

Appendix E: Greenhouse Gas Reduction Analysis

The Blueprint for Carbon Neutrality lays out the City’s ambitious greenhouse gas (GHG) reduction plan within the realistic bounds of current capacity, technology, and State and Federal policy. The GHG analysis models the GHG reductions from mandatory building and energy upgrades, resulting in: energy efficiency and decarbonization modifications in 40 percent of all buildings in Petaluma; 25 percent of all vehicles in Petaluma are electric; and 50 percent of all travel occurring in modes other than single-occupancy vehicles. The GHG reductions from the “Ambitious Climate Action” scenario are expected to be 256,710 MTCO_{2e} in 2030, a 51 percent decrease compared to 1990 levels and 60 percent compared to forecasted emissions.

Not all measures in the Blueprint are quantified as part of the GHG reduction analysis. Measures may not be quantified because of a lack of data, they are supportive with no direct emissions reduction, or they are outside of the scope of the community inventory and GHG reduction plan. Furthermore, the number of measures in this technical appendix may not match the number of actions in the Blueprint because many of the partnership and funding actions have been omitted as they support GHG reductions and the implementation of other measures but have no direct impact on emissions. The reductions from actions focused on municipal operations are incorporated into the communitywide reductions.

Clean Energy Action Plan (CE)

Energy Generation Strategy

Background

Clean grid electricity from Sonoma Clean Power (SCP) and the installation of distributed energy resources (DERs) such as local solar projects, are major components of the effort being led by the State to achieve its climate goals that Petaluma can benefit from. Residential and nonresidential energy use, including electricity and natural gas, account for 24 percent of Petaluma’s 2018 communitywide greenhouse gas emissions.

Carbon-free electricity is a foundational measure of the Blueprint. It can be harnessed by Petaluma in two ways: 1) through local distributed energy resources (DERs) such as solar PV installations, and 2) by accessing clean grid energy by participating in the regional community choice aggregation program, Sonoma Clean Power (SCP).

Participating in SCP gives the City immediate access to carbon-free electricity, before the state requirements on investor-owned utilities. Senate Bill 100 renewable portfolio standard requires that supplied energy is both 100 percent carbon-free by 2045 and 100 percent generated from renewable sources like wind, solar, local biogas, or green hydrogen. Furthermore, access to clean electricity makes the transition to electric vehicles across Petaluma more beneficial by enabling electric vehicles to charge using carbon-free energy and thereby reducing tailpipe emissions, improving regional air quality, and eliminating carbon emissions.

As of 2020, the community wide participation rate in SCP is 89 percent. Only 4 percent of SCP accounts in Petaluma are in the EverGreen 100 percent renewable energy tier. The remaining 96 percent of SCP accounts are in the CleanStart carbon-free tier.

Benefits of local and community solar include cost savings, increased property values, emissions reductions, and resilience benefits when paired with storage.¹ Community solar is defined by the US Department of Energy as any solar project or purchasing program, within a geographic area, in which the benefits of a solar project flow to multiple customers such as individuals, businesses, nonprofits, and other groups. In most cases, customers are benefitting from energy generated by solar panels at an off-site array.² Community solar projects are more equitable in that they allow everyone to benefit from solar energy even if those who can't put panels on a rooftop.

Table E-1. Energy Generation Strategy Results

	Measure	2030 Reduction (MTCO _{2e})	2045 Reduction (MTCO _{2e})
1.	(2025) Adopt solar plus storage reach codes for residential and nonresidential development to require solar (kW/sf) for nonresidential buildings and for residential to cover the expected load of the home with PV systems. Ensure that systems are designed for the simultaneous or future installation of and connection to battery storage.	0	0
1a.	Utilize existing cost-effectiveness studies developed by the California Energy Commission (CEC).	Supportive	Supportive
1b.	Hire a consultant to evaluate the cost effectiveness of clean energy options including SCP, rooftop solar, and community solar projects.	Supportive	Supportive
1c.	Submit the adopted ordinances to the California Energy Commission (CEC) and California Building Standards Commission (CBSC) as required to have requirements apply to the current code cycle. Re-adopt this reach code with the new building code in 2026, if the 2025 code cycle doesn't include a storage component.	Supportive	Supportive
2.	(2025) Establish an annual reporting system to transparently report progress on switching from natural gas to electric equipment in privately owned buildings and city facilities. See the Carbon Neutral Monitoring and Reporting Action Plan for more details.	0	0
3.	(2025) Conduct a community-wide renewable energy generation analysis to identify locations in the City where renewable energy generation can be installed. Asses the feasible locations and proposed equipment identified in the communitywide renewable energy generation analysis under CEQA.	0	0

¹ US DOE. 2022. Energy Saver. <https://www.energy.gov/energysaver/benefits-residential-solar-electricity>. Accessed December 16, 2022.

² US DOE. 2022. Community Solar Basics. <https://www.energy.gov/eere/solar/community-solar-basics#:~:text=What%20are%20the%20Customer%20Benefits,money%20on%20their%20monthly%20bills..> Accessed December 16, 2022.

4.	(2025) Establish a program to offer support to affordable housing developments with the installation of on-site solar and battery storage.	0	0
5.	(2026) Adopt a policy requiring municipal back-up energy systems, including generators, be powered by carbon-free energy. Phase out the existing systems at or before the end of their useful life.	Not quantified	Not quantified
6.	(2026) Consider banning gas-powered lawn and garden equipment in the city, and establish a program allowing electric equipment to be charged throughout the day as it is used.	Not quantified	Not quantified
7.	(2030) Increase participation in SCP to 96%, ensuring 100% carbon-free electricity is the only option for residents and businesses.	3,570	0
8.	(2030) Consider generating 100% of municipal energy from local (within Sonoma County), renewable sources, exploring grid-independent energy generation and storage at critical facilities.	0	0
8a.	Determine the anticipated generation capacity (kW) of planned renewable energy projects including at the Community Center, Community Sports Field, Police Department, Swim Center/Fairgrounds, and Ellis Creek Water Recycling Facility.	Supportive	Supportive
8b.	Determine the energy storage potential at existing city facilities.	Supportive	Supportive
9.	(2025) Partner with Sonoma Clean Power (SCP) to identify barriers for large users and/or sectors to participate at the 100% RE tier and develop and conduct a robust awareness and education campaign to boost enrollment targeting the 11% of customers in Petaluma that have remained with PG&E.	0	0
10.	(2025) Conduct public hearings, public notices, and formally adopt solar reach code ordinances.	0	0
11.	(2025) Provide links to resources on local, Federal, and State solar credits and other financing incentives on the city website. Explore partnering with a solar consultant firm to provide guidance for property owners. Offer free post-installation roof inspections.	0	0
12.	(2026) Partner with PG&E and SCP to expand programs and rates that provide low-income customers with 100% carbon-free electricity.	0	0
13.	(2027) Partner with SCP to identify funding for installation of renewable energy generation at feasible locations.	0	0
Subsector Total GHG Reduction		3,570	0

Methodology and Assumptions

Although solar has many community benefits, its GHG reductions are nominal because local and community solar installations are offsetting already carbon-free energy provided by SCP. Measures 1-4 and 8-13 are modeled as supportive measures meaning that their implementation results in no direct

emissions reductions but either aids in the implementation of measures with direct emissions reductions or enhances the GHG reductions. These measures' emissions reductions are not included in the GHG reduction model because they are offsetting electricity use that is already carbon-free provided by SCP.

Measures 5 and 6 are not quantified in the GHG reduction analysis because of insufficient data.

Measure 7 reduces emissions by increasing participation in SCP from 89 percent to 96 percent. The measure also aims to increase the portion of those accounts in the 100 percent renewable (EverGreen) tier; however, this does not impact GHG reductions because all SCP electricity is at least carbon-free. GHG reductions for the measure are calculated as compared to the baseline PG&E energy intensity. The difference between SCP's electricity emissions factor and that of PG&E determines the GHG reductions from this measure. The reductions are less over time as PG&E's energy becomes less carbon intensive as a result of complying with the requirements of SB 100 and the renewable portfolio standard.

