
# Appendix C: GHG Emissions Reductions Technical Report

# Sunnyvale Playbook Update

## Greenhouse Gas Emissions Reductions Technical Report
## Final

*prepared by*

**City of Sunnyvale**

505 West Olive Avenue
Sunnyvale, California 94086
Contact: Madeline Khair, Environmental Programs Manager

*prepared with the assistance of*

**Rincon Consultants, Inc.**
449 15th St #303
Oakland, California 94612

**June 2024**

RINCON CONSULTANTS, INC.
Environmental Scientists | Planners | Engineers
rinconconsultants.com

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# 1 Introduction

This technical report presents the quantification and substantial evidence that support the greenhouse gas (GHG) emissions reduction potential of the City of Sunnyvale's Climate Action Playbook Update (**Playbook Update**) and supports its classification as a qualified GHG reduction plan. The Playbook Update is Sunnyvale's updated plan to reduce GHG emissions and address climate change. It includes measures (called "**Plays**") with measurable targets to reduce GHG emissions and the **Game Plan 2028** which is a list of actions (called "**Next Moves**") that the City will implement in the next five years to reduce GHG emissions.

Section 15183.5(b)(1) of the California Environmental Quality Act (CEQA) guidelines establishes several criteria which a plan must meet to be considered a qualified GHG reduction plan and allow for programmatic CEQA streamlining of project GHG emissions. This report details the evidence substantiating the GHG emissions reductions associated with the Plays of the Playbook Update pursuant to Subsection (D) which requires measures (i.e., Plays) 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 GHG emissions level. This report demonstrates the Plays and Moves in the Playbook Update provide the GHG emission reductions necessary to meet the City's 2030 GHG emission reduction target, which exceeds the State's GHG emission reduction goal established by Senate Bill (SB) 32 and make substantial progress towards the City's 2045 target which aligns with the State's goal established Assembly Bill (AB) 1279.[1] The City's 2045 target was established as part of the Playbook Update to align with best practices and California's current long-term goal, which was accelerated from a goal of reducing GHG emissions 80 percent below 1990 levels by 2050.[2] More information is provided in Section 1.1, GHG Emissions Reductions.

The quantification and substantial evidence in this report are specifically intended to illustrate a reasonable approach to achieve Sunnyvale's 2030 GHG emission reduction target and make substantial progress towards Sunnyvale's 2045 target based on the Plays and Next Moves established in the Playbook Update and Game Plan 2028. While the Game Plan 2028 is intended to achieve the City's 2030 target, it is not intended to achieve the 2045 target. Rather, the Game Plan 2028 is intended to make substantial progress towards the City's 2045 target and a Game Plan with new Moves will be developed in alignment with department work plans and current best practices (including use of available technology) every five years, to develop Moves that, once implemented, will achieve the City's 2045 target.

Mechanisms to monitor the implementation of the Game Plan 2028 and its progress toward achieving the GHG emission reductions are included in the Playbook, as required in CEQA Guidelines Section 15183.5(b)(e). If, based on the tracking of community GHG emissions, the City is not on track to reach the 2030 GHG emission reductions specified in this report, the Playbook as a whole or specific Moves in the Game Plan 2028 will be amended. Based on these amendments, a new

[1] SB 32 established the State goal to reduce GHG emission 40 percent below 1990 levels by 2030. AB 1279 established the State goal to achieve carbon neutrality by 2045. The State defines carbon neutrality as net zero carbon emissions, which is achieved by reducing GHG emissions at least 85 percent below 1990 levels and removing the remaining emissions.

[2] The State's previous goal of reducing GHG emissions 80 percent below 1990 levels by 2050 was set by Executive Order S-3-05 at the time that the first Playbook was developed. AB 1279 accelerates this State goal to reducing GHG emissions 85 percent below 1990 levels by 2045.

Playbook Update and/or Game Plan 2028 will be prepared that includes altered or additional Plays and Moves, with evidence that their implementation can achieve the City's 2030 GHG emission reduction target.

## 1.1 GHG Emission Reduction Targets

The City of Sunnyvale's GHG emission reduction targets exceed California's goal to reduce GHG emissions 40 percent below 1990 levels by 2030 (SB 32) and align with California's goal to achieve carbon neutrality by 2045 (AB 1279) defined as reducing GHG emissions at least 85 percent below 1990 levels and removing or sequestering the remaining GHG emissions.

Sunnyvale's short- and long-term GHG emission reduction targets are:

- Reduce GHG emissions 56 percent below 1990 levels by 2030; and
- Reduce GHG emissions 85 percent below 1990 levels by 2045.

## 1.2 Measures and Actions Organization

As part of the Playbook Update process, the City of Sunnyvale has developed a comprehensive set of Plays and Next Moves to reduce communitywide GHG emissions to achieve the City's 2030 GHG emission reduction target and make substantial progress towards the City's 2045 target. The Plays are organized around a set of six strategies to reduce GHG emissions. Each Play is then supported by a set of Moves from the Game Plan 2028. The structure of the Strategies, Plays, and Moves are as follows:

- **Strategies**: establish approaches to reduce GHG emissions.
- **Plays**: identify areas for action. Plays have measurable targets that will help assess progress towards goals.
- **Moves:** define specific actions the City and community can collectively take to address climate change.

The Plays and Moves can be either quantitative or supportive, defined as follows:

- **Quantitative:** Quantitative Plays result in direct and measurable GHG emissions reductions when their Moves, backed by substantial evidence, are implemented. GHG emissions reductions from these Plays and Moves are justified by case studies, scientific articles, calculations, and other third-party substantial evidence that establish the effectiveness of the reduction Moves. Quantitative Plays can be summed to quantify how the City of Sunnyvale will meet its 2030 GHG emission reduction target and demonstrate progress towards the 2045 target.
- **Supportive:** Supportive Plays may also be quantifiable and have substantial evidence to support their overall contribution to GHG emission reductions. However, due to one of several factors – including a low GHG emission reduction benefit, indirect GHG emission reduction benefit, or potential for double-counting– they have not been quantified and do not contribute directly to achieving and making progress towards the City's GHG emission reduction targets. Despite not being quantified, supportive Plays are nevertheless critical to the overall success of the Playbook and provide support so that the quantitative Plays will be successfully implemented.

This report identifies both the quantitative and supportive Plays and provides a complete description of their contribution to achieving the City of Sunnyvale's 2030 GHG emission reduction

target. This report, however, only details the quantitative Moves that enable each Play. The supportive Moves are excluded from this report because they do not contribute directly to achieving and making progress towards the City's GHG emission reduction targets. These supportive Moves are nevertheless critical to the overall success of each Play. Detail on these supportive Moves can be found in the Game Plan 2028.

## 1.3 GHG Emissions Reductions

Table 1 summarizes the Plays and their associated targets for 2030 and 2045. It also presents a summary of the 2030 GHG emissions reductions calculated for each Play which are supported by the Game Plan 2028 Moves.

As part of the Playbook Update, the Play targets for 2030 and 2045 were updated to demonstrate the level of action needed in each area to guide the City towards the 2030 GHG reduction target and the new, accelerated 2045 GHG emission reduction target. The Play targets were updated using the GHG emission forecast, which was completed in 2023 using the most recently available and accurate data, and detailed calculations to quantify GHG emission reductions feasible for Sunnyvale based on best practices.

Together, the Plays and Moves in Game Plan 2028 provide Sunnyvale with the GHG emission reductions necessary to achieve Sunnyvale's 2030 GHG emission reduction target (see

Table 2). Since the Game Plan 2028 Moves are intended to be implemented within the next five years and then updated and supplemented with a new or updated set of Moves (e.g., in the Game Plan 2033) based on new information and future technologies, the Moves do not account for progress after 2030. Therefore, due to the evolving nature of the City's program, this report does not quantify GHG emission reductions for 2045. The Moves will be updated in future Game Plan iterations based on information the City gains from implementing Game Plan 2028, new technologies that emerge over the time period, and new State programs and regulations that are established to reduce GHG emissions. The Game Plan 2028 Moves do, however, make substantial progress on the City's 2045 GHG emission reduction target by exceeding the State's goal for 2030 (SB 32) to put Sunnyvale on a path to acheiveing the 2045 target (AB 1279).

**Table 1 Sunnyvale Playbook Update 2030 GHG Emission Reduction Summary**

| Play ID | Play | 2030 Play Target | 2045 Play Target | 2030 GHG Emission Reductions (MT $CO_2e$) |
|---|---|---|---|---|
| **Strategy 1: Promoting Clean Energy** | | | | |
| Play 1.1 | Promote 100% clean energy | 100% clean energy | 100% clean energy | 3,320 |
| Play 1.2 | Increase local solar photovoltaics | 3% of electrical load from local solar | 5% of electrical load from local solar | 3 |
| Play 1.3 | Increase distributed electricity storage | 2% of electricity demand stored in batteries locally | 5% of electricity demand stored in batteries locally | Supportive |
| **Strategy 2: Decarbonizing Buildings** | | | | |
| Play 2.1 | Reduce energy consumption in existing buildings | 5% of existing homes and businesses receive deep energy retrofit | 30% of existing homes and businesses receive deep energy retrofit | Supportive |

| Play ID | Play | 2030 Play Target | 2045 Play Target | 2030 GHG Emission Reductions (MT $CO_2e$) |
|---|---|---|---|---|
| Play 2.2 | Support electrification of existing buildings | 44% reduction in residential natural gas consumption; and 38% reduction in commercial natural gas consumption | 92% reduction in residential natural gas consumption; and 86% reduction in commercial natural gas consumption | 108,935 |
| Play 2.3 | Achieve all-electric new construction | 100% all-electric new construction | 100% all-electric new construction | 75,786 |
| **Strategy 3: Decarbonizing Transportation & Sustainable Land Use** | | | | |
| Play 3.1 | Increase opportunities for and encourage development of mixed-use sites to reduce vehicle miles per person | 20% reduction in vehicle miles per person | 30% reduction in vehicle miles per person | 66,162 |
| Play 3.2 | Increase transportation options and support shared mobility | | | |
| Play 3.3 | Increase zero-emission vehicles | 42% of all vehicles on road are zero-emission vehicles | 90% of all vehicles on road are zero-emission vehicles | 98,079 |
| Play 3.4 | Decarbonize off-road vehicles and equipment | 30% of all vehicles and equipment off road are zero-emission | 75% of all vehicles and equipment off road are zero-emission | 15,753 |
| **Strategy 4: Managing Resources Sustainably** | | | | |
| Play 4.1 | Achieve Zero Waste goals for solid waste | Reduce landfilled garbage to 1 pound per person per day and achieve 75% diversion of landfilled organics | Reduce landfilled garbage to <1 pound per person per day and achieve 75% diversion of landfilled organics | 45,258 |
| Play 4.2 | Ensure resilience of water supply | TBD | TBD | Supportive |
| Play 4.3 | Enhance natural carbon sequestration capacity | N/A | N/A | Supportive |
| Play 4.4 | Promote awareness of sustainable good and services | N/A | N/A | Supportive |
| **Strategy 5: Empowering Our Community** | | | | |
| Play 5.1 | Enhance community awareness and engagement | N/A | N/A | Supportive |
| Play 5.2 | Track and share data and tools | N/A | N/A | Supportive |
| **Strategy 6: Adapting to a Changing Climate** | | | | |
| Play 6.1 | Assess climate vulnerabilities for Sunnyvale | N/A | N/A | Supportive |

| Play ID | Play | 2030 Play Target | 2045 Play Target | 2030 GHG Emission Reductions (MT $CO_2e$) |
|---|---|---|---|---|
| Play 6.2 | Protect shoreline area from seal level rise and coastal flooding | N/A | N/A | Supportive |
| Play 6.3 | Strengthen community resiliency | N/A | N/A | Supportive |
| **Total** | | | | **413,274** |

Notes: TBD = to be defined per State requirements; N/A = not applicable

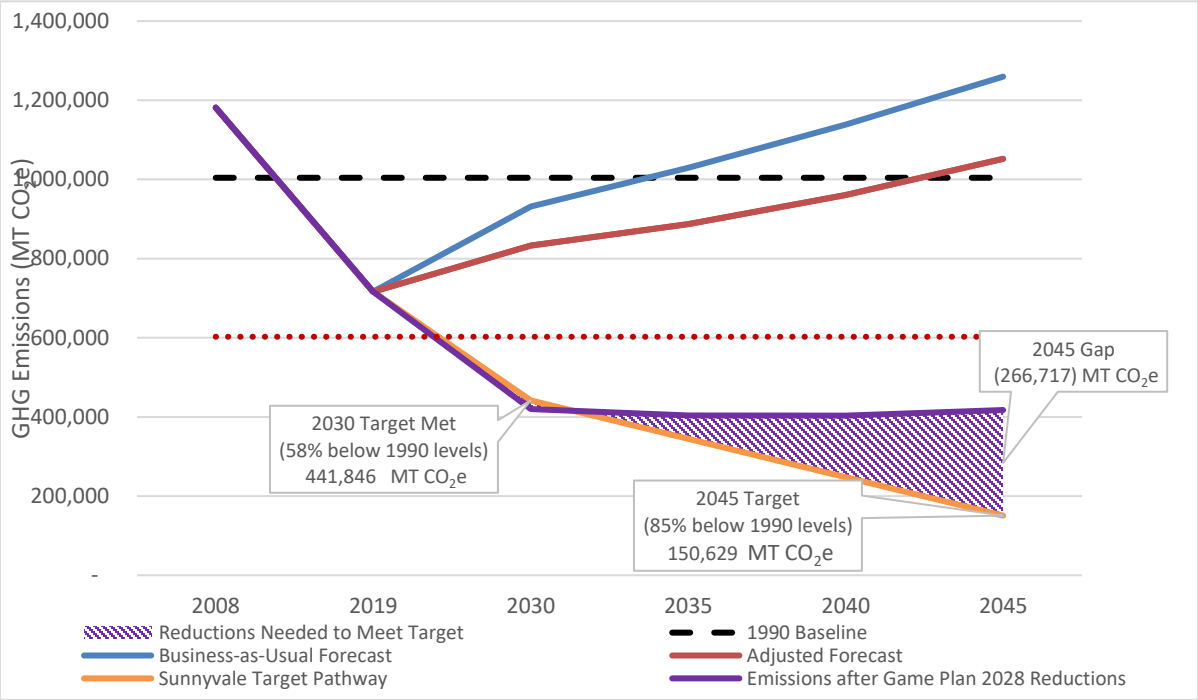
**Table 2 City of Sunnyvale's GHG Emissions Reductions Pathway**

| GHG Emission Forecast or Reduction Target | 2030 GHG Emissions (MT $CO_2e$) |
|---|---|
| Business-as-usual Forecast | 931,298 |
| Adjusted Forecast | 833,092 |
| GHG Emissions Reductions (from full implementation of Moves) | 413,274 |
| GHG Emissions Remaining (after Move reductions) | 419,818 |
| GHG Emission Reduction Target | 441,846 |
| GHG Emissions Gap (between remaining GHG emissions and target) | (22,027) |
| **Target Anticipated to be Met** | **Yes** |

Notes: Numeric numbers donated in parathesis represent negative numbers.

