Upgrade California financial programs, please visit: http://www.marincounty.org/energyupgrade

[5] For more information on Energy Efficiency Mortgages, please visit: https://www.energystar.gov/index.cfm?c=mortgages.energy_efficient_mortgages

[6] For more information on federal tax credits for energy efficiency, please visit: https://www.energystar.gov/?c=tax_credits.tx_index

Planning Grants from the Strategic Growth Council

The Strategic Growth Council (SGC) of the California Department of Conservation (DOC) manages competitive grants for cities, counties, and designated regional agencies that promote sustainable community planning and natural resource conservation. The DOC has allocated approximately $18 million of Proposition 84 funds for competitive grants to support development, adoption, and implementation of Sustainable Community planning elements, including, but not limited to, CAPs and general plan amendments. The grants awarded from this solicitation will cover up to a 3-year project period. Grant requests for amounts from $100,000 to $1,000,000 will be considered.[7]

State Funding for Infrastructure

The state's Infill Infrastructure Grant Program may be used by the County to help fund strategies that promote infill housing development. Grants are available to support funding for infrastructure improvements necessary for specific residential or mixed-use infill development projects.[8]

Transportation-Related Funding

The following funding sources that may be utilized to fund strategies related to transit, bicycle, or pedestrian improvements. Residents, businesses, and fleet operators can receive funds or incentives depending on the program.

- Safe, Accountable, Flexible, Efficient Transportation Equity Act—Legacy for Users (SAFETEA-LU)
- Surface Transportation Program (STP) Fund, Section 1108
- Congestion Mitigation and Air Quality Improvement Program(CMAQ), Section 1110
- Transportation Enhancement Activities (TEA)
- National Recreational Trails Program
- National Highway System Fund (NHS)
- National Highway Safety Act, Section 402
- Transit Enhancement Activity, Section 3003
- Section 3 Mass Transit Capital Grants
- Bridge Repair & Replacement Program (BRRP)
- Federal Transit Administration (FTA) 5309
- FTA Small Starts
- FTA Section 5311(f)
- California's Bicycle Transportation Account
- Environmental Enhancement and Mitigation (EEM) Program

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[7] For more information on Planning Grants from the Strategic Growth Council, please visit: http://sgc.ca.gov/m_grants.php

[8] For more information on the state's Infill Infrastructure Grant Program, please visit: http://www.hcd.ca.gov/fa/iig/

- Safe Routes to School (SR2S)
- Office of Traffic Safety (OTS)
- Transportation Development Act (TDA) Article III
- Transportation Funds for Clean Air (TFCA, formerly AB 434)
- Flexible Congestion Relief (FCR) Program
- State Highway Operations and Protection Program (SHOPP)

California Proposition 1: State Water Bond 2014

Proposition 1 is a $7.5 billion general obligation bond measure that was approved by California voters on November 4, 2014. Proposition 1 will fund investments in water projects and programs as part of a statewide, comprehensive water plan for California. In addition to funding programs ranging from water conservation to recycling to groundwater cleanup to water storage, Proposition 1 is expected to leverage additional local and regional funds to provide a total investment of $25 billion to $30 billion to address California's water needs. The bond funds will be distributed through a competitive grant process overseen by various state agencies, including the Department of Water Resources, the State Water Resources Control Board, and the California Water Commission. The agencies will conduct processes to solicit proposals for grants, review applications, and award the funding.

USDA Natural Resources Conservation Service

The Natural Resources Conservation Service (NRCS) provides financial and technical assistance programs that help eligible agricultural producers:

- Construct or improve water management or irrigation structures
- Improve resource conditions such as soil quality, water quality, water quantity, air quality, habitat quality, and energy
- Implement conservation practices, or activities, such as conservation planning, that address natural resource concerns on their land

California Cap-and-Trade Funding

The California Cap-and-Trade Program, a key element of AB 32, established greenhouse gas (GHG) emissions permits (allowances). A portion of these allowances are sold at quarterly auctions and reserve sales. The legislature and governor appropriate proceeds from the sale of state-owned allowances for projects that support the goals of AB 32. The County may be able to obtain funding from these sales to support the GHG reduction measures in this CAP Update.

Methane digesters can be funded through offsets allowed under the Cap-and-Trade system. Cap-and-Trade Funding may also be available to support carbon farming once appropriate protocols are approved.