Data Sources

Avg. DC system size (kW): NREL PVWatts Calculator default value: <https://pvwatts.nrel.gov/pvwatts.php>

Annual kWh generated by PV: NREL PVWatts Calculator default value:

<https://pvwatts.nrel.gov/pvwatts.php>

Commercial building assumptions: A Look at the U.S. Commercial Building Stock: Results from EIA's 2012 Commercial Buildings Energy Consumption Survey (CBECS)

<https://www.eia.gov/consumption/commercial/reports/>

Electricity emissions factor: SCP EverGreen tier is modeled as 0 MTCO_{2e}/kWh. Emissions factors provided by RCPA Sonoma County Greenhouse Gas Inventory (2020).

PG&E natural gas emissions factor: 0.00532265 MTCO_{2e}/therm provided by RCPA Sonoma County Greenhouse Gas Inventory (2020).

Current SCP participation rate: 89% overall (99.8% of residential accounts and 98.6% of nonresidential accounts). Provided by City of Petaluma.

Commercial building assumptions: A Look at the U.S. Commercial Building Stock: Results from EIA's 2012 Commercial Buildings Energy Consumption Survey (CBECS)

<https://www.eia.gov/consumption/commercial/reports/>

Proportion of homes using natural gas: California Residential Building Electrification Market Assessment

https://www.ethree.com/wp-content/uploads/2019/04/E3_Residential_Building_Electrification_in_California_April_2019.pdf

Avg. Building size: California Residential Building Electrification Market Assessment

https://www.ethree.com/wp-content/uploads/2019/04/E3_Residential_Building_Electrification_in_California_April_2019.pdf

Buildings Action Plan

New Buildings Strategy (NBS)

Background

Energy use in residential and nonresidential buildings accounts for 24 percent of community emissions and natural gas use accounts for nearly 80 percent of energy-related emissions. There are two main approaches to reduce emissions in buildings. The first is improved energy efficiency of new buildings and the second is through the decarbonization of the energy sources used by equipment in new buildings.

The number of employees and residents in Petaluma is expected to grow through 2045 by 15 percent and 6.5 percent respectively.³ This growth will result in the construction of new residential and commercial buildings. New construction is governed by the California Building Code and must meet the California Green Building Standards (CALGreen), which includes requirements for energy performance. The building code is updated every three years to increase baseline energy efficiency, incorporate industry best practices, and support State energy goals.

To avoid the construction of GHG-emitting buildings and infrastructure with lifespans beyond the City's emissions reduction goals, enhanced green building will be the standard for all new construction and major remodels. In order to go beyond CALGreen code minimums the City will revise their existing all-electric reach code for new construction to include remodels and alterations/additions. Electrification of new residential and commercial construction will eliminate the use of natural gas for space heating, water heating, clothes drying, and cooking.

The California Energy Commission has found that all-electric new construction is cost effective across building types in Petaluma's climate zone. Several additional studies have found that all-electric construction is cheaper than building a mixed-fuel building.⁴ Electrification of new residential and commercial construction will eliminate the use of natural gas for space heating, water heating, clothes drying, and cooking. Space heating is the largest energy use in buildings and is dominated by non-electric fuels.⁵

Table E-2. New Building Strategy Results

	Measure	2030 Reduction (MTCO ₂ e)	2045 Reduction (MTCO ₂ e)
1.	(2025) Determine the feasibility and impacts of incentives to encourage new development to exceed Title 24 energy efficiency standards and adopt feasible best practices.	0	0

³ Association of Bay Area Governments. (2018). Bay Area Projections 2040. https://mtc.ca.gov/sites/default/files/Projections_2040-ABAG-MTC-web.pdf (Extrapolated to 2045)

⁴ Studies include: Rocky Mountain Institute. (2020). Economics of Electrifying Buildings.; New Building Institute (2022). Cost Study of the Building Decarbonization Code.; E3. (2022) The Economics of All-Electric New Construction in Utah.; California Energy Commission (2019). Cost Effectiveness studies for residential and nonresidential new construction.

⁵ Deason, Jeff. et al. 2018. Electrification of buildings and Industry in the United States. pp.10. <https://escholarship.org/content/qt8qz0n90q/qt8qz0n90q.pdf>. Accessed December 16, 2022.

2.	(2025) Add a question to the Solar Photovoltaic Systems Submittals form for all new solar systems installed if there is the ability to connect a battery storage.	0	0
3.	(2025) Provide new development checklist to require as part of discretionary project review that includes all sustainability building requirements.	0	0
4.	(2026) Encourage or mandate that all new homeowners enroll in Sonoma Clean Power.	0	0
5.	(2026) Revise existing all-electric reach code to include ADUs, remodels, and tenant improvements of a certain size or dollar amount in addition to new construction.	630	990
6.	(2026). Explore incentives and requirements, including adopting CALGreen Tier 2, for use of a minimum amount of reused and salvaged local building materials in remodels and new construction, especially forward-facing exterior applications	Not quantified	Not quantified
6a.	Consider amending the building permit application to require recycled/reused material content.	Supportive	Supportive
6b.	Determine which building materials have low-embodied carbon alternatives and are appropriate for the expected types of development projects in the city. Use existing green building rating systems, including LEED and Living Building Challenge Red List as a resource.	Supportive	Supportive
6c.	(2027) Prepare policy that phases in requirements for low embodied carbon materials (residential and commercial), conduct CEQA analysis as needed.	Supportive	Supportive
7.	(2028) Hire a consultant to calculate expected emissions related to annual building activity within the city.	Not quantified	Not quantified
8.	(2030) Adopt ordinance requiring all new construction achieve net zero energy use in construction and continuing operations.	Not quantified	Not quantified
9.	(2025) Coordinate with stakeholders including City staff and officials and external stakeholders to explore incentive options including financial, permitting, and process efficiencies.	0	0
10.	(2025) Engage with stakeholders including City staff and officials, and external stakeholders, such as local developers regarding the purpose and impact of the requirements.	0	0
11.	(2025) Coordinate with Sonoma Clean Power and other entities to provide educational information and technical assistance to developers and architects about alternative materials. Make resources available on the City website, at the City permit counters, and local and regional home improvement stores.	0	0
12.	(2026) Coordinate with Sonoma Clean Power and other entities to provide technical resources, including hosting workforce development trainings for installers and building owners/operators to discuss benefits and technical requirements of alternative materials.	0	0
13.	Collaborate with XeroHome to create a database for the community that will enable carbon and energy use data specific to individual addresses.	0	0
Subsector Total GHG Reduction		630	990

Methodology and Assumptions

The only measure with quantified reductions included in this analysis is number 5. This measure reduces emissions by requiring new residential and nonresidential construction as well as major remodels and alterations/additions be all-electric beginning in 2025 with the potential for buildings to utilize other carbon-free energies as it becomes available. This measure is a mandatory measure that is required to be implemented by applicable individuals and projects. Incentives may be provided. The GHG reduction model assumes a 90 percent compliance rate beginning in 2025 and continuing through 2045. This compliance rate is based on similar water conservation requirements, while allowing for special exemptions from the requirements for certain building types or occupancies to be determined during ordinance development.

Measures 1-3 and 6-13 are supportive measures that encourage more sustainable building design and construction. Although there are no direct emissions from the implementation of these measures, they serve an educational function that can result in future emissions reductions through the construction of more efficient buildings that use less electricity and natural gas. Furthermore, more efficient construction reduces operational building energy use and thus the demand on the grid. Additionally, these measures are written using language that encourages the City to explore requirements but does not commit the City to future implementation and thus cannot be quantified as part of our analysis.

Measure 4 directs the City to encourage or mandate that all new homeowners enroll in Sonoma Clean Power. The potential GHG reductions associated with this measure are accounted for as part of Clean Energy measure 7 increase enrollment in SCP.

Measures 7 and 8 are both studies that the City will undertake to explore the GHG implications of new development in the City. This knowledge will allow the City to develop an annual GHG emissions budget for new development in the future. It will also allow the City to justify the passage of an ordinance requiring all new construction to be net zero energy in 2030. However, more data is needed to quantify any additional reductions that may result from net zero energy construction in addition to what the all-electric reach code already generates. Benefits of net zero energy construction include local energy generation and improved resilience and insulation from grid interruptions.

Data Sources

Commercial building assumptions: A Look at the U.S. Commercial Building Stock: Results from EIA's 2012 Commercial Buildings Energy Consumption Survey (CBECS)

<https://www.eia.gov/consumption/commercial/reports/>

Electricity emissions factor: SCP EverGreen tier is modeled as 0 MTCO_{2e}/kWh. Emissions factors provided by RCPA Sonoma County Greenhouse Gas Inventory (2020).