Figure 1 shows the GHG emission reduction targets in relation to the City's GHG emissions after implementation of the Plays and Moves included in Game Plan 2028. The implementation progress achieved by 2030 is assumed to remain constant through 2045. Future Game Plan updates will include additional Plays and Moves as necessary and increase the rate at which Plays and Moves are implemented to reduce the gap through 2045 and achieve the long-term target. A complete description of each Play and its quantitative Moves is included in the remainder of the report.

**Figure 1 City of Sunnyvale's GHG Emissions Reductions Pathway**



# 2 Strategy 1: Promoting Clean Energy

The City of Sunnyvale's strategy to promote clean energy focuses on leveraging the renewable and carbon-free electricity provided by Silicon Valley Clean Energy (SVCE) along with increasing the generation of local solar energy and increasing distributed electricity storage.[3] Through continued reduction of non-SVCE and direct access usage rates along with installation of solar photovoltaic and energy storage systems, Sunnyvale will continue increasing the use of renewable and carbon-free electricity, reducing the GHG emissions associated with the community's residential and commercial electricity consumption. This strategy will further amplify GHG emission reductions achieved through electrification of the City's building stock (Strategy 2: Decarbonizing Buildings) and transportation system (Strategy 3: Decarbonizing Transportation & Sustainable Land Use) by providing renewable and carbon-free electricity to meet the additional electricity demand resulting from these strategies. Based on this strategy, the Playbook Update's clean energy strategy consists of the following Plays presented in Table 3. The table also indicates which Plays are quantitative and which Plays are supportive. The following subsections detail the substantial evidence and calculation methodologies of the quantitative Plays and the role of the supportive Plays.

**Table 3 Strategy 1: Promoting Clean Energy 2030 GHG Emission Reduction Summary**

| Play ID | Play | 2030 Play Target | 2030 GHG Emission Reductions (MT $CO_2e$) |
|---|---|---|---|
| **Strategy 1: Promoting Clean Energy** | | | |
| Play 1.1 | Promote 100% clean energy. | 100% clean energy | 3,320 |
| Play 1.2 | Increase local solar photovoltaics. | 3% of load from local solar | 3 |
| Play 1.3 | Increase distributed electricity storage. | 2% of electricity demand stored in batteries locally | Supportive |
| **Total** | | | **3,323** |

[3] Distributed energy storage consist smaller capacity energy storage units distributed close to end consumers. These storage systems can support the transition to renewable energy by smoothing out the timing differences between the supply of renewable energy and demand for energy.

## Play 1.1: Promote 100% clean energy.

Play 1.1 aims to increase the share of Sunnyvale's residential and nonresidential electricity consumption sourced from clean energy to 100 percent. The primary Move that enables this target is **Move 1.A** which directs the City to continue to support and steer SVCE in providing electricity sourced 100 percent from a mix of carbon-free and eligible renewable sources to the Sunnyvale community.[4]

SVCE currently offers an electricity option with a GHG emission rate lower than the other electricity options offered in the region. This electricity option, known as GreenPrime, supplies electricity sourced 100 percent from solar and wind at a GHG emissions rate of zero.[5] Currently, electricity customers in Sunnyvale are automatically enrolled in SVCE's GreenStart electricity option but are allowed to opt-up to SVCE's GreenPrime electricity option, opt-out to receive electricity directly from PG&E, or opt-out to procure electricity at wholesale directly from electricity generators (i.e., direct access). However, as of 2023, SVCE enrollment in GreenPrime has been closed due to current constraints in obtaining enough carbon-free and eligible renewable energy to accept more customers to this tier.[6] SVCE is currently evaluating future and additional sources for carbon-free electricity and eligible renewables and anticipates being able to offer this tier to additional customers in the near future. Additionally, by 2030, SVCE plans to have an energy portfolio that will allow them to source 65 percent of their electricity from eligible renewables, while maintaining a 100 percent carbon-free energy portfolio on an annual basis.[7] This Play assumes Sunnyvale will support SVCE in achieving this energy portfolio by 2030, supplying all Sunnyvale SVCE customers with electricity sourced 100 percent from a mix of carbon-free and eligible renewable sources for an electricity GHG emissions rate of zero.

Since SVCE's inception and the move to automatically enroll Sunnyvale customers in SVCE, Sunnyvale has seen a two percent opt-out rate for residential customers and a three percent opt-out rate for commercial customers. For this reason, an opt-out rate of three percent is assumed for this Play's quantification.

This low opt-out rate will be supported by education and available financial assistance programs. The City understands cost is often the deciding factor for residents and businesses when making energy provider choices.[8] For this reason, Sunnyvale will focus educational efforts on available financial assistance programs to keep customers in SVCE. Studies have also shown informational programs can result in up to a 70 percent implementation rate of recommended practices by participants.[9] The City will, therefore, include education on the benefits of clean energy for residents and businesses to encourage customers to remain in SVCE. With these factors it is assumed the City will be able to maintain the SVCE opt-out rate to a minimum of three percent.

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[4] 'Eligible renewable sources' refers to renewable energy sources that are eligible for the Renewable Portfolio Standard.

[5] California Energy Commission. 2021 Power Content Label: Silicon Valley Clean Energy. Accessed at: https://www.energy.ca.gov/filebrowser/download/4672.

[6] SVCE. Upgrade to GreenPrime. Accessed at: https://svcleanenergy.org/greenprime/.

[7] SVCE. 2022 Integrated Resource Plan (2022). Accessed at: https://svcleanenergy.org/wp-content/uploads/svce_irp_public_v1.pdf.

[8] Villasenor, Karen. The City of Rancho Mirage Launches Community Choice Aggregation Program with Low Opt-Out Rate (2018). Accessed at: https://www.civicbusinessjournal.com/city-rancho-mirage-launches-community-choice-aggregation-program-low-opt-rate/.

[9] Laquatra, Joseph et al. The Consumer Education Program for Residential Energy Efficiency (2009). Accessed at: https://archives.joe.org/joe/2009december/a6.php.

Table 4 shows the parameters and data sources that support these clean energy GHG emission reductions and Table 5 shows the calculations as outlined in Equations 1 through 1.1.

### SVCE Clean Energy Equations

Equation 1 $CO_2e\ Reduction_{Elec,y,i}=Total\ Elec_{y,i}*(1-Opt\text{-}Out\ Rate)*(EF_{elec,y,i}-EF_{CF\ and\ ER,y})$

Equation 1.1 $Total\ Elec_{y,i}=Elec_{y,i}+Total\ Elec\ Converted_{y,i}$

### Table 4 SVCE Clean Energy Parameters and Data Sources

| Variable | Definition | Value | Unit | Data Source |
|---|---|---|---|---|
| **Equation 1** | | | | |
| $CO_2e\ Reduction_{Elec,y,i}$ | Electricity GHG emission reductions | See calculation table | MT $CO_2e$ | Calculated |
| $Total\ Elec_{y,i}$ | Total electricity consumption | See calculation table | kWh | Calculated |
| *Opt-Out Rate* | SVCE opt-out rate | 3% | percentage | Estimated to account for potential opt-out from SVCE, minimized by education on incentives and benefits.[8, 9] |
| $EF_{elec,y,i}$ | Forecasted electricity emission factor | See calculation table | MT $CO_2e$/kWh | Forecast |
| $EF_{CF\ and\ ER,y}$ | Electricity emission factor of SVCE carbon-free and eligible renewable electricity | 0 | MT $CO_2e$/kWh | California Energy Commission[10] |
| *y* | Year | 2030 | year | N/A |
| *i* | Subsector | Residential or Nonresidential | N/A | N/A |
| **Equation 1.1** | | | | |
| $Elec_{y,i}$ | Forecasted electricity consumption | See calculation table | kWh | Forecast |
| $Total\ Elec\ Converted_{y,i}$ | Total electricity usage from conversions | See calculation table | kWh | Play 2.2, Play 2.3, and Play 3.3. See Section 3 (Strategy 2: Decarbonizing Buildings) and Section 4 (Strategy 3: Decarbonizing Transportation & Sustainable Land Use) of this report. |

[10] California Energy Commission. 2021 Power Content Label: Silicon Valley Clean Energy.

## Table 5 SVCE Clean Energy GHG Emission Reduction Calculations

| Definition | Definition | Units | Sector | 2030 |
|---|---|---|---|---|
| **Equation 1** | | | | |
| $Elec_{y,i}$ | Forecasted electricity consumption | kWh | Residential | 333,108,881 |
| | | | Nonresidential | 1,520,790,248 |
| *Total Elec Converted*$_{y,i}$ | Total electricity usage from conversions | kWh | Residential | 309,650,488 |
| | | | Nonresidential | 168,600,685 |
| *Total Elec*$_{y,i}$ | Total electricity consumption | kWh | Residential | 642,759,369 |
| | | | Nonresidential | 1,689,390,933 |
| | | | | **Equation 1** |
| $EF_{elec,y,i}$ | Forecasted electricity emission factor | MT $CO_2e$/kWh | Residential | 0.0000016 |
| | | | Nonresidential | 0.0000014 |
| ***$CO_2e$ Reduction***$_{NG,y,i}$ | **Electricity GHG emission reductions** | **MT $CO_2e$** | **Residential** | **1,005** |
| | | | **Nonresidential** | **2,316** |

## Play 1.2: Increase local solar photovoltaics.

Play 1.2 sets Sunnyvale up to transition three percent of the community's electrical load to local solar energy by 2030. The primary Move that enables this target is **Move 1.D** which directs the City to enforce the solar panel requirements of the new building reach codes and the Moffett Park Specific Plan.

In 2021, Sunnyvale adopted reach codes for residential and commercial developments that require new construction projects to include solar panels. The codes require the residential buildings (including low-rise multi-family buildings) install a solar panel system with a generation capacity greater than or equal to the anticipated dwelling's annual electrical usage and nonresidential buildings (including high-rise multi-family buildings) must install a minimum of three-kilowatt or five-kilowatt solar photovoltaic system based on square foot thresholds. The reach codes include an exemption to the solar photovoltaic requirement for nonresidential buildings (including high-rise multi-family buildings) that allows for a solar hot water system (i.e., solar thermal) instead of the solar photovoltaics.[11, 12] In 2030, the residential reach codes alone have the potential to generate six percent of the City's total electricity consumption with solar energy. This estimate makes three percent a conservative implementation goal for the Play since the estimate is higher than the implementation level even though it excludes potential solar installations on nonresidential buildings due to potential exemptions.[13] Since these reach codes were adopted in 2021, they were not included in Sunnyvale's 2019 inventory nor the adjusted forecast and are instead included in the Playbook Update as part of Move 1.D to allow the City to accurately account for the GHG emissions reductions.

The Moffett Park Specific Plan, adopted in July of 2023, also encourages the installation of solar photovoltaic systems in Moffett Park as part of the plan's goals for energy and healthy, climate-ready site and building design (i.e., Policy IU-5.2, DS-4.7, and DS-4.8).[14] These goals will further encourage local solar energy generation in Sunnyvale and support the Play's target.

Table 6 shows the parameters and data sources that support these electrification ordinance GHG emission reductions and Table 7 shows the calculations as outlined in Equations 2 through 2.1. To remain conservative and avoid potential double counting (with Play 1.1), the calculations only apply the three percent implementation factor to the City's non-SVCE electricity after Play 1.1.

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[11] City of Sunnyvale. Single-Family, Duplex, and Townhome Reach Codes (Rev 1/2023). Accessed at: https://www.sunnyvale.ca.gov/home/showpublisheddocument/1780/637820861891230000.

[12] City of Sunnyvale. Nonresidential and Multifamily Reach Codes (2021). Accessed at: https://www.sunnyvale.ca.gov/home/showpublisheddocument/1496/637820847520270000#:~:text=BUILDINGS%20%2D%20HIGH%2DRISE-,Electric%20appliances%20are%20required.,Gas%20lines%20are%20prohibited.

[13] The six percent coverage by the residential reach codes was estimated by multiplying the number of new households expected to be built by 2030 (since reach code adoption in 2021) by the estimated annual system output of a solar system in Sunnyvale. The resulting annual kilowatt-hours of solar electricity was divided by the total forecasted electricity consumption (including residential electricity, nonresidential electricity, and additional electricity from electrification—see Play 2.2, Play 2.3, and Play 3.3) to calculate the share of electricity this potential solar electricity covers. New households were estimated using Sunnyvale's adjusted forecast (i.e., change in projected households between 2030 and 2021). Estimated annual system output was calculated using the National Renewable Energy Laboratory's PVWatts Calculator for a four-kilowatt system in Sunnyvale. A four-kilowatt system is considered conservative for a household and the low end of the calculator's outputs was used to remain conservative.

National Renewable Energy Laboratory. PVWatts Calculator. Accessed at: https://pvwatts.nrel.gov/pvwatts.php.

[14] City of Sunnyvale. Moffett Park Specific Plan (2022). Accessed at: https://www.moffettparksp.com/.