Senate Bill 1183

Senate Bill 1183, sponsored by Senator Mark DeSaulnier (D-Concord), allows local jurisdictions in California to propose a small vehicle registration fee (no more than $5) on their local ballots, requiring approval from at least two-thirds of local voters, to fund bike trails and paths on park-district land.[9] This bill remains in effect until January 1, 2025. The bill would require the Department of Motor Vehicles to administer the surcharge and transmit the net revenues from the surcharge to the local agency. The bill would require the local agency to use these revenues for improvements to paved and natural-surface trails and bikeways, including existing and new trails and bikeways and other bicycle facilities, and associated maintenance purposes. The bill would limit to 5% the amount of net revenues that may be used by the local agency for its administrative expenses in implementing these provisions.[10]

Regional and Local Funding Options

Bay Area Air Quality Management District

Bay Area Air Quality Management District (BAAQMD) offers several grant programs related to air quality improvement, as noted below. The air district also promotes state programs offered by the ARB, such as the Carl Moyer Program. Residents, businesses, and fleet operators may be eligible to receive funds or incentives, depending on the program rules.[11]

- Mobile Source Incentive Fund (MSIF)
- Transportation Fund for Clean Air (TFCA) (County Program Manager Fund and Regional Fund)
- Cash for Retiring Vehicles - California Consumer Assistance Program (administered by the California Bureau of Automotive Repair)
- Environmental Justice Small Grants Program (administered by the California Environmental Protection Agency)
- Hybrid Electric Vehicle Purchase Vouchers (HVIP) (administered by CALSTART)
- Zero-Emission Agricultural Utility Terrain Vehicle (Agricultural UTV) Rebate Program (administered by the San Joaquin Valley Air Pollution Control District)
- Strategic Incentives Division (SID) Program

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[9] For more information on Senate Bill 1183, please visit: http://la.streetsblog.org/2014/09/22/governor-brown-signs-protected-bike-lane-bill-car-fee-for-bike-paths/comment-page-1/.

[10] For more information on Senate Bill 1183, please visit: http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140SB1183.

[11] For more information on the incentive programs, please visit: http://www.baaqmd.gov/Divisions/Strategic-Incentives/Funding-Sources.aspx.

Marin Transit

Although the County does not have control over how Marin Transit chooses to expend its resources, it is possible that Marin Transit could take the following measures to generate revenue that would lead to reductions in GHG emissions.

- **Bus Stop Sponsorships**. Sponsorship of bus stops through advertising has been used as a revenue source.
- **Transit Fare Increases**. Increased fares could help fund capital improvements, although increases also have the potential to decrease ridership in the short term.
- **Parcel Tax**. An election consistent with Proposition 218[12] could serve to increase the existing level of taxation and provide additional funding for transit-related capital improvements. However, in the current economic climate, this may not be a likely financing source unless economic conditions improve and community support for such a taxation approach is favorable.

Golden Gate Transit

Golden Gate Transit is funded through tolls at the Golden Gate Bridge. Tolls could be altered to provide supplemental funding for expansion of transit.

Marin Energy Watch Partnership

The Marin Energy Watch Partnership, administered by the County in partnership with PG&E, provides resources and incentives to residents, businesses, and public agencies to increase energy efficiency. All public agencies, business, and residences in the county who are PG&E or Marin Clean Energy customers can participate.[13]

Marin Clean Energy Programs

Marin Clean Energy offers energy efficiency programs and financing for multi-family, single-family and commercial properties. MCE's programs include the following:[14]

- A Feed-In Tariff (FIT) program is now available to anyone in Marin County wishing to sell the power output from an eligible small-scale (1 MW or less) distributed renewable generation resource.
- Solar Rebate (currently available to eligible low income properties): This program provides a $500 solar rebate for Marin Clean Energy residential customers who qualify for the Single-Family Affordable Solar Home (SASH) or Multi-Family Affordable Home (MASH) programs.
- Green Home Loans: MCE has partnered with First Community Bank to offer Green Home Loans to MCE customers. Homeowners can finance home retrofits with the loan and pay it back directly on their PG&E bill.

[12] Proposition 218 requires voter approval for new general taxes affecting private property, new and increased property assessments, and property-related fees imposed as an "incident of property ownership."

[13] For more information on the Marin Energy Watch Partnership, including a list of available resources and incentives, please visit: http://www.marinenergywatch.org

[14] For more information on efficiency programs from Marin Clean Energy, please visit: http://www.marincleanenergy.org/ee

- Multi-Family Energy Assessments: MCE is now offering free walk-through energy assessments for qualifying properties to determine specific energy improvements and their potential energy and cost savings. MCE will also provide tenant units with certain free measures such as exchanging incandescent bulbs with high efficiency lighting, installing high performance faucet aerators and showerheads, and wrapping hot water pipes with insulation at no cost to building owners.
- Green Property Loans: MCE has partnered with River City Bank to offer Green Property Loans to provide multi-family and small commercial properties with competitive financing for energy efficiency upgrades. This new program allows property owners to finance energy improvements and re-pay the loan on their energy bill, removing up-front costs.

