APPENDIX D

Measure Quantification and Substantial Evidence

Livermore Climate Action Plan Update

prepared for

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1 Introduction

This document presents the technical quantification and evidence supporting the greenhouse gas (GHG) emission reduction potential of the City of Livermore's Climate Action Plan (CAP) Update. Section 15183.5(b)(1) of the California Environmental Quality Act (CEQA) guidelines establishes several criteria which must be met in order to allow for CEQA streamlining and to be considered a "qualified GHG reduction plan". This document provides the information substantiating the GHG reductions identified for the CAP strategies pursuant to Subsection (D) which states, "strategies or a group of strategies, including performance standards, that substantial evidence demonstrates, if implemented on a project-by-project basis, would collectively achieve the specified emissions level."

As part of the CAP Update process, the City of Livermore – in coordination with Rincon Consultants, Inc. (Rincon), the Livermore Climate Action Plan Advisory Committee and the community of Livermore – has developed a comprehensive strategy for reducing community-wide GHG emissions over time. The strategies, actions, and steps in this appendix are consistent with the Climate Action Plan. In addition, steps are also identified in this document. These implementation steps will directly drive GHG emission reductions and direct day to day implementation of the CAP.

The Climate Action Plan's claimed GHG emission reductions are organized around three levels which include:

1. **Sectors.** Sectors define the category in which the GHG reductions will take place and include Energy, Transportation, Waste, Carbon Sequestration, Municipal, Implementation and Outreach, and Carbon Restoration.
2. **Strategies.** Strategies define core strategies within each sector that will result in substantial reductions in GHG emissions
3. **Actions.** Each strategy is driven by sets of actions that together support the GHG emissions reduction necessary to achieve the City's targets
4. **Steps.** This document also identifies steps which are specific policies, ordinances, and other approaches that will directly drive GHG emission reductions.

Strategies and steps can be either quantitative or supportive and are defined as follows:

- **Quantitative.** These strategies and steps are supported by case studies, scientific articles, calculations, or other third-party substantial evidence that demonstrate that the implementation of said strategy/action will achieve the identified measurable GHG reduction. Quantitative strategies/steps can be summed to quantify how the City of Livermore will meets its 2030 target and show substantial progress towards the 2045 emission target. These targets exceed the state goal set by Senate Bill 32 (SB32) of 40% below 1990 by 2030, and carbon neutrality by 2045 as set by Executive Order B-55-18.[1] The GHG reductions were calculated using published evidence provided through adequately controlled investigations, studies, and articles carried out by qualified experts that establish the effectiveness of the reduction

[1] The Association of Environmental Professionals recommends limiting CEQA GHG Analysis to the State GHG Planning Horizon based on a State Legislatively Mandated Target (i.e., SB 32). Therefore, at this time, it is recommended that cities demonstrate quantitatively how they plan to achieve GHG reductions that align with SB 32, but are not required to do the same for the 2045 carbon neutrality goal established by EO-B-55-18, as this goal has not yet been adopted by the State Legislature. Rather, it is recommended that cities demonstrate "substantial progress" towards the 2045 carbon neutrality goal. See *Final White Paper Beyond 2020 and Newhall: A Field Guide to New CEQA Greenhouse Gas Thresholds and Climate Action Plan Targets for California* (Association of Environmental Professionals, 2016).

strategies and steps. Further, the strategies and steps were developed to achieve the 2030 target established by the City of Livermore and make substantial progress towards the 2045 target. The estimates and underlying calculations, provided in this report, include substantial evidence and a transparent approach to achieving the City's shot term GHG emissions reduction target and substantial progress towards achieving the long-term target.

- **Supportive.** These strategies and steps may also be quantifiable and have substantial evidence to support their overall contribution to GHG reduction. However, due to one of several factors – including a low/no direct GHG reduction benefit, indirect GHG reduction benefit, potential for double-counting, or simply a high level of difficulty in quantifying accurate GHG reductions – they have not been quantified and do not contribute directly to the expected GHG reduction target and consistency with the state goals. Despite not being quantified, supportive strategies/steps are nevertheless critical to the implementation of other strategies and action and generally the overall success of the CAP.

Together, the quantitative and supportive strategies and steps listed herein provide Livermore with the GHG emissions reduction necessary to achieve the identified target of reducing per capita emissions by 40% below 1990 levels by 2030 to an estimated 3.17 MT CO_2e per person. Based on current population projections this per capita target translates to a 67% reduction below 1990 GHG emission reduction levels by 2030, exceeding the requirements of SB32.[2] Per capita emission targets were identified by the California Air Resources Board (CARB) and explained in the 2017 Scoping Plan Update provided .[3] The City has also established a target consistent with Executive Order (EO) B-55-18 to achieve carbon neutrality by 2045.[4] The strategies identified in this CAP will lead to a substantial progress in GHG emissions by 2045, providing a foundation for achieving net carbon neutrality. However, the strategies reasonably available to the city and included in this CAP do not provide enough GHG emissions reduction to meet the long term 2045 GHG emissions goal. Achieving carbon neutrality will require significant changes to the technology and systems currently in place. This CAP aims to establish new systems that are resilient and equitable in the face of change that will allow for a transition to carbon neutrality in the future. This includes carbon neutral electricity (which will also lower water and wastewater emissions from local electricity use), electrification of building and transportation systems and increased shift to shared and active mobility, waste reduction and diversion, and carbon sequestration. As the current strategies and steps are implemented, the City will gain more information, new technologies will emerge, and identified pilot projects and programs will scale to the size needed to reach carbon neutrality. Furthermore, the State is expected to continue providing updated regulations and support once the 2030 target is achieved. Future CAP updates will make necessary adjustments and outline new strategies needed to reach Livermore's long-term target of carbon neutrality.[5]

The quantification in this report is intended to illustrate one of several viable paths to pursue as the strategies and steps of the CAP are implemented at full scale. As required in CEQA Guidelines Section 15183.5(b)(e), mechanisms to monitor the CAP's progress toward achieving the GHG emission reductions provided in this report have been established through the CAP development

[2] The percent reduction target is calculated as a reduction in projected absolute emissions from 1990 levels. However, total projected emissions, emission targets, and emission reductions in 2030 and 2045 are dependent on population levels and the targets established in this CAP are efficiency targets. Therefore, while absolute emissions in 2030 and 2045 may differ due to differences between the projected population and actual population, per capita emission targets and per capita emissions reductions will remain stable.

[3] https://ww2.arb.ca.gov/sites/default/files/classic/cc/scopingplan/scoping_plan_2017.pdf

[4] The goal of carbon neutrality is also consistent with the Paris Agreement and the International Panel on Climate Change's target of carbon neutrality by mid-century.

[5] Association of Environmental Professionals, 2016.

process. If, based on the tracking of community GHG emissions, the City is found to not be on target to reach the GHG reduction levels specified here for meeting SB 32 targets, the CAP as a whole or specific strategies and steps will be required to be amended and a CAP update will be prepared that includes altered or additional strategies and steps and evidence that upon implementation can achieve the City's targets.

Avoiding interference with and making substantial progress toward the state's 2030 and long-term goals is important as these have been set at levels that achieve California's fair share of international emissions reduction targets established by the Paris Agreement and the International Panel on Climate Change that will stabilize global climate change effects and avoid the adverse environmental consequences described under EO B-55-18 Section 3.1.3, Potential Effects of Climate Change.

The strategies and steps laid out in the CAP were driven by a development framework that considered the costs and benefits of each action (Appendix C). In addition, a set of guiding principles were developed that reflected the City's and the community's values. Each strategy and action was developed by carefully considering these guiding principles. The guiding principles are highlighted below in Table 1.

Table 1 Guiding Principles

Principles	Description
Mitigation and/or adaptation benefit	Strategies should achieve measurable reductions in GHG and/or improvements in resilience.
Structural change	Strategies should establish institutional and policy framework to facilitate long-term change.
Education	Strategies should include community engagement and empower residents and stakeholders to take action.
Equity	Strategies should promote inclusive participation in decision making and equitable access to benefits.
Partnerships	Strategies should utilize partnerships with outside agencies and community organizations to leverage expertise and resources and maximize the City's capacity.
Economics	Strategies should strive to be cost-effective for the City and the community.

2 CEQA Qualified CAP

Livermore's CAP aligns with the requirements set forth in CEQA Guidelines Section 15183.5(b) for development of a qualified GHG reduction plan. This includes setting GHG emissions reduction targets which align with those set by the State of California (described above). As a qualified GHG Reduction Plan, development projects that are consistent with the strategies in the CAP can streamline their GHG analysis under CEQA by presuming that the project's GHG emissions are not significant. The requirements set forth in CEQA Guidelines Section 15183.5(b) are as outlined below:

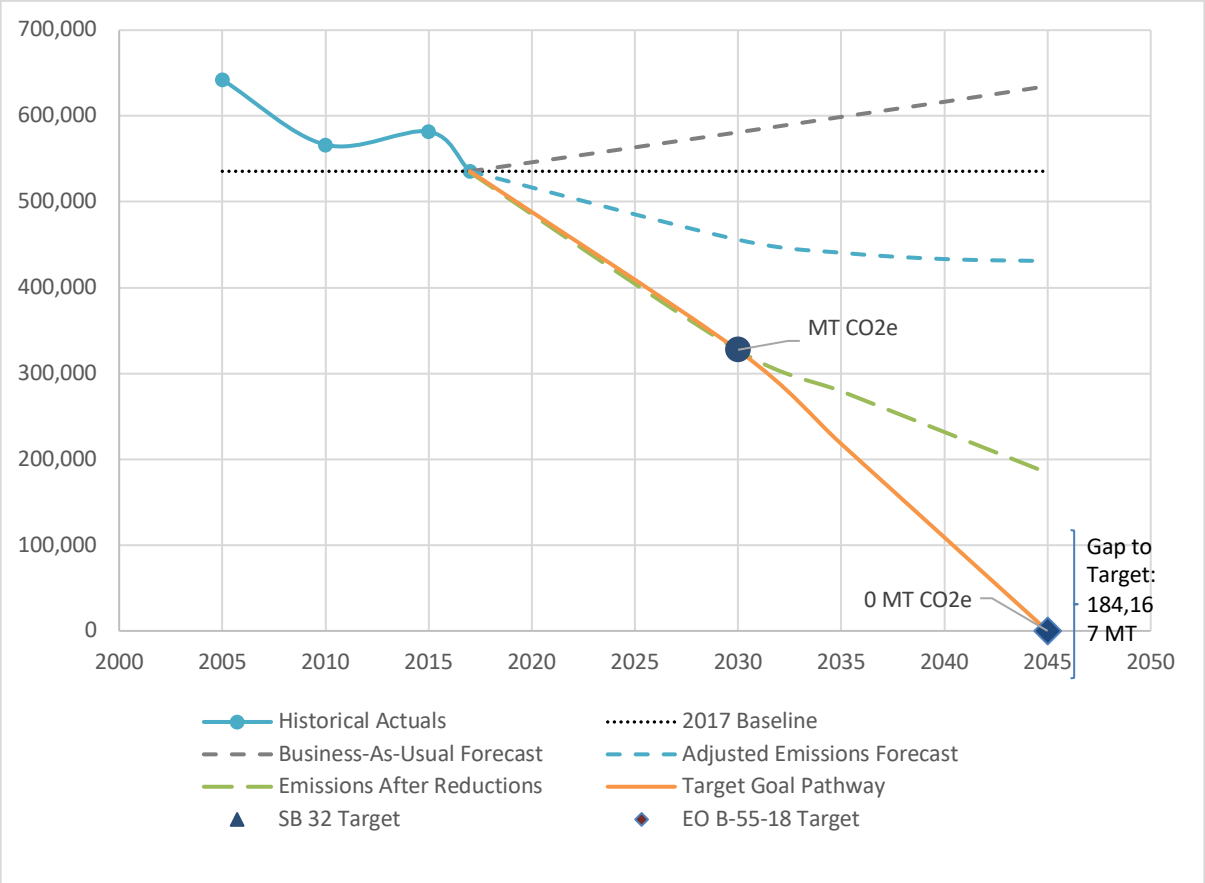
- Quantify GHG emissions, both existing and projected over a specified time period, resulting from activities within a defined geographic area; (Chapter 2)
- Establish a level, based on substantial evidence, below which the contribution to GHG emissions from activities covered by the plan would not be cumulatively considerable; (Chapter 2)
- Identify and analyze the GHG emissions resulting from specific actions or categories of actions anticipated within the geographic area; (Chapter 2)
- 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; (Chapter 3)
- Establish a mechanism to monitor the plan's progress toward achieving the level and to require amendment if the plan is not achieving specified levels; (Chapter 4)
- Be adopted in a public process following environmental review. (Associated CEQA Analysis)
- A qualified CAP allows Livermore to streamline new development that meets our climate goals, decreasing costs, and incentivizing climate smart development.