PG&E natural gas emissions factor: 0.00532265 MTCO_{2e}/therm provided by RCPA Sonoma County Greenhouse Gas Inventory (2020).

Proportion of homes using natural gas: California Residential Building Electrification Market Assessment

https://www.ethree.com/wp-content/uploads/2019/04/E3_Residential_Building_Electrification_in_California_April_2019.pdf

Avg. Building size: California Residential Building Electrification Market Assessment

https://www.ethree.com/wp-content/uploads/2019/04/E3_Residential_Building_Electrification_in_California_April_2019.pdf

Avg. appliance efficiencies: <https://rael.berkeley.edu/wp-content/uploads/2017/07/Raghavan-Wei-Kammen-WaterHeating--ENergyPolicy-2017.pdf>

Participation rate assumptions: Determined for Petaluma by assessing the rates of annual home sales, new construction, and major renovations. The average participation rate is about 2% for voluntary programs. Mandatory programs have higher participation rates due to code compliance policies. Source: BayREN. (2022). Local Government Policy Calculator for Existing Single-Family Buildings. <https://www.bayren.org/how-adopt-reach-code/addressing-existing-buildings>

Commercial building assumptions: A Look at the U.S. Commercial Building Stock: Results from EIA's 2012 Commercial Buildings Energy Consumption Survey (CBECS) <https://www.eia.gov/consumption/commercial/reports/>

Employees per square foot: Strategic Economics study, which did actual business case studies to estimate those numbers (see A-4 and A-5). Many communities do estimate 4 employees per 1,000sf for a traffic model, <https://www.sanjoseca.gov/home/showdocument?id=22529>

Existing Building Energy Efficiency Strategy

Background

Electricity use in residential and nonresidential buildings accounts for 5 percent of community emissions and natural gas use accounts for 19 percent of community emissions in Petaluma in 2018. Most of the building-related emissions are attributable to the existing building stock, which is less energy efficient than new construction. Sources of energy use in buildings include space conditioning, water heating, lighting, appliances, and plug loads. GHG emissions have historically been from grid-delivered electricity and the on-site combustion of natural gas. Electricity purchased from PG&E generates GHG emissions at a specific rate, while each Rate Product for electricity purchased from SCP also generate GHG emission at varying rates depending on the amount of renewable and GHG-free electricity included in the electricity source mix. GHG emissions associated with community natural gas consumption are based on default emission factors obtained from the United States Environmental Protection Agency (USEPA).⁶

Reducing both electricity and natural gas use is a fundamental strategy for the City to encourage and support as the electrical grid becomes increasingly cleaner and ultimately carbon-free and buildings in the City are updated to become more efficient and use all carbon-free energy sources.

The measures in this strategy aim to reduce GHG emissions by increasing energy efficiency in homes and businesses by reducing electricity and natural gas use. The energy efficiency measures increase energy efficiency by increasing consumer access to energy use information, promoting existing utility incentives and programs, and exploring the development of city-funded incentive programs.

Table E-3. Existing Building Energy Efficiency Strategy Results

	Measure	2030 Reduction (MTCO _{2e})	2045 Reduction (MTCO _{2e})
1.	(2026) Prepare and adopt ordinance establishing benchmarking and retrofitting requirements for nonresidential buildings. Explore the potential for a building performance standard.	40	90

⁶ USEPA. 2018. Emission Factors for Greenhouse Gas Inventories. https://www.epa.gov/sites/production/files/2018-03/documents/emission-factors_mar_2018_0.pdf. Accessed May 16, 2021.

1a.	(2025) Conduct a study to determine the appropriate square footage threshold to capture additional buildings than is required by AB 802 for benchmarking. AB 802 is the "Building Energy Benchmarking Program." The Building Energy Benchmarking Program requires owners of large commercial and multifamily buildings to report energy use to the California Energy Commission by June 1 annually.	Supportive	Supportive
2	(2026) Require low-rise residential properties older than 10 years to provide an energy audit, disclose Home Energy Rating System (HERS) score or EPA Home Energy Score at time of sale or rental agreement.	0	0
3.	(2027) partner with BayREN to implement a direct install program for energy efficiency improvements or specific rebates for installation labor.	25,620	59,490
4.	(2027) Adopt an ordinance requiring energy submeters to be installed in multifamily residential properties.	0	0
5.	(2025) Promote energy efficiency programs and incentives from PG&E, SCP, BayREN, BAAQMD.	Supportive	Supportive
6.	(2025) Provide funding to support community partners and companies in developing green job training and conducting home energy retrofits.	0	0
7.	(2025) Work with PG&E and SCP to implement retrocommissioning in the existing building stock.	Supportive	Supportive
8.	(2026) Engage with stakeholders including residential and nonresidential property owners, managers, real estate agents, leasing brokers, and Chamber of Commerce to explain the benefits of providing a Home Energy Score	0	0
Subsector Total		25,660	59,580

Methodology and Assumptions

Emissions reductions from implementing measures 1-8 are the result of decreased electricity and natural gas use in existing buildings. Measure 1 is a mandatory measure, which means all applicable buildings will be required to participate starting in 2026. Incentives may be offered to encourage and support implementation but are not assumed in the analysis. The GHG reduction model assumes programs are designed to achieve an average voluntary participation rate of 2.5% annually and a mandatory participation rate that results in 80-85 percent of buildings undergoing retrofits over a 15-year period. The model also assumes that the benchmarking program is designed in a way that will achieve the GHG reductions associated with commercial building benchmarking as identified in the California Energy Commission's Options for Energy Efficiency in Existing Buildings report.

Measure 3 is a voluntary measure, which means it is elective and not required to be implemented by applicable individuals and projects. Incentives may be offered but are not assumed. The GHG reduction model assumes an average voluntary participation rate of 2.5% through 2045. The model also assumes that the utility and IOU funded incentive programs support the common types of energy efficiency upgrades and energy use reductions that are outlined in the US Department of Energy's Advanced Energy Retrofit Guides (2011) for nonresidential buildings and the California Energy Commission's Large Scale Residential Retrofit Program.

The remaining measures are categorized as supportive measures meaning that no direct emissions reductions result from implementation but implementing these measures either aids in the implementation of measures with direct emissions reductions or enhances the GHG reductions. For example, providing financial incentives increases the likelihood that individuals will install energy efficiency improvements in buildings, therefore supporting the implementation of measure 3 but their existence alone does not result in GHG emission reductions.

Data Sources

Participation rate assumptions: Determined for Petaluma by assessing the rates of annual home sales, new construction, and major renovations. The average participation rate is about 2% for voluntary programs. Mandatory programs have higher participation rates due to code compliance policies. Source: BayREN. (2022). Local Government Policy Calculator for Existing Single-Family Buildings. <https://www.bayren.org/how-adopt-reach-code/addressing-existing-buildings>

Commercial building assumptions: A Look at the U.S. Commercial Building Stock: Results from EIA's 2012 Commercial Buildings Energy Consumption Survey (CBECS) <https://www.eia.gov/consumption/commercial/reports/>

Employees per square foot: Strategic Economics study, which did actual business case studies to estimate those numbers (see A-4 and A-5). Many communities do estimate 4 employees per 1,000sf for a traffic model, <https://www.sanjoseca.gov/home/showdocument?id=22529>

Electricity emissions factor: SCP EeverGreen tier is modeled as 0 MTCO_{2e}/kWh. Emissions factors provided by RCPA Sonoma County Greenhouse Gas Inventory (2020).

PG&E natural gas emissions factor: 0.00532265 MTCO_{2e}/therm provided by RCPA Sonoma County Greenhouse Gas Inventory (2020).