SmartLights

This program, sponsored by the County, PG&E and MCE, is designed to help small businesses become more energy-efficient by offering free start-to-finish technical assistance and instant rebates to help defray the cost of upgrading and/or repairing existing equipment.[15]

Bay Area Regional Energy Network (BayREN) Energy Efficiency Programs

BayREN offers additional rebates for the Energy Upgrade California program, commercial PACE financing, codes & standards programs and a multi-family program. The PAYS On-Bill Efficiency Program is a joint effort of Bay Area cities and counties and their water agencies to partner in the implementation of a unique on-bill program that allows municipal water utility customers to pay for efficiency improvements through a monthly charge attached to their meter, with no up-front costs and the assurance that their utility bill savings will exceed the program charge.[16]

Other Utility Programs

PG&E and the local water service providers offer a variety of rebates and incentives for single-family homes, multi-family homes, and commercial and industrial developments. PG&E programs apply to energy efficiency improvements and renewable energy projects, whereas the water service provider programs apply to water conservation efforts.[17]

PG&E and MCE also offer net energy metering to customers who have solar or other small renewable generation systems. Participants who generate more electricity than they use get credited for that excess electricity.[18]

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[15] For more information on SmartLights, please visit: www.smartlights.org

[16] For more information on BayREN programs, please visit: https://www.bayareaenergyupgrade.org/get-fit-fast-upgrades

[17] For more information on available PG&E incentive programs and rebates, please visit: http://www.pge.com/myhome/saveenergymoney/rebates/ and http://www.pge.com/en/mybusiness/save/rebates/index.page. For more information on available water service provider programs, please visit: http://www.marinwater.org/163/Rebates and http://www.nmwd.com/conservation.php.

[18] For more information on net energy metering, please visit: http://www.pge.com/en/b2b/energytransmissionstorage/newgenerator/netenergymetering/index.page and http://marincleanenergy.org/PDF/Net_Metering.pdf

On-Bill Financing

On-bill financing (OBF), offered by both PG&E and MCE, can be used to support commercial energy-efficiency retrofits. Funding from OBF is a no- or low interest loan that is paid back through the monthly utility bill. Lighting, refrigeration, heating ventilation and air conditioning, and energy efficient streetlights are all eligible projects.[19]

Privately-Sponsored Funding Options

Power Purchase Agreements

Power purchase agreements (PPAs) involve a private company that purchases, installs, and maintains a renewable energy technology through a contract that typically lasts 15 years. After 15 years, the company would uninstall the technology, sign a new contract, or sell the system at fair market value.

Property-Assessed Clean Energy Financing Districts

The Property-Assessed Clean Energy (PACE) finance program is intended to finance energy and water improvements within a home or business through a land-secured loan, and funds are repaid through property assessments. Municipalities are authorized to designate areas where property owners can enter into contractual assessments to receive long-term, low-interest loans for energy and water efficiency improvements and renewable energy installation on their property.

Private Equity Loans

Builders who own and operate buildings (i.e., commercial buildings or apartment complexes) can use private equity to finance these improvements, with returns realized as future cost savings (e.g., reduced energy expenditures). As market conditions improve over time, rents can be increased to reflect improved facilities and defray the investment costs.

Future Funding Options for County Implementation Costs

The County is not proposing any local fees or taxes at this time. While current economic conditions and fiscal realities limit funding options for the local reduction measures, additional funding sources that are currently infeasible may become realistic as the economy recovers. Potential future funding options are described below.

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[19] For more information on On-bill financing, please visit:
http://www.pge.com/en/mybusiness/save/rebates/onbill/index.page? and
http://www.mcecleanenergy.org/finance-tools/

New Development Impact Fees

New development impact fees may have some potential to provide funding, but such fees are best implemented when the real estate market and overall regional economic conditions are strong.

Utility User Tax Increase

Increasing utility taxes could help fund ongoing implementation, operations, and maintenance efforts. Any increase of tax rates will need to be highly sensitive to current local economic conditions and overall local, state, and national economic and financial context.

Additional Local Sales Parcel Tax

Increasing local sales parcel taxes could help fund ongoing implementation, operations, and maintenance efforts. Any increase of tax rates will need to be highly sensitive to current local economic conditions and overall local, state, and national economic and financial context.

Community Facilities District Special Taxes

Creating special district taxes would require voter approval and should be directed towards strategies that achieve broad benefits for the community (e.g., transit, pedestrian, and bicycle facilities). Any increase of tax rates will need to be highly sensitive to current local economic conditions and overall local, state, and national economic and financial context.

General Obligation Bond

A general obligation bond is a form of long term borrowing and could be utilized to fund municipal improvements.

Other Incentives

The following programs do not provide funding, but they do provide incentives to the community to participate in CAP actions.