3 Emission Reduction Summary

The strategies, actions, and steps established by Livermore's CAP Update are expected to reduce per capita emissions below 1990 levels by 68% in 2030 and 85% by 2045. The reductions expected in 2030 exceed the requirements of SB32, but reductions expected in 2045 fall short of the carbon neutrality goal established by EO B-55-18 (

Figure 1). However, as described above, this Climate Action Plan puts Livermore on the pathway to achieve carbon neutrality by 2045.

Figure 1 Estimated GHG Emissions Reduction



A breakdown of the GHG emissions reduction calculated for each strategy is included in Table 2. A complete description of each strategy and its contributing actions and steps is included in the sections that follow.

Table 2 Estimated Emission Reduction Potential of CAP Strategies

Strategy Number	Strategy	2030 Emissions Reduction (MT CO_2e)	2045 Emissions Reduction (MT CO_2e)
Buildings and Energy			
B-1	Require new buildings to be all-electric and incentivize electrification retrofits of existing buildings	27,383	121,493
B-2	Decarbonize electricity from the grid and increase local renewable energy generation	25,505	0
Transportation and Land Use			
T-1	Facilitate a transition to electric vehicles	49,494	93,458
T-2	Facilitate a transition to transit and shared mobility services	3,033	4,656
T-3	Improve and expand active transportation infrastructure	2,127	2,111
T-4	Support sustainable land use practices	Not quantified	Not quantified
Waste and Materials			
W-1	Reduce the amount of waste that is landfilled	19,379	22,646
W-2	Expand use of low-carbon and recycled building materials	Not quantified	Not quantified
Carbon Sequestration			
S-1	Maximize local carbon sequestration	2,008	2,434
Overall Reductions			
Emissions Reduction Needed to Achieve State Targets		128,238	430,965
Estimated Reduction Achieved by Full Implementation of Strategies		128,929	246,798
Absolute Emissions Reduction from 1990 (%)[1, 2]		(40%)	(66%)
Per Capita Emissions Reduction from 1990 (%)		(68%)	(85%)
Gap to SB 32 Target		(692)[3]	184,167

MT CO_2e = metric ton of carbon dioxide equivalent

[1] Emissions reductions go to zero by 2045 due to Senate Bill 100 and the Renewable Portfolio Standard.

[2] Absolute emissions reduction values are estimated based on current population projections and are for reference. Actual progress toward the 2030 target will be determined by comparison to the per capita GHG emissions target of 3.08 MT of CO_2e per person pursuant to guidance in the 2017 Scoping Plan.

[3] Parentheses denote a negative number or an exceedance of the target.

Note: Quantitative GHG emissions reduction values were rounded to the nearest tenth to reflect the level of estimation involved in calculations.

As shown in Table 2, the strategies adopted in Livermore's CAP Update have the ability when fully implemented to reduce GHG emissions below the City of Livermore's 2030 GHG reduction target and make substantial progress towards a 2045 carbon neutrality target. However, a gap still remains to reach the goal of carbon neutrality in 2045. As new technologies develop, and the state consolidates around the 2045 carbon neutrality goal, the City of Livermore will monitor progress and adopt new strategies to achieve this long-term goal. Furthermore, the strategies, actions, and steps in this CAP will create the basis for long-term carbon neutrality when implemented, including electrified buildings and vehicles coupled with decarbonized electricity, improved active transportation, decreased waste generation, and increased carbon sequestration.

The following sections contain the substantial evidence and quantification methodology intended to provide reasonable assurance that the GHG reduction strategies adopted in the City of Livermore's CAP Update will lead to the GHG emissions reduction necessary to achieve the City's ambitious 2030 emission target.

4 Buildings and Energy

4.1 2030 Objectives

- Provide 100 percent renewable electricity by 2024
- Require all-electric new construction by 2023
- Incentivize electric retrofits in 12% of existing buildings by 2030
- Develop equitable funding and financing for building electrification
- Incentivize local on-site energy generation and storage

Strategy B-1 Require New Buildings to be All-electric and Incentivize Electrification Retrofits of Existing Buildings

Livermore's building stock currently relies heavily on natural gas and retrofitting existing buildings to be all-electric will be a substantial task. To ensure new buildings won't need to be retrofitted later, Action B-1.1 will require new buildings and major retrofits be built to utilize only electricity as an energy source through an electrification ordinance. Meanwhile, Action B-1.2 and B-1.3 will provide a framework of updated regulations, incentives, rebates, and outreach to drive the electrification of existing buildings. The details of each action, including their implementation steps and evidence of their GHG reduction potential, are included below.

- **Action B-1.1**: Require new construction to be all-electric
- **Action B-1.2**: Incentivize electric retrofits in existing buildings
- **Action B-1.3**: Conduct a cost analysis and feasibility study for existing building electrification requirements
- **Action B-1.4**: Partner with stakeholders to conduct electrification outreach, promotion, and education

Action B-1.1 Require New Construction to be All-electric by 2023

Step Number	Guiding Principles	Implementation Steps	Anticipated Reduction (MT CO_2e)
1	GHG Reductions/ Structural Change	**Require new construction to be all-electric:** Adopt an electrification reach code by 2023 which bans the use of natural gas in all new construction where electrification is cost effective. Additionally, require major retrofits to be electric ready (i.e., install a 200-amp electric panel and prewire for electric vehicles and appliances).	2030: 10,891 2045: 28,056
2	Economical	Minimize the number of exemptions associated with the ordinance to limit the number of stranded assets in the City. Allow case by case allowances for certain site development standards when an applicant can demonstrate infeasibility.	
3	Equity	Conduct a cost effectiveness study to ensure no cost increases for low/medium income housing	
4	Education	Conduct outreach and engagement around new building electrification with the community and key stakeholders prior to adopting an electrification ordinance. A strong understanding of the benefits of electrification will be key to avoiding exceptions.	
5	Connectivity	Establish a partnership with the Building Decarbonization Coalition, or a similar organization, to engage with local building industry stakeholders in development of an Electrification Reach Code.	

Continuing to allow natural gas in new buildings would result in an increase in GHG emissions through 2045, due to increases in the population and residential construction in the City projected through 2045 (see adjusted forecast in Appendix A). Conversely, GHG emissions from electricity generation are expected to decrease to almost zero by 2025 due to Action B-2 (emissions from electricity would otherwise decrease to zero in 2045, due to SB 100). Requiring new construction to be all-electric would lead to a mandatory reduction in natural gas consumption compared to adjusted forecast projections by replacing natural gas with electricity.

Emission reductions for Action 1 were calculated separately for residential and commercial construction. It was assumed that with full implementation of the ordinance, no increases in residential and commercial natural gas demand would occur after 2022. Natural gas saved after ordinance implementation was converted to electricity usage (i.e., therms converted to kWh), with the assumption that a modern electric heat pump is on average three time more efficient than natural gas heater.[6] The emission factor for electricity was calculated based on the assumption that Action B-2 would be fully implemented by 2025 (more details on how this emission factor was calculated are included in the section for Strategy E-3). Total emissions saved are equivalent to emissions saved from eliminating natural gas in new construction, minus emissions from increased electricity usage.

Population forecast data based upon MTC projections reflect a steady increase in population between 2017 and 2045 (see Appendix A). The forecast for natural gas usage mirrors this pattern, along with projections for new housing units, which is expected to increase in Livermore through 2045. Residential natural gas from new construction was therefore, calculated based on housing estimates from MTC. Commercial gas usage avoided by electrification was calculated based on the

[6] https://help.leonardo-energy.org/hc/en-us/articles/203047881-How-efficient-is-a-heat-pump-

therms projections from commercial buildings in the adjusted forecast which considers the jobs growth over time. Minimizing the number of exemptions will be a key factor in the success of the ordinance and the reductions claimed as part of the Climate Action Plan. More exemptions, especially for a specific appliance like gas stoves would result in the same amount of natural gas infrastructure being deployed. Under this worst case scenario, the cost of natural gas infrastructure would remain the same, but the amount of natural gas consumed would decrease, significantly increasing the cost of each therm.[7] Therefore, the City will undergo a robust outreach campaign prior to adoption to ensure the community understands the importance of electrification and the long term cost increases expected for natural gas. Emission reduction calculation for Action B-1.1 are shown below in Table 3.

Table 3 Action B-1.1 Calculations

Year	2030	2045
Residential Reductions		
Housing units[1]	37,573	44,026
NG usage (therms)[2]	14,394,143	17,352,806
NG usage per housing unit (therms per house)	383	394
Additional housing units since implementation year[1]	4,853	11,306
NG usage avoided (therms)	1,859,101	4,456,315
Emissions from NG usage avoided (MT CO_2e)[3]	9,873	23,665
Electricity usage from converting to electric (kWh)[4]	18,157,278	43,523,493
Electricity EF (MT CO_2e/kWh)[5]	0.0000026	0
Emissions from converted electricity usage (MT CO_2e)	47	0
Emission reductions (MT CO_2e)	9,826	23,665
Commercial Reductions		
NG usage (therms)[1]	11,081,548	11,707,129
NG usage avoided (therms)	201,276	826,856
Emissions from NG usage avoided (MT CO_2e)[3]	1,069	4,391
Electricity usage from converting to electric (kWh)[4]	1,965,799	8,075,656
Electricity EF (MT CO_2e/kWh)[5]	0.0000021	0
Emissions from converted electricity usage (MT CO_2e)	4	0
Emission reductions (MT CO_2e)	1,065	4,391
Total reductions (MT CO_2e)	**10,891**	**28,056**

[1] MTC Plan Bay Area Projections 2040 long-term growth forecasts (2018), adjusted for population growth in Livermore observed from 2015-2017.

[2] Values from GHG Emissions Forecast. See Appendix A.

[3] Based on an emission factor of 0.00531051 MT CO_2e/therms, as established in Appendix A.

[4] Based on a conversion factor of 29.3001 kWh/therms and the assumption that electric appliances are generally three time more efficient than gas appliances. https://help.leonardo-energy.org/hc/en-us/articles/203047881-How-efficient-is-a-heat-pump-

[5] The residential and commercial electricity emission factors were calculated based on opt-out rates for different CCA customers. See Strategy E-3 for further details on this calculation.

[7] https://gridworks.org/initiatives/cagas-system-transition/

Action B-1.2 Electrify Existing Buildings to Reduce Natural Gas Consumption 12% by 2030 and 61% by 2045

Step Number	Guiding Principles	Implementation Step	Anticipated Reduction (MT CO_2e)
1	Economics	**Perform an electrification feasibility study/existing building analysis** in order to understand the potential for, and associated costs of, electrification retrofitting in the City of Livermore and establish a plan for eliminating natural gas from existing buildings. This would include an analysis for implementing requirements for newly permitted HVAC/hot water heaters and other appliances to be electric. At minimum, the plan would identify a pathway to reduce natural gas use by 12% by 2030.	2030: 16,492 2045: 93,437
2	Partnerships	**Identify and partner with stakeholders to develop resident-level funding pathways for implementing electrification ordinance:** Leverage partnerships with stakeholders and establish funding pathways to ease community members' costs when complying with the electrification ordinance, including: ▪ Partner with East Bay Community Energy and other stakeholders such as PG&E to create or expand electrification/retrofit programs and incentives (e.g., PACE program), especially for low-income residents to support the electrification ordinances. These could include on-bill financing, metered energy efficiency, providing rebates for residential replacement of natural gas-powered air and water heating appliances with electric-powered models, or providing rebates for replacement of antiquated wiring and windows in historic homes and buildings.	
3	Structural Change	**Develop a permit tracking program** for existing building electrification to track annual progress in achieving the targeted electrification goal(s), possibly through the City's existing Accela platform.	
4	Equity	**Develop a suite of Equity Guardrails** with input from the community to ensure existing building electrification improves equity in the community by limiting displacement and promoting equitable distribution of electrification benefits like resiliency, improved health outcomes, and reduced energy burden.	
5	Education	**Identify and partner with stakeholders to conduct electrification outreach, promotion, and education:** Leverage partnerships with stakeholders to conduct outreach, promotion, and education around new and existing building electrification, including: ▪ Induction/electric stove cooking competition to demonstrate the competitiveness of electric stoves for replacing gas stoves. ▪ Information sessions/events that educate the public on safety concerns around gas stoves and health benefits of replacing with electric, as well as potential cost benefits. ▪ Promote water heater, space heating, and appliance (electric stove/dryers) replacement programs and incentives (residential) at time of construction permit. ▪ Work with partners to develop financial and technical resources, including hosting workforce development trainings for installers and building owners/operators to discuss benefits and technical requirements of electrification and move towards all-electric requirements.	

