Appendix B: Technical Background

Contents

Overview

The Climate Action Playbook (Playbook) identifies how the City will meet or exceed the State of California's climate goals. The State has adopted ambitious targets to encourage greater climate action, including statewide GHG emissions reductions of:

- 1990 levels by 2020 (Assembly Bill 32, 2006)
- 40% below 1990 levels by 2030 (Senate Bill 32, 2016)
- 80% below 1990 levels by 2050 (Executive Order S-3-05, 2005)

To develop appropriate GHG emissions reduction strategies and actions, the City analyzed its baseline GHG emissions, forecasted future emissions while accounting for moderating impacts of existing policies and programs and determined future scenarios for emissions to estimate how emissions can be reduced through climate action. This analysis was used to guide the development of the Strategies, Plays and Next Moves documented in the Climate Action Playbook.

This appendix provides technical supporting information related to the abovementioned analyses, including a description of the overall methodology, key assumptions, calculations and supporting materials used for the analyses performed.

The work described herein was performed by consultants DNV GL and Fehr & Peers and utilized DNV GL's Climate Scenario Analysis Tool in combination with Fehr & Peers' TrendLab+ Tool for transportation emissions. These tools enabled City staff and community stakeholders to explore the trade-offs between different GHG reduction strategies and emissions reductions between sectors.

GHG Emissions Inventory and Forecast

Greenhouse gas (GHG) emissions inventories estimate the GHG emissions produced within a city's jurisdictional boundaries. They provide a quantifiable means for measuring progress toward reducing GHG emissions over time. The GHG inventory used to guide the development of the Playbook represents community-wide emissions from all entities (residential, commercial, industrial and municipal) within the City of Sunnyvale's jurisdictional boundaries.