## Local Solar Equations

Equation 2 $CO_2e\ Reduction_{Elec,y,i} = Non\text{-}SVCE\ Elec_{y,i} * Converted\ Solar_y * (EF_{elec,y,i} - EF_{solar,y})$

Equation 2.1 $Non\text{-}SVCE\ Elec_{y,i} = Total\ Elec_{y,i} * Opt\text{-}Out\ Rate$

### Table 6 Local Solar Parameters and Data Sources

| Variable | Definition | Value | Unit | Data Source |
|---|---|---|---|---|
| **Equation 2** | | | | |
| $CO_2e\ Reduction_{Elec,y,i}$ | Electricity GHG emission reductions | See calculation table | MT $CO_2e$ | Calculated |
| $Non\text{-}SVCE\ Elec_{y,i}$ | Electricity consumption from PG&E (aka. non-SVCE electricity) | See calculation table | kWh | Calculated |
| $Converted\ Solar_y$ | Percent of load converted to local solar energy | 3% | percentage | Estimated based on conservative coverage of reach codes. |
| $EF_{elec,y,i}$ | Forecasted electricity emission factor | See calculation table | MT $CO_2e$/kWh | Forecast |
| $EF_{solar,y}$ | Electricity emission factor of solar electricity | 0 | MT $CO_2e$/kWh | N/A |
| *y* | Year | 2030 | year | N/A |
| *i* | Subsector | Residential or Nonresidential | N/A | N/A |
| **Equation 2.1** | | | | |
| $Total\ Elec_{y,i}$ | Total electricity consumption | See calculation table | kWh | Play 1.1 |
| *Opt-Out Rate* | SVCE opt-out rate | 3% | percentage | Play 1.1 |

### Table 7 Local Solar GHG Emission Reduction Calculations

| Definition | Definition | Units | Sector | 2030 |
|---|---|---|---|---|
| **Equation 1.1** | | | | |
| $Total\ Elec_{y,i}$ | Total electricity consumption | kWh | Residential | 642,759,369 |
| | | | Nonresidential | 1,689,390,933 |
| $Non\text{-}SVCE\ Elec_{y,i}$ | Electricity consumption from PG&E (aka. non-SVCE electricity) | kWh | Residential | 19,282,781 |
| | | | Nonresidential | 50,681,728 |
| **Equation 1** | | | | |
| $EF_{elec,y,i}$ | Forecasted electricity emission factor | MT $CO_2e$/kWh | Residential | 0.0000016 |
| | | | Nonresidential | 0.0000014 |
| **$CO_2e\ Reduction_{NG,y,i}$** | **Electricity GHG emission reductions** | **MT $CO_2e$** | **Residential** | **0.93** |
| | | | **Nonresidential** | **2.15** |

## Play 1.3: Increase distributed electricity storage.

Play 1.3 aims to increase distributed electricity storage in Sunnyvale to store two percent of electricity demand in batteries locally by 2030. Distributed electricity storage consists of smaller capacity energy storage units located close to end consumers rather than in a few centralized locations. These systems support the transition to renewable and carbon-free electricity—and in turn support the GHG emission reductions from Play 1.1 and Play 1.2—by providing flexible, carbon-free electricity.

First, these systems prevent power fluctuations and power quality problems that may occur with renewable and carbon-free sources in the grid. The systems smooth out the timing differences between the supply of carbon-free, renewable energy (i.e., solar and wind) and the demand for energy. Solar and wind energy have variable output characteristics that mean supply will not match the energy demand at every time. Distributed electricity storage systems allow customers the flexibility to store energy when wind and solar supply is high and dispatch the stored energy when supply is low. This characteristic allows them to maintain consistent, high-quality power with a renewable grid and reduce GHG emissions by conserving renewable energy for use during times when renewable energy is not available, thereby offsetting fossil fuel-powered electricity generation.[15] Similarly, distributed energy storage systems can shield customers from outages during extreme weather events. The stored renewable and carbon-free energy can be dispatched during supply outages, increasing resilience without requiring customers to switch to fossil fuel-based energy sources.[16]

[15] Aktas, Ahmet. The Importance of Energy Storage in Solar and Wind Energy, Hybrid Renewable Energy Systems (2020). Accessed at: https://www.sciencedirect.com/science/article/abs/pii/B9780128212219000104.

[16] International Energy Agency. Unlocking the Potential of Distributed Energy Resources (2022). Accessed at: https://www.iea.org/reports/unlocking-the-potential-of-distributed-energy-resources.

# 3 Strategy 2: Decarbonizing Buildings

The City of Sunnyvale's strategy to decarbonize buildings leverages renewable and near-zero or zero-carbon electricity (provided by Strategy 1: Promoting Clean Energy) through building electrification and energy efficiency improvements. Electrifying Sunnyvale's building stock consists of transitioning natural gas stationary equipment—the equipment that heats the water we use and heats and cools the spaces we live and work in—to electric alternatives. When combined with renewable and zero-carbon electricity, all-electric buildings eliminate GHG emissions from natural gas consumption and transition to a zero-emission operational energy footprint. Further, when accounting for the increased energy efficiency of modern appliances, building electrification can be cost-effective for the community and minimize electricity demand increases. Based on this strategy, the Playbook Update's building decarbonization strategy consists of the following Plays presented in Table 8. The table also indicates which Plays are quantitative and which Plays are supportive. The following subsections detail the substantial evidence and calculation methodologies of the quantitative Plays and the role of the supportive Plays.

**Table 8 Strategy 2: Decarbonizing Buildings 2030 GHG Emission Reduction Summary**

| Play ID | Play | 2030 Play Target | 2030 GHG Emission Reductions (MT $CO_2e$) |
|---|---|---|---|
| **Strategy 2: Decarbonizing Buildings** | | | |
| Play 2.1 | Reduce energy consumption in existing buildings. | 5% of existing homes and businesses receive deep energy retrofit | Supportive |
| Play 2.2 | Support electrification of existing buildings. | 44% reduction in residential natural gas consumption; and 38% reduction in commercial natural gas consumption | 108,935 |
| Play 2.3 | Achieve all-electric new construction. | 100% all-electric new construction | 75,786 |
| **Total** | | | **184,720** |

## Play 2.1: Reduce energy consumption in existing buildings.

Play 2.1 aims to reduce energy consumption in existing buildings by providing deep energy retrofits to five percent of existing buildings by 2030. While this reduction in energy consumption may provide GHG emission reductions, there is a high potential for double counting these GHG emission reductions as buildings are electrified (Play 2.2 and Play 2.3) and 100 percent renewable and carbon-free electricity is achieved (Strategy 1: Promote Clean Energy). Therefore, this Play is classified as supportive rather than quantified as it does, support these clean energy and electrification Plays.

When combined with electrification, energy efficiency improvements can support electrification by reducing utility bills over the long run and enabling better grid management by making room for added electrical load.[17, 18] The Cost Effectiveness Explorer for California local governments demonstrates that energy efficiency measures—such as light-emitting diode (LED) installations, ductwork sealing, insulation improvements, and heat pump installations—make electrification cost-effective in Sunnyvale for existing and new buildings—especially when combined with the installation of solar photovoltaics.[19] These energy efficiency improvements also decrease the demand existing appliances put on electrical infrastructure, making room for additional electricity demand from electrification projects.

[17] American Council for an Energy-Efficient Economy (ACEEE). Electrification and Efficiency: Crafting an Enduring Relationship (2019). Accessed at: https://www.aceee.org/blog/2019/01/electrification-and-efficiency.

[18] Institute for Market Transformation (IMT). Stronger Together: Why Efficiency with Electrification Catalyzes Systems Change (2020). Accessed at: https://www.imt.org/news/stronger-together-why-efficiency-with-electrification-catalyzes-systems-change/.

[19] California Energy Codes & Standards. The Cost Effectiveness Explorer. Accessed at: https://explorer.localenergycodes.com/jurisdiction/sunnyvale-city/study-results/4-PGE?only_study_type=existing-buildings.

## Play 2.2: Support electrification of existing buildings.

Play 2.2 puts Sunnyvale on a path to reduce residential natural gas consumption 44 percent and commercial natural gas consumption 38 percent by 2030 to reduce GHG emissions. The primary Moves that enable this level of adoption include both the Moves for the adoption and enforcement of replace on burnout ordinances (Move 2.G, Move 2.J, and Move 2.K) and the Moves that achieve early retirement of natural gas appliances and equipment (Move 2.D, Move 2.L, and Move 2.M).

**Move 2.G** and **Move 2.J** commit the City to adopting residential and commercial electrification ordinances by 2026 to require HVAC system and hot water heater replacements to be all-electric; and **Move 2.K** commits the City to increasing community compliance with the ordinances by implementing a comprehensive permitting compliance program.

These ordinances will prepare Sunnyvale residents and businesses to comply with the Bay Area Air Quality Management District's (BAAQMD) amendments to Rule 9-4: Nitrogen Oxides from Fan Type Residential Central Furnaces and Rule 9-6: Nitrogen Oxides Emissions from Natural Gas-Fired Boilers and Water Heaters. These rules govern point of sale emission standards for space and water heating systems starting January 1, 2027. The only technologies currently available that meet the amended indoor air quality rules are electric space and water heating systems. Although there are a range of electric alternatives (e.g. electric resistance space heating), heat pump HVAC and heat pump water heaters are the most cost-effective option on the market due to their significantly higher efficiency (300 to 400 percent) and resulting lower operating costs.[20] These Moves target electric HVAC and water heater replacements specifically to prepare property owners and contractors for the BAAQMD rules and require electrification to save homeowners and property owners costs from duplicative or future infrastructure upgrades.

The City's permit compliance program will work to increase compliance with the electric replacements required by the ordinances. Although permits are required for many energy efficiency improvements (e.g., water heaters, insulation, HVAC systems, duct replacement) many jurisdictions face permit evasion issues, with permitted HVAC systems only accounting for eight to about 30 percent of total installations.[21, 22] This trend in permit evasion means jurisdictions face issues determining compliance with building ordinances and codes. Strategies that have proven effective at improving permit compliance in various states and local jurisdictions include streamlining the compliance process, improving third-party enforcement, and advanced training for enforcement staff—all actions Sunnyvale's permit compliance program will implement to compliment the electrification ordinances.[23] Sunnyvale will monitor permit numbers to estimate compliance rates and adjust the permit program strategies as needed to achieve a 85 percent compliance rate with

[20] Redwood Energy. A Pocket Guide to All-Electric Retrofits of Commercial Buildings (2022). Accessed at: https://assets-global.website-files.com/62b110a14473cb7777a50d28/6377e7c7fd6f8cc30f88afa7_Redwood%20Energy-s%20Pocket%20Guide%20to%20All-Electric%20Commercial%20Retrofits.pdf.

[21] Emily Alvarez and Bruce Mast. BayREN Codes & Standards Program. Local Government Policy Calculator for Existing Single-Family Buildings – User Guide (2021). Accessed at: https://www.bayrencodes.org/wp-content/uploads/2021/11/BayREN-Policy-Calculator-User-Guide_10.29.2021.pdf.

[22] California Public Utilities Commission (CPUC). Final Report: 2014-16 HVAC Permit and Code Compliance Market Assessment (Work Order 6) Volume I – Report (2017). Accessed at: http://www.calmac.org/publications/HVAC_WO6_FINAL_REPORT_VolumeI_22Sept2017.pdf.

[23] Ryan Meres et al. American Council for an Energy-Efficient Economy (ACEEE). Successful Strategies for Improving Compliance with Building Energy Codes (2012). Accessed at: https://www.aceee.org/files/proceedings/2012/data/papers/0193-000112.pdf.

the electrification ordinances.[24] Sunnyvale will also work with SVCE and Bay Area Regional Energy Network (BayREN) to design comprehensive outreach efforts to educate contractors on requirements and techniques for electric and heat pump replacements; and help property owners identify qualified/knowledgeable contractors.

Together, these Moves, will reduce residential natural gas consumption by 20 percent and commercial natural gas consumption by 17 percent by 2030 through the replace on burnout ordinances and the permit compliance program.

Table 9 shows the parameters and data sources that support these electrification ordinance GHG emission reductions and Table 10 shows the calculations as outlined in Equations 3 through 3.5.

### Existing Building Electrification Ordinance Equations

Equation 3 $CO_2e\ Reduction_{NG,y,i}=(Fuel\ Avoided_{NG,y,i}*EF_{NG})-(Elec\ Converted_{y,i}*EF_{elec,y,i})$

Equation 3.1 $Fuel\ Avoided_{NG,y,i}=Fuel_{NG,y,i}*Reduction_{NG,y,i}$

Equation 3.2 $Reduction_{NG,y,i}=(EOL_{NG,y,i,wh}*Fuel\ Share_{NG,i,wh})+(EOL_{NG,y,i,HVAC}*Fuel\ Share_{NG,i,HVAC})$

Equation 3.3 $EOL_{NG,y,i,wh}=1/LSP_{i,wh}*(y\text{-}imp.y_i)*(1\text{-}NCR_i)$

Equation 3.4 $EOL_{NG,y,i,HVAC}=1/LSP_{i,HVAC}*(y\text{-}imp.y_i)*(1\text{-}NCR_i)$

Equation 3.5 $Elec_{convert,y,i}=Fuel\ _{AvoidedNG,y,i}*CF_{elec}/Eff_{elec}$

### Table 9 Existing Building Electrification Ordinance Parameters and Data Sources

| Variable | Definition | Value | Unit | Data Source |
|---|---|---|---|---|
| **Equation 3** | | | | |
| $CO_2e\ Reduction_{NG,y,i}$ | Natural gas GHG emission reductions | See calculation table | MT $CO_2e$ | Calculated |
| $Fuel\ Avoided_{NG,y,i}$ | Natural gas consumption avoided | See calculation table | therms | Calculated |
| $EF_{NG}$ | Natural gas emission factor | 0.005321 | MT $CO_2e$/therm | Inventory & Forecast |
| $Elec\ Converted_{y,i}$ | Electricity usage from conversion | See calculation table | kWh | Calculated |
| $EF_{elec,y,i}$ | Forecasted electricity emission factor | See calculation table | MT $CO_2e$/kWh | Forecast |
| $y$ | Year | 2030 | year | N/A |
| $i$ | Subsector | Residential or Nonresidential | N/A | N/A |
| **Equation 3.1** | | | | |
| $Fuel_{NG,y,i}$ | Forecasted natural gas consumption after new building electrification (Play 2.3) | See calculation table | therms | Forecast |
| $Reduction_{NG,y,i}$ | Natural gas reduction percent | See calculation table | percentage | N/A |

[24] BAAQMD recently adopted zero nitrogen oxide (NOx) standards for building appliances. These rules require natural gas-fired furnaces and water heaters installed in 2027 and onward to emit zero NOx emissions. These rules will compliment Sunnyvale's electrification ordinance (because electric appliances meet the standards) and strengthen the need for permit compliance in Sunnyvale to demonstrate compliance to BAAQMD. BAAQMD. Air District Strengthens Building Appliance Rules to Reduce Harmful NOx Emissions, Protect Air Quality and Public Health (2023). Accessed at: https://www.baaqmd.gov/news-and-events/page-resources/2023-news/031523-ba-rules.