Marin Solar Program

The Marin Solar Program can help homeowners and business owners evaluate the suitability of installing solar systems. The County staff can perform a free preliminary analysis of a site's solar potential to determine if it has the physical properties to support a solar installation. The Marin Solar Program is an outreach and education effort administered by the County of Marin Community Development Agency. The program does not participate in the design, purchase or sale of photovoltaic systems.[20]

[20] For more information on the Marin Solar Program, please visit www.marinsolar.org

Green Business Program

Business in the county can be certified with Green Business Program if they pledge to stay green, and select measures to conserve water, conserve energy, reduce waste, and prevent pollution. Businesses that participate receive streamlined environmental assistance, money saving opportunities, and promotional items to distribute to customers.[21]

[21] For more information on the Green Business program, visit:
www.maringreenbusiness.org for local resources
www.greenbusinessca.org for statewide resources, directory and enrollment information

Appendix E

Sea Level Rise Maps

Appendix E
Sea-Level Rise Inundation Maps

Introduction

This appendix provides additional examples of the sea-level rise inundation maps available for Marin County, including maps provided by the Marin County Development Agency's Collaboration: Sea-level Marin Adaptation Response Team (C-SMART) partnership and a multi-stakeholder initiative called Our Coast, Our Future (OCOF) (County of Marin 2014; Our Coast, Our Future 2015).

The C-SMART partnership has developed a series of PDF maps of selected regions and communities along the coast of Marin County. These maps depict coastal assets that may be exposed to sea-level rise and storm surges. The regional maps show the location of each community as well as exposed assets between communities that could be inundated under the following sea-level rise and storm scenarios:

- 25 centimeter (cm) sea-level rise with an annual storm,
- 25 cm sea-level rise with a 20-year storm,
- 50 cm sea-level rise with a 20-year storm,
- 100 cm sea-level rise with a 100-year storm, and
- 200 cm sea-level rise with a 100-year storm.

The community maps show the land within each of the community boundaries that could be inundated under the same sea-level rise and storm scenarios detailed above, highlighting key assets within the communities and the inundation zones. The regional maps are provided for the northern and southern regions of Marin's ocean coast, while community maps are provided for Muir Beach, Stinson Beach (see **Figure 1**), Seadrift (see **Figure 2**), Bolinas (East), Bolinas (West), Inverness (North), Inverness (South), Point Reyes Station (see **Figure 3**), Eastshore (South), Eastshore (North), Marshall, Lawson's Landing, and Dillon Beach.

The OCOF web site houses a dynamic web tool that features the San Francisco Bay Area and depicts the extent of flooding, waves, current, duration, and flood potential under various sea-level rise and storm scenarios. The scenarios range from 0 to 500 cm of sea-level rise with the following storm scenarios: no storm, an annual storm, a 20-year event, a 100-year event, or a king tide scenario.[1] The OCOF web site also allows users to choose which layers to view, with topic data that include levees, place names, land use, protected areas, rivers and streams, cliff and shoreline retreat, shorebirds, coastal armoring, roads and transportation, trails, buildings, and utilities and services. The geographic coverage of the tool extends alongshore of the outer coast, from Bodega Head to just south of Pillar Point Harbor in Half Moon Bay. The figures below provide examples of the OCOF flood maps, which include a map of Sausalito flooding under a 200 cm sea-level rise and a 100-year storm scenario in **Figure 4**, and a map of Doran Beach flooding under a 125 cm sea-level rise and a 20-year storm scenario in Figure **5**.

[1] King tide is a colloquial term for an especially high tide, which typically occurs when the earth is at its closest point in its orbit to both the moon and the sun at the same time.

Figure 1. Sea-Level Rise Exposure and Asset Identification Map for Stinson Beach, Marin County