Step Number	Guiding Principles	Implementation Step	Anticipated Reduction (MT CO_2e)
		▪ Conduct internal trainings with planners and building officials on state decarbonization goals and incentives available for electric homes. ▪ Work with partners and stakeholders to establish a comprehensive, coordinated education campaign for property owners and occupants for reducing the use of natural gas in homes and businesses. This could include keeping an updated list of rebates and incentives available for residents who would like to electrify their buildings, and providing multilingual education on the potential savings and benefits of electric heat pumps for water heating and space heating.	

Natural gas usage from existing buildings accounted for about 23% of emissions in Livermore in 2017. The City of Livermore will begin by promoting electrification through education, outreach, and incentives. Performing an electrification feasibility study will support implementation of Action B-1.2 contributing to achieving the GHG reduction benefits of those steps. The feasibility study will help determine which buildings in Livermore can be electrified, how to make electrification cost effective in specific cases, clarify the timeline on which electrification will happen, and investigate more concretely how to implement electrification equitably. The feasibility study will further determine if mandatory actions will need to be take and the cost effectiveness of those actions. While the City will begin implementation of Action B-1.2 through voluntary actions a mandatory requirement may be required in the future based on the results of the electrification study and the community progress. The impacts associated with promotional and educational outreach for electrification have not been well documented due to the cutting-edge nature of the strategy. Electrification as a GHG reduction strategy has only begun to gain traction in California mostly due to the implementation of SB 100 and the expansion of community choice aggregations. While it is not clear how the community will respond to electrification, energy efficiency outreach has been conducted since as early as the 1970's and some research has been conducted on the effects of outreach and education on energy. One study in New York showed that out of the 8,991 people who participated in informational programs, 69% implemented the recommended practices.[8] Another research meta-analysis reviewed dozens of papers covering various energy efficiency, water efficiency, and waste outreach and found that education-only campaigns could produce between 10-12% energy savings.[9]

Electrification is a new idea and not well understood by the community. The education associated with this action as well as the Climate Action Plan itself will facilitate adoption of all-electric technologies. The City will conduct a CAP update after 5 years to check progress and adopt more voluntary or potentially mandatory strategies if necessary.

Approximately 34% of residential natural gas usage is used for water heaters, while 40% is used for space heating.[10] The average life-span for water heaters and HVAC systems is 10 years and 18 years, respectively, and the ordinance would be fully implemented by 2025.[11] As a backstop to voluntary steps and pending the results of the electrification study the City of Livermore could no longer

[8] https://www.joe.org/joe/2009december/pdf/JOE_v47_6a6.pdf

[9] https://aceee.org/files/proceedings/2000/data/papers/SS00_Panel8_Paper10.pdf

[10] https://www.synapse-energy.com/sites/default/files/Decarbonization-Heating-CA-Buildings-17-092-1.pdf

[11] https://www.lowes.com/n/how-to/when-to-replace-a-water-heater, https://www.thisoldhouse.com/ideas/how-long-things-last

accept permits to replace natural gas HVAC and hot water heaters starting in 2025, especially if voluntary efforts have not been successful. These units have been selected due to their large contribution to natural gas use and their cost effectiveness.[12] Based on a 2025 implementation date and the assumed life span of the covered equipment natural gas usage in existing buildings should decrease 12% by 2030, and 61% by 2045. This timeline would be expedited along the way by Action 3, which updates the Green Building Standards Code to encourage electrification at time-of-retrofit or at time-of-sale, including the installation of new 200-amp panels or requiring demonstration of electrification feasibility with an existing panel.

Similar to calculations used for Strategy B-1, avoided natural gas usage was assumed to be replaced by additional electricity usage, and electric appliances were assumed to be three times more efficient than their natural gas counterparts. The emission factor for electricity is assumed to be consistent with Strategy B-3. Emission reduction calculations for Strategy B-2 are shown below in Table 4.

Table 4 Strategy B-2 Calculations

Year	2030	2045
Residential Buildings		
Residential NG usage (therms)[1]	14,394,143	17,352,806
Residential NG usage after new building electrification is implemented (therms)[2]	12,535,042	12,896,491
Percentage of homes with replaced water heaters[3]	18%	100%
NG reduction from water heater replacement (%)[4]	6%	34%
NG saved from water heater replacement (therms)	767,145	4,384,807
Percentage of homes with replaced HVAC[5]	18%	100%
NG reduction from HVAC replacement (%)[6]	7%	40%
NG saved from HVAC replacement (therms)	902,523	5,158,596
Total NG saved (therms)	1,669,668	9,543,403
Emissions from total NG saved (MT CO_2e)[7]	8,867	50,680
Electricity usage from converting to electric (kWh)[8]	16,307,143	93,207,557
Electricity EF (MT CO_2e/kWh)[9]	0.0000026	0
Emissions from converted electricity usage (MT CO_2e)	42	0
Commercial Buildings		
Commercial NG usage (therms)	11,081,548	11,707,129
Commercial NG usage after new building electrification is implemented (therms)	10,880,273	10,880,273
Percentage of commercial with replaced water heaters	18%	100%
NG reduction from water heater replacement (%)	6%	34%
NG saved from water heater replacement (therms)	665,873	3,699,293
Percentage of commercial with replaced HVAC	18%	100%
NG reduction from HVAC replacement (%)	7%	40%
NG saved from HVAC replacement (therms)	783,380	4,352,109
Total NG saved (therms)	1,449,252	8,051,402
Emissions from total NG saved (MT CO_2e)	7,696	42,757

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

Year	2030	2045
Electricity usage from converting to electric (kWh)	14,154,413	78,635,625
Electricity EF (MT CO_2e/kWh)	0.0000021	0
Emissions from converted electricity usage (MT CO_2e)	29	0
Total reductions (MT CO_2e)	**16,492**	**93,437**

[1] Values from forecast. See Appendix A.

[2] Forecasted natural gas minus natural gas lost to new building electrification

[3] Assumes 100% of homes replace their water heaters incrementally over 10 years after ordinance is first passed. Based on average water heater lifetime of 10 years. https://www.lowes.com/n/how-to/when-to-replace-a-water-heater.

[4] Assume 34% of natural gas usage goes to water heaters. https://www.synapse-energy.com/sites/default/files/Decarbonization-Heating-CA-Buildings-17-092-1.pdf. Multiply by percentage of homes with replaced water heaters to derive total percentage of natural gas reduction from water heater replacement.

[5] Assume 100% of homes replace their HVAC 18 years after ordinance is first passed. Based on average HVAC lifetime of 18 years. https://www.thisoldhouse.com/ideas/how-long-things-last.

[6] Assume 40% of natural gas usage goes to heating/cooling. https://www.synapse-energy.com/sites/default/files/Decarbonization-Heating-CA-Buildings-17-092-1.pdf. Multiply by percentage of homes with replaced water heaters to derive total percentage of natural gas reduction from HVAC replacement.

[7] Based on an emission factor of 0.00531051 MT CO_2e/therm, as established in Appendix A.

[8] Based on a conversion factor of 29.3001 kWh/therm and the assumption that electric appliances are generally three time more efficient than gas appliances. https://help.leonardo-energy.org/hc/en-us/articles/203047881-How-efficient-is-a-heat-pump-

[9] The residential electricity emission factor was calculated based on opt-out rates for different CCA customers. See Strategy E-3 for further details on this calculation.

This action would also focus on building the funding pathway to make existing building electrification possible, particularly for low-income residents of Livermore. The largest barrier to existing building electrification is higher up-front capital costs compared to natural gas. [13] Utility-offered incentives to offset these costs for the end-user are therefore among the most promising opportunities for updating this technology.[14] Once up-front costs are financed, long term savings can be used to achieve cash flow positive retrofits and/or acceptable ROI's. Demonstrating cost effective pathways for existing building electrification will be a key step before mandatory requirements can be set. Examples of funding/financing strategies include:

Low-income Electrification/Retrofit Programs

Electrification programs that target low-income residents are the most cost-effective and potentially successful approach for equitable decarbonization to combat climate change.[15] For example, the Low-Income Weatherization Program (LIWP) is the state's first energy efficiency program that targets low-income Californians and has reduced energy bills in participating multifamily buildings by 30% and overall energy usage by an average of 40%.[16] A case study on a major energy retrofit in a Lancaster 100-unit low income multifamily complex resulted in a one-third reduction in natural gas use (approximately 145 therms per apartment).[17] The study also showed that such retrofits can

[13] California Center for Sustainable Energy. 2009. Solar Water Heating Pilot Program: Interim Evaluation Report. https://www.ethree.com/wp-content/uploads/2019/04/E3_Residential_Building_Electrification_in_California_April_2019.pdf

[14] https://www.synapse-energy.com/sites/default/files/Decarbonization-Heating-CA-Buildings-17-092-1.pdf

[15] http://greenlining.org/wp-content/uploads/2019/10/Greenlining_EquitableElectrification_Report_2019_WEB.pdf

[16] California Housing Partnership Corporation and Association for Energy Affordability (2018). California's Cap-and-Trade-Funded Low Income Weatherization Program Multifamily: Impact Report, 3.

[17] https://ww2.energy.ca.gov/2019publications/CEC-500-2019-021/CEC-500-2019-021.pdf

result in increased tenant retention, improved health and comfort, and better ability to afford necessities like food, medicine, health care, and rent.

On-bill Financing

A case study from affordable multi-family residential complexes in Santa Monica showed that electricity savings from the program ranged from 1,811-17,712 kWh and natural gas savings ranged from 914-2,567 therms, with overall energy improvement ranging from 10-35%.[18]

Energy Efficiency Retrofit Programs (e.g., PACE, PG&E's Low-income Weatherization Program, Million Watt Challenge, Metered Energy Efficiency)

While the use of carbon neutral electricity by 2045 due to SB100 ensures all-electric buildings have zero energy emissions, there is still a need to reduce energy consumption within Livermore. Reducing energy consumption will reduce stress on the electricity grid, require less renewable energy generation to meet needs thereby saving resources, and help reduce energy bills within the community.

The best mechanism the City will have for tracking electrification progress – and accurately measuring its GHG reduction benefit as it happens – is through a permit tracking program. Tracking electrification progress on a yearly schedule will allow the City to adjust its electrification approach and respond to potential obstacles as they occur and as new information about electrification becomes available. Utilizing the already existing Accela platform to do this would help to further increase effectiveness and integrate into City efforts.

One of the best ways the City can ensure that electrification has a positive impact on equity in the community is by developing a suite of equity guardrails. These would help to establish what equitable implementation would look like in Livermore, with input from the community. Goals of these guardrails include limiting displacement and promoting the equitable distribution of benefits like resiliency, improved health outcomes, and reduced energy burden.