Proportion of homes using natural gas: California Residential Building Electrification Market Assessment https://www.ethree.com/wp-content/uploads/2019/04/E3_Residential_Building_Electrification_in_California_April_2019.pdf

Avg. Building size: California Residential Building Electrification Market Assessment https://www.ethree.com/wp-content/uploads/2019/04/E3_Residential_Building_Electrification_in_California_April_2019.pdf

Avg. appliance efficiencies: <https://rael.berkeley.edu/wp-content/uploads/2017/07/Raghavan-Wei-Kammen-WaterHeating--ENergyPolicy-2017.pdf>

Energy savings of retrocommissioning: CEC Options for Energy Efficiency in Existing Buildings. Source document CEC-400-2005-039-CMF.pdf available from: http://400.sydneyplus.com/CaliforniaEnergy_SydneyEnterprise/Portal/public.aspx?lang=en-US&p_AAAAIR=tab5&d=d

Energy Savings of nonresidential retrofits: Advanced Energy Retrofit Guides https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-20814.pdf, https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-20761.pdf

Energy Savings of residential retrofits: Davis Energy Group. 2017. CEC Large Scale Residential Retrofit Program. Source document: CEC-500-2017-009.pdf available from: http://400.sydneyplus.com/CaliforniaEnergy_SydneyEnterprise/Portal/public.aspx?lang=en-US&p_AAAAIR=tab5&d=d

Existing Building Electrification Strategy

Background

Electricity use in residential and nonresidential buildings accounts for 5 percent of community emissions and natural gas use accounts for 19 percent of community emissions in Petaluma in 2018. Most of the building-related emissions are attributable to the existing building stock, which is less energy efficient than new construction. Sources of energy use in buildings include space conditioning, water heating, lighting, appliances, and plug loads. GHG emissions have historically been from grid-delivered electricity and the on-site combustion of natural gas. Electricity purchased from PG&E generates GHG emissions at a specific rate, while each Rate Product for electricity purchased from SCP also generate GHG emission at varying rates depending on the amount of renewable and GHG-free electricity included in the electricity source mix. GHG emissions associated with community natural gas consumption are based on default emission factors obtained from the United States Environmental Protection Agency (USEPA).⁷

Since the carbon intensity associated with electricity provided by SCP are less than that of natural gas, a primary way to reduce emissions is to switch natural gas-powered appliances and building systems to an electric or other carbon-free energy source alternative. Common natural gas-powered appliances in buildings include water heaters, furnaces, cooktops, and clothes dryers. Transitioning water and space heating equipment to efficient electric heat pumps can significantly reduce emissions. Furthermore, the California Air Resources Board included a measure in the 2022 State SIP Strategy that beginning in 2030, 100 percent of sales of new space and water heaters (for either new construction or replacement of burned-out equipment in existing buildings) would need to meet zero-emission standards. It is expected that this regulation would rely heavily on heat pump technologies currently being sold to electrify new and existing homes.⁸ Furthermore, Bay Area Air Quality Management District (BAAQMD) passed rules 9-4 and 9-6 in April 2023 that will require gas-powered water heaters and furnaces be replaced with zero-NOx alternatives, essentially non-combustion electric equipment, starting in 2027.⁹

Measures EBS 2.1-2.7 aim to reduce emissions by decarbonizing building equipment in existing buildings in Petaluma. This is achieved by transitioning natural gas-powered appliances to electricity. This strategy is effective in Petaluma due to their participation in SCP and access to carbon-free electricity.

Table E-4. Existing Buildings Electrification Strategy Results

	Measure	2030 Reduction (MTCO _{2e})	2045 Reduction (MTCO _{2e})
1.	(2024) Initiate a conversation with SCP about regional coordination around existing building electrification efforts.	Not quantified	Not quantified
2.	(2025) Prepare policy requiring electric panel upgrades at point of sale and/or rental turnover for single family and low-rise residential buildings.	0	0

⁷ USEPA. 2018. Emission Factors for Greenhouse Gas Inventories. https://www.epa.gov/sites/production/files/2018-03/documents/emission-factors_mar_2018_0.pdf. Accessed May 16, 2021.

⁸ CARB. 2022. 2022 State Strategy for the State Implementation Plan. https://ww2.arb.ca.gov/sites/default/files/2022-08/2022_State_SIP_Strategy.pdf. Accessed December 16, 2022.

⁹ BAAQMD. 2023. Rules 9-4 and 9-6 Building Appliances. <https://www.baaqmd.gov/rules-and-compliance/rule-development/building-appliances>. Accessed September 25, 2023.

2a.	Explore establishing a residential resale inspection program, using City building inspectors, to validate all time of sale sustainability requirements have been met.	Supportive	Supportive
2b.	Develop an inventory of rental units in the city and require annual reporting by property owners or managers on vacancy and turnover.	Supportive	Supportive
2c.	(2028) Establish a process to record decarbonization status from each property at the time of sale.	Supportive	Supportive
3.	(2025) Create a system to monitor the replacement of natural gas equipment with electric equipment and other decarbonization retrofits.	0	0
3a.	Create an electric equipment installation permit category.	Supportive	Supportive
3b.	Establish an annual reporting system to inform the Climate Action Commission on progress on the switching from natural gas to electric equipment.	Supportive	Supportive
4.	(2025) Explore enhancing SCP's incentive program with a reduced-cost electric heat pump space heater and water heater program for income-qualified residents.	0	0
5.	(2026) Establish an early natural gas equipment buyout program to incentivize early retirement of gas-powered equipment and building systems.	Quantified as part of 7	Quantified as part of 7
6.	(2026) Map and define existing infrastructure needed for electrification and identify areas where infrastructure upgrades are needed.	0	0
6a.	Prioritize installation of infrastructure upgrades in DACs followed by other identified install neighborhoods.	Supportive	Supportive
7.	(2027) develop a phased-in Existing Building Electrification strategy to retrofit 85% of existing homes and businesses to all-electric by 2030, and potentially adopt a burnout ordinance. Conduct CEQA analysis as needed.	25,620	59,490
8.	(2028) Establish a process to record decarbonization status from each property at the time of sale. Explore requiring property owners to report building decarbonization status using tools, such as XeroHome	0	0
9.	(Ongoing) Continue to work with PG&E and SCP to determine electric distribution system and service infrastructure limitations and work to resolve issues, including a focus on improving access reliability in disadvantaged communities.	Not quantified	Not quantified
10.	(2025) Establish an education campaign around cooking with electric appliances, including demonstrations from chefs and/or local restaurants.	0	0
11.	(2025) Create an online "one-stop shop" for incentives that promote the cost and environmental benefits of electrification to residents and business owners before appliance failure. Promote SCP Electrify resources and incentives to builders, property owners, and contractors on the City website and at the City permit counters.	0	0

11a.	Collaborate with Xero Homes project to help homeowners understand their carbon footprint.	Supportive	Supportive
12.	(2025) Work with local businesses to promote electric appliances in-store.	0	0
13.	(2026) Waive permit approval fees for electrical upgrades to support the future installation of new electric appliances that will replace existing natural gas.	0	0
14.	(2026) Provide technical resources, including hosting workforce development trainings for installers and building owners/operators to discuss benefits and technical requirements of electrification.	0	0
15.	(2026) Utilize economies of scale related to electric equipment through cooperative purchasing to reduce upfront costs for low-income residents.	0	0
16.	(2030) Work with PG&E to identify opportunities for natural gas infrastructure pruning to reduce the chance of stranded assets, provide potential funding, and establish an efficient transition to carbon neutral buildings.	Not quantified	Not quantified
Subsector Total		25,660	59,490

Methodology and Assumptions

Emissions reductions from implementing measures 1-16 are the result of decreased natural gas use in existing buildings. All measures except measures 5 and 7 are supportive measures that do not result in direct emissions reductions; however, their implementation supports the overall decarbonization effort and the realization of emissions reductions from measures 5 and 7. The supportive measures help with “electric-readiness” to prepare buildings to fuel switch, prepare the local electric distribution system to accommodate the additional load, and track electrification progress. Measure 7 is a phased in measure that is voluntary and then requires mandatory compliance by 2027. Incentives may be offered during both phases to encourage and support implementation but are not assumed in the analysis. Furthermore, the model assumes that 40 percent of existing buildings have electrified by 2030 and 85 percent by 2045.

The reductions associated with measure 5 that establishes an early natural gas equipment buyout program to incentivize early retirement of gas-powered equipment and building systems is included in the total reductions of the Existing Building Electrification strategy plan. This measure is essentially an incentive supported burnout ordinance that requires gas-powered equipment to be replaced with electric alternatives at the end of its useful life. This policy can jump-start electrification and aligns with BAAQMD’s new rules.