| | | | | |
|---|---|---|---|---|
| **Equation 3.2** | | | | |
| $EOL_{NG,y,i,wh}$ | Percent of water heaters reaching end-of-life | See calculation table | percentage | N/A |
| *Fuel* $Share_{NG,i,wh}$ | Percent of sector natural gas consumption from water heaters | See below rows | | |
| *Fuel* $Share_{NG,Residential,wh}$ | Percent of residential natural gas consumption from water heaters | 50% | percentage | SVCE. Buildings Baseline Study. Appendix C (2020).[25] |
| *Fuel* $Share_{NG,Nonresidential,wh}$ | Percent of nonresidential natural gas consumption from water heaters | 35% | percentage | Ibid. |
| $EOL_{NG,y,i,HVAC}$ | Percent of HVAC units reaching end-of-life | See calculation table | percentage | |
| *Fuel* $Share_{NG,i,HVAC}$ | Percent of sector natural gas consumption from HVAC units | See below rows | | |
| *Fuel* $Share_{NG,Residential,HVAC}$ | Percent of residential natural gas consumption from HVAC units | 44% | percentage | SVCE. Buildings Baseline Study. Appendix C (2020).[25] |
| *Fuel* $Share_{NG,Nonresidential,HVAC}$ | Percent of nonresidential natural gas consumption from HVAC units | 35% | percentage | Ibid. |
| **Equation 3.3** | | | | |
| $LSP_{i,wh}$ | Average water heater lifespan in sector | See below rows | | |
| $LSP_{Residential,wh}$ | Average residential water heater lifespan | 13 | years | U.S. Energy information Administration. Updated Buildings Sector Appliance and Equipment Costs and Efficiencies (2023).[26] |
| $LSP_{Nonresidential,wh}$ | Average nonresidential water heater lifespan | 10 | years | Ibid. |
| $imp.y_i$ | Ordinance implementation year | See calculation table | year | N/A |
| $NCR_i$ | Ordinance noncompliance rate | 15% | percentage | Estimate based on permit evasion rates and strategies to increase building code compliance.[21, 22, 23] |
| **Equation 3.4** | | | | |
| $LSP_{i,HVAC}$ | Average HVAC unit lifespan in sector | See below rows | | |
| $LSP_{Residential,HVAC}$ | Average residential HVAC unit lifespan | 21.5 | years | U.S. Energy information Administration. Updated Buildings Sector Appliance and Equipment Costs and Efficiencies (2023).[26] |

[25] SVCE. Appendices Buildings Baseline Study. Accessed at: https://www.svcleanenergy.org/wp-content/uploads/2020/02/Appendices-SVCE-Buildings-Baseline-Study_FINAL.pdf

[26] U.S. Energy Information Administration. Updated Buildings Sector Appliance and Equipment Costs and Efficiencies (2023). Accessed at: https://www.eia.gov/analysis/studies/buildings/equipcosts/pdf/full.pdf

| | | | | |
|---|---|---|---|---|
| $LSP_{Nonresidential,HVAC}$ | Average nonresidential HVAC unit lifespan | 23 | years | Ibid. |
| **Equation 3.5** | | | | |
| $CF_{elec}$ | Electricity to therms conversion factor | 29.3 | kWh/therm | Metric Conversions[27] |
| $Eff_{elec}$ | Efficiency factor of electric equipment relative to natural gas equipment | 3 | unitless | European Copper Institute[28] |

[27] Metric Conversions. Therms (US) to Kilowatt-hours. Accessed at: https://www.metric-conversions.org/energy-and-power/therms-us-to-kilowatt-hours.htm.

[28] European Copper Institute. Heat Pumps: Integrating technologies to decarbonise heating and cooling (2018). Accessed at: https://help.leonardo-energy.org/hc/en-us/articles/203047881-How-efficient-is-a-heat-pump-.

### Table 10 Existing Building Electrification Ordinance GHG Emission Reduction Calculations

| Definition | Definition | Units | Sector | 2030 |
|---|---|---|---|---|
| **Equation 3.1** | | | | |
| $Fuel_{NG,y,i}$ | Forecasted natural gas consumption after new building electrification (Play 2.3) | therms | Residential | 21,357,897 |
| | | | Nonresidential | 29,325,481 |
| $Reduction_{NG,y,i}$ | Natural gas reduction percent | percentage | Residential | 20% |
| | | | Nonresidential | 17% |
| $Fuel\ Avoided_{NG,y,i}$ | Natural gas consumption avoided | therms | Residential | 4,298,957 |
| | | | Nonresidential | 5,007,007 |
| **Equation 3.3 & Equation 3.4** | | | | |
| $EOL_{NG,y,i,wh}$ | Percent of water heaters reaching end-of-life since ordinance implementation | percentage | Residential | 26% |
| | | | Nonresidential | 34% |
| $EOL_{NG,y,i,HVAC}$ | Percent of HVAC units reaching end-of-life since ordinance implementation | percentage | Residential | 16% |
| | | | Nonresidential | 15% |
| $imp.y_i$ | Ordinance implementation year | year | Residential | 2026 |
| | | | Nonresidential | 2026 |
| **Equation 3.5** | | | | |
| $Elec\ Converted_{y,i}$ | Electricity usage from conversion | kWh | Residential | 41,986,476 |
| | | | Nonresidential | 48,901,769 |
| **Equation 3** | | | | |
| $EF_{elec,y,i}$ | Forecasted electricity emission factor | MT $CO_2$e/kWh | Residential | 0.0000016 |
| | | | Nonresidential | 0.0000014 |
| ***$CO_2$e Reduction$_{NG,y,i}$*** | **Natural gas GHG emission reductions** | **MT $CO_2$e** | **Residential** | **22,809** |
| | | | **Nonresidential** | **26,575** |

The remaining 24 percent of residential natural gas consumption and 21 percent of commercial natural gas consumption that is planned to be reduced by 2030 will occur through voluntary replacements of gas appliances with electric appliances due to a combination of factors.

First, currently available incentives will help continue the natural growth in electric space and water heaters seen in California over the past decade. According to Opinion Dynamics' *California Heat Pump Residential Market Characterization and Baseline Study* (2022), electric space heaters have grown from a five percent market share in 2009 to a 20 percent market share in 2019. Likewise, electric water heaters have grown from a six percent market share in 2009 to an 11 percent market share in 2019.[29] This natural trend is not only expected to continue through 2030 as electric appliances become more efficient and more cost-effective, but also be accelerated when coupled with the large amount of federal, State, regional, and SVCE funding available for Sunnyvale community members to replace their space and water heating appliances with electric or heat pump alternatives. While the total amount of funding available will change with sunset dates and

[29] Opinion Dynamics. California Heat Pump Residential Market Characterization and Baseline Study (2022). Accessed at: https://pda.energydataweb.com/#!/documents/2625/view.

budget cycles, the currently available federal (i.e., High Efficiency Electric Home Rebate [HEEHRA], Homeowner Managing Energy Savings [HOMES] Rebate, Inflation Reduction Act), State (i.e., TEHC Clean California), regional (i.e., BayRENHome+ Program, Bay Area Multifamily Building Enhancements [BAMBE] Program), and local (i.e., SVCE's rebates for California Alternate Rates for Energy [CARE] and Family Electric Rate Assistance Program [FERA] customers) funding incentivizes low- and middle-income residents in Sunnyvale to install heat pump space and water heaters at no additional cost compared to gas space and water heaters. In some cases, such customers will even be able to install the heat pump water heaters for free.[30] This substantial amount of funding available to Sunnyvale residents and businesses will help drive the voluntary market trend for electric space and water heating appliances through 2030.

Second, Sunnyvale will support these trends to accelerate electrification by supporting a series of technical assistance programs and direct incentives to achieve early retirement of natural gas equipment. **Move 2.D** directs the City to work with SVCE and BayREN to offer robust incentives for residents and businesses to replace natural gas equipment with electric alternatives and upgrade supporting infrastructure before the natural gas equipment reach their end-of-life. This Move will continue and expand the local funding (i.e., SVCE's rebates for CARE and FERA customers) currently available in Sunnyvale. The Move also direct the City to work with SVCE and BayREN to educate the community about the benefits of heat pumps and availability of incentives. **Move 2.L** directs the City to develop a Building Performance Standard for large, existing commercial buildings that requires electrification before 2030 by setting GHG emissions requirements (e.g., GHG emissions per square foot) in line with the City's GHG emissions reductions targets. Lastly, **Move 2.M** directs the City to work with community partners to implement community-support programs that provide the technical assistance and incentives needed to make residential building electrification accessible and affordable to the community. It also directs the City to work with community partners to supply utilities at rates that support electrification because heat pump adoption in the U.S. is strongly correlated with electricity prices.[31]

With a focus on outreach, incentives, cost-effective utility rates, and technical assistance, these Moves, along with the existing market trends and available incentives, will help capture the remaining equipment replacements needed to reduce GHG emissions from natural gas consumption that the electrification ordinances do not cover (i.e., replacements before equipment reaches end-of-life). These Moves will help accelerate equipment replacements in Sunnyvale, as demonstrated as possible in Europe where, in 2022 alone, heat pump sales grew by over 40 percent.[32] Because early retirement of natural gas appliances and equipment is more aggressive than actions needed to align with State goals and regulations, the City will need to monitor and scale their level of effort over time to meet the ambitious targets of this Play. The Moves will be monitored, scaled, and adjusted (through the Game Plan Update process outlined in "The Playing Field" section of the plan) to reach the targeted level of residential and commercial natural gas consumption reductions.

Table 11 shows the parameters and data sources that support these electrification programs and incentives for early retirement and Table 12 shows the GHG emissions reductions as outlined in Equations 4 through 4.2.

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[30] Rincon Consultants, Inc. Installation Costs for Zero-NOx Space and Water Heating Appliances (2024).

[31] Davis, Lucas W. The Economic Determinants of Heat Pump Adoption (2024). National Bureau of Economic Research. Accessed at: https://faculty.haas.berkeley.edu/ldavis/Davis%20NBER%20EEPE%202024.pdf.

[32] International Energy Agency. Heat Pumps. Accessed at: https://www.iea.org/energy-system/buildings/heat-pumps.

## Existing Building Technical Assistance and Incentive Program Equations

Equation 4 $CO_2e\ Reduction_{NG,y,i} = (Fuel\ Avoided_{NG,y,i} * EF_{NG}) - (Elec\ Converted_{y,i} * EF_{elec,y,i})$

Equation 4.1 $Fuel\ Avoided_{NG,y,i} = Fuel_{NG,y,i} * Reduction_{NG,y,i}$

Equation 4.2 $Elec_{convert,y,i} = Fuel_{AvoidedNG,y,i} * CF_{elec} / Eff_{elec}$

**Table 11 Existing Building Technical Assistance and Incentive Program Parameters and Data Sources**

| Variable | Definition | Value | Unit | Data Source |
|---|---|---|---|---|
| **Equation 4** | | | | |
| $CO_2e\ Reduction_{NG,y,i}$ | Natural gas GHG emission reductions | See calculation table | MT $CO_2e$ | Calculated |
| $Fuel\ Avoided_{NG,y,i}$ | Natural gas consumption avoided | See calculation table | therms | Calculated |
| $EF_{NG}$ | Natural gas emission factor | 0.005321 | MT $CO_2e$/therm | Inventory & Forecast |
| $Elec\ Converted_{y,i}$ | Electricity usage from conversion | See calculation table | kWh | Calculated |
| $EF_{elec,y,i}$ | Forecasted electricity emission factor | See calculation table | MT $CO_2e$/kWh | Forecast |
| *y* | Year | 2030 | year | N/A |
| *i* | Subsector | Residential or Nonresidential | N/A | N/A |
| **Equation 4.1** | | | | |
| $Fuel_{NG,y,i}$ | Forecasted natural gas consumption after new building electrification (Play 2.3) | See calculation table | therms | Forecast |
| $Reduction_{NG,y,i}$ | Natural gas reduction percent for sector | | | |
| $Reduction_{NG,y,i}$ | Residential natural gas reduction percent | 24 | percentage | Estimated based on the level of residential reductions targeted from early retirement of natural gas equipment by monitoring, scaling, and adjusting outreach, incentives, utility rates, and technical assistance programs. |
| $Reduction_{NG,y,i}$ | Nonresidential natural gas reduction percent | 21 | percentage | Estimated based on the level of nonresidential reductions targeted from early retirement of natural gas equipment by monitoring, scaling, and adjusting outreach, incentives, utility rates, and technical assistance programs. |
| **Equation 4.2** | | | | |
| $CF_{elec}$ | Electricity to therms conversion factor | 29.3 | kWh/therm | Metric Conversions[33] |
| $Eff_{elec}$ | Efficiency factor of electric equipment relative to natural gas equipment | 3 | unitless | European Copper Institute[34] |

[33] Metric Conversions. Therms (US) to Kilowatt-hours.

[34] European Copper Institute. Heat Pumps: Integrating technologies to decarbonise heating and cooling (2018).

## Table 12 Existing Building Technical Assistance and Incentive Program GHG Emission Reduction Calculations

| Variable | Definition | Units | Sector | 2030 |
|---|---|---|---|---|
| **Equation 4.1** | | | | |
| $Fuel_{NG,y,i}$ | Forecasted natural gas consumption after new building electrification (Play 2.3) | therms | Residential | 21,357,897 |
| | | | Nonresidential | 29,325,481 |
| *Fuel Avoided*$_{NG,y,i}$ | Natural gas consumption avoided | therms | Residential | 5,184,036 |
| | | | Nonresidential | 6,037,861 |
| **Equation 4.2** | | | | |
| *Elec Converted*$_{y,i}$ | Electricity usage from conversion | kWh | Residential | 50,630,750 |
| | | | Nonresidential | 58,969,781 |
| **Equation 4** | | | | |
| $EF_{elec,y,i}$ | Forecasted electricity emission factor | MT $CO_2$e/kWh | Residential | 0.0000016 |
| | | | Nonresidential | 0.0000014 |
| ***$CO_2$e Reduction***$_{NG,y,i}$ | **Natural gas GHG emission reductions** | **MT $CO_2$e** | **Residential** | **27,505** |
| | | | **Nonresidential** | **32,046** |

## Play 2.3: Achieve All-electric new construction.

Move 2.E commits the City to continue implementing and augmenting the reach codes that require all-electric new construction. In 2021, Sunnyvale adopted reach codes for residential and commercial developments that require new construction to be all-electric. The reach codes include exemptions for certain high-rise multi-family buildings and nonresidential buildings (i.e., F, H, and L occupancies, unavoidable gas applications, Emergency Operation Centers, commercial dryers in large hotels) but require the exempt buildings be prewired for future electric appliances.[35, 36]

Since these reach codes were adopted in 2021, they were not included in Sunnyvale's 2019 inventory nor the adjusted forecast and are instead included in the Playbook Update as part of **Move 2.N** to allow the City to accurately account for the GHG emissions reductions. While the reach codes currently have exemptions that allow some buildings to be constructed with natural gas, this Play assumes 100 percent of new construction will be all-electric. To account for the new construction that may utilize the exemptions, this assumption is also incorporated into Sunnyvale's CEQA GHG Emissions Thresholds and CEQA GHG Emissions Analysis Compliance Checklist. This means new buildings that utilize the exceptions will need to mitigate the GHG emissions associated with their natural gas use below the GHG emissions level that they would have with all-electric construction. Thus, the GHG emission reductions from this Play are based on the forecasted residential and commercial building growth in the City and the assumption that 100 percent of new buildings will be all-electric. Table 13 shows the parameters and data sources that support these electrification GHG emission reductions and Table 14 shows the calculations as outlined in Equations 5 through 5.1.