Strategy B-2 Decarbonize Electricity from the Grid and Increase Local Renewable Energy Generation

In order for Livermore to reach its 2030 reduction target and 2045 carbon-neutrality target, the majority of energy utilized in the City will need to be carbon-free. Renewable electricity procurement is essential for decarbonizing the City's emissions from electricity and will create the foundation for a carbon-free future. The focus of Livermore's energy strategy is procuring 100 percent carbon-free electricity for both residents and businesses as soon as possible. Decarbonizing electricity works hand-in-hand with building electrification and EVs to achieve carbon neutrality in both the building and transportation sectors in Livermore. To reach this objective, the City of Livermore has developed the following actions:

- Action B-2.1: Opt-up community EBCE accounts to 100 percent renewable electricity
- Action B-2.2: Coordinate with stakeholders to provide local energy generation and storage incentives
- Action B-2.3: Establish renewable energy facility standards and permitting requirements
- Action B-2.4: Explore hydrogen and renewable fuel opportunities

[18] https://1p08d91kd0c03rlxhmhtydpr-wpengine.netdna-ssl.com/wp-content/uploads/2017/03/Santa-Monica-Test-Web.pdf

Action B-2.1 Decarbonize Electricity Prior to 2024 to Reduce Electricity GHG Emissions 96% by 2030

Step Number	Guiding Principles	Implementation Steps	Anticipated Reduction (MT CO_2e)
1	GHG Reductions/ Structural Change/ Economical	**Provide carbon neutral electricity to the community:** Opt-up East Bay Community Energy community accounts in Livermore to 100% carbon-free/renewable electricity by 2024 with an opt-out option	2030: 25,505 2045: 0
2	Education	**Conduct outreach to lower the community opt-out rate:** Maximize the usage of renewable power within the community after all accounts are opted-up, by continuing to achieve an opt-out rate lower than 5% for EBCE 100% renewable power. Monitor progress and perform public outreach and education campaigns highlighting the benefits of 100% renewable energy, including: ▪ Monitoring opt-out rates on an annual basis ▪ Tabling at community events ▪ Establishing a multilingual informational resource page on the City website ▪ Regular social media posts in multiple languages ▪ Energy bill inserts	Supportive
3	Equity/Connectivity	Partner with community organizations to ensure low/medium income households are aware of EBCE's CARE program to receive decreased electricity rates and provide technical assistance as needed.	Supportive

Electricity in Livermore is currently supplied by PG&E, which provides a power mix with 39% renewable resources, and 89% GHG free overall (including nuclear and large hydro).[19] While the portion of renewables in PG&E's grid mix is relatively high compared to other utility providers in the state, the emission factor associated with its electricity is not expected to decrease to zero until the state-mandated year of 2045. In order to reduce GHG emissions in the short-term, the City will provide 100% carbon free electricity to the community through EBCE, Livermore's CCA energy provider by 2024. In general, CCAs use the purchasing power of the community to procure electricity directly from electricity generators. This allows the community to choose its own grid mix, with an option to procure electricity from 100% carbon free renewable generation sources. PG&E will continue to deliver power, maintain lines and infrastructure, and coordinate billing. EBCE currently provides three power mix options[20] for residents to choose from:

- **Bright Choice:** Base option with 60% eligible renewable energy, with prices one percent below PG&E rates
- **Brilliant 100:** 100% carbon-free option that includes hydroelectric power. Same price as PG&E
- **Renewable 100:** 100% renewable option. Price is one cent per kilowatt hour above PG&E rates

To maximize the GHG reduction opportunity this presents, the City will automatically enroll all community accounts in a 100% carbon free option, as many cities in California have already done

[19] https://www.pge.com/en_US/about-pge/environment/what-we-are-doing/clean-energy-solutions/clean-energy-solutions.page?WT.mc_id=Vanity_cleanenergy

[20] https://ebce.org/compare-plans-residential/

today.[21] Customers will have the option to opt-out of the CCA back to PG&E or opt-down to another grid mix option. Currently, about 11% of Livermore residential customers and 4% of commercial customers currently choose to opt-out.[22] Livermore's residential opt-out rate is relatively high compared to other cities, and Action 2 will focus on conducting outreach and educating citizens about the benefits of opting in to EBCE electricity. Based on the added outreach the opt-out rate was assumed to be 5% for residential and 4% for commercial which is more in line with other EBCE communities. The GHG reduction quantification below is based on the forecasted electricity consumption under the adjusted forecast as well as the forecasted electricity emission factor in each year. The increases in electrification and comensurate reduction from a near zero emission factor resulting from other steps are not included in this strategy. It is assumed in all other electrification strategies that the City completes this strategy by 2025.

These actions also have the benefit of making all municipal electricity 100% emission-free, as municipal accounts will have 0% op-out. This includes local electricity usage from the water and wastewater sector from distribution, processing, and transportation. These water/wastewater emission reductions were estimated to be approximately 389 MT CO2e in 2030. However, this reduction is a subset of the community emissions (municipal electricity use is included in the overall community electricity use), and was not added to the community reductions to avoid double counting. The finding of this calculation is included here only for supportive purposes. Calculations for quantified emission reductions from Strategy E-3 are shown below in Table 5.

Purchasing 100% carbon free electricity through EBCE is one of the most cost-effective actions the City can take to meaningfully reduce GHG emissions within the City. The cost of opting up into carbon free electricity with EBCE is approximately the same as the PG&E rate and 100% renewable rates with both PG&E and EBCE are only a few dollars a month extra for most residential rate schedules.[23] However, even a small increase on monthly bills can make a big difference for the most vulnerable populations. Both PG&E and EBCE provides a CARE rate schedule for low-income households. As part of this outreach, the City would partner with community partners to ensure that qualifying community members know about and are able to enroll in CARE to further reduce their energy burden on a monthly basis.

[21] https://innovation.luskin.ucla.edu/2019/09/04/50-cities-are-quietly-leading-the-nations-100-clean-energy-wave/

[22] Opt-out rates based on data received directly via email from Gabrielle Ruxin at EBCE. February 8th, 2021.

[23] https://www.pge.com/pge_global/common/pdfs/customer-service/other-services/alternative-energy-providers/community-choice-aggregation/ebce_rateclasscomparison.pdf

Table 5 Action B-2.1 Calculations

Year	2030	2045
Residential electricity usage (kWh)[1]	222,591,232	247,321,911
Commercial electricity usage (kWh)[1]	294,346,152	306,917,819
PG&E Electricity EF (MT CO_2e/kWh)[3]	0.0000516	0
Emissions from electricity usage before CCA (MT CO_2e)	26,684	0
CCA Electricity EF (MT CO_2e/kWh)[4]	0	0
Weighted residential electricity EF after accounting for opt-out (MT CO_2e/kWh)[5]	0.0000026	0
Weighted commercial electricity EF after accounting for opt-out (MT CO_2e/kWh)[6]	0.0000021	0
Emissions from electricity usage after CCA (MT CO_2e)	1,178	0
Total reductions (MT CO_2e)	**25,505**	**0**

[1] Values from forecast. See Appendix A. Additional electricity load expected from Strategies E-1 and E-2 not included here due to CCA reductions for the added electricity being accounted for in each strategy's respective quantification. Municipal electricity usage subtracted from total commercial electricity usage for independent modelling. See note 2 for details on municipal electricity usage data.

[2] Based on electricity data provided by PG&E. Municipal usage not expected to change substantially between 2020 and 2045.

[3] Values from forecast. See Appendix A.

[4] All community accounts to be automatically enrolled in 100% renewable electricity package with an opt-out option.

[5] Assume 11% residential account opt-out such that 11% of accounts continue to have a PG&E emission factor, while 89% of accounts continue with the CCA-provided emission factor of 0 MT CO_2e/kWh. Opt-out rate provided by Gabrielle Ruxin at EBCE via email on February 8th, 2021.

[6] Assume 4% commercial account opt-out. Opt-out rate provided by Gabrielle Ruxin at EBCE via email on February 8th, 2021.

5 Transportation and Land Use

5.1 2030 Objectives

- Add 1,284 publicly accessible electric vehicle chargers by 2030
- Reduce Vehicle Miles Traveled (VMT) by 2.3%
- Achieve 10% bike mode share
- Support sustainable land use practices

Strategy T-1 Facilitate a Transition to Electric Vehicles

On-road transportation accounts for almost 59% of total GHG emissions in Livermore, with 58% of those emissions coming from passenger vehicles, and 42% coming from commercial vehicles (see Appendix A). It is important to electrify the transportation sector so it can benefit from increasingly clean electricity as a result of SB 100.

While the City cannot require its residents to buy ZEVs and electrify remaining passenger vehicle trips, Strategy T-1 will ensure the infrastructure and support is present in the City to begin to remove present barriers to ZEV adoption. All of the actions and steps in Strategy T-1 support the overall goal and therefore, have been quantified together below.

Action T-1.1 Expand EV Infrastructure to Support 28% Passenger and 16% Commercial EV Adoption by 2030

Step Number	Guiding Principles	Implementation Steps	Anticipated Reduction (MT CO_2e)
1	Education	**Develop an EV[1] Readiness Plan:** Develop an EV Readiness Plan that is consistent with the Alameda County EV Readiness Guide and Livermore 2003-2025 General Plan transportation policies and actions. This plan should establish a path forward to increase EV infrastructure within the City, promote equitable mode shift to EVs, and identify funding for implementation of public charging infrastructure in key locations. In conjunction with an EV Readiness Plan, conduct a community EV Feasibility Study to assess infrastructure needs and challenges, particularly in frontline communities.	2030: 49,494 2045: 93,458
2	Partnerships	**Increase privately owned EV charging infrastructure:** Work with public and private partners to increase publicly accessible DCFC and Level 2 EV chargers around the City, with a focus on providing access to low-income households and affordable housing by 2030.	
3	Structural Change	**Require EV capable charging spaces:** Amend the Livermore Development and Municipal Code to promote EV chargers in both existing and new development, requiring Cal Green Tier 2 EV Charging levels or equivalent.	
4	Structural Change	**Streamline EV charger permitting:** Streamlining the permitting process for EV infrastructure and alternative fuel stations, including allowing independent charging stations to be erected in the right-of-way or any zoning district or land use type.	

Step Number	Guiding Principles	Implementation Steps	Anticipated Reduction (MT CO_2e)
5	Partnerships	**Identify and partner with stakeholders to develop EV-related rebates:** Investigate partnerships with public and private partners for rebates on at-home electric circuits, panel upgrades, and Level 2 chargers, with a focus on supporting EV purchases for low-income households in frontline communities.	
6	Equity Education	**Encourage EV adoption amongst residents:** Providing multi-lingual education and outreach to the community on new and existing rebates, incentives, and programs for installation of Level 2 chargers on private property and availability of public charging, through the use of City events, social media, and the City website.	
7	Partnerships	**Increase business EV adoption:** Working with major employers (e.g., Lawrence Livermore National Lab, Kaiser Permanente, GILLIG, Topcon) to encourage EV adoption and improvements to EV infrastructure.	
8	Structural Change	**Establish electrical and technical standards for EVSE[2]:** Establish electrical and technical standards for Electric Vehicle Supply Equipment (EVSE), including construction of equipment, wiring methods, and safety protection consistent with the California Electrical Code and the Underwriter's Laboratories guidance on EVSE. The EVSE inspection process should be streamlined by: ▪ Removing the need for inspection or conducting spot inspections for simpler installations. ▪ Condensing inspections for more complex installations that do not include panel upgrades or underground conduit. ▪ Establish a 24-hour, flexible inspection request program online or with voicemail ▪ Providing shorter inspection windows. ▪ Remolding requirement for electricity to be present during inspection to decrease consumer costs.	
9	Education	**Promote the use of electric construction equipment:** Requiring construction projects to comply with BAAQMD best management practices, including alternative-fueled vehicles and equipment	
10	Education	**Establish universal EV signage:** Establish universal, accessible, and multi-lingual EV signage and marking requirements for EV parking spaces.	
11	Structural Change	**Establish preferential EV parking:** Introduce preferential parking for EVs throughout the City, with a focus on downtown and other busy locations identified around the City.	
12	Structural Change	**Require EV charging infrastructure at new gas stations:** Pass an ordinance to require all new gas stations and major remodels to install electric vehicle charging as space allows.	
13	Economics Structural Change	**Electrify retail delivery vehicles:** Charging licensing fees for UPS, FEDEX, and USPS trucks making online retail deliveries to provide funding for new active transportation and EV charging infrastructure, and/or provide discount licensing fees for delivery companies which utilize electric vehicles.	

Step Number	Guiding Principles	Implementation Steps	Anticipated Reduction (MT CO_2e)
14	Structural Change	**Adopt an ordinance:** limiting new drive thru businesses and other sources of idling emissions.	