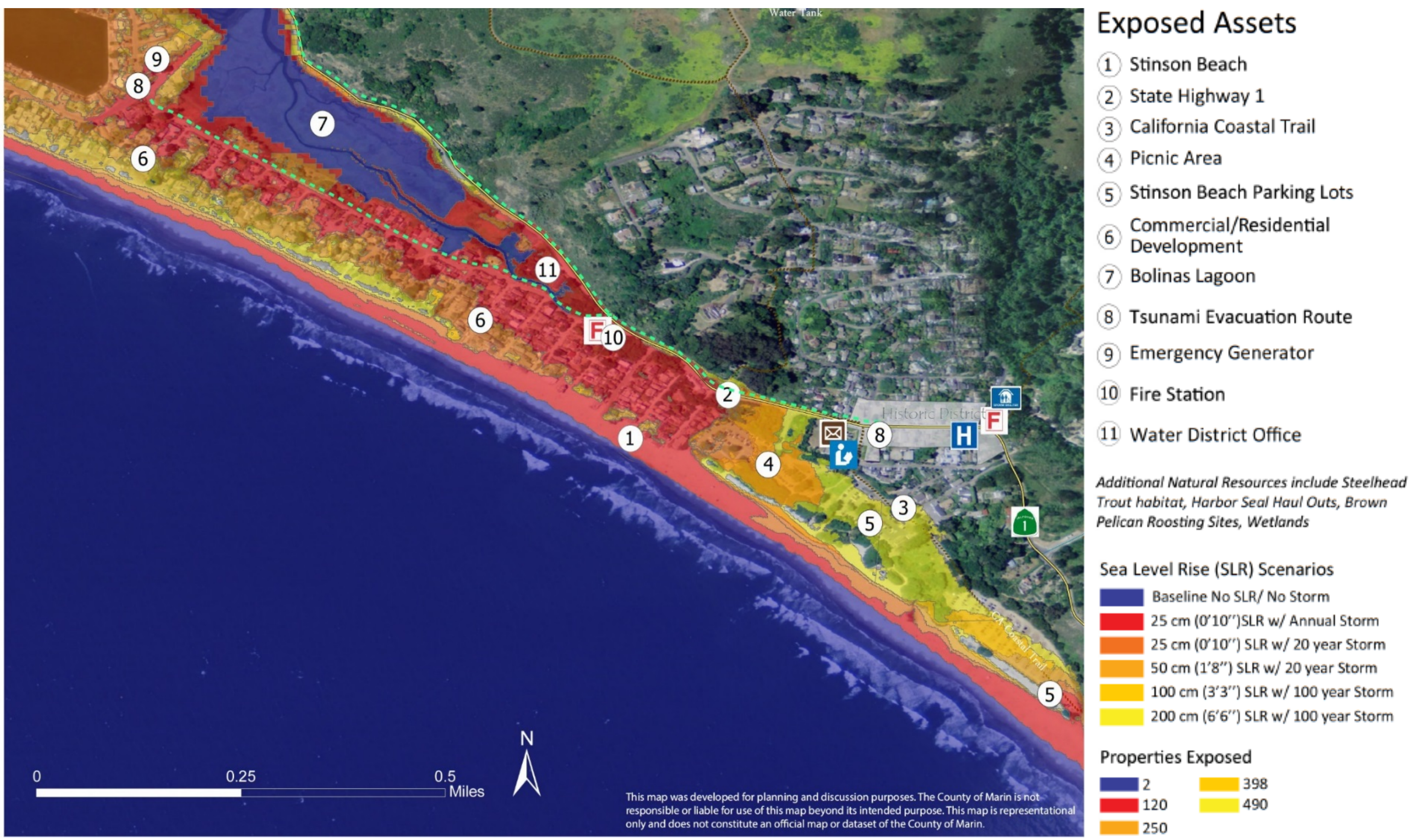


Figure 2. Sea-Level Rise Exposure and Asset Identification Map for Seadrift, Marin County