### All-electric New Construction Equations

Equation 5 $CO_2e\ Reduction_{NG,y,i}=(Fuel\ Avoided_{NG,y,i}*EF_{NG})-(Elec\ Converted_{y,i}*EF_{elec,y,i})$

Equation 5.1 $Fuel\ Avoided_{NG,y,i}=Fuel_{NG,y,i}-Fuel_{NG,imp.yi}$

Equation 5.2 $Elec_{convert,y,i} = Fuel_{\ AvoidedNG,y,i}*CF_{elec}/Eff_{elec}$

35 City of Sunnyvale. Single-Family, Duplex, and Townhome Reach Codes (Rev 1/2023).

36 City of Sunnyvale. Nonresidential and Multifamily Reach Codes (2021).

## Table 13 All-electric New Construction Parameters and Data Sources

| Variable | Definition | Value | Unit | Data Source |
|---|---|---|---|---|
| **Equation 5** | | | | |
| $CO_2e\ Reduction_{NG,y,i}$ | Natural gas GHG emission reductions | See calculation table | MT $CO_2e$ | Calculated |
| $Fuel\ Avoided_{NG,y,i}$ | Natural gas consumption avoided | See calculation table | therms | Calculated |
| $EF_{NG}$ | Natural gas emission factor | 0.005321 | MT $CO_2e$/therm | Inventory & Forecast |
| $Elec\ Converted_{y,i}$ | Electricity usage from conversion | See calculation table | kWh | Calculated |
| $EF_{elec,y,i}$ | Forecasted electricity emission factor | See calculation table | MT $CO_2e$/kWh | Inventory & Forecast |
| $y$ | Year | 2030 | year | N/A |
| $i$ | Subsector | Residential or Nonresidential | N/A | N/A |
| **Equation 5.1** | | | | |
| $Fuel_{NG,y,i}$ | Forecasted natural gas consumption | See calculation table | therms | Forecast |
| $Fuel_{NG,imp.y}$ | Forecasted natural gas in implementation year | See calculation table | therms | Calculated |
| $imp.y_i$ | Ordinance implementation year | See calculation table | year | N/A |
| **Equation 5.2** | | | | |
| $CF_{elec}$ | Electricity to therms conversion factor | 29.3 | kWh/therm | Metric Conversions.[37] |
| $Eff_{elec}$ | Efficiency factor of electric equipment relative to natural gas equipment | 3 | unitless | European Copper Institute[38] |

[37] Metric Conversions. Therms (US) to Kilowatt-hours.

[38] European Copper Institute. Heat Pumps: Integrating technologies to decarbonise heating and cooling (2018).

**Table 14 All-electric New Construction GHG Emission Reduction Calculations**

| Definition | Definition | Units | Sector | 2030 |
|---|---|---|---|---|
| **Equation 5.1** | | | | |
| $Fuel_{NG,y,i}$ | Forecasted natural gas consumption | therms | Residential | 29,421,612 |
| | | | Nonresidential | 35,543,481 |
| $imp.y_i$ | Ordinance implementation year | year | Residential | 2021 |
| | | | Nonresidential | 2021 |
| $Fuel_{NG,imp.y}$ | Forecasted natural gas in implementation year | therms | Residential | 21,357,897 |
| | | | Nonresidential | 29,325,481 |
| $Fuel\ Avoided_{NG,y,i}$ | Natural gas consumption avoided | therms | Residential | 8,063,714 |
| | | | Nonresidential | 6,218,000 |
| **Equation 5.2** | | | | |
| $Elec\ Converted_{y,i}$ | Electricity usage from conversion | kWh | Residential | 78,755,609 |
| | | | Nonresidential | 60,729,135 |
| **Equation 5** | | | | |
| $EF_{elec,y,i}$ | Forecasted electricity emission factor | MT $CO_2e$/kWh | Residential | 0.0000016 |
| | | | Nonresidential | 0.0000014 |
| ***CO2e Reduction*** $_{NG,y,i}$ | **Natural gas GHG emission reductions** | **MT $CO_2e$** | **Residential** | **42,783** |
| | | | **Nonresidential** | **33,003** |

# 4 Strategy 3: Decarbonizing Transportation & Sustainable Land Use

The City of Sunnyvale's strategy to decarbonize transportation aims to reduce vehicle miles traveled (VMT) and leverage renewable and zero-carbon electricity (provided by Strategy 1: Promoting Clean Energy) to reduce GHG emissions from the transportation system. Reducing VMT consists of transitioning Sunnyvale residents and visitors out of single-occupancy vehicles and into active transportation mode options (i.e., walking and biking) and public and shared transit options (e.g., public buses, rail, carpools) by improving these mode options and choosing efficient land use development options. The remaining VMT will then be decarbonized by increasing the adoption of zero-emission vehicles. When combined with renewable and zero-carbon electricity, electric vehicles eliminate GHG emissions from fossil fuel combustion and transition to a zero-emission operational footprint. Additionally, the strategy targets off-road equipment and vehicles for decarbonization. Based on this strategy, the Playbook Update's transportation decarbonization and sustainable land use strategy consists of the following Plays presented in Table 15. The table also indicates which Plays are quantitative and which Plays are supportive. The following subsections detail the substantial evidence and calculation methodologies of the quantitative Plays and the role of the supportive Plays.

**Table 15 Strategy 3: Decarbonizing Transportation & Sustainable Land Use 2030 GHG Emission Reduction Summary**

| Play ID | Play | 2030 Play Target | 2030 GHG Emission Reductions (MT $CO_2e$) |
|---|---|---|---|
| **Strategy 3: Decarbonizing Transportation & Sustainable Land Use** | | | |
| Play 3.1 | Increase opportunities for and encourage development of mixed-use sites to reduce vehicle miles per person | 20% reduction in vehicle miles per person | 66,162 |
| Play 3.2 | Increase transportation options and support shared mobility | | |
| Play 3.3 | Increase zero-emission vehicles | 42% of all vehicles on road are zero-emission vehicles | 98,079 |
| Play 3.4 | Decarbonize off-road vehicles and equipment | 30% of all vehicles and equipment off road are zero-emission | 15,753 |
| **Total** | | | **179,994** |

## Play 3.1 and Play 3.2: Increase opportunities for and encourage development of mixed-use sites to reduce vehicle miles per person and increase transportation options and support shared mobility.

Plays 3.1 and 3.2 aim to reduce, on average, VMT per person by 20 percent by 2030 to reduce GHG emissions from transportation. The primary Moves that enable this target include:

- **Move 3.A** which commits the City to identify areas that are most appropriate for parking strategies that discourage vehicle use, such as pricing, time limits, and supply reduction.
- **Move 3.B** which enhances the City's Transportation Demand Management (TDM) program implementation and monitoring to facilitate further reductions in single-occupant automobile trips, citywide.
- **Move 3.C** which directs the City to work with regional service providers to implement high quality transit service and a robust set of first- and last-mile strategies in over two-thirds of the cross-City corridors.
- **Move 3.D** which commits the City to update and implement the Active Transportation Plan to achieve a connected, safe, and active network.
- **Move 3.I** which directs the City to establish and implement a plan to convert vehicle roadways to bicycle and pedestrian space to increase opportunities for active transportation in the community.
- **Move 3.J** which commits the City to require employers with 1,000 employees and more to develop and implement Transportation Demand Management (TDM) programs with subsidies for employees to bike, walk, or carpool.
- **Move 3.K** which commits the City to establish tracking metrics to evaluate the effectiveness of the above Moves' impact on VMT, establish a monitoring schedule to report progress, and revise the above Moves accordingly based on a VMT progress report.

These Moves are among the suite of measures provided by the California Air Pollution Control Officers Association (CAPCOA) to reduce VMT and the associated GHG emissions.[39] Together, the Moves target increase in neighborhood connectivity, active transportation, and public transit use among Sunnyvale's residents, employees, and visitors as well as encourage use of alternative mobility options over single-occupancy vehicles using land use design and parking management strategies.

Sunnyvale requires new developments and redevelopments of high-industrial, office developments, and multi-family residences to implement TDM programs through the municipal code.[40] TDM programs are defined as the incorporation of a variety of incentives or disincentives, services, and actions that influence the reduction of automobile trips, such as promoting work related transit use, ridesharing, walking and bicycling to work, and flexible work schedules (i.e., work from home) as well as offering services such as employee-sponsored vanpool, subsidized transit passes, implementing employee parking cash-out programs or pricing workplace parking. Move 3.B commits the City to enhancing the monitoring and implementation of this mandatory ordinance thereby improving its effectiveness. Move 3.J builds on this program by directing the City to expand

[39] California Air Pollution Control Officers Association (CAPCOA). Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity (2021). Accessed at: https://www.caleemod.com/documents/handbook/full_handbook.pdf.

[40] Sunnyvale Municipal Code Chapters 19.45 and 10.60 (https://ecode360.com/42731260)

the requirement to existing employers in the City with 1,000 or more employees.[41, 42] This requirement will cover about 60 percent of employees in the City,[43] increasing the coverage of the TDM program and impacting the VMT by these employees. While the City will develop specific reduction targets for VMT in the program, a multiyear study on the implementation of a mandatory commute trip reduction program at Genentech's South San Francisco campuses demonstrated a 26 percent reduction in employee commute vehicle miles traveled and associated GHG emissions.[44] In addition to redevelopment of Sunnyvale land-use to a transit-oriented, mixed-use housing near job centers, TDM program development, such as the adopted Moffett Park Specific Plan,[45] further promotes the transition out of single occupancy vehicles for employee commuting. According to census data, since 2019, vehicle commuting in Sunnyvale has decreased by approximately 16 percent while work from home has increased from 4 to 25 percent.[46] With TDM program enforcement, City land use redevelopment, and continued work from home behaviors, employee commute VMT has the potential to be reduced by up to 32 percent by 2030. Based on Bureau of Transportation Statistics, approximately 20 percent of all annual passenger miles traveled are for commuting to and from work.[47] As such, the Moves reducing employee commute VMT has the potential to reduce total passenger VMT by approximately 7 percent.[48]

In terms of public transit, the City recognizes that its jurisdiction is limited to the boundaries of Sunnyvale; however, a public transit network that effectively reduces VMT is regional in nature and crosses city boundaries. For this reason, Move 3.C directs the City to work with regional service providers to increase the coverage and improve the quality of public transit in Sunnyvale. Before COVID-19, the City of San Francisco led the State with 26 percent public transportation mode share in 2017. Although the transit mode share has decreased in recent years due to COVID-19 and work from home trends, the City of San Francisco still reports a mass transit mode share of over 10 percent.[49] Key strategies employed by cities looking to increase public transportation mode share include significant expansions of public transportation service lines, designated streets or lanes for

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41 Division of Transportation and Traffic, City of Sunnyvale. Transportation Demand Management (TDM) Program Guidelines (Rev 10/2016). Accessed at: https://www.sunnyvale.ca.gov/home/showpublisheddocument/2862/637822670459570000.

42 City of Sunnyvale. Transportation Demand Management, Chapter 19.45 of Municipal Code. Accessed at: https://library.qcode.us/lib/sunnyvale_ca/pub/municipal_code/item/title_19-article_4-chapter_19_45.

43 In March 2023, Sunnyvale had 13 employers with 1,000 or more employees, accounting for a total of 57,514 employees. This employee count represents about 60 percent of the jobs forecasted for 2023 in Sunnyvale's GHG Forecast.

City of Sunnyvale. 25 Largest Employers – March 2023. Accessed at: https://www.sunnyvale.ca.gov/business-and-development/economic-development/community-and-business-profiles.

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

45 Moffett Park Specific Plan was adopted in July 2023 and lays out a plan to redevelop the northern portion of the city, where Sunnyvale's largest employment centers lie, into a climate smart community that is fully interconnected with bicycle, pedestrian and transit routes, encompassed mixed-use housing an, job centers and other amenities to reduce daily travel distance for residents. Accessed at: https://www.moffettparksp.com/

46 https://data.census.gov/table/ACSST5Y2022.S0801?q=Sunnyvale%20city,%20California&t=Commuting&tid=ACSST5Y2019.S0801

47 https://www.bts.gov/content/average-annual-pmt-vmt-person-trips-and-trip-length-trip-purpose

48 VMT reduction related to TDM measures was quantified by taking into account commuter VMT reduction based on census data work from home trends, assuming work from home trends would be supported by employers, and using CAPCOA T-5 methodology that quantified VMT reduction for the implementation of a mandatory commute trip reduction program that is monitored and includes penalties for non-compliance. See reference 44 for calculation details.

49 https://sfgov.org/scorecards/transportation/non-private-auto-mode-share

bus lines to decrease headways, implementation of taxes to support transit, and reduced parking availability. Studies which incorporated factors such as elasticity of transit demand and average mode shift factors have estimated that doubling transit coverage (e.g., areas serviced or hours) in a city can reduce VMT—and associated GHG emissions—up to 4.6 percent.[50] Studies have also shown that increasing the frequency of transit service (up to 300 percent) can produce a maximum reduction in VMT—and associated GHG emissions—of 11.3 percent.[51] With the focus of Move 3.C on approximately two-thirds of the cross-City corridors and the level of redevelopment planned in the City to create a more connected and reliable network of transit (e.g., Moffett Park Transit Oriented Development Zoning Districts), it is reasonable to estimate that Sunnyvale can expect a 4 percent reduction in passenger VMT in the City.[52] This estimate is considered conservative to account for the census observed reduction in public transit use in the City from 7 percent transit use in 2019 to 4 percent in 2022, that is largely attributed to COVID-19 impacts.[53] While conservatively excluded from the quantification of GHG emissions reduction herein, Moves 3.E and 3.F, which include the evaluation of micro-transit programs and shuttle services in redeveloped areas, like Peery Park, have also been shown to increase transit mode share if they become a permanent program by increasing access and convenience of regional or cross-City transit.[54]

The City will also improve opportunities for active transportation through Move 3.D. Sunnyvale developed and adopted an Active Transportation Plan in 2020, which commits Sunnyvale to increase the miles of bikeways in the City from about 90 miles to about 160 miles to support the overall goal to increase bicycle mode share from 1.5 percent to 5 percent by 2030.[55] This Move commits the City to updating this plan with additional bikeway expansions, as needed, and implementing it by 2030. Expansions of and investments in active transportation infrastructure such as those directed by this Move have demonstrated reductions in VMT and associated GHG emissions.[56] Specifically, urban cities that make a strong commitment to bicycle travel can see up to an 11 percent reduction in VMT and associated GHG emissions. [57] Similar reductions can be reasonably expected because in 2017, about 16 percent of vehicle trips made nationally were one mile or less—a distance easily travelled by foot or bicycle.[58] An improved, safer, and expanded pedestrian and bike network is the most effective and direct approach for shifting those shorter

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[50] California Air Pollution Control Officers Association. Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity (2021).