[1] EV = electric vehicle

[2] EVSE = electric vehicle supply equipment

Together the actions and steps within Strategy T-1 will encourage electric vehicle (EV) adoption within the community. The state has established a goal of putting 5 million EVs on the road by 2030.[24] However, the recent passing of executive order N-79-20 calls for 100% of passenger vehicles sold to be all electric by 2035.[25] This new executive order puts the total number of EV's on the road by 2035 at approximately 15 million.[26] Based on the current number of vehicles registered in California and a 2% growth rate per year, 15 million EV's accounts for 35% of total vehicles in 2035. Interpolating between todays EV percentage (5%) gives us an expected EV adoption rate of 25%. As a part of this strategy, the City has established its own goal in line with this and aims to reach 28% passenger EV adoption by 2030 and 50% by 2045. Livermore currently has 1,026 electric vehicles and 766 plug-in hybrid vehicles out of 84,243 vehicles currently registered, together accounting for 2.1% of the vehicles registered within the City.[27]

The City has also adopted commercial EV adoption goals, with 16% by 2030 and 50% by 2045. This is backed by new regulations that CARB adopted in June 2020, requiring truck manufacturers to transition from diesel trucks and vans to electric zero-emission trucks beginning in 2024, and establishing a target for every new truck sold in California to be zero-emission by 2045.[28] Companies in the commercial sector are already moving to electrify their fleets, with Amazon planning to have 100,000 electric delivery vehicles on the road by 2030.[29] If both passenger and commercial EV adoption rates are outpacing EV charging infrastructure, adjustments can be made over time to reflect total EVs as well as charging technologies and consumer behaviors.

While the City cannot require residents or businesses to buy and use EVs rather than gas-powered vehicles, the City will take actions to incentivize this behavior change and support this level of EV adoption. As a part of this strategy, the City's primary target will be to provide one public EV charger for every 20 EV's and ensure as many privately owned chargers are installed in new development as practicable, in line with the leading Cities in California (San Francisco, Los Angeles, and San Jose) and recent charging infrastructure studies. Since the City of Livermore already has 82 existing public charging stations, there is currently one public EV charger for every 22 EVs, and the City will need to have 1,138 new public chargers installed to meet the forecasted demand from passenger vehicles by 2030. The actual number and ideal locations for these EV charging stations would need to be further investigated through an EV Readiness Plan and Feasibility Study, including analysis of greater fast charging infrastructure needed to power the 19 zero-emission commercial truck models set to

[24] https://www.cpuc.ca.gov/zev/

[25] https://ww2.arb.ca.gov/resources/fact-sheets/governor-newsoms-zero-emission-2035-executive-order-n-79-20

[26] https://spectrumnews1.com/ca/la-west/transportation/2020/10/05/what-it-will-take-to-sell-100--evs-in-california

[27] https://www.dmv.ca.gov/portal/uploads/2020/09/MotorVehicleFuelTypes_City_01012020.pdf

[28] https://ww2.arb.ca.gov/news/california-takes-bold-step-reduce-truck-pollution#:~:text=SACRAMENTO%20%E2%80%93%20Today%2C%20the%20California%20Air,California%20will%20be%20zero%2Demission.

[29] https://www.businessinsider.com/amazon-creating-fleet-of-electric-delivery-vehicles-rivian-2020-2

come to the North American market over the next three years (Action 1).[30] Increasing the amount of EV charging infrastructure overall will support these vehicles operating in Livermore. As the need for charging infrastructure changes over time depending on new technologies such as smart chargers, megawatt-scale charging systems tailored specifically to medium- and heavy-duty electric trucks, and trends in personal EV adoption, it will be important for the City to continue updating its long-term goals as necessary.[31]

Steps 2-4 will account for the majority of the targeted number of EV chargers in 2025 and 2030. A 2015 report by Idaho National Laboratory, *Plugged In: How Americans Charge Their Electric Vehicles*, found that nearly 98% of all EV charging events occurred at home or work.[32] In support of these findings, and to address the challenges faced by those who may not be able to install their own home chargers, adoption of an EV Readiness Reach Code would support increased infrastructure at new and existing commercial and multi-family residential developments. EV-ready building codes are one of the most effective and low-cost strategies for states and local governments to encourage consumers to buy or lease electric vehicles and can save consumers thousands of dollars in installation costs.[33]

The City of Livermore currently has EV charging stations installed at City Hall, the Livermore Municipal Airport, and the Maintenance Service Center, both for electric City Trucks and employees with electric cars.[34] Public charging stations in the City are clustered north of I-580 near Las Positas College and Costco Wholesale, as well as high-power chargers (eight 150 kW and two 350 kW charging stations) at San Francisco Premium Outlets. There are also a number of chargers along Discovery Drive to the west of Isabel Avenue, including two stations near the Tesla Warehouse. Other locations in Livermore are scattered throughout central and eastern parts of the City, mainly along Las Positas Road and south of I-580.[35] City-owned EV charging units currently cost a fee to charge per kilowatt hour, which are used to maintain the charging units and to cover electricity costs. While not directly quantifiable, EV charging fees increase turnover at charging stations, helping to promote equitable access to EV charging infrastructure and encourage widespread EV adoption across a greater demographic range.

Title 24, Part 11, Chapter 5 of the California Green Building Standards Code requires all new construction to provide parking spaces and electrical infrastructure sufficient to support future installation of EVSE.[36] Relevant standards can be found in the California Electrical Code and the Underwriter's Laboratories guidance on EVSE, including the construction of equipment, wiring methods, and safety protection. This strategy ensures that Livermore will have clear guidelines and standards in place for installing EVSE infrastructure. It also calls for creating a streamlined permitting and inspection procedure for EVSE ensures reduced wait times and costs for new EV owners. Applying for a permit and waiting for an inspector can be time intensive and costly – as many as three separate visits by the installer may be required to apply for the permit, perform the work, and complete the inspection, and a fourth visit may be needed if the utility requires a separate inspection. To avoid this, the City will streamline the EVSE permitting and inspection process to further ease the burden on new EV owners and support the goals of the strategy.

[30] https://www.greenbiz.com/article/we-should-be-talking-about-charging-infrastructure-heavy-duty-trucks

[31] https://www.nrel.gov/transportation/medium-heavy-duty-vehicle-charging.html

[32] https://www.osti.gov/biblio/1369632-plugged-how-americans-charge-electric-vehicles

[33] https://www.swenergy.org/cracking-the-code-on-ev-ready-building-codes

[34] https://www.cityoflivermore.net/citygov/cdd/planning/cap/default.htm

[35] https://www.plugshare.com/directory/us/california/livermore

[36] https://codes.iccsafe.org/content/CAGBSC2016/chapter-5-nonresidential-mandatory-strategys

Requiring new gas stations in the City to install EV charging stations will help support steps 2-4, and further promote increased EV adoption. Germany announced in 2020 that all of its gas stations would soon be required to provide EV charging, to help remove recharging concerns and boost consumer demand for the vehicles.[37]

The next phase for electric vehicle supply equipment (EVSE) expansion will provide additional publicly accessible charging. Emission reductions from the actions and steps in Strategy T-1 were calculated together as emissions saved by meeting EV adoption goals in 2030 and 2045. Emission reduction calculations are shown below in Table 6.

Promoting the use of electric vehicles for retail deliveries will also help support steps 2-4, and decrease emissions from the commercial transportation sector. This would provide additional funding for the City to install additional EV charging infrastructure. The retail delivery sector is already trending in this direction, with Amazon revealing its first electric vehicle delivery van in 2020, which began making deliveries in 2021. The company has ordered 100,000 electric delivery vehicles already from electric vehicle maker Rivian.[38]

[37] https://www.reuters.com/article/us-health-coronavirus-germany-autos/germany-will-require-all-petrol-stations-to-provide-electric-car-charging-idUSKBN23B1WU

[38] https://www.businessinsider.com/amazon-creating-fleet-of-electric-delivery-vehicles-rivian-2020-2

Table 6 Strategy T-1 Calculations

Year	2030	2045
Passenger Vehicles		
Passenger VMT after mode shift to bikes and transit [1]	577,613,999.81	602,887,641.34
Passenger Vehicle Emission Factor ($MTCO_2e$/mile) (EMFAC)[3]	0.00022828	0.00019801
Emissions from Passenger VMT (MT CO_2e)	131,859.42	119,376.32
EV adoption[2]	28%	50%
Emissions reduced from EV adoption (MT CO_2e)	34,115.75	57,148.81
Additional EV miles from new EV adoption (VMT)	149,445,032.16	288,619,317.11
Additional kWh from new EV miles	53,800,211.58	103,902,954.16
Electricity EF (MT CO_2e/kWh)[4]	0.000002581	0
Emissions from electricity usage for EVs	138.85	0
Commercial Vehicles		
Commercial VMT after mode shift to bikes and transit (VMT)[1]	91,769,379.83	78,282,003.56
Commercial Vehicle Emission Factor ($MTCO_2e$/mile) (EMFAC)[3]	0.00105757	0.00092764
Emissions from Commercial VMT (MT CO_2e)	97,052.48	72,617.62
EV adoption	16%	50%
Emissions reduced from EV adoption (MT CO_2e)	15,528.40	36,308.81
Additional EV miles from new EV adoption (VMT)	14,683,100.77	39,141,001.78
Additional kWh from new EV miles	5,285,916.28	14,090,760.64
Electricity EF (MT CO_2e/kWh)[4]	0.000002052	0
Emissions from electricity usage for EVs	10.85	0
Total reductions (MT CO_2e)	49,494.45	93,457.62

[1] VMT from forecast (see Appendix A) minus VMT avoided from mode shift to bikes in Strategy T-1

[2] Based on executive order N-79-20 100% of passenger vehicle sales will electric by 2035. Assuming 15 million EV's by 2035 due to N-79-20 and a 2% growth rate from current vehicle registrations (32,000,000) and a 5% current share of EV's California would be projected to have 25% EV's by 2030. 25% is in line with State goals. (https://spectrumnews1.com/ca/la-west/transportation/2020/10/05/what-it-will-take-to-sell-100--evs-in-california)

[3] Derived from EMFAC model output for Alameda County 2030 and 2045

[4] The residential electricity emission factor was calculated based on opt-out rates for Livermore as according to EBCE. See Strategy E-3 for further details on this calculation.

The number of new public chargers needed to support Livermore's passenger EV adoption goals were also calculated, shown below in Table 7. This was based on 2020 vehicle registration data from the DMV and the assumption that one public charger should be available for every 20 EVs. The 82 publicly-available EV charging stations already availble in the City were also taken into account. Commercial EVs were not included in this calculation due to the lack of data on current heavy duty trucks registered in the Livermore area. Total registered vehicles were forecasted based on the 2020 ratio of registered vehicles to population.

Table 7 EV Charger Count for Passenger Vehicles Calculations

Year	2030	2045
Population[1]	105,967	129,158
Total registered vehicles[2]	97,590	118,948
Registered EV goal[3]	24,398	59,474
EV's per charger[4]	20	20
New publicly available EV chargers needed[5]	1,138	2,892

[1] Values from forecast. See Appendix A.

[2] Based on a calculated value for cars for capita (0.921) derived by dividing the total number of registered vehicles in Livermore in 2020 (https://www.dmv.ca.gov/portal/uploads/2020/09/MotorVehicleFuelTypes_City_01012020.pdf) by the 2020 population of Livermore as established in Appendix A.

[3] Calculated as total registered vehicles multiplied by EV adoption percentage in above table

[4] https://theicct.org/sites/default/files/publications/US_charging_Gap_20190124.pdf

[5] Based on the assumption that approximately one public EV charger is needed per 20 EVs, taking into account the existing 82 EV chargers already in Livermore. This assumption may change over time due to better technology, changes to consumer behavior, or both. The total number of chargers especially in 2045 will need to be revisited to ensure the numbers reflect the current EV landscape[39]

Strategy T-2 Facilitate a transition to transit and shared mobility services

Improving shared mobility and transit programs and infrastructure through Strategy T-2 will help to shift mode share to public transit. To do this the City must work with regional stakeholders, including the Altamont Corridor Express (ACE), Bay Area Rapid Transit (BART), and the Livermore Amador Valley Transit Authority (LAVTA), to expand service lines and increase the convenience of transit by reducing the time it takes to reach a destination via transit as well as reducing wait times (headways) for transit. Working with the recently created Tri-Valley – San Joaquin Valley Regional Rail Authority will also be key to implement Strategy T-2, specifically on the proposed Valley Link project which would connect the existing BART station in Dublin/Pleasanton to the approved ACE North Lathrop Station in San Joaquin County.[40] By making transit more convenient and making decisions to prioritize transit over single occupancy vehicles, Livermore will begin to shift towards shared transit. Like Strategy T-1 the actions and steps within Strategy T-2 have been quantified together.