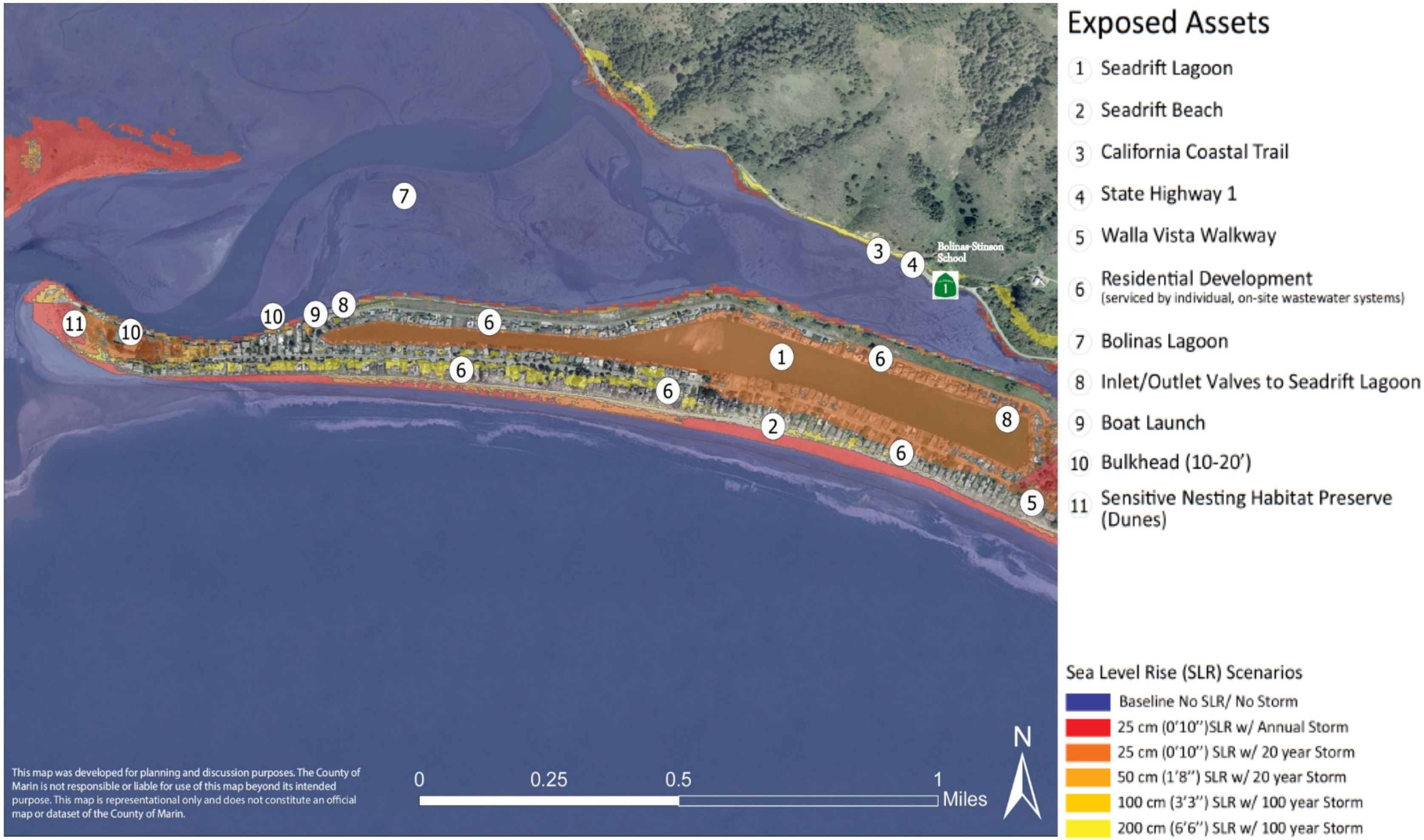


Figure 3. Sea-Level Rise Exposure and Asset Identification Map for Point Reyes Station, Marin County