[51] Ibid.

[52] VMT reduction related to transit measures was quantified using CAPCOA T-24, T-25, and T-26 methodology that quantified VMT reduction for the extension of transit network coverage or hours, increase in transit service frequency, and implementation of transit-supportive roadway treatments, respectively. See reference 37 for calculation details.

[53] https://data.census.gov/table/ACSST5Y2022.S0801?q=Sunnyvale%20city,%20California&t=Commuting&tid=ACSST5Y2019.S0801

[54] McQueen, M., G. Abou-Zeid, J. MacArthur, and K. Clifton. 2020. Transportation Transformation: Is Micromobility Making a Macro Impact on Sustainability? Journal of Planning Literature. November. Available: https://doi.org/10.1177/0885412220972696.

[55] City of Sunnyvale. Sunnyvale Active Transportation Plan (2020). Accessed at: https://www.sunnyvale.ca.gov/home/showpublisheddocument/2844/637822670426570000.

[56] Glazener, Andrew and Khreis, Haneen. Transforming our Cities: Best Practices Towards Clean Air and Active Transportation (2019). Accessed at: https://link.springer.com/article/10.1007/s40572-019-0228-1

[57] Jacob Mason et al., Institute for Transportation & Development Policy and the University of California, Davis. A Global High Shift Cycling Scenario (2015). Accessed at: https://itdpdotorg.wpengine.com/wp-content/uploads/2015/11/A-Global-High-Shift-Cycling-Scenario_Nov-2015.pdf

[58] National Household Travel Survey. Population Vehicle Trips Statistics (2021). Accessed at: https://nhts.ornl.gov/vehicle-trips

vehicle trips to walking, and studies show that distance to destinations is one of the strongest predictors of walking as a mode choice. Move 3.I will also support this expansion in active transportation infrastructure by establishing and implementing a plan to convert vehicle roadways to bicycle and pedestrian spaces. This Move will effectively create new bikeways in areas the community already frequents on foot and by bicycle. Sunnyvale has demonstrated commitment to this Move by permanently closing part of their downtown core—South Murphy Ave—to vehicular traffic in 2023.[59] Further, planned redevelopment in Sunnyvale, including Moffett Park, focuses on building the district to be mixed-use, connected with complete streets and safe bike and pedestrian routes that are within 15-minutes or less to key amenities and job centers.

Mode shift potential associated with Move 3.D and Move 3.I was evaluated by comparing other cities with similar buildouts (bike network mileage versus city land square footage). Results from significant investment in bicycle infrastructure in California suggest that bicycle mode share can be increased on par with leading bicycle cities in the State. The City of Davis leads the State with a 20 percent bicycle mode share[60] and 9.2 miles of bike lane per square mile of the City.[61] The City of Berkely has a 9.7 percent bicycle mode [62] with approximately 4.8 miles of bike land per square mile of the City.[63] Sunnyvale's current bicycle mode share is 1.5 percent according to Census data[64] and has 4 miles of bike lane per square mile of the City.[65] With the City adding an additional 70 miles of bike lane through implementation of the Active Transportation Plan, there would be approximately 7.7 miles of bike lane per square mile of City. Based on other similar cities, this increase in bicycle lane miles per square mile of City and planned infrastructure projects within the City has the potential to result in a bicycle mode share of up to 10 percent. Based on information obtained from the Active Transportation Plan on the planned projects, infrastructure improvements, and connectivity improvements and using the CAPCOA methodology for VMT reduction, it was estimated that approximately 4 percent of passenger VMT could be reduced with implementation of Move 3.D and Move 3.I.[66]

To further reduce VMT with this Play, other defensible strategies were considered such as implementing a fee to drive downtown, implementing parking fees for existing City parking,

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[59] Gelhaus, Anne. Sunnyvale Council Votes to Make this Downtown Street a Pedestrian Mall (2023). Accessed at: https://www.mercurynews.com/2023/02/12/sunnyvale-council-votes-to-make-downtown-street-a-pedestrian-mall/?utm_source=ground.news&utm_medium=referral.

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

[61] https://www.cityofdavis.org/city-hall/public-works-engineering-and-transportation/bike-pedestrian-program/davis-bike-and-pedestrian-infrastructure#:~:text=4%20miles%20of%20buffered%20bike,and%20twenty%2Done%20underpass%20crossings.

[62] City of Berkeley. May 2017. City of Berkeley Bicycle Plan. Accessed at: https://www.cityofberkeley.info/uploadedFiles/Public_Works/Level_3_-_Transportation/Berkeley-Bicycle-Plan-2017-Executive%20Summary.pdf

[63] https://www.visitberkeley.com/media-press/press-kit/fact-sheet/

[64] 5-year estimate of bicycle mode share in 2022 according to census data obtained from: https://data.census.gov/table/ACSST5Y2022.S0801?q=Sunnyvale%20city,%20California&t=Commuting&tid=ACSST5Y2019.S0801 1

[65] City of Sunnyvale includes 22 square miles of land obtained from: https://data.census.gov/profile/Sunnyvale_city,_California?g=160XX00US0677000

[66] VMT reduction potential was quantified following CAPCOA methodology for T-16 Improve Street Connectivity, T-17 Provide Pedestrian Network Improvement, T-18A Construct or Improve Bike Facility, and T-18B Construct or Improve Bike Boulevard. See reference 37 for calculation details.

implementing a parklet program to reduce parking availability in the City, and unbundling residential and non-residential parking costs from property costs. The strategies are encompassed by Move 3.B and are strategies that the Moffett Park Specific Plan intends to implement in the Moffett Park redevelopment to improve mobility, limit congestion, support growth, and right size the parking supply.[67] Studies have shown that pricing on-street parking, particularly in areas with available alternatives to driving, VMT—and associated GHG emissions can be reduced by up to 30 percent depending on the parking price increase and percent of total community VMT impacted.[68] With an increase in priced parking by 150 percent, assuming that 25 percent of total passenger VMT in the Sunnyvale is occurring in areas that priced parking occurs and that 35 percent of parking in such areas is on-street, Move 3.B is estimated to reduce VMT up to approximately 5 percent (See Table 16Table 1 for calculations details).

Studies have also shown that unbundling a project's parking costs from property costs can reduce VMT – and associated GHG emissions – in the study area by up to 15.7 percent depending on the annual parking cost per space compared with the average vehicle cost.[69] As part of the Moffett Park Specific Plan, adopted in July of 2023, policies that unbundle both multi-family residential and non-residential parking from the property cost will be implemented.[70] Given that Moffett Park is projected to add 20,000 new mixed-use homes, this would house approximately 16 percent of forecasted population that can drive and thereby impacting approximately 16 percent of the forecasted VMT in the City. Assuming that the annual parking fee would be $600, unbundling parking fees from the property cost just in Moffett Park has the potential to reduce total passenger VMT by approximately 3 percent. Combined, Move 3.B and other parking strategy implementation is estimated to reduce passenger VMT by approximately 4.5 percent.[71]

Together, these Moves work to develop more connected and transit-oriented neighborhoods near job centers and amenities, to improve active transportation and transit opportunities in Sunnyvale, and target employers to incentivize mode shift to reduce VMT and the associated GHG emissions. Moves that focus on parking pricing and management are designed to reduce VMT in the community through disincentivizing driving when other alternative means of transport are available. These Moves combined are estimated to reduce VMT in Sunnyvale by approximately 20 percent based on the reductions shown in the cited studies on mandatory TDM programs, public transit coverage and frequency improvements, active transportation infrastructure build-out, and parking management. This percentage is also made under the conservative assumption that each Move would be implemented one after another with diminishing returns rather than have an aggregated effect on total vehicle miles traveled. To confirm these Moves work together to reduce VMT by 20 percent, the City will follow Move 3.K to establish tracking metrics as well as a monitoring and

[67] City of Sunnyvale. Moffett Park Specific Plan. July 2023. Accessed February 2024 at: https://www.moffettparksp.com/

[68] Pierce, G., and D. Shoup. 2013. Getting the Prices Right: An Evaluation of Pricing Parking by Demand in San Francisco. Journal of the American Planning Association 79(1)67–81. May. Available: https://www.tandfonline.com/doi/pdf/10.1080/01944363.2013.787307?needAccess=true

[69] CAPCOA. Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity (2021). Accessed at: https://www.caleemod.com/documents/handbook/full_handbook.pdf.

[70] City of Sunnyvale. Moffett Park Specific Plan. July 2023. Accessed February 2024 at: https://www.moffettparksp.com/

[71] VMT reduction related to parking pricing was quantified using CAPCOA T-23 Implement Market Price Public Parking and VMT reduction from unbundling parking costs from property costs was quantified using CAPCOA T-15 Unbundle Residential Parking Costs from Property Cost. See reference 37 for calculation details.

reporting schedule to monitor the Moves' effect on VMT and revise the Moves as necessary to meet the targeted level of VMT reduction.

Table 16 shows the parameters and data sources that support the GHG emission reductions associated with reducing VMT and Table 17 shows the calculations as outlined in Equations 6 through 6.2.

### Vehicle Miles Traveled Reduction Equations

Equation 6 $CO_2e\ Reduction_y = (VMT\ Reduced_y * CO_2e\ EF)$

Equation 6.1 $VMT\ Reduced_{c,y} = VMT_y * VMT\ Share_{t,y} * VMT\ Reduction_{t,c,y}$

### Table 16 Vehicle Miles Traveled Reduction Parameters and Data Sources

| Variable | Definition | Value | Unit | Data Source |
|---|---|---|---|---|
| **Equation 6** | | | | |
| $CO_2e$ *Reduction* | VMT GHG emission reductions | See calculation table | MT $CO_2e$ | Calculated |
| $CO_2e$ *EF* | $CO_2e$ weighted emission factor | See calculation table | MT $CO_2e$/ passenger VMT | Adjusted Forecast |
| *VMT Reduced*$_y$ | VMT reduced | See calculation able | miles | Calculated |
| *c* | Measure category | TDM, transit improvements, active transportation, and parking management | N/A | N/A |
| *t* | VMT trip type | Work related or All other VMT | N/A | N/A |
| *y* | Year | 2030 | N/A | N/A |
| **Equation 6.1** | | | | |
| $VMT_y$ | Forecasted Passenger VMT | See calculation table | miles | Based on forecasted VMT and EMFAC2021 vehicle share where in 2030, 93.5% of total VMT is from passenger vehicles.[72] |
| *VMT Reduction*$_{t,c,y}$ | TDM – Work-related VMT | 6.8% | percentage | Estimated based on the reductions shown in studies on mandatory TDM programs targeting commuters and , public transit coverage and frequency improvements, active transportation infrastructure build-out, and parking management targeting all passenger trip types.[44, 50, 57] CAPCOA methodology used to quantify reductions based on specific measure types.[44,48,52,66,71] |
| | Transit Improvements - All other VMT | 3.9% | | |
| | Active Transportation – All other VMT | 4.3% | | |
| | Parking Management – All other VMT | 4.5% | | |
| *VMT Share*$_{t,y}$ | Share of VMT by trip type | See calculation table | percentage | Estimated based on Bureau of Transportation Statistics on distribution of annual VMT by trip type.[47] |

[72] California Air Resources Board (CARB). 2021 EMission FACtor (EMFAC) Model. Version 1.0.2. Accessed at: https://arb.ca.gov/emfac/.

**Table 17 VMT Reduction GHG Emission Reduction Calculations**

| Definition | Definition | Units | Sector | 2030 |
|---|---|---|---|---|
| **Equation 6.1** | | | | |
| $VMT_y$ | Forecasted Passenger VMT | miles | Passenger vehicles | 1,053,170,888 |
| $VMT\ Share_{t,y}$ | Share of VMT by trip type | percentage | Work Related (Commuter) | 20% |
| | | | All other non-work related | 80% |
| $VMT\ Reduced_{c,y}$ | VMT reduced by Move type | miles | TDM | 71,914,274 |
| | | | Transit Improvements | 41,189,389 |
| | | | Active Transportation | 44,986,680 |
| | | | Parking Management | 47,282,473 |
| **Equation 6** | | | | |
| $CO_2e\ EF_f$ | $CO_2e$ emission factor | MT $CO_2e$/VMT | Passenger Vehicles | 0.0003222 |
| ***$CO_2e$ Reduction*** | **VMT GHG emission reductions** | **MT $CO_2e$** | **Passenger Vehicles** | **66,162** |

## Play 3.3: Increase zero-emission vehicles.

Play 3.3 aims for Sunnyvale to increase zero-emission vehicle adoption to 42 percent by 2030. While the State is anticipated to reach a 26 percent zero-emission vehicle adoption rate by 2030,[73] Sunnyvale plans to exceed this goal through ample public and private investments in electric vehicle charging infrastructure.

The primary Move that enables this target is **Move 3.N** which directs Sunnyvale to develop a Community Electric Vehicle Readiness and Infrastructure Plan to install the number publicly accessible chargers needed to support Sunnyvale's zero-emission vehicle adoption target. This Move enables zero-emission vehicle adoption because studies have consistently found that limited charging infrastructure is one to the primary barriers to electric vehicle adoption.[74, 75] Publicly accessible electric vehicle chargers make owning an electric vehicle convenient for all drivers—including those who cannot charge at home or drive daily distances longer than their electric vehicle battery range. To this point, it is expected that 20 percent of electric vehicle charging nationally will occur at publicly accessible chargers in 2030.[76] The U.S. Department of Energy's Electric Vehicle Infrastructure Projection Tool outputs for the San Jose-Sunnyvale-Santa Clara Metropolitan Area with inputs that reflect Sunnyvale's 2030 zero-emission vehicle targets was used to estimate the number of publicly accessible chargers needed in Sunnyvale in 2030 to support a 42 percent adoption rate.[77]

Table 18 shows the parameters and data sources used to calculate the publicly accessible electric vehicle chargers needed in 2030 with this tool and Table 19 shows the calculations as outlined in Equations 7 through 7.2.

### Publicly Accessible Electric Vehicle Chargers Equation

Equation 7 $EV\ Chargers_y = Region\ EV\ Chargers_y * (EVs_y / (Region\ EVs_y) - Existing\ EV\ Chargers_{by}$

Equation 7.1 $EVs_y = Population_y * (Vehicles_{by} / Population_{by}) * ZEV\ Adoption_y$

Equation 7.2 $Region\ EVs_y = Region\ Vehicles_y * ZEV\ Adoption_y$

[73] Based on the zero-emission vehicle goals for passenger vehicles established by Executive Order N-79-20, eight million zero-emission vehicles are anticipated statewide by 2030. Sunnyvale calculated that these eight million zero-emission vehicles represent 26 percent of the total passenger vehicles expected statewide by 2030 (based on statewide passenger car and light-duty truck counts in 2016 and population estimates for 2016 and 2030).