[39] https://theicct.org/sites/default/files/publications/US_charging_Gap_20190124.pdf

[40] https://www.valleylinkrail.com/valleylink-project

Action T-2.1 Improve Transit and Shared Mobility Services to Reduce Passenger VMT 2% by 2030, and 4% by 2045

Step Number	Guiding Principles	Implementation Steps	Anticipated Reduction (MT CO_2e)
1	Partnerships	**Partner with Valley Link, ABAG, LAVTA, BART, and ACE to improve and expand transit within the City.** This could include: ▪ Expanded transit service, especially along transit priority corridors surrounding the downtown core ▪ More frequent and reliable transit service ▪ Improved and/or more efficient technology ▪ Improved service/communication through multi-lingual interactive service maps, app ▪ payments, and real time arrival info ▪ Increase active transportation access to transit stops ▪ Provide enhanced, comfortable stops and stations ▪ Provide multi-lingual education and outreach to the community on new and existing shared transit options ▪ Subsidized transit passes ▪ Provide transit service within ½ mile of all residents in the city where and when the gross density surrounding or adjacent to feasible transit routes meets or exceeds 10-12 units/acre	2030: 3,033 2045: 4,656
2	Mitigation/Adaptation Benefit Partnerships	**Promote Tri-Valley Wheels:** Promote the use of Tri-Valley Wheels, particularly for downtown transit. This could include bus open houses and promoting use of the Transit app	
3	Education	**Prepare for shared bike programs:** Conduct a bike share (e.g., bike-share, scooter-share) feasibility study, in accordance with the Active Transportation Plan and possibly in coordination with Pleasanton and Dublin.	
4	Structural Change	**Adopt a shared-ride services ordinance:** Adopt an ordinance to allow shared-ride services (car/bike/scooter share) to operate in Livermore, possibly in coordination with Pleasanton and Dublin. Seek to establish a pilot bike sharing program downtown, ideally with e-bikes. Ensure access to frontline communities.	
5	Equity	**Improve local transportation equity:** Facilitate transportation equity through multi-lingual programs that identify local equity issues and seek to remove barriers for people of color, low-income, people experiencing homelessness, and senior populations to take transit, walk, bike, use rideshare, or carshare.	
6	Economics	**Conduct a local transportation survey:** Include multi-lingual National Citizens Survey questions related to transportation to better understand the community's needs and motivation for travelling by car versus other alternatives such as by bike, light rail, or bus. Use survey results to inform transit expansion and improvement projects.	
7	Structural Change	**Reduce idling emissions from drive thru restaurants:** Adopt an ordinance banning new drive thru restaurants within in the City to reduce idling emissions.	

In general, increases and improvements to public transportation systems reduce a city's dependence on fossil fuels and reduce VMT. The best ways to improve a transit system and reduce driving is to expand its geographical reach and increase the frequency and reliability of transit service. Approximately 1% increase in transit frequency saves 0.5% in VMT.[41] Bus Rapid Transit can also yield a corridor-level VMT reduction of 1-2%.[42] Mode shift of 2% to transit in Livermore by 2030 and 4% by 2045 was calculated based on new construction being largely transit-oriented development, supported by the two new Valley Link transit stops other actions included in this strategy including lower parking requirements for new developments (see Action 3 below).

In addition, effective communication, especially communication that takes advantage of new and emerging technologies to accurately and easily disseminate trip planning and real-time status information, is a strong factor in helping customers decide to use transit for business or leisure trips.[43] Further, improving transit access has the potential to shift trips from cars to transit, which may reduce vehicle trips, VMT, and GHG emissions, with time spent getting to a transit stop being the key indicator of transit access.[44]

By working with regional stakeholders and partners, Livermore will see significant expansion of transit usage by 2030, which will result in decreases in VMT from passenger vehicles. Most important is the proposed Valley Link rail project, which is a new 42-mile, 7-station passenger rail project that will connect the existing Dublin/Pleasanton BART Station to the approved ACE North Lathrop Station in San Joaquin County. This project will loosely follow I-580, and includes two stations in Livermore, at Isabel and Greenville. The Tri-Valley-San Joaquin Valley Regional Rail Authority, which was established in 2018 through the enactment of Assembly Bill 758, adopted the proposed project plan in October 2019, and is currently undergoing further design and environmental review. The project is scheduled to be finalized by 2025, with the Livermore segment of the project being a part of Phase I construction. Overall VMT reduction from the project is estimated at 99.4 million per year by 2040.[45] As a member agency, along with ACE, BART, and LAVTA (Tri-Valley Wheels), the City of Livermore will continue to work with regional transportation stakeholders to ensure that the new Valley Link rail project is supported by local transit-oriented development through 2030.

A 2019 report from the City of Santa Monica found that 49% of shared rideable trips replaced vehicle trips based on answers to survey questions.[46] A 2014 study from Utrecht University suggests that the car substitution rate of shared rideables is dependent on what proportion of trips are already taken by car in a city. [47] In the study, Minneapolis and Melbourne had between 70% and 76% vehicle mode share in 2014 and showed high rates of car mode substitution (19% to 21%) after shared rideables were introduced. On the other hand, London and Washington DC had between 36% and 46% vehicle mode share in 2014 and showed much lower rates of car mode substitution where shared rideables were introduced (2% to 7%). Sacramento and Santa Monica both had high vehicle mode share (83% and 72% respectively) before shared rideables were introduced, suggesting that the City of Livermore would see a similar if not higher car substitution rate of shared

[41] https://www.smartgrowthamerica.org/app/legacy/documents/smartgrowthclimatepolicies.pdf

[42] https://www.smartgrowthamerica.org/app/legacy/documents/smartgrowthclimatepolicies.pdf

[43] https://transitleadership.org/docs/TLS-WP-Improving-the-Customer-Experience.pdf

[44] https://ww3.arb.ca.gov/cc/sb375/policies/transitaccess/transit_access_brief120313.pdf

[45] https://adobeindd.com/view/publications/434ac81e-84bf-4f0a-868d-a386dce975d2/1/publication-web-resources/pdf/Valley_Link_Project_Over_View_202102.pdf

[46] https://www.smgov.net/uploadedFiles/Departments/PCD/Transportation/SantaMonicaSharedMobilityEvaluation_Final_110419.pdf

[47] http://mobility-workspace.eu/wp-content/uploads/Bike-shares-impact-on-car-use-3.pdf

rideables as Santa Monica and Sacramento. Both studies previously mentioned suggest that average trip duration of shared rideable trips is about 2 miles (this is seen consistently across the six diverse cities mentioned above) and appears to be largely independent of other city metrics. An e-bike ride share program has the potential to see the most successful, as e-bike riders can go longer distances and are more accessible to non-riders. A study in Portland, OR found that a 15% e-bike mode share could result in a 12% reduction in transportation-related emissions.[48]

Performing a bike share feasibility study would assess whether or not Livermore has the density and demand required to support a bike share program, which are an increasingly popular means of transportation in the United States. Bike share programs allow people to rent both traditional and electric bicycles for short periods of time. This study would support Transportation Strategy 3 and implement Livermore's Active Transportation Plan which recommended the City research bike share program options. Conducting this study in collaboration with Dublin and Pleasanton could increase the value of the study overall, and possibly enable the City to enter into a joint bike share program agreement with these two other cities.

Based on the inclusion of shared rideables and the extension of the Valley Link as well as the other coordination and transit improvements listed above, Livermore conservatively assumes a 2% VMT reduction through 2030. The GHG emissions savings associated with this transition is calculated in Table 8.

Table 8 Strategy T-2 Calculations

Year	2030	2045
Passenger miles after mode shift to bikes (VMT)	577,613,999.81	602,887,641.34
Emissions from passenger VMT (MT CO2e)	131,859.42	119,376.32
Decrease in VMT from measure	2%	4%
Adjusted VMT	564,328,878	579,375,023
Emission reductions from VMT avoided (MT CO2e)	**3,033**	**4,656**

[1] VMT from forecast (see Appendix A) minus VMT avoided from mode shift to bikes

Strategy T-3 Improve Active Transportation Infrastructure

Tailpipe emissions are a major source of Livermore's GHG emissions. Reducing the number of miles driven by fossil fuel-powered vehicles, particularly when replaced with public-health boosting active modes of transportation, provides a critical way to reduce GHG reductions while connecting communities and keeping Livermore residents healthy. As part of the CAP strategy, Livermore will prioritize active transportation by expanding access to safe, low-stress, and convenient biking and pedestrian infrastructure. Expanding active transportation infrastructure will increase quality of life and public health through increased exercise and increased community connectivity. Like the other transportation and land use strategies the actions and steps within Strategy T-2 have been quantified together.

[48] https://www.sciencedirect.com/science/article/pii/S1361920920306696

Strategy T-3 Improve Active Transportation Infrastructure to Achieve Greater than 10% Mode Shift Away from Passenger Vehicles by 2030, and Maintain that Percentage through 2045

Step Number	Guiding Principles	Implementation Steps	Anticipated Reduction (MT CO_2e)
1	Structural Change	**Implement Livermore Active Transportation Plan:** Fully implement the Livermore Bicycle, Pedestrian, and Trails Active Transportation Plan adopted in 2018 by 2030 in accordance with the Plan's goals, objectives, and policies so that the City adds approximately 154 miles to the active transportation network. Implementation of the Plan will prioritize frontline communities and: ▪ Improve existing crossings for on-road vehicles, and provide for future crossings of creeks, railroads, and roadways. ▪ Require new facilities be built in conjunction with road reconstruction or re-striping projects, subdivision development, and related off-site improvements, unless a significant cost/feasibility issue is shown. ▪ Construct Class I or Class 4 bikeways in undeveloped areas prior to or concurrent with the development of these areas. ▪ Provide for, and maintain, shaded routes where possible. ▪ Connect neighborhoods, schools, workplaces, transit facilities, and other destinations with on-street facilities and/or separated trails. ▪ Support and participate in Federal, State, Regional, and Local programs, such as countywide Safe Routes to School efforts. ▪ Coordinate with other agencies, adjacent jurisdictions, and regional partners to plan and implement projects that improve Livermore's network and connections to the region. ▪ Continue to provide convenient bicycle parking in the downtown core, either on the street or in public or private parking lots. If demand exists, remove vehicle parking in favor of bicycle parking. Provide adequate bicycle parking facilities at local recreation areas. ▪ Regularly update the City's Bicycle, Pedestrian, and Trails Map and share throughout City and stakeholder partnership platforms, ensuring that the maps are accessible for people with disabilities and speakers of non-English languages.	2030: 2,127 2045: 2,111
2	Economics	**Perform a nexus study:** Conduct a nexus study, and develop an ordinance requiring payment of fees from development projects to implement safe active transportation routes and infrastructure citywide.	Supportive
3	Partnerships	**Identify and partner with stakeholders on active transportation education:** Support and promote local bike community organizations in hosting workshops and classes on bike riding, safety, and maintenance by certified instructors for all ages and skill levels. Also, subsidize safety equipment, such as headlights and helmets, for low-income residents.	Supportive
4	Economics Education Structural Change	**Establish car-free days downtown:** Institute car-free days downtown potentially coupled with the Farmer's Market or other large and regular events.	Supportive
5	Education	**Promote active transportation:** Establish multilingual Citywide events, outreach, educational programs, or platforms to promote active transportation in the community.	Supportive

Step Number	Guiding Principles	Implementation Steps	Anticipated Reduction (MT CO_2e)
6	Structural Change	**Incorporate outreach into prioritization of active transportation projects:** Continually improve methods for engaging the community, gathering their input, and utilizing it to help prioritize the implementation of projects and actions in the Active Transportation Plan.	Supportive
7	Economics	**Explore new funding opportunities:** Explore new opportunities to generate funding for active transportation projects, such as by implementing a local gas tax used to fund bike and pedestrian improvement projects, prioritizing those in frontline communities.	Supportive