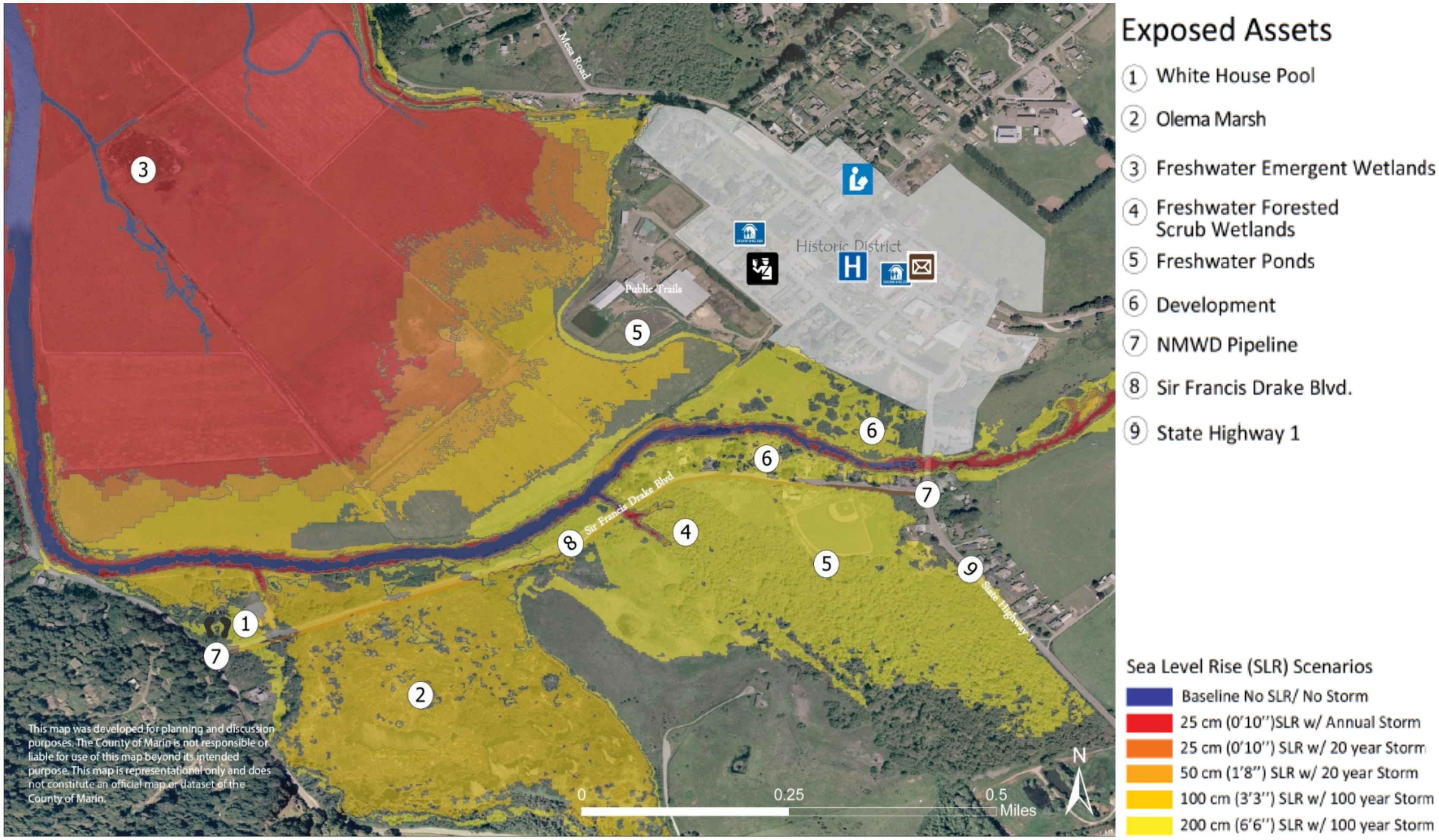


Figure 4. Flooding under a 200 cm Sea-Level Rise and 100-Year Storm Scenario at Sausalito, Marin County