Data Sources

Participation rate assumptions: Determined for Petaluma by assessing the rates of annual home sales, new construction, and major renovations. The average participation rate is about 2% for voluntary programs. Mandatory programs have higher participation rates due to code compliance policies. Source: BayREN. (2022). Local Government Policy Calculator for Existing Single-Family Buildings. <https://www.bayren.org/how-adopt-reach-code/addressing-existing-buildings>

Commercial building assumptions: A Look at the U.S. Commercial Building Stock: Results from EIA's 2012 Commercial Buildings Energy Consumption Survey (CBECS)

<https://www.eia.gov/consumption/commercial/reports/>

Employees per square foot: Strategic Economics study, which did actual business case studies to estimate those numbers (see A-4 and A-5). Many communities do estimate 4 employees per 1,000sf for a traffic model, <https://www.sanjoseca.gov/home/showdocument?id=22529>

Electricity emissions factor: SCP EverGreen tier is modeled as 0 MTCO_{2e}/kWh. Emissions factors provided by RCPA Sonoma County Greenhouse Gas Inventory (2020).

PG&E natural gas emissions factor: 0.00532265 MTCO_{2e}/therm provided by RCPA Sonoma County Greenhouse Gas Inventory (2020).

Proportion of homes using natural gas: California Residential Building Electrification Market Assessment https://www.ethree.com/wp-content/uploads/2019/04/E3_Residential_Building_Electrification_in_California_April_2019.pdf

Avg. Building size: California Residential Building Electrification Market Assessment https://www.ethree.com/wp-content/uploads/2019/04/E3_Residential_Building_Electrification_in_California_April_2019.pdf

Avg. appliance efficiencies: <https://rael.berkeley.edu/wp-content/uploads/2017/07/Raghavan-Wei-Kammen-WaterHeating--ENergyPolicy-2017.pdf>

Transportation and Land Use Action Plan (TL)

Transportation and Land Use Strategy, Transportation Demand Management Strategy, Parking Management Strategy, Active Transportation and Complete Streets Strategy, and Transit Service Strategy

- TL 1.1 Adopt and implement General Plan Land Use Element (2025)
- TL 1.2 Streamline permitting for complete neighborhoods and housing (2025)
- TL 1.3 Adopt revised zoning code (2028)
- TL 1.4 Mandatory transportation demand management (TDM) program (2025)
- TL 1.5 Explore Universal Basic Mobility Program (2026)
- TL 1.6 Unbundle residential parking (2025)
- TL 1.7 Residential parking maximums (2026)
- TL 1.8 Parking pricing strategy (2027)
- TL 1.9 Adopt and implement Active Transportation Plan (2025)
- TL 1.10 Bike share program (2025)
- TL 1.11 Transit service improvements (2030)

Results

The measures included in the Transportation and Land Use Action Plan serve to shift trips away from SOVs to other modes including walking, biking, carpooling, and transit use. Estimating the potential GHG reduction of mode shift requires consideration of many qualitative factors, including the local context of Petaluma that influence walking and biking, transit, and vehicle use. The analysis is based on the collective impact of these measures to reduce SOV VMT so that by 2030 50 percent of all trips taken in Petaluma are non-SOV

Background

Transportation-related emissions are the largest contributor to communitywide emissions, accounting for 67 percent of total GHG emissions citywide. One way to reduce transportation related emissions is to reduce vehicle miles traveled (VMT) through programs and policies that shift VMT away from single-occupancy vehicles (SOV) to other modes including walking and biking, transit, and e-mobility, and

transportation demand management programs and policies. These mode shift measures generate many co-benefits such as reduced congestion, safer conditions for walking and biking, and improved air quality.

Methodology and Assumptions

Measures related to the Transportation and Land Use Coordination Strategy shift trips to non-SOV modes by redesigning the city to deemphasize the automobile. Measures Adopting the City's new General Plan Land Use Element and implementing the following prioritized measures by 2030:

- Locate housing and jobs close to high quality transit corridors, including S McDowell Blvd, E Washington St., and Petaluma Blvd.
- Define transit-oriented communities at high-quality transit stops that mix quality development, affordable housing, community services and amenities, and improved mobility options. Adopt the General Plan Land Use Designations to expand housing capacity by increasing heights and densities within transit-oriented communities.
- Establish complete 15-minute neighborhoods around Town Centers, Neighborhood Centers, and other active nodes to enable residents to access most of their daily needs with a short walk, bike or transit trip. Develop maps defining the boundaries of complete neighborhoods and inventory services and amenities.
- Enable incremental infill within the city's existing residential neighborhoods, including accessory dwelling unit and plex housing types.
- Examine rezoning to allow for light-touch, missing middle housing up to 10 units per acre. Implement streamlining provisions established in SB 10

GHG reductions are determined by measuring the effect these interventions have on shifting trips from SOVs to carpooling, walking, biking, or transit. The GHG reduction model assumes that these land use measures achieve a mode split of up to 31 percent in 2030 based on the 2021 CAPCOA Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity.¹⁰ The CARB EMFAC2019 model is then used to determine the emissions reduced because of reduced SOV VMT. Measures TL 1.2-1.3 are the supportive implementation actions to help actualize TL 1.1.

Measure TL 1.4 creates a mandatory TDM program reduces commute VMT by up to 26%.¹¹ By 2025 the City will adopt a TDM policy for employers and housing developments that requires employers and housing developments of a certain size to submit an emission reduction plan to the City to meet the City's greenhouse gas reduction target. For smaller employers and housing developments, establish a requirement to provide employees and residents with educational materials about active transportation and transit options within the city. The City will work with businesses so compliance will be phased in over two years. TDM programs reduce emissions by shifting commute trips from SOV to other modes through incentives and education.

Measures TL 1.6-1.7 limit residential parking. Limiting the amount of parking available creates scarcity and adds additional time and inconvenience to trips made by private auto, thus disincentivizing driving as a mode of travel.¹² GHG reductions associated with measures TL 1.6 and 1.7 are limited to trips

¹⁰ California Air Pollution Control Officers Association. 2021. Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity.

https://www.airquality.org/ClimateChange/Documents/Final%20Handbook_AB434.pdf. Accessed December 19, 2022.

¹¹ CAPCOA 2021. Measure T-6.

¹² CAPCOA 2021. Measure T-15.

accessing the site up to a 15.7 percent reduction in VMT.¹³ Measure 1.8 established the City's parking pricing strategy. Pricing on-street parking in a given community, with a focus on parking near central business districts, employment centers, and retail centers. Increasing the cost of parking increases the total cost of driving to a location, incentivizing shifts to other modes and thus decreasing total VMT to and from the priced areas up to a 30% reduction in GHG emissions.¹⁴

Measures TL 1.9 and 1.10 improve bicycle and pedestrian access in Petaluma by connecting and improving bike and pedestrian networks. These improvements encourage active transportation by making use more convenient and safer. According to CAPCOA, these improvements can lead to a reduction of less than 8% of total VMT.

Measures 1.3 and 1.11 improve Petaluma Transit's services by implementing the Petaluma Short-Range Transit Plan and expanding service as needed. Measure 1.3 establishes a Universal Mobility Program with subsidized fare or a free transit program by 2027. Collectively, these measures can reduce total trips up to 16.5 percent in 2030.¹⁵

Data Sources

EV Fuel assumptions: Hybrid and Plug-In Electric Vehicle Emissions Data Sources and Assumptions
https://afdc.energy.gov/vehicles/electric_emissions.html

Number and Types of EVs in Sonoma County: California Energy Commission. (Updated 2023). Zero Emission Vehicle and Infrastructure Statistics. <https://www.energy.ca.gov/data-reports/energy-almanac/zero-emission-vehicle-and-infrastructure-statistics>

VMT per trip: EMFAC2019 model for Sonoma County

Average trip length: EMFAC2019 model for Sonoma County

VMT: RCPA Sonoma County Greenhouse Gas Inventory (2020).

2018 current mode split: US Census Bureau.

¹³ CAPCOA 2021. Measure T-16.

¹⁴ CAPCOA 2021. Measure T-24.

¹⁵ CAPCOA 2021. Measures T-25-29.