The overall goal of the Livermore Active Transportation Plan is to provide a long-term vision for improving the active transportation network in Livermore and enhance connections to transit facilities, employment, retail and commercial centers, and public facilities. Implementing the Livermore Active Transportation Plan will consist of coordinating City departments with stakeholders (e.g., Bike East Bay, Las Positas College, National Laboratories, other Tri-Valley cities, Alameda County, and frontline communities) to accomplish the following:

- Adding approximately 77 miles to the bikeway network based on a list of prioritized infrastructure and citywide projects developed through a community outreach process with the goal of improving school access, downtown access, I-580 crossings, and other connectivity issues throughout Livermore
- Developing and implementing an effective network-wide wayfinding system that reflects the character of Livermore
- Adding streetscape amenities in the downtown core, along major corridors, and near transit stops, including providing additional waste receptacles near pathways
- Improving safety on bike paths with improved pedestrian-scale lighting, developing e-bike regulations with the Livermore Police Department and Alameda County, and requiring adequate temporary traffic control that considers bicyclists and pedestrians during construction or maintenance activities
- Seek opportunities to include bicycle infrastructure at the time of major road upgrades or major development projects, as this significantly decreases the cost of installation. This action is included as a best practice to decrease the cost burden on the City and further facilitate timely implementation of the Active Transportation Plan
- Improving comfort on bike paths by providing for and maintaining shaded routes where possible
- Improve and increase end-of-trip facilities such as secure, shaded, and well-lit bicycle parking by working with partners/stakeholders and using the permitting process for new development. This includes short term and long-term bicycle parking, including bike racks, bike lockers, and secure parking areas
- Working with ACE, BART, LAVTA, and Tri-Valley – San Joaquin Valley Regional Rail Authority to integrate with transit and other transport modes to address the first/last mile challenge
- Partnering with stakeholders (e.g., Bike East Bay, Las Positas College, National Laboratories) to promote and encourage biking in Livermore.

- Identifying and competing for available funding sources for bicycle projects, including from the California Active Transportation Program, Caltrans Transportation Planning Grants, and Highway Safety Improvement Program

A complete description of the goals, strategy, policy, and implementation framework for expanding and improving Livermore's bikeway network is included in the Livermore Active Transportation Plan as adopted in 2018. The Plan will be updated every five years to identify new projects for implementation, and ensure that improvement projects are correctly prioritized and meet the plan's guiding principles.

Accelerating implementation of the Active Transportation Plan is expected to increase pedestrian and bicycle mode share from 2.3% in 2018 to 10% in 2030. Full implementation of the Active Transportation Plan would increase the length of Livermore's active transportation network by 22.9%. In order to estimate the mode shift potential associated with implementing the Active Transportation Plan, other cities with similar buildouts were compared. Currently the City of Davis has a bike network similar to what Livermore would have at full implementation. Davis currently has a 20% mode share.[49] Similar to Livermore's Active Transportation Plan, the City of Santa Cruz's 2017 Active Transportation Plan establishes a set of projects and programs to increase the mode share of active transportation, from 19.6% in 2014 to 27% in 2030.[50] Therefore, an increase in mode share from 2.3% to 10% is considered conservative. Emission reduction calculations assumed the average bike trip length was 1.5 miles[51] and used model results from EMFAC to characterize VMT in Livermore.

Improving active transportation networks is an important part of building Complete Streets – streets that accommodate bikes, cars, shared transit, and pedestrians in an accessible way. Livermore's Active Transportation Plan implements the City's Complete Streets Policy.[52] Nationally, 48% of all vehicle trips were three mile or less in 2019, a distance easily travelled by foot, bicycle, or other micro mobility platforms.[53] An improved and expanded pedestrian network is the most effective and direct approach for shifting those shorter vehicle trips to walking, and studies show that distance to destinations is one of the strongest predictors of walking as a mode choice. However, not much research has been conducted to determine quantitatively how improving the pedestrian network translates to increased pedestrian mode share. This is further complicated by the fact that while improved pedestrian networks almost always have a positive correlation with increased walking, that does not always translate to decreased VMT. In other words, increased walking does not mean that walking trips are replacing driving trips. Therefore, although Livermore's Active Transportation Plan calls for projects that would increase its active transportation network by 22.9%, the mode shift associated with this was estimated more conservatively. Emission reduction calculations are shown below in Table 9.

[49] https://www.theguardian.com/cities/2015/aug/03/davis-california-the-american-city-which-fell-in-love-with-the-bicycle

[50] https://www.cityofsantacruz.com/home/showpublisheddocument?id=60966

[51] Caltrans California Household Travel Survey (2013)/CARB Bike Path Reductions Technical Documentation (2019)

[52] Livermore Active Transportation Plan (2018), Page 4. https://www.cityoflivermore.net/civicax/filebank/documents/18254

[53] https://inrix.com/blog/2019/09/managing-micromobilty-to-success/

Table 9 Strategy T-3 Calculations

Year	2030	2045
Mode share shift[1]	2%	10%
Passenger Vehicle VMT[3]	586,932,289	613,546,706
Estimated trips/passenger vehicle mile (EMFAC)[2]	0.13746	0.15041
Estimated passenger vehicle trips	80,677,829	92,286,277
New bike trips substituted for vehicle trips[4]	6,212,193	7,106,043
New bike miles substituted for passenger vehicles (miles)	9,318,289	10,659,065
Passenger Vehicle Emission Factor ($MTCO_2e$/mile) (EMFAC)	0.00022828	0.00019801
Total reductions (MT CO_2e)	**2,127**	**2,111**

[1] Livermore Active Transportation Plan Update (2018) proposes projects that will increase total active transportation network length by 22.9% assuming the fully implemented. As Livermore is currently at 2.3% bicycle mode share, the remaining mode share shift in 2030 and 2045 is expected to be 10%.

[2] Derived from EMFAC model output for Alameda County 2030 and 2045

[3] Values from forecast. See Appendix A.

[4] Assume the average bicycle trip is 1.5 miles. Caltrans California Household Travel Survey (2013)/CARB Bike Path Reductions Technical Documentation (2019)

Additional steps such as performing a nexus study will provide the necessary information to develop an active transportation in lieu fee on new development projects to fund additional active transportation infrastructure projects in the future. This study would meet the requirements of the California Mitigation Fee Act for local agencies to charge development impact fees, and could be similar to those conducted by other cities for active transportation purposes, including the City of Oakland and City of San Diego.[54] [55]

Providing education on the benefits of active transportation as well as technical information such as trip planning, safety best practices, incentives and other programs will help generate momentum around active transportation and support the overall strategy. The City has collaborated with Bike East Bay, the National Laboratories, and Wheels bus service to hold Bike to Work Day activities to promote commuting to work by bicycle.[56] The additional promotional activities identified under this action, including establishing car free days downtown and holding bike safety workshops, will continue to build an active transportation community and culture in Livermore.

Finding new funding sources to fund additional active transportation projects are an important part of implementing priority projects identified in Livermore's Active transportation Plan. By exploring new avenues to generate funding, such as by establishing a local gas tax that goes directly to new active transportation efforts, Livermore can increase its ability to implement a wide array of projects.

[54] http://www2.oaklandnet.com/government/o/PBN/OurOrganization/PlanningZoning/s/ImpactFee/index.htm

[55] https://www.sandiego.gov/sites/default/files/6_mobility_choices_nexus_study.pdf

[56] https://www.llnl.gov/news/labs-promote-pedal-power-bike-work-day

6 Waste and Materials

6.1 2030 Objectives

- Reduce the amount of organic waste that is landfilled 75% from 2014 levels by 2025
- Maintain or exceed 75% solid waste diversion each year
- Improve local re-use and repair programs
- Expand the use of low-carbon and recycled building materials

Strategy W-1 Reduce the Amount of Waste that is Landfilled

Emission reductions in the waste sector are driven by compliance with SB 1383, which requires all jurisdictions in California to reduce organic waste disposal 75% and increase edible food recovery 20% relative to 2014 levels by 2025. CalRecycle has provided a suite of recommendations and requirements for complying with SB 1383, including the following:

- Conduct capacity planning and ensure there is adequate capacity and collection services to comply with SB 1383 requirements
- Increase organic waste collection services for all residents and businesses
- Implement an edible food recovery program for commercial edible food generators, with compliance beginning between 2022 and 2024.
- Adopt enforceable ordinances prior to 2022 to ensure that all organics generators and edible food generators are compliant
- Procure organic waste to meet or exceed organic waste product procurement targets for the City, as notified by CalRecycle by 2022
- Conduct education and outreach to all businesses, residents, and commercial edible food generators by 2022
- Monitor compliance beginning in 2022, conduct enforcement beginning in 2024, and maintain records of implementation

The main mechanism through which Livermore will comply with SB 1383 is by updating waste hauler contracts and identifying and partnering with appropriate stakeholders to ensure requirements for organic waste reduction and edible food recovery are met (Strategy W-1). The details of the strategy, including its supporting steps and evidence of its GHG reduction potential, are included below.

Strategy W-1 Update Waste Hauler Contracts to Implement Requirements of SB 1383 and Achieve 75% Reduction in Organic Waste by 2025

Step Number	Guiding Principles	Implementation Steps	Anticipated Reduction (MT CO_2e)
1	Structural Change	**Require residential and commercial organic waste collection through updated waste hauler contracts:** Update waste hauler contracts to include expanded organic waste collection that meets the requirements of SB 1383. Conduct multilingual outreach and education regarding these changes throughout the community.	2030: 19,379 2045: 22,646
2	Equity	**Require edible food recovery:** Adopt an edible food recovery ordinance or similarly enforceable mechanism to ensure edible food generators, food recovery services, and food recovery organizations comply with requirements to increase recovery rates. Work with local food security groups on ordinance design and implementation.	Supportive
3	Structural Change	**Increase the City's recycled product procurement:** Procure and use compost to meet California Model Water Efficient Landscape Ordinance (WELO) requirement for incorporating compost into new and renovated permitted landscapes (at least four cubic yards per 1,000 sq. ft. to a depth of six inches of compost).	Supportive
4	Structural Change	**Conduct capacity planning for organic waste collection:** Engage in organic waste collection capacity planning by executing the following: ▪ Estimate Livermore's disposal of organic waste in tons ▪ Identify and verify amount of available organic waste recycling infrastructure ▪ Estimate the amount of new or expanded capacity needed to process organic waste ▪ Develop and submit an implementation schedule highlighting planning effort to provide enough new or expanded organics capacity, including timelines and relevant milestones by the end of the report period ▪ Identify proposed new or expanded facilities that could be used for additional capacity	Supportive
5	Structural Change Equity	**Conduct capacity planning for edible food recovery:** Engage in edible food recovery capacity planning by executing the following actions: ▪ Estimate the amount of edible food that will be disposed by organics generators in Livermore ▪ Work with commercial food generators to reduce excess edible food generation ▪ Work regionally to establish a full list of food recovery organizations that can receive edible food from Livermore businesses • Identify proposed new or expanded food recovery capacity ▪ Identify the minimum capacity required to recover 20% of edible food that is estimated to be disposed, through a Feasibility Study if necessary ▪ If existing and planned capacity is insufficient based on the above process, the City of Livermore must develop and submit an implementation schedule highlighting the planning effort to provide enough new or expanded capacity for increasing edible food donations and identify proposed new or expanded facilities to be used to for additional capacity	Supportive

Step Number	Guiding Principles	Implementation Steps	Anticipated Reduction (MT CO_2e)
6	Education Partnerships	**Develop and implement a partnered education and outreach program:** Develop and implement a multi-lingual education and outreach program that provides compliance assistance to organics and edible food generators, including: ▪ Identify percentage of organics generators who are "limited English-Speaking households" or "linguistically isolated." If more than five percent (5%) of Livermore's organics generators are defined as "limited English-speaking households" or linguistically isolated," provide education and outreach in a language or languages that will assure the information is understood by that community ▪ Prior to February 2022 and annually thereafter, provide organics generators with information regarding requirements to properly separate materials, organic waste prevention and on-site recycling, and implementing organic waste collection services. ▪ Provide edible food generators with information about methane reduction benefits and information related to edible food donation. ▪ Consider providing in-person technical assistance to generators to set up donation programs and donate appropriate types of edible food	Supportive
7	Education	**Educate the community:** Conduct multi-lingual outreach and education at schools on composting, recycling, waste reduction, nutrition education, and the importance of edible food recovery. Partner with StopWaste on outreach programs if possible.	Supportive
8	Structural Change	**Develop and implement an inspection and compliance program:** Implement an equitable inspection and compliance program for the edible food recovery program and organics procurement program with equitable and clearly defined enforcement mechanisms and penalties, as required by Article 16 in SB 1383.	Supportive
9	Structural Change	**Keep SB 1383 compliance records:** Maintain records, including an initial compliance report, annual report, and implementation record as required by Articles 3, 14, and 16 of SB 1383 for (1) the organic waste collection program, (2) the edible food recovery program, and (3) the organics procurement program.	Supportive
10	Structural Change	**Require organics collection programs:** Pass an ordinance with equitable enforcement mechanisms requiring organics generators to subscribe to organics collection programs or alternatively report organics self-hauling and/or backhauling.	Supportive
11	Structural Change	**Require composting services at businesses:** Pass an ordinance, with equitable enforcement mechanisms and technical assistance for low-income entrepreneurs, that requires composting services at businesses, including front-of-house (FOH) composting collection at most food service businesses.	Supportive

Requiring residential and commercial organic waste generators to subscribe to an organics collection program (provided through updated waste hauler contracts) is expected to provide the level of composting required to reduce Livermore's organic waste disposal 75% below 2014 levels by 2025, one of the primary goals of SB 1383. StopWaste and Livermore Sanitation have been preparing for implementation of SB 1383, and are in the process of assessing local composting

capacity and facilities. This action will capitalize on those efforts and expand them to meet the necessary composting capacity.