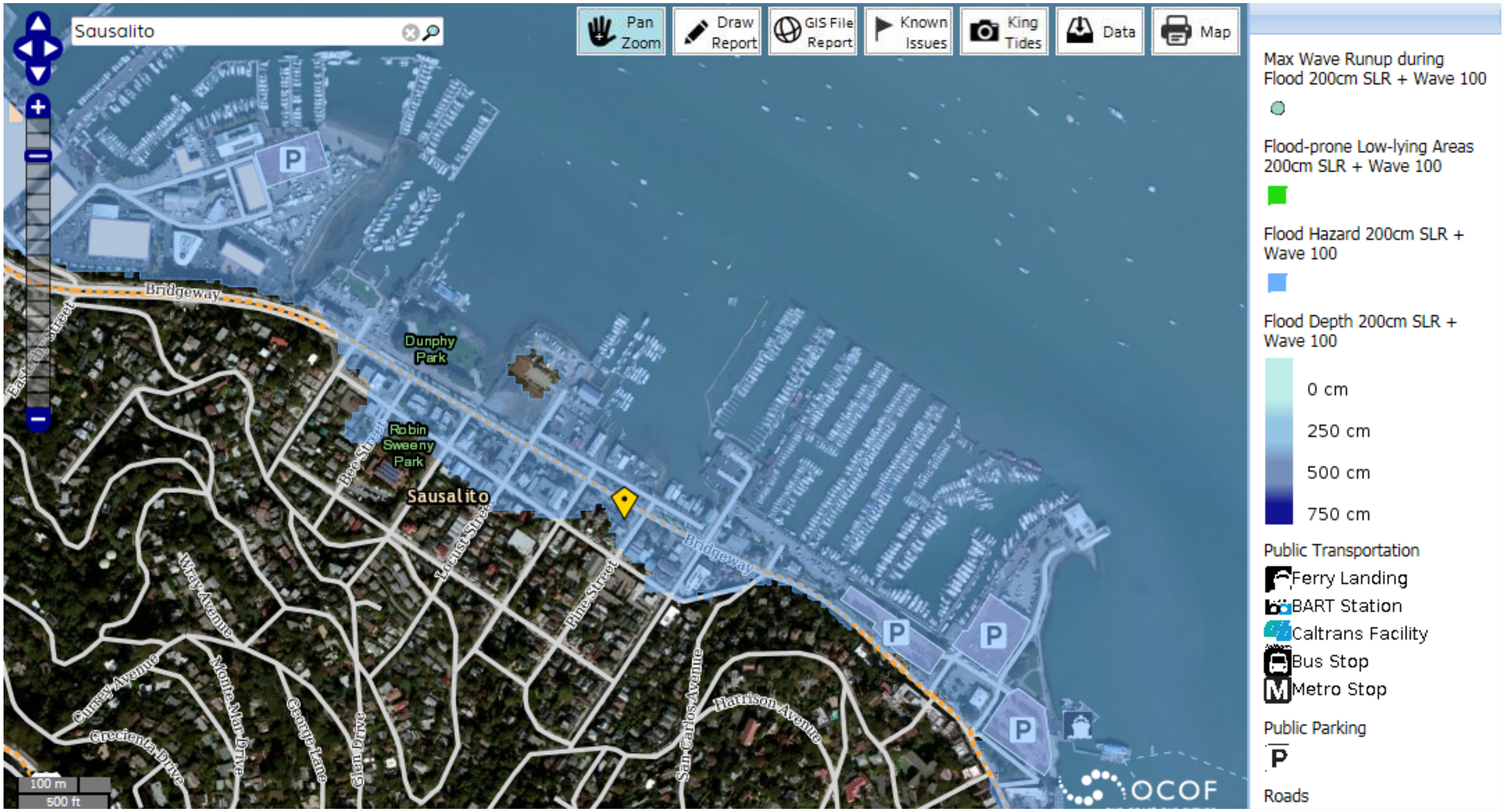
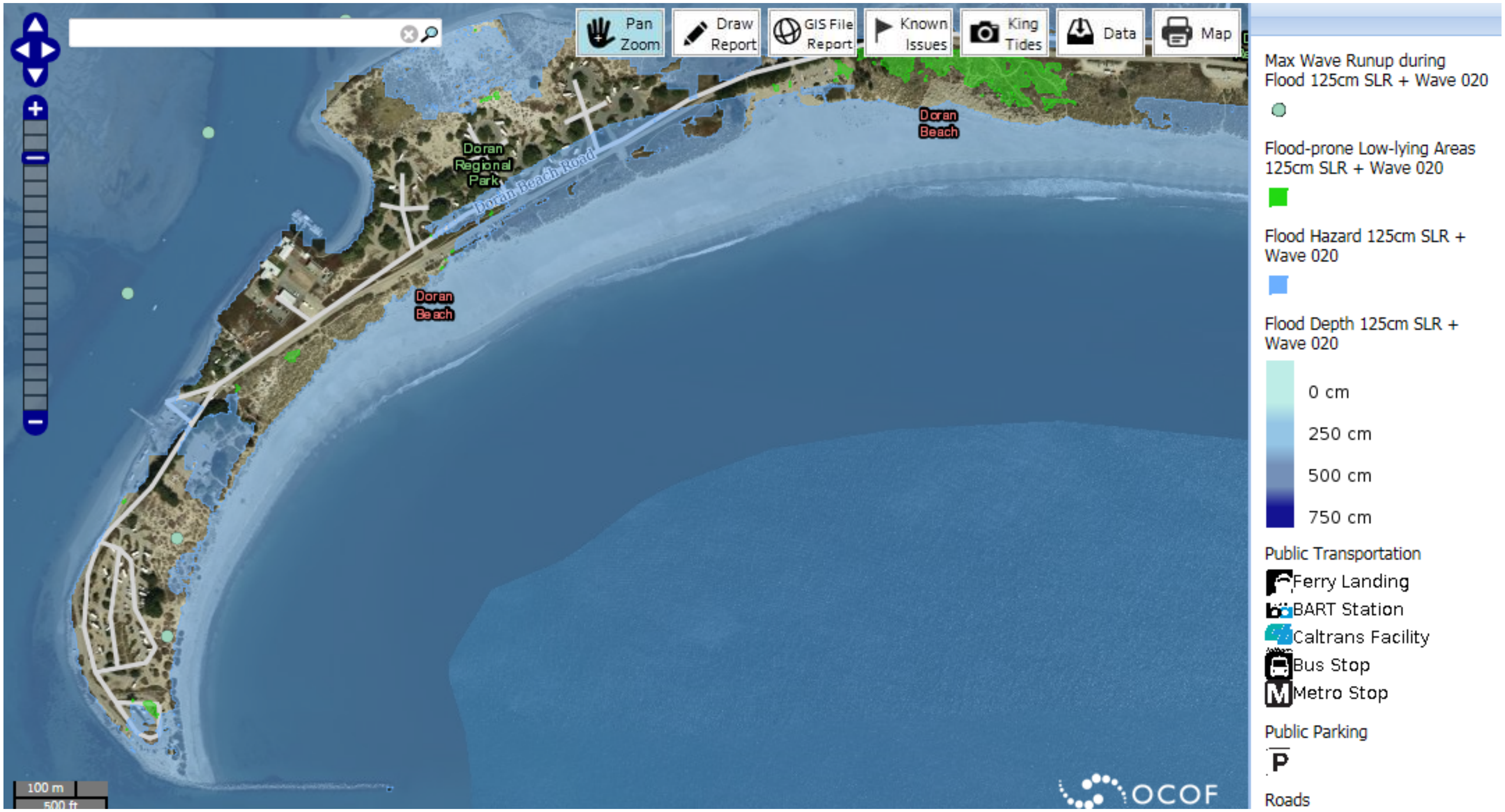


Figure 5. Flooding under a 125 cm Sea-Level Rise and a 20-Year Storm Scenario at Doran Beach, Marin County



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Marin County. 2014. *Exposure/Asset Identification Maps*. Marin County Development Agency's Collaboration: Sea-level Marin Adaptation Response Team (C-SMART) partnership. Available: <www.marincounty.org/depts/cd/divisions/planning/sea-level-rise/exposure-asset-identification>. Accessed: March 31, 2015.

Our Coast, Our Future. 2015. *Flood Map*. Available: <data.prbo.org/apps/ocof/index.php?page=flood-map>.