Crisostomo, Noel et al. Assembly Bill 2127 Electric Vehicle Charging Infrastructure Assessment: Analyzing Charging Needs to Support Zero-Emission Vehicles in 2030. Accessed at: Calmatters.org/environment/2023/03/california-electric-cars-demographics/?utm_id=91724&sfmc_id=4863450.

[74] Kumar, Rajeev Ranjan and Kumar Alok. Adoption of Electric Vehicle: A Literature Review and Prospects for Sustainability (2020). Accessed at: https://www.sciencedirect.com/science/article/abs/pii/S095965261934781X.

[75] Winjobi, Olumide and Kelly, Jarod. Used Plug-in Electric Vehicles as a Means of Transportation Equity in Low-Income Households (2021). Accessed at: https://www.osti.gov/biblio/1658592.

[76] Kampshoff, Philipp et al. Building the Electric-Vehicle Charging Infrastructure America Needs (2022). Accessed at: https://www.mckinsey.com/industries/public-sector/our-insights/building-the-electric-vehicle-charging-infrastructure-america-needs.

[77] U.S. Department of Energy. Electric Vehicle Infrastructure Projection Tool (EVI-Pro) Lite. Accessed at: https://afdc.energy.gov/evi-pro-lite.

**Table 18 Publicly Accessible Electric Vehicle Charger Parameters and Data Sources**

| Variable | Definition | Value | Unit | Data Source |
|---|---|---|---|---|
| **Equation 7** | | | | |
| *EV Chargers$_y$* | New publicly accessible electric vehicle chargers needed in Sunnyvale | See calculation table | chargers | Calculated |
| *Region EV Chargers$_y$* | Regional electric vehicle chargers needed | 32,331 | electric vehicles | Estimated using the Electric Vehicle Infrastructure Projection Tool public charger outputs for the San Jose-Sunnyvale-Santa Clara Metropolitan Area with the *Region EVs$_y$* value as the input.[78] |
| *EVs$_y$* | Electric vehicles targeted in Sunnyvale | See calculation table | electric vehicles | Calculated |
| *Region EVs$_y$* | Regional electric vehicles targeted | See calculation table | electric vehicles | Calculated |
| *Existing EV Chargers$_{by}$* | Existing publicly accessible electric vehicle chargers in Sunnyvale | 208 | chargers | PlugShare[79] |
| *y* | Year | 2030 | year | N/A |
| *by* | Baseline year | 2019 | year | N/A |
| **Equation 7.1** | | | | |
| *Population$_y$* | Forecasted population in Sunnyvale | See calculation table | people | Inventory |
| *Vehicles$_{by}$* | Vehicles in baseline year in Sunnyvale | 115,970 | vehicles | California Department of Motor Vehicles[80] |
| *Population$_{by}$* | Population in baseline year in Sunnyvale | 154,252 | people | Inventory |
| *ZEV Adoption$_y$* | Zero-emission vehicle adoption target | See calculation table | percentage | Targeted zero-emission vehicle adoption for Play. |
| **Equation 7.2** | | | | |
| *Region Vehicles$_y$* | Regional vehicles | 1,580,600 | vehicles | Electric Vehicle Infrastructure Projection Tool value for the San Jose-Sunnyvale-Santa Clara Metropolitan Area.[81] |

[78] U.S. Department of Energy. Electric Vehicle Infrastructure Projection Tool (EVI-Pro) Lite.

[79] PlugShare. EV Charging in Sunnyvale, CA.

[80] California Department of Motor Vehicles. Fuel Type by County as of 1/1/2020. Accessed at: https://www.dmv.ca.gov/portal/uploads/2020/09/MotorVehicleFuelTypes_City_01012020.pdf.

[81] U.S. Department of Energy. Electric Vehicle Infrastructure Projection Tool (EVI-Pro) Lite.

**Table 19 Publicly Accessible Electric Vehicle Charger Parameters and Data Sources**

| Definition | Definition | Units | 2030 |
|---|---|---|---|
| **Equation 7.2** | | | |
| $ZEV\ Adoption_y$ | Zero-emission vehicle adoption target | percentage | 42% |
| $Region\ EVs_y$ | Regional electric vehicles targeted | electric vehicles | 663,852 |
| **Equation 7.1** | | | |
| $Population_y$ | Forecasted population in Sunnyvale | people | 231,502 |
| $EVs_y$ | Electric vehicles targeted in Sunnyvale | electric vehicles | 73,100 |
| **Equation 7** | | | |
| $EV\ Chargers_y$ | New publicly accessible electric vehicle chargers needed in Sunnyvale | chargers | 3,353 |

Sunnyvale will install these 3,353 publicly accessible electric vehicle chargers by 2030 by committing to a Community Electric Vehicle Readiness and Infrastructure Plan. The plan will set a list of prioritized locations for new chargers and a detailed funding plan that establishes an approach to working directly with private properties and private investments to install the publicly accessible chargers needed to support a 42 percent zero-emission vehicle adoption in Sunnyvale by 2030.

These zero-emission vehicles will also be supported by private electric vehicle chargers in new developments and existing buildings. **Move 3.O** directs the City to work with SVCE to expand their incentive program for electric vehicle chargers. This local action along with new federal and State funding will help cover the upfront costs to purchasing an electric vehicle and installing the equipment or infrastructure upgrades needed to charge an electric vehicle at home as high costs are one of the barriers to electric vehicle adoption for low-income households.[82] Sunnyvale's residential and commercial reach codes adopted in 2021, will also expand private electric vehicle charging as they require electric vehicle ready circuits (i.e., outlets) in all new single- and multi-family residential building along with electric vehicle capable conduits and electric vehicle charger stations (i.e., Level 2 and DC Fast charging) in certain commercial buildings.[83, 84] These reach codes along with the SVCE incentives will help ease the barriers residents of multi-family buildings face to electric vehicle adoption as these residents are unlikely to have access to home charging.[85, 86] These actions will enable Sunnyvale to install as many privately owned electric vehicle chargers in existing buildings and new developments as practical to support a 42 percent zero-emission vehicle adoption by 2030.

Table 20 shows the parameters and data sources that support GHG emission reductions from the zero-emission vehicle adoption and Table 21 shows the calculations as outlined in Equations 8 through 8.2.

[82] Gaillard, Isa. Ingredients for Equitable Electrification: Analyzing Equity in Statewide Electric Vehicle Rebate Programs (2022). Accessed at: https://greenlining.org/wp-content/uploads/2022/10/Greenlining-Ingredients-Equitable-Transportation-WebFINAL.pdf.

[83] City of Sunnyvale. Single-Family, Duplex, and Townhome Reach Codes (Rev 1/2023).

[84] City of Sunnyvale. Nonresidential and Multifamily Reach Codes (2021).

[85] DeShazo, J.R. et a. Overcoming Barriers to Electric Vehicle Charging in Multi-Unit Dwellings: A Westside Cities Case Study (2021). Accessed at: https://www.energy.ca.gov/publications/2021/overcoming-barriers-electric-vehicle-charging-multi-unit-dwellings-westside.

[86] Hsu, Chih-Wei and Fingerman, Kevin. Public Electric Vehicle Charger Access Disparities Across Race and Income in California (2021). Accessed at: https://www.sciencedirect.com/science/article/pii/S0967070X20309021.

### Zero-emission Vehcile Adoption Equations

Equation 8 $CO_2e\ Reduction_{VMT,y}=(VMT\ Reduced_{ICE,y}*EF_{VMT,y})-(Elec\ Converted_y*EF_{elec,y})$

Equation 8.1 $VMT\ Reduced_{ICE,y}=VMT_y*(ZEV\ Adoption_y-ZEV\ Adoption\ Baseline_y)$

Equation 8.2 $Elec\ Converted_y=VMT\ Reduced_{ICE,y}*EPM_{ZEV\ VMT,y}$

### Table 20 Zero-emission Vehicle Adoption Parameters and Data Sources

| Variable | Definition | Value | Unit | Data Source |
|---|---|---|---|---|
| **Equation 8** | | | | |
| $CO_2e\ Reduction_{VMT,y}$ | VMT GHG emission reductions | See calculation table | MT $CO_2e$ | Calculated |
| $VMT\ Reduced_{ICE,y}$ | Internal combustion engine VMT reduced | See calculation table | miles | Calculated |
| $EF_{VMT,y}$ | Forecasted VMT emission factor | See calculation table | MT $CO_2e$/mile | Forecast |
| $Elec\ Converted_y$ | Electricity from zero-emission vehicle conversion | See calculation table | kWh | Calculated |
| $EF_{elec,y}$ | Forecasted residential electricity emission factor[87] | See calculation table | MT $CO_2e$/kWh | Forecast |
| $y$ | Year | 2030 | N/A | N/A |
| **Equation 8.1** | | | | |
| $VMT_y$ | Forecasted total VMT after VMT reductions (Play 3.1 and Play 3.2) | See calculation table | miles/gallon | Forecast and Plays 3.1 and 3.2 |
| $ZEV\ Adoption_y$ | Zero-emission vehicle adoption target | 42% | percentage | Target that is enabled by 3,353 new publicly accessible chargers. |
| $ZEV\ Adoption\ Baseline_{by}$ | Zero-emission vehicle adoption baseline | 9% | percentage | Inventory |
| $by$ | Baseline year | 2019 | Year | N/A |
| **Equation 8.2** | | | | |
| $EPM_{ZEV\ VMT,y}$ | Forecasted electricity usage per mile of zero-emission vehicles | See calculation table | kWh/mile | Forecast |

[87] To remain conservative, it is assumed all zero-emission vehicles are charged at residents' homes (Sunnyvale's forecasted residential electricity emission factor is higher than the forecasted commercial electricity emission factor).

## Table 21 Zero-emission Vehcile Adoption GHG Emission Reduction Calculations

| Definition | Definition | Units | 2030 |
|---|---|---|---|
| **Equation 8.1** | | | |
| $VMT_y$ | Forecasted total VMT after VMT reductions (Play 3.1 and Play 3.2) | miles | 921,030,579 |
| $ZEV\ Adoption_y$ | Zero-emission vehicle adoption target | percentage | 42% |
| $ZEV\ Adoption\ Baseline_{by}$ | Zero-emission vehicle adoption baseline | percentage | 9% |
| $VMT\ Reduced_{ICE,y}$ | Internal combustion engine VMT reduced | miles | 305,070,720 |
| **Equation 8.2** | | | |
| $EPM_{ZEV\ VMT,y}$ | Forecasted electricity usage per mile of zero-emission vehicles | kWh/mile | 0.41 |
| $Elec\ Converted_y$ | Electricity from zero-emission vehicle conversion | kWh | 124,383,003 |
| **Equation 8** | | | |
| $EF_{VMT,y}$ | Forecasted VMT emission factor | MT $CO_2e$/mile | 0.00032 |
| $EF_{elec,y}$ | Forecasted electricity emission factor | MT $CO_2e$/kWh | 0.0000016 |
| **$CO_2e\ Reduction_{VMT,y}$** | **VMT GHG emission reductions** | **MT $CO_2e$** | **98,079** |

## Play 3.4: Decarbonize off-road vehicles and equipment.

Play 3.4 aims for Sunnyvale to decarbonize 30 percent of off-road vehicle and equipment use in the community by 2030. The Moves that enable this Play include **Move 3.P** which commits the City to establishing a phased ordinance by 2026 to ban local operation of gasoline and diesel-powered off-road vehicles and equipment by type.

The phased ordinance will first ban the operation of off-road vehicles and equipment with gasoline- and diesel-powered small off-road engines by 2028. As defined by the California Air Resources Board (CARB), small off-road engines (SORE) are those equipment types with rated power at or below 19 kilowatts (i.e., 25 horsepower). Typical off-road vehicle and equipment types that use these engines include lawn and garden equipment, portable generators, and pressure washers.[88] In 2028, gasoline and diesel used by these small off-road engines will compromise 18 percent of the off-road vehicle and equipment fuel used in Sunnyvale.[89] By banning the operation of gasoline- and diesel-powered small off-road engines, the ordinance will effectively reduce 18 percent of the community's off-road fuel usage.

The remaining 12 percent of off-road fuel will be reduced by 2030 by targeting other vehicles and equipment types through different phases of the ordinance. For example, the ordinance will ban the operation of gasoline- and diesel-powered lawn and garden equipment with engines greater than 25 horsepower, as well as these types of engines in light commercial vehicles and equipment and portable equipment or construction vehicles and equipment. The fuel use by engines greater than 25 horsepower in lawn and garden equipment accounts for 0.2 percent of total off-road fuel in Sunnyvale while those engines in light commercial account for four percent, those in portable equipment account for 14 percent, and those in construction account for 17 percent of total off-road fuel used in Sunnyvale.

Targeting a combination of these off-road vehicle and equipment types will reduce the remaining 12 percent of off-road fuel. Where equipment does not have market-ready electric alternatives available, the ordinance will still require decarbonization of targeted equipment through the use of renewable diesel. Renewable diesel is a drop-in renewable fuel produced from non-petroleum renewable sources—including vegetable oils and animal fats—and is readily available in California due to existing regulation requiring its use.[90] This requirement for renewable diesel will be a strong tool to increase compliance with the local ordinance by providing flexibility and can be counted towards the Move because the State requirements for renewable diesel were not included in Sunnyvale's adjusted forecast.

This ordinance aligns with the State's goals and regulations. The ordinance exceeds CARB's SORE regulations which ban the sale of off-road vehicles and equipment with gasoline- and diesel-powered small off-road engines starting in 2024 and bans the sale of gasoline- and diesel-powered portable generators starting in 2028. The ordinance does however align with Executive Order

[88] California Air Resources Board. SORE Applicability Fact Sheet (2021). Accessed at: https://ww2.arb.ca.gov/resources/fact-sheets/sore-applicability-fact-sheet.

[89] Sunnyvale's small off-road fuel usage in 2028 was estimated by filtering CARB OFFROAD2021 model outputs (for Santa Clara County in 2028) for horsepower ratings greater than or less than 25 and attributing the resulting County-level annual fuel usage to Sunnyvale based on the attribution methodology used in the inventory and forecast. The results were divided by the total estimated off-road fuel usage in Sunnyvale in 2028 to estimate the share, or percentage, of fuel usage attributable to small off-road engines.

[90] California Air Resources Board. Fact Sheet: Renewable Diesel Fuel Requirements. Accessed at: https://ww2.arb.ca.gov/resources/fact-sheets/fact-sheet-renewable-diesel-fuel-requirements.