Vehicle Electrification and Electric Mobility Strategy

Background

Transportation-related emissions are the largest contributor to communitywide emissions, accounting for 67 percent of total GHG emissions citywide. The other way to reduce transportation related emissions is to “clean” VMT through decarbonization of the transportation system and the adoption of zero emission vehicles (ZEVs) that utilize electricity or other carbon-free sources of fuel such as hydrogen. Vehicle electrification results in immediate emissions reductions due to the availability of carbon-free electricity in the city. However, the rate of EV adoption is not directly within the City’s control. Theoretically, using cleaner fuel vehicles can reduce up to 100% of transportation related emissions.¹⁶

The State of California has adopted ambitious goals for ZEV adoption, with the most recent EO N-79-20 striving to achieve 100 percent ZEV vehicle sales by 2035. To align with these aggressive State goals, Petaluma seeks to increase ZEV adoption to 25 percent of vehicles by 2030 and 43 percent by 2045. Reaching these targets will require significant investment in electric vehicle charging infrastructure to facilitate the transition to electric vehicles.

Table E-5. Vehicle Electrification and Electric Mobility Strategy Results

	Measure	2030 Reduction (MTCO2e)	2045 Reduction (MTCO2e)
1	(2025) Expand reliable, publicly accessible electric vehicle charging across Petaluma. Ensure that is financially and geographically accessible		
1a.	(2025) Require new development to meet CalGreen Tier 2 standards for electric vehicle charging.		
1b.	(2025) Explore amending EV charger permitting requirements to include operation and maintenance plans for EV charger installations of four or more ports.		
1c.	(2026) Complete a study to establish a curbside charging pilot program.		
1d.	(2027) Create a fast-charging hub serving a “disadvantaged community” as identified in the General Plan.		
1e.	(2030) Expand charging to 10% of spaces within privately owned large commercial garages.		
2.	Launch a series of pilot programs and incentive programs to support the transition to electric vehicles and mobility, remaining flexible about how vehicle electrification continues to evolve and the varied and evolving uses, including hydrogen fuel cells, trucks, and towing.		
2a.	(2025) Pilot the use of zero-emission vehicles, e-bikes, and electric scooters for delivery and meal delivery services.		
2b.	(2028) Study creating a pilot Zero Emission Delivery Zone.	25,880	36,760

¹⁶ CAPCOA 2021. Measure T-30

3.	(2026) Develop/consolidate a comprehensive package of incentives to encourage the adoption of zero emission vehicles (ZEVs) including establish a fee waiver and/or permit streamlining program to support the installation of EV charging stations in existing residential, mixed use and commercial development.		
4.	(2025) Launch a public awareness campaign, including messaging tailored to specific communities, with the goal of educating residents about the health, economic, and environmental benefits of transit, active transportation, and electric vehicles.	Supportive	Supportive
5.	(2025) Collaborate with local bicycle and scooter businesses to launch a pilot project to test the use of accessible bicycles, e-bicycles and e-scooters for recreation and commuting.	0	0
6.	(2025) Explore how businesses are approaching EV Infrastructure and co-habiting business are located near charging stations.	0	0
7.	Work with PG&E and Sonoma Clean Power to ensure the electrical grid has the capacity to support large scale electric vehicle charging at all multifamily properties.	Not quantified	Not quantified
Subsector Total		25,880	36,760

Methodology and Assumptions

GHG emission reductions for the increased adoption of EV's are based on replacing fossil fueled vehicles with electric versions in the community. Increased electricity consumption from EV adoption is accounted for, offsetting some of the emissions reduction from replacing fossil fueled vehicles.

Measures 1-3 aim to achieve the infrastructure needed to align with the State's previous goal of bringing 1.5 million ZEVs to the road by 2025 and 5 million by 2030.¹⁷ This goal has since been pushed even further by the State through EO N-79-20, with a goal of reaching 8 million light-duty ZEVs on the roads by 2030, requiring approximately 1.5 million chargers. Sonoma County currently has 871 chargers, 624 of which are public.¹⁸ The GHG reduction analysis assumes that Petaluma is on track to meet the State's EV adoption goals through the collective impact of these measures.

Measure 1 works to improve the availability of EV charging across Petaluma through the installation of publicly accessible chargers and at multi-family and commercial buildings with the adoption of CALGreen Tier 2 EV requirements for new construction and remodels.

Measures 4-7 promote ZEV adoption and infrastructure installation through education and outreach and financial and permitting incentives.

¹⁷ Executive Order B-48-18 provides a target of 5 million ZEVs to be in California's vehicle fleet in 2030, with an interim target of 1.5 million ZEVs on the road by 2025.

¹⁸ California Energy Commission (2023). Electric Vehicle Chargers in California. <https://www.energy.ca.gov/zevstats>. Accessed on September 26, 2023.

Data Sources

EV Fuel assumptions: Hybrid and Plug-In Electric Vehicle Emissions Data Sources and Assumptions
https://afdc.energy.gov/vehicles/electric_emissions.html

Number and Types of EVs in Sonoma County: California Energy Commission. (Updated 2023). Zero Emission Vehicle and Infrastructure Statistics. <https://www.energy.ca.gov/data-reports/energy-almanac/zero-emission-vehicle-and-infrastructure-statistics>

VMT per trip: EMFAC2019 model for Sonoma County

Average trip length: EMFAC2019 model for Sonoma County

VMT: RCPA Sonoma County Greenhouse Gas Inventory (2020).

2018/current mode split: US Census Bureau.

Resource Consumption Action Plan (RC)

Solid Waste Diversion Strategy

Background

By consuming less materials and recycling and composting more, the community will be able to reduce the amount of waste sent to landfill and eventually become a zero-waste city. Organic materials are the focus of the recent landmark legislation SB 1383 (Short-Lived Climate Pollutants: Organic Waste Reductions). This State law has the immediate goal of reducing organic waste sent to landfill and the ultimate objective of reaching statewide methane emissions reduction goals. Specifically, it sets a statewide goal for the reduction in organic waste to landfills – 50 percent by 2020 and 75 percent by 2025 – in addition to the recovery of 20 percent of edible food waste for human consumption. SB 1383 requires local governments to provide organics collection to all generators and require all generators to subscribe. It also has specific mandates for container systems, education, and outreach programs, monitoring and contamination reporting, and enforcement of regulations.¹⁹

The Petaluma community generated 57,590 tons of waste sent to landfill in 2018, representing 7 percent of total communitywide emissions. According to the 2014 California Waste Characterization Study and Zero Waste Sonoma, about 44 percent of waste sent to landfills is organic material including 20.5 percent food waste.²⁰ Therefore, in 2018 Petaluma generated 11,806 tons of organic waste. SB 1383 requires that 75 percent of that (8,855 tons) be diverted from landfill by 2025.

Table E-6. Solid Waste Diversion Strategy Results

	Measure	2030 Reduction (MTCO _{2e})	2045 Reduction (MTCO _{2e})
1.	(Ongoing) Update the special event permitting process to include zero waste requirements for events, such as requiring applicants to submit a “waste plan” for each event.	Not quantified	Not quantified
2.	(2024) Research local disposal facility diversion rates to determine potential for additional diversion.	Not quantified	Not quantified
3.	(2025) Update enclosure standards for new construction to provide space for three streams in low-rise multifamily residential, high-rise multifamily residential, and nonresidential development.	0	0
4.	(2026) Adopt construction and demolition (C&D) diversion requirements for all new construction above what is required by CALGreen Tier 1. ²¹ File the adopted ordinance with the California Building Standards Commission (CBSC).	Not quantified	Not quantified

¹⁹ California Air Resources Board. 2017. Short-Lived Climate Pollution Reduction Strategy.

<https://ww2.arb.ca.gov/resources/documents/slcp-strategy-final#:~:text=The%20Short%2DLived%20Climate%20Pollutant,%2C%20and%20anthropogenic%20black%20carbo>. Accessed December 17, 2022.

²⁰ California Department of Resources Recycling and Recovery. 2015. 2014 Disposal-Facility-Based Characterization of Solid Waste in California. <https://www2.calrecycle.ca.gov/Publications/Download/1301>. Accessed December 17, 2022.

²¹ 2019 CALGreen Tier 1 requires a minimum of 65% and Tier 2 requires a minimum of 80% construction waste reduction. The new code cycle, 2022 CALGreen, will be effective by January 1, 2023.