Livermore is projected to produce 82,313 tons of waste in 2030, with the majority if not all emissions from this waste coming from organics. Calculations assumed that emission reductions would come from diverting that waste to compost, decreasing the disposal emission factor to zero. In fact, the emission factor for composting those materials is negative, due to the carbon sequestration potential of compost, but these negative emissions were not credited to the City of Livermore as carbon sequestration of the compost would occur at the location of procurement. For the purposes of emission calculations, landfill emissions were assumed to come entirely from organic materials so that a 75% reduction in organics results in a 75% reduction in waste emissions.[57] Emission reduction calculations are shown below in Table 10.

Table 10 Strategy W-1 Calculations

Year	2030	2045
Waste Emissions	25,839	30,194
Organics reduction from SB 1383[1]	75%	75%
Total reductions (MT CO_2e)	**19,379**	**22,646**

[1] SB 1383 requires 75% reduction in organic waste from 2014 levels by 2025.

Other steps like the edible food recovery ordinance will provide an enforceable mechanism through which the City can help organics generators meet the edible food recovery requirements of SB 1383. Jurisdictions are responsible for implementing an edible food recovery program for commercial edible food generators. This means ensuring that there are edible food recovery organizations that have enough capacity and collection services, which will be accomplished through implementation of Action 5. Commercial edible food generators must recover for human consumption the maximum amount of their edible food that they would otherwise dispose of in landfills by making written agreements with food recovery organizations or services to accept this food instead. “Tier One” food generators — supermarkets and large grocery stores, food services providers, food distributors and wholesale food vendors — must comply beginning January 1, 2022. “Tier Two” food generators — large restaurants, hotels with an on-site food facility and 200 or more rooms, health facilities with an on-site food facility and 100 or more beds, large venues and large events, state agencies with large cafeterias and local educations agencies with on-site food facilities — have until January 1, 2024 to comply.

CalRecycle currently does not have an estimate for what percentage of the California waste stream is edible, therefore the effects of this action have not been quantified but characterized as supportive. However, CalRecycle estimates that every 2 ½ tons of edible food recovered is the equivalent of taking one car off the road for a year.[58]

Increasing recycled product procurement will lower the City’s consumption-based emissions – emissions attributed to the production of materials brought into the City – and provide a local market for recycled products, including recycled paper and compost.

[57] Method for Estimating Greenhouse Gas Emission Reductions from Diversion of Organic Waste from Landfills to Compost Facilities (CARB, 2017)

[58] https://www.calrecycle.ca.gov/blogs/in-the-loop/in-the-loop/2020/03/02/yolo-county-edible-food-recovery-kick-off

- **Recycled Paper.** Over 30 years, recycled paper can deliver 1.1 to 1.95 gigatons of carbon dioxide emission reductions.[59] This is because recycled paper produces about 25% fewer total emissions than conventional paper. A particular piece of paper can be reprocessed roughly five to seven times, before fibers are no longer viable, avoiding methane emissions from landfilling each time. Recycling paper has the added benefit of saving trees and reducing water waste.
- **Compost.** Composting avoids methane production in landfills, with the added benefit of carbon sequestration ability, which actively removes carbon from the atmosphere. Additional benefits to using compost are improved soil health, reduced soil loss, increased water filtration and storage, and reduction of other inputs.[60]

SB 1383 requires jurisdictions to conduct capacity planning around SB 1383 to ensure organics recovery and edible food recovery targets can be reasonably met. Conducting capacity planning will help the City develop an implementation plan for SB 1383 and provide information for discussions with waste haulers and other stakeholders, providing support for the GHG reductions expected from overall strategy implementation.

Conducting inspection and compliance activities around the requirements of SB 1383 will help ensure the community is doing its best to achieve the desired organics waste reduction and edible food recovery targets, thereby supporting the GHG emission reductions inherent to Steps 1 and 2.

[59] https://www.drawdown.org/solutions/recycled-paper

[60] https://www.sanjoseca.gov/home/showdocument?id=198

7 Carbon Sequestration

7.1 2030 Objectives

- Maximize local carbon sequestration
- Plant 200 trees by 2025 and 1,000 trees by 2030
- Update City landscaping standards to expand shade tree requirements for new development
- Provide free or reduced cost-trees to residents in Livermore
- Preserve open spaces
- Implement carbon-farming projects
- Explore technology-based carbon capture and storage opportunities

Strategy S-1 Maximize Local Carbon Sequestration

A carbon neutral future includes carbon sequestration mechanisms which take carbon out of the atmosphere. The best technology cities have for achieving higher rates of carbon sequestration is through increasing the urban tree canopy by planting more trees and greenscaping. The CAP strategy supporting this goal will do just that – increase carbon sequestration through greenscaping programs. The primary action under this strategy is implementing an Urban Forest Revitalization Program, which would establish tree planting goals for the future. The details of each action supporting the carbon sequestration strategy, and evidence of their GHG reduction potential, are included below.

Strategy S-1 Increase Carbon Sequestration by Planting 1,000 New Trees and Meeting the Procurement Requirements of SB 1383

Action Number	Action	Anticipated Reduction (MT CO_2e)
1	**Implement an Urban Forest Revitalization Program:** Implement an Urban Forest Revitalization Program to plant 200 trees by 2025 and 1000 trees by 2030. Focus on areas of City with low tree canopy cover and the highest socioeconomic need based on the development of a canopy map. Identify opportunities for green walls and green roofs in priority locations.	2030: 58 2045: 58
2	**Meet the procurement requirements of SB 1383:** Procure and apply compost to promote carbon sequestration and other benefits.	2030: 1,950 2045: 2,367
3	**Preserve open spaces:** Avoid conversion of open lands to urban areas - achieve carbon and other benefits by keeping the landscape as conservation land or working land.	Supportive
4	**Conduct a carbon farming study and pilot project:** Work with agricultural stakeholders to find a partner for a carbon farming study and pilot project.	Supportive
5	**Improve urban forest management to maximize carbon sequestration:** Prepare and adopt an Urban Forest Management Plan for the City that includes an inventory of existing trees, and the identification of both future tree planting opportunities and a climate-ready tree palette, as well as ongoing operations and maintenance needs.	Supportive
6	**Adopt a Greenscaping Ordinance:** Adopt a Greenscaping Ordinance that has a street tree requirement for all zoning districts, has a shade tree requirement for new development, requires greening of parking lots, and increases permeable surfaces in new development.	Supportive
7	**Establish urban canopy and vegetative barrier best practices:** Adopt a standard policy and set of practices for expanding urban tree canopy and placing vegetative barriers between busy roadways and developments to reduce exposure to air pollutants from traffic.	Supportive

Livermore should develop and implement an Urban Forest Revitalization Program that identifies the goal of planting 200 trees by 2025 and 1000 trees by 2030, prioritizing low-income communities with low tree canopy cover. As of December 2016, the City had approximately 2,500 trees under its management.[61] As a part of the Urban Forest Revitalization Program, the total number of planting locations in the City's Right-of-Way should be identified, to inform a higher tree planting goal that could be set for 2045. Emission reduction calculations associated with this action assume that both the 2025 and 2030 tree planting goals will be met, and that the carbon sequestration potential for seedlings averaged over 40 years is about 0.058 MT CO_2e per tree per year. This number is an average of the 40-year carbon sequestration potential for four common tree species already being planted in Livermore: red oak, black tupelo, valley/white oak, and red maple.[62] Emission reduction calculations are shown below in Table 11.

[61] https://www.eastbaytimes.com/2016/12/16/livermore-assesses-ways-to-keep-tree-stands-alive/

[62] https://planting.itreetools.org/app/report/

Table 11 Strategy S- 1 Tree Planting Calculations

Year	2030	2045
Trees Planted[1]	1,000	1,000
Total reductions (MT CO_2e)[2]	**58**	**58**

[1] Per goals to be set in Livermore's Urban Forest Revitalization Program

[2] Assuming a carbon sequestration potential of 0.057979 MT CO_2e/tree/year; an average of four common municipal tree types (red oak – 0.05268 MT CO_2e/tree/year, black tupelo – 0.03816 MT CO_2e/tree/year, valley/white oak – 0.08466 MT CO_2e/tree/year, and red maple – 0.05641 MT CO_2e/tree/year). https://planting.itreetools.org/app/report/

In addition to the concrete tree planting goals the City has established under Step 1, other steps will help create additional carbon sequestration potential for the City. However, emission reductions from these steps are not quantified, due to the difficulty in determining the exact impact these steps will have on GHG emissions in Livermore. Seeking partnerships with local agriculture stakeholders and the National Laboratories can help the city to pilot innovative carbon farming studies and pilot projects which will help further the City's vision for carbon restoration in the future. Livermore can look to the Marin Carbon Project as a model for carbon farming projects, which has assisted in the development and implementation of over a dozen carbon farm plans in Marin County.[63] A Greenscaping Ordinance which includes increased street tree requirements will help to support these steps and improve the local tree canopy. As the City moves forward in implementing these steps, an updated inventory will be developed to help quantify their impacts.

SB 1383 requires Livermore to procure approximately 7,297 tons of compost or other organic material annually. Livermore's responsibility based on the 2022 population is 7,297 tons based on a 2022 population of 91,216 people and the reported CalRecycle procurement targets.[64] Based on CARB methodologies applying one ton of compost results in carbon sequestration of 0.23 MT CO_2e.[65] The overall GHG emissions savings are calculated in Table 12.

Table 12 Strategy S-1 Compost Application Calculations

Year	2030	2045
Population	105,967	129,158
Estimated procurement requirement[2]	8,477	10,332
MT CO_2e/Ton Compost[1]	0.23	0.23
Total Sequestration (MT CO2e)	1,950	2,376

[1] METHOD FOR ESTIMATING GREENHOUSE GAS EMISSION REDUCTIONS FROM DIVERSION OF ORGANIC WASTE FROM LANDFILLS TO COMPOST FACILITIES DRAFT (ca.gov)

[2] Estimated based on current per capita procurement requirements and projected population data. https://calrecycle.ca.gov/organics/slcp/procurement/recoveredorganicwasteproducts/

63 https://www.marincarbonproject.org/carbon-farming

64 https://calrecycle.ca.gov/organics/slcp/procurement/recoveredorganicwasteproducts/

65 METHOD FOR ESTIMATING GREENHOUSE GAS EMISSION REDUCTIONS FROM DIVERSION OF ORGANIC WASTE FROM LANDFILLS TO COMPOST FACILITIES DRAFT (ca.gov)