N-79-20's statewide goal to transition off-road vehicles and equipment operations to 100 percent zero-emission by 2035.

In addition to establishing the phases and revising the ordinance as necessary to achieve the Play's target, Sunnyvale will establish a communications and outreach program to support effective implementation of the ordinance throughout the community.

Table 22 shows the parameters and data sources that support off-road ordinance GHG emission reductions and Table 23 shows the calculations as outlined in Equations 9 through 9.1.

### Off-road Decarbonization Equations

Equation 9 $$CO_2e\ Reduction_{Fuel,y} = Fuel\ Reduced_y * EF_{Fuel}$$

Equation 9.1 $$Fuel\ Reduced_y = (Fuel_{Gasoline,y} + Fuel_{Diesel,y} + Fuel_{Natural\ Gas,y}) * Fuel\ Reduction_y$$

### Table 22 Off-road Decarbonization Parameters and Data Sources

| Variable | Definition | Value | Unit | Data Source |
|---|---|---|---|---|
| **Equation 9** | | | | |
| $CO_2e\ Reduction_{Fuel,y}$ | Fuel GHG emission reductions | See calculation table | MT $CO_2e$ | Calculated |
| $Fuel\ Reduced_y$ | Fuel use reduced | See calculation table | gallons | Calculated |
| $EF_{Fuel}$ | Weighted fuel emission factor | 0.008438 | MT $CO_2e$/gallon | Inventory |
| $y$ | Year | 2030 | N/A | N/A |
| **Equation 9.1** | | | | |
| $Fuel_{Gasoline,y}$ | Forecasted gasoline use | See calculation table | gallon | Forecast |
| $Fuel_{Diesel,y}$ | Forecasted diesel use | See calculation table | gallon | Forecast |
| $Fuel_{Natural\ Gas,y}$ | Forecasted natural gas use | See calculation table | gallon | Forecast |
| $Fuel\ Reduction_y$ | Fuel use reduction target | 30% | percentage | Estimated based on the share of small off-road engines in Sunnyvale and direction of State goals (i.e., EO N-79-20).[89] |

### Table 23 Off-road Decarbonization GHG Emission Reduction Calculations

| Definition | Definition | Units | 2030 |
|---|---|---|---|
| **Equation 9.1** | | | |
| $Fuel_{Gasoline,y}$ | Forecasted gasoline use | gallons | 2,075,523 |
| $Fuel_{Diesel,y}$ | Forecasted diesel use | gallons | 2,413,519 |
| $Fuel_{Natural\ Gas,y}$ | Forecasted natural gas use | gallons | 1,733,800 |
| $Fuel\ Reduced_y$ | Fuel use reduced | gallons | 1,866,853 |
| **Equation 9** | | | |
| **$CO_2e\ Reduction_{Fuel,y}$** | **Fuel GHG emission reductions** | **MT $CO_2e$** | **15,753** |

# 5 Strategy 4: Managing Resources Sustainably

The City of Sunnyvale's strategy to manage resources sustainably focuses on optimizing the use of resources and enhancing the City's natural services to increase resilience in the community and reduce GHG emissions. The strategy aims to accomplish these goals by reducing and diverting solid waste, conserving and reusing water, enhancing natural ecosystems, and reducing the consumption of carbon-intensive consumer goods and food.

Most of these actions will increase community resilience and reduce personal carbon footprints rather than have a significant impact on GHG emissions in Sunnyvale. However, reducing and diverting solid waste will significantly reduce GHG emissions in Sunnyvale by reducing and diverting organic waste from the landfill. In the landfill, organic waste decays without access to light or oxygen and produces methane ($CH_4$) gas. Reducing the occurrence of this anaerobic decomposition serves as an important opportunity for Sunnyvale to reduce GHG emissions.

Based on this strategy, the Playbook Update's strategy to manage resources sustainably consists of the following Plays presented in Table 24. The table also indicates which Plays are quantitative and which Plays are supportive. The following subsections detail the substantial evidence and calculation methodologies of the quantitative Plays and the role of the supportive Plays.

**Table 24 Strategy 4: Managing Resources Sustainably 2030 GHG Emission Reduction Summary**

| Play ID | Play | 2030 Play Target | 2030 GHG Emission Reductions (MT $CO_2e$) |
|---|---|---|---|
| **Strategy 4: Managing Resources Sustainably** | | | |
| Play 4.1 | Achieve Zero Waste goals for solid waste. | Reduce landfilled garbage to 1 pound per person per day | 45,258 |
| Play 4.2 | Ensure resilience of water supply. | TBD | Supportive |
| Play 4.3 | Enhance natural carbon sequestration capacity. | N/A | Supportive |
| Play 4.4 | Promote awareness of sustainable goods and services. | N/A | Supportive |
| **Total** | | | **45,258** |

Notes: TBD = to be defined per State requirements; N/A = not applicable

## Play 4.1: Achieve Zero Waste goals for solid waste.

Play 4.1 aims for Sunnyvale to reduce landfilled waste to one pound per person per day by 2030. As part of this target, the Play includes a series of Moves that put Sunnyvale on the path to meet Senate Bill (SB) 1383 requirements to recover 20 percent of disposed edible food for human consumption and reduce landfilled organic waste—and its associated GHG emissions—75 percent by 2025. The primary Moves that enable this target include:

- **Move 4.C** which directs the City to meet SB 1383 landfilled organic waste reduction requirements by continuing to provide organic collection service to single-family residents and multi-family residents and establishing organic collection service to the entire commercial sector.
- **Move 4.D** which directs Sunnyvale to expand the edible food recovery program to edible food generators beyond those required by SB 1383;[91] and
- **Move 4.E** which directs the City to continue implementing the waste diversion ordinance that requires all residents visitors, and businesses to place their discards in the appropriate container (i.e., recycle, compost, or garbage) and includes monitoring of contamination by waste hauler drivers.

In addition to these Moves, Sunnyvale is committed to updating their communitywide waste characterization study every ten years as part of their GHG inventory update process. These Moves and inventory process encompass the activities the California Department of Resources Recycling and Recovery (CalRecycle) requires jurisdictions to conduct to comply with SB 1383 requirements.[92] Continuing and completing these activities is thus expected to provide the levels of diversion, composting, and food donations needed to reduce Sunnyvale's landfilled organic waste 75 percent by 2025. This level of landfilled organic waste reduction is expected to directly reduce solid waste disposal GHG emissions 75 percent because nearly all GHG emissions from the natural decay of solid waste in landfills come from organic waste.[93]

Table 25 shows the parameters and data sources that support the landfilled organic waste reduction GHG emission reductions and Table 26 shows the calculations as outlined in Equation 10.

### Landfilled Organic Waste Reduction Equations

Equation 10 $$CO_2e\ Reduction_{LOW,y} = CO_2e\ Emissions_{LOW,y} * LOW\ Reduction_y$$

[91] Sunnyvale has contracted with Joint Venture Silicon Valley (JVSV) to manage edible food recovery in the City. JVSV has contacted tier two commercial generators to begin donating edible food (ahead of the January 1, 2024 deadline). Concurrently, JVSV has begun identifying edible food generators beyond those required by SB 1383 to expand the edible food recovery program in Sunnyvale.

See the following resource for the definition of tier two commercial generators: California Department of Resources Recycling and Recovery (CalRecycle). Guidance for Jurisdictions: How to Identify SB 1383 Commercial Edible Food Generators. Accessed at: https://www2.calrecycle.ca.gov/Docs/Web/118917.

[92] CalRecycle. SB 1383 Jurisdiction Responsibilities. Accessed at: https://www2.calrecycle.ca.gov/Docs/Web/119160#:~:text=Beginning%20in%202022%2C%20SB%201383,is%20automatically%20provided%20the%20service.

[93] According to the Local Governments for Sustainability (ICLEI) U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, Appendix E – Solid Waste Emission Activities and Sources, GHG emissions are generated by non-biologic wastes only if they are combusted.

**Table 25 Off-road Decarbonization Parameters and Data Sources**

| Variable | Definition | Value | Unit | Data Source |
|---|---|---|---|---|
| **Equation 10** | | | | |
| $CO_2e\ Reduction_{LOW,y}$ | Landfilled organic waste GHG emission reductions | See calculation table | MT $CO_2e$ | Calculated |
| $CO_2e\ Emissions_{LOW,y}$ | Landfilled organic waste GHG emissions | See calculation table | MT $CO_2e$ | Forecast |
| $LOW\ Reduction_y$ | Landfilled organic waste reduction percent | 75 | percentage | Estimated based on compliance with CalRecycle's required activities for SB 1383 compliance and GHG emission factors for solid waste.[92,93] |
| *y* | Year | 2030 | N/A | N/A |

**Table 26 Off-road Decarbonization GHG Emission Reduction Calculations**

| Definition | Definition | Units | 2030 |
|---|---|---|---|
| **Equation 10** | | | |
| $CO_2e\ Emissions_{LOW,y}$ | Landfilled organic waste GHG emissions | MT $CO_2e$ | 60,344 |
| **$CO_2e\ Reduction_{LOW,y}$** | **Fuel GHG emission reductions** | **MT $CO_2e$** | **45,258** |

## Play 4.2: Ensure resilience of water supply.

Play 4.2 aims to increase the resilience of water supply by reducing water consumption communitywide and increasing the reuse or recycling of water in the City. While both actions may provide GHG emission reductions, there is a high potential for double counting reductions as the electricity used to distribute water and treat wastewater is included in the City's electricity consumption and decarbonized through Plays to increase renewable and carbon-free electricity in the City (Strategy 1: Promote Clean Energy). This Play does, however, directly support the clean energy Plays by reducing the amount of energy used to distribute water and treat wastewater.

The Center for Water-Energy Efficiency has begun demonstrating the quantifiable value of water conservation towards GHG emission reduction goals in California. Specifically, the center found that during the Governor's Mandate (between June 2015 and May 2016), California saved 524,000 million gallons of water which translated to 1,830 gigawatt hours of electricity savings and 521,000 MT $CO_2e$ of GHG emission reductions.[94] A study by the University of California, Los Angeles Field of Public Health also found that increasing the use of recycled water in California would have the greatest potential to reduce energy use and GHG emissions when compared to other water resilience options such as banning landscape irrigation.[95]

[94] Center for Water-Energy Efficiency, University of California, Davis. Impact of Water Conservation on Electricity Consumption and GHG Emissions. Accessed at: https://cwee.ucdavis.edu/research/waterconservation_energyghg/#:~:text=The%20study%20showed%20the%20state,tons%20of%20carbon%20dioxide%20equivalents.

[95] Sokolow, Sharona et al. Impacts of Urban Water Conservation Strategies on Energy, Greenhouse Gas Emissions, and Health. Accessed at: https://ajph.aphapublications.org/doi/full/10.2105/AJPH.2016.303053.

## Play 4.3: Enhance natural carbon sequestration capacity.

Play 4.3 to aims to enhance Sunnyvale's capacity to sequester carbon through nature-based solutions. While this Play cannot be counted towards Sunnyvale's GHG emission reduction targets (due to the difference between reductions and sequestration and the potential for the Play to produce indirect GHG emission reductions), it is still critical for climate action in Sunnyvale. Through urban forest management, green stormwater infrastructure, and assessments of regional sequestration opportunities, this Play will lay the foundation for Sunnyvale to develop the natural capacity to sequester the GHG emissions remaining in 2045 once the long-term GHG emission reduction target is achieved (i.e., 85 percent reduction in GHG emissions from 1990 levels).

## Play 4.4: Promote awareness of sustainable goods and services.

Play 4.4 aims to promote the awareness of sustainable goods and services in the community to reduce solid waste generation and reduce residents' and business' personal carbon footprints. While solid waste reduction can reduce GHG emissions in the community, there is a high potential for double counting reductions as solid waste reductions are quantified in Play 4.1. This Play does, however, directly supports the solid waste reduction Play by encouraging the use of reusable containers that can reduce the use of single-use plastic or compostable containers. The Play will also help reduce residents' and businesses' personal carbon footprints by encouraging the use of products with lower upstream GHG emissions. These potential GHG emission reductions cannot be counted towards the City's GHG emission reduction target because upstream GHG emissions from the consumption of products are excluded from Sunnyvale's GHG inventory, but they can be influenced by the City through creative policies.

# 6 Strategy 5: Empowering Our Community

The City of Sunnyvale's strategy to empower the community focuses on engaging the community in the Playbook Update process, educating the community on opportunities to reduce GHG emissions, and maintaining a transparent process to monitor and report progress on the City's targets. This strategy will support all other Plays by increasing participation in GHG emission reduction initiatives through education (e.g., building electrification, organic waste diversion, active transportation, and electric vehicles) and increasing accountability for the City to update the Playbook and produce new Game Plans based on results from annual GHG emission inventories.

Based on this strategy, the Playbook Update's strategy to empower the community consists of the following Plays presented in Table 27. The table indicates that all Plays are supportive. The Playbook Update provides further detail on purpose of this strategy and the supportive Plays.

**Table 27 Strategy 5: Empowering Our Community 2030 GHG Emission Reduction Summary**

| Play ID | Play | 2030 Play Target | 2030 GHG Emission Reductions (MT $CO_2e$) |
|---|---|---|---|
| **Strategy 5: Empowering Our Community** | | | |
| Play 5.1 | Enhance community awareness and engagement. | N/A | Supportive |
| Play 5.2 | Track and share data and tools. | N/A | Supportive |
| **Total** | | | **0** |

Notes: N/A = not applicable

# 7 Strategy 6: Adapting to a Changing Climate

The City of Sunnyvale's strategy to adapt to climate change impacts focuses on adjusting the community to climate impacts and increasing the community's ability to anticipate, prepare for, and recover from hazardous events strengthened and made more frequent by climate change. While this strategy will not result in direct GHG emission reductions, it will support the other Plays by building a strong, connected community that can implement them. Based on this strategy, the Playbook Update's strategy to adapt to climate change consists of the following Plays presented in Table 28. The table indicates that all Plays are supportive. The Playbook Update provides further detail on purpose of this strategy and the supportive Plays.

**Table 28 Strategy 6: Adapting to a Changing Climate 2030 GHG Emission Reduction Summary**

| Play ID | Play | 2030 Play Target | 2030 GHG Emission Reductions (MT $CO_2e$) |
|---|---|---|---|
| **Strategy 6: Adapting to a Changing Climate** | | | |
| Play 6.1 | Assess climate vulnerabilities for Sunnyvale. | N/A | Supportive |
| Play 6.2 | Protect shoreline area from seal level rise and coastal flooding. | N/A | Supportive |
| Play 6.3 | Strengthen community resiliency. | N/A | Supportive |
| **Total** | | | **0** |

Notes: N/A = not applicable