5.	(2027) Explore modifying waste rate structure to encourage collection efficiency before the Recology franchise agreement ends December 31, 2027.	0	0
6.	(2028) Support development of a “market” for compost through local collaboration.	0	0
7.	(2028) Establish local ordinance prohibiting single use plastics (including water bottles) at City facilities and events, private events, and vending machines.	Not quantified	Not quantified
8.	(Ongoing) Continue partnership with Recology to fuel trash trucks with biogas generated by wastewater treatment plant. Explore opportunities to expand facility capacity to include food waste.	Not quantified	Not quantified
9.	(2025) partner with Recology to: provide quarterly route reviews to identify prohibited contaminants potentially found in containers that are collected along route; clearly label all new containers indicating which materials are accepted in each container, and by January 1, 2025, place or replace labels on all containers; increase education and establish penalties for noncompliance with source separation requirements; review franchise agreement at regular intervals and include any new or relevant waste reduction and efficiency programs or stipulations in updated agreement.	3,820	4,420
10.	(2025) Partner with Cool Petaluma to have volunteers lead sessions in their neighborhood on correct residential waste sorting.	0	0
11.	(2026) Partner with Zero Waste Sonoma JPA to implement and enforce an edible food recovery program for commercial food uses, farmers market vendors, and events.	Supportive	Supportive
11a.	Identify commercial edible food generators that will be required to send surplus food to food recovery organizations.	Supportive	Supportive
11b.	Conduct focus groups to assess local food recovery organizations / food banks and pantries’ capacity to accept recovered food.	Supportive	Supportive
11c.	Consider implementing a grant program to help organizations build their infrastructure. Prioritize funds for those located in disadvantaged communities.	Supportive	Supportive
11d.	Conduct outreach to educate affected retailers on the requirements.	Supportive	Supportive
12.	Utilize the City's membership in the Zero Waste Sonoma JPA to educate the public about how to separate and divert waste, as well as the associated environmental and community benefits. Partner with Zero Waste Sonoma JPA to: identify contaminated waste generators in need of technical assistance; develop and distribute educational materials (such as the Sonoma Zero Waste Guide) and in-person assistance; coordinate local participation in food recovery and distribution program; promote the use of compost for backyard gardens for small-scale food production and carbon sequestration.	Quantified as part of 9.	Quantified as part of 9.

13.	Develop partnerships with local business organizations such as the Downtown Association to ensure local businesses understand and adhere to waste diversion requirements.	Supportive	Supportive
Subsector Total		3,820	4,420

Methodology and Assumptions

Measures 6 and 9 are mandatory measures to be implemented by the City requiring 100 percent compliance with SB 1383 from all waste generators in Petaluma. The other measures in this strategy are supportive measures that seek to reduce waste and aid in the implementation of measures 6 and 9 but result in no direct emissions reductions. Measures 6 and 9 reduce GHG emissions by diverting organic waste material from landfills where it would emit methane. Emission factors for each waste types when landfilled were obtained from the CARB 2017 Method for Estimating Greenhouse Gas Emission Reductions from Diversion of Organic Waste from Landfills to Compost Facilities.²² A weighted average of the GHG emission factors for food waste, mixed paper, and yard waste was developed based on the percentages of the waste stream for each organic waste type.

Data Sources

Tons of waste: RCPA Sonoma County Greenhouse Gas Inventory (2020).

Proportion of organic waste: California Department of Resources Recycling and Recovery. (2015). 2014 Disposal-Facility-Based Characterization of Solid Waste in California.
<https://www2.calrecycle.ca.gov/WasteCharacterization/>

Average emissions factor per ton organic waste: 0.33 MTCO₂e <http://nrcne.org/wp-content/uploads/2019/12/Method-estimating-GHG-emissions-reductions.pdf>

²² California Air Resources Board. 2017. Method for Estimating Greenhouse Gas Emission Reductions from Diversion of Organic Waste from Landfills to Compost Facilities. <http://nrcne.org/wp-content/uploads/2019/12/Method-estimating-GHG-emissions-reductions.pdf>. Accessed March 8, 2021.

Local Food System and Grocery Strategy and Goods and Services Strategy

Background

The measures from the Local Food System and Grocery Strategy and Goods and Services Strategy are not included as part of the Blueprint GHG reduction analysis because they are Scope 3 emissions and not included in the City's community inventory based on the ICLEI Global Protocol for Community-Scale Greenhouse Gas Emission Inventories. Scope 3 emissions are defined as "All other GHG emissions that occur outside the city boundary as a result of activities taking place within the city boundary."²³ These measures also do not have readily available methods to estimate reductions. CAPCOA only has quantification methods for "those reductions over which a user can exercise direct control," and the only indirect emissions it quantifies are those "associated with electrical generation and the use of natural gas."²⁴

Another reason these measures are not quantified is a lack of available high-quality data. The City has included measures in the Blueprint related to collecting data and tracking consumption-based emissions so that they can possibly be quantified in the future.

²³ ICLEI. (2021). Global Protocol for Community-Scale Greenhouse Gas Emission Inventories.

²⁴ CAPCOA 2021. P. 36.

Water Action Plan (WC)

Water Conservation Strategy

Background

Petaluma purchases approximately 95 percent of its potable water from Sonoma Water. The city meets the other 1-10 percent of demand with locally pumped groundwater. The city offsets 2-3 percent of demand with non-potable recycled water generated by the Ellis Creek Water Recycling Facility (ECWRF). In 2018, Petaluma consumed 8,524 AF of water.²⁵

GHG emissions from water supply are generated by the energy used to convey, treat, and distribute water. Imported water sources, like those supplying Petaluma, have a high energy intensity. Although water sector GHG emissions account for less than 1 percent of communitywide emissions in Petaluma, access to clean and safe water supply has innumerable quality of life benefits.

Residential and commercial buildings use water both indoors for cooking, cleaning, bathing, and toilet flushing, and outdoors to irrigate landscaping and maintain pools and fountains. Efficiency measures not only reduce the amount of water used but also reduce the amount of energy needed to heat water as a result of conservation.

Table E-7. Water Conservation Strategy Results

	Measure	2030 Reduction (MTCO ₂ e)	2045 Reduction (MTCO ₂ e)
1.	(Ongoing) Hold giveaways for aerators and nozzles at public events or establish a periodic door-to-door or pick-up program offering immediate installations.	0	0
2.	(Ongoing) Explore the feasibility of purple pipe expansion, dual plumbing, and blackwater system installation in the update of the Recycled Water Master Plan.	Not quantified	Not quantified
3.	(Ongoing) Implement capital improvements at ECWRF to increase peak tertiary treatment capacity.	300	0
4.	(2025) Research example water neutrality ordinances and incentives and current greywater permitting processes and determine which type of systems to pre-qualify.	0	0
5.	(2025) Explore adding installation support as a part of the low-flow toilet subsidy program.	0	0
6.	(2025) Continue to utilize, promote and build-out online permit application submittal and processing systems, and shorten the inspection process to one inspection for qualifying greywater systems.	0	0
7.	(2025) Amend Municipal Code Sec. 15.17.050 with improved landscape water use efficiency standards and amend Sec. 15.17.050(C)(4) with new Petaluma River-Friendly Landscaping guidelines. Consider restricting or disallowing	215	0

²⁵ City of Petaluma. 2022. 2020 Urban Water Management Plan. <https://cityofpetaluma.org/documents/2020-urban-water-management-plan/>. Accessed May 16, 2023.

	lawn installations or replacements, including disallowing artificial turf except in cases of athletic facilities.		
8.	adopt the CALGreen Tier 2 water efficiency and conservation requirements for additions, alterations, and remodels.	540	0
8a.	Note the most recent standards to avoid continuous updates – Note all the locations in the code.		
8b.	Consider additional incentives or exceptions for affordable housing development.		
9.	(2025) Replace existing water meters with Advanced Metering Infrastructure (AMI) system that will include easy-to-use web-based tools that allow customers to track and monitor water use. Promote the availability of Home Water Reports and provide materials on how to utilize the available information.	0	0
10.	(2026) Explore a direct install water efficiency upgrade program for customers qualified for subsidized water/sewer rates. Include low-flow toilets, weather-based irrigation controllers, rainwater capture systems, and drip irrigation.	0	0
11.	(2027) Explore legal authority for greywater requirements as part of building code for all new construction and major renovations of existing buildings.	0	0
12.	(2030) Explore adopting a tiered rate structure for water use, and mandatory benchmarking, audits, and retrofits for disproportionately high-water users.	0	0
13.	(2025) Engage stakeholders including QWEL certified landscapers, developers, architects, and property owners regarding the purpose and impact of the requirements.	0	0
14.	(2025) Conduct public hearings, public notices, and formally adopt reach code ordinance.	0	0
15.	(2025) Partner with Greywater Action or similar organization to determine eligibility criteria for systems that qualify for expedited permitting and provide permitting checklist.	0	0
16.	(2025) Continue implementing and evolve public education campaigns that highlights water conservation practices and promotes and provides demonstrations of graywater and rainwater systems focusing on low-income customers with organizations like Daily Acts.	0	0
17.	(2027) Create a social media campaign with awards to highlight Petaluma residents and businesses that have successfully modified their landscaping and/or reduced indoor water consumption.	0	0
18.	(Ongoing) Continue collaborating with Petaluma Groundwater Sustainability Agency for long-term regional sustainable water management.	0	0
Subsector Total		1,055	0

Methodology and Assumptions

The GHG emissions reduction associated with measure 3 are the result of reducing the City's need for higher energy-intensive imported water and replacing it with local reclaimed water by expanding the ECWRF peak tertiary treatment capacity from 4.68 to 6.8 MGD, producing a yield of 712 AFY to meet peak demands.²⁶

The GHG emission reductions associated with measure 7 and 8 are a result of the decreased energy consumption required to convey, pump, treat, and distribute less potable water to end users through increased end use efficiency. These measures would amend the building code to require higher efficiency fixtures to be installed in residential and nonresidential new construction and major remodels that trigger CALGreen compliance. As such it is a mandatory measure for new construction meaning that measure is required to be implemented by applicable individuals and projects. Incentives may be provided. The GHG reduction model assumes this measure is fully implemented by 2025.

The remaining measures are supportive measures that have no direct emissions reductions associated with them but aid in the implementation of measures with direct emissions reductions or enhance the emissions reductions of other measures. The educational, incentive, and administrative changes of these measures allow for and promote the implementation of measures 7 and 8.

Data Sources

Proportion of residential and commercial indoor and outdoor water use: CDWR https://pacinst.org/wp-content/uploads/2013/02/appendix_e3.pdf

Residential water use efficiency savings: CDWR https://pacinst.org/wp-content/uploads/2013/02/appendix_b3.pdf; Energy Code Ace [https://energycodeace.com/download/13929/file_path/T20%20Plumbing%20FS%20081116%20\(2\).pdf](https://energycodeace.com/download/13929/file_path/T20%20Plumbing%20FS%20081116%20(2).pdf)

Commercial water use efficiency savings: Energy Code Ace: energy.ca.gov/research/iaw/water.html; Pac Institute "Urban Water Conservation and Efficiency Potential in CA" <https://pacinst.org/wp-content/uploads/2014/06/ca-water-urban.pdf>

Recycled/reclaimed water/energy savings: CPUC water/energy Calculator https://www.cpuc.ca.gov/nexus_calculator/

Local Groundwater water/energy savings: CPUC water/energy Calculator https://www.cpuc.ca.gov/nexus_calculator/

San Francisco Bay imported water energy intensity: CAPCOA 2021 Table W-1.1

Petaluma Water supplies: City of Petaluma 2020 Urban Water Management Plan

²⁶ Capacity information provided by City of Petaluma staff at staff working session in March 2023.

Natural Systems and Sequestration Action Plan (NS)

Urban Forestry Strategy

Background

Petaluma has the opportunity to engage in carbon sequestration activities through enhancing open space, urban greening, and protecting and increasing the City’s urban forest or tree stock. The City has the goal of planting 10,000 trees as part of the ReLeaf Petaluma program.

Table E-8. Urban Forestry Strategy Results

	Measure	2030 Reduction (MTCO2e)	2045 Reduction (MTCO2e)
1.	(Ongoing) Collaborate with ReLeaf Petaluma to support their 10,000 trees program, including potential fee reductions or water bill credits, if feasible.	354	354
2.	(2025) Conduct an inventory of existing trees in Petaluma	0	0
3.	(2025) Adopt a revised Tree Ordinance that prioritizes tree preservation	0	0
4.	(2025) Revise tree pruning and clarify and reinforce removal criteria for street trees to minimize the loss of street trees, increases street tree planting opportunities, and improve maintenance of existing trees for long term health of urban canopy.	0	0
5.	(2025) Adopt an updated List of Approved Street Trees that prioritizes climate and ecosystem appropriate trees and plants. Consider integrating the ReLeaf Petaluma Plant Palette recommendations	0	0
6.	(2026) Complete a study to establish a pathway and funding mechanisms to reduce emissions from off-road equipment focusing on lawn and garden equipment, and other sources of off-road emissions in the city.	Not quantified	Not quantified
7.	(2026) Develop and adopt a Petaluma Urban Forest Plan in partnership with community organizations.	0	0
8.	(2026) Establish and fund a citywide street tree maintenance and tree planting program.	0	0
9.	(2026) Adopt a monitoring system to track tree canopy cover over time.	0	0
10.	(2027) Determine baseline data on existing carbon sequestration including Petaluma’s share of legacy emissions and consumption emissions.	Not quantified	Not quantified
11.	(2027) Establish an incentive program to reduce impervious surfaces on private property.	0	0
12.	(2030) Offset carbon that cannot be sequestered locally through regional carbon sequestration and offset programs.	Not quantified	Not quantified

13.	(Ongoing) Continue hosting an Arbor Day public event or event series to educate Petalumans about tree care, native species, tree benefits, etc.	Supportive	Supportive
14.	Develop landscape management resources for residents and local businesses, including information on: incentives for low water use, nature-scaping, and large tree planting and model landscapes to demonstrate principles.	Supportive	Supportive
15.	(2024) Partner with community organizations in Petaluma, such as ReLeaf, to coordinate tree planting on land use types where the City does not have jurisdiction (i.e. private property and schools).	Supportive	Supportive
16.	(2025) Work with community volunteers to collect place-based data (i.e. observational studies of the shade and trees in public places).	Supportive	Supportive
17.	(2025) Conduct a map-based survey asking Petalumans what locations they think need more trees.	Supportive	Supportive
Subsector Total		354	354

Methodology and Assumptions

Measure 1 aims to increase tree cover to reduce the urban heat island effect and increase the City's carbon sequestration potential, effectively reducing GHG emissions. Implementing measure 1 will plant 10,000 trees by 2030. GHG emission reductions were estimated based on the number of trees to be added to the inventory and the average CO₂e accumulation factor per tree (0.0354 MT CO₂e/tree/year).²⁷

Measures NS 2-16 are supportive measures that are designed to aid the city in planting 10,000 trees by 2030 as well as preserve and enhance the health of the existing urban forest through improved management. They do not have direct emissions reductions.

Data Sources

Average CO₂e sequestered/tree: CAPCOA 2021

https://www.airquality.org/ClimateChange/Documents/Final%20Handbook_AB434.pdf

²⁷ CAPCOA. 2021. Quantifying Greenhouse Gas Mitigation Measures.
https://www.airquality.org/ClimateChange/Documents/Final%20Handbook_AB434.pdf

Open Space Management Strategy and Climate Smart Working Lands Strategy

Background

These two land management strategies demonstrate the several forms of carbon sequestration that can be applied in open space, including planting trees, applying compost, reusing tree biomass (tree chips) as mulch, and restoring and protecting natural riparian areas such as along the Petaluma River. They also recognize agriculture as an important part of Petaluma's heritage. Today, there are about 200 acres of agricultural land in the city.²⁸

Results

At this time only the carbon benefits of urban forestry can be assessed, as additional research is needed to assess the benefits of vegetation and soil management. Nonetheless, over time as emissions are removed from more and more sectors, carbon sequestration will play an increasingly important role in California's ability to achieve carbon neutrality.

Methodology and Assumptions

At this time only the carbon benefits of urban forestry can be assessed as additional research is needed to assess the benefits of vegetation and soil management. Nonetheless, over time as emissions are removed from more and more sectors, carbon sequestration will play an increasingly important role in California's ability to achieve carbon neutrality.

Data Sources

N/A

²⁸ Agricultural area provided by City of Petaluma staff as part of the General Plan update.