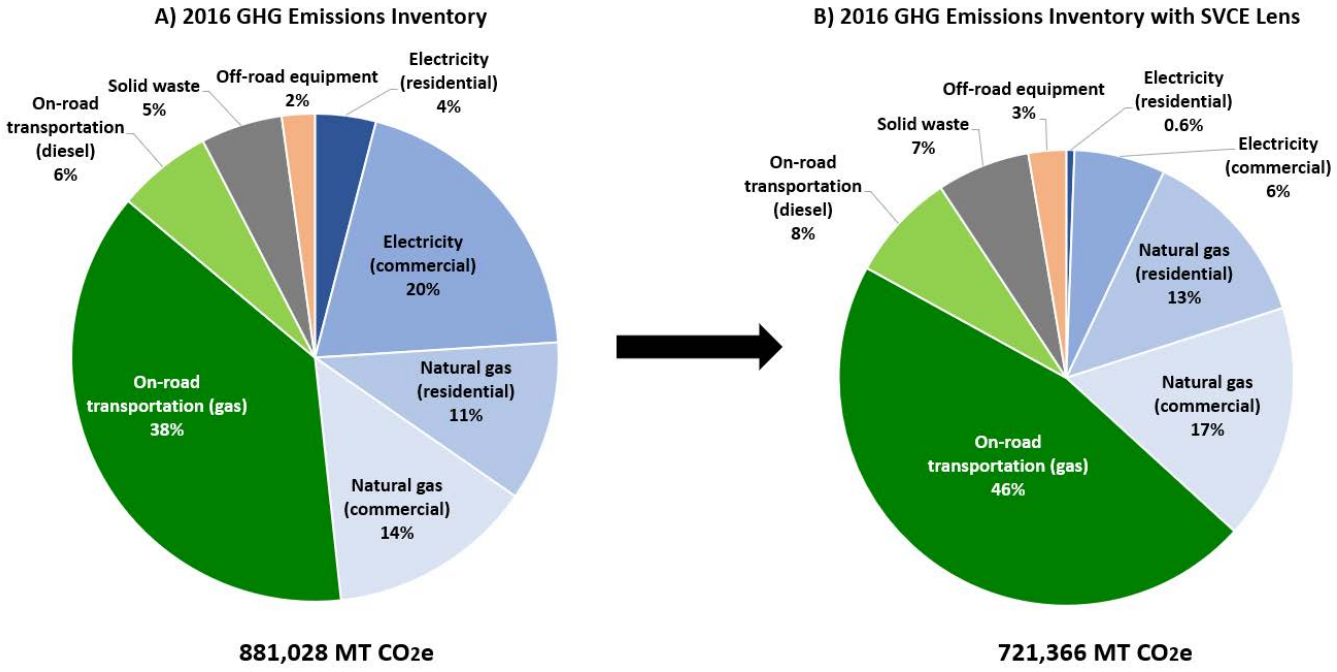
A. GHG Emissions Inventory

As a part of its original Climate Action Plan (CAP 1.0, adopted in May 2014), a baseline GHG emissions inventory was completed for calendar year 2008 to identify the major sources of GHG emissions within Sunnyvale. This inventory provides a baseline against which future progress can be measured. The City's GHG inventory was guided by the U.S. Community Protocol for Accounting and Reporting Greenhouse Gas Emissions (U.S. Community Protocol), developed by International Council for Local Environmental Initiatives (now called ICLEI-Local Governments for Sustainability, hereafter ICLEI) and industry stakeholders.

Following the 2008 baseline inventory, the City completed subsequent GHG emissions inventories for calendar years 2014 and 2016, in accordance with the two-year reporting cycle committed to in the CAP 1.0 Implementation Work Plan (adopted November 2014). These inventories followed the same methodology as the 2008 baseline inventory to provide an "apples-to-apples" comparison across years. The 2016 GHG inventory by sector is shown in Figure 1 (a).

With the launch of Silicon Valley Clean Energy (SVCE) in 2017, which provides carbon-free electricity throughout the community, the City anticipated a drastic drop in electricity sector emissions. To reflect the impact of SVCE's clean electricity, a modified 2016 GHG emissions inventory was created (Table 1) to estimate the GHG emissions impact as if the complete launch of SVCE had occurred in 2016. This serves as a proxy for understanding the magnitude of SVCE's impact and is called the "2016 GHG Emissions Inventory with SVCE Lens," shown in Figure 1(B). With the SVCE Lens, Sunnyvale's community-wide emissions are anticipated to decrease by 18% (from the original 2016 community-wide emissions), as demonstrated by the shrinking pie chart.

Figure 1: Sunnyvale's 2016 GHG Emissions Inventory by Sector



*Emissions from Caltrain, water and wastewater account for less than 1% of total emissions and are not shown in the above charts.

An updated 2018 GHG inventory will be utilized to track progress against City's climate targets adopted as a part of the Playbook.

Table 1: 2016 GHG Emissions Inventory with SVCE Lens

Emissions Sector	2016 Emissions ($MTCO_2e$)	Percent of 2016 Emissions
Electricity (residential)	4,165	0.6%
Electricity (commercial)	46,385	6%
Natural gas (residential)	92,999	13%
Natural gas (commercial)	119,659	17%
On-road transportation (gasoline)	331,074	46%
On-road transportation (diesel)	55,154	8%
Water & wastewater	3,202	0.5%
Solid waste	47,409	7%
Off-road equipment	19,173	3%
Caltrain	1,197	0.2%
Total (all sectors)	720,418	100%

Note: Data shown may not add up to the total due to rounding.

B. Forecast Methodology and Assumptions

A GHG emissions forecast estimates how emissions will grow or decrease in the future based on anticipated growth projections, impact of local and state policies and programs, anticipated changes in technologies and community

behavior trends. To estimate the GHG reductions needed to reach the state's targets, Sunnyvale's GHG emissions were forecasted based on anticipated growth in population, housing units, jobs, commercial and industrial space, and vehicle miles traveled or VMT (Table 2).

All data on growth variables was pulled from the City's Land Use and Transportation Element (LUTE), adopted in 2017. The LUTE provides values of growth variables for the year 2014 and projects them for year 2035. For the Playbook, 2016, 2030 and 2050 values were calculated by either interpolating or extrapolating using the growth rate projected between the 2014 and 2035 values. The estimated 2016 values presented in Table 2 differ by less than 2% from the actual 2016 values published in the City's Climate Action Plan Biennial Progress Report 2018 and cited in *The Playing Field* chapter of the Playbook (page 14). This difference does not have a significant impact on the scenario analysis described in the subsequent section of this appendix.

Table 2: Business-as-usual Growth Variable Forecast Assumptions based on 2035 LUTE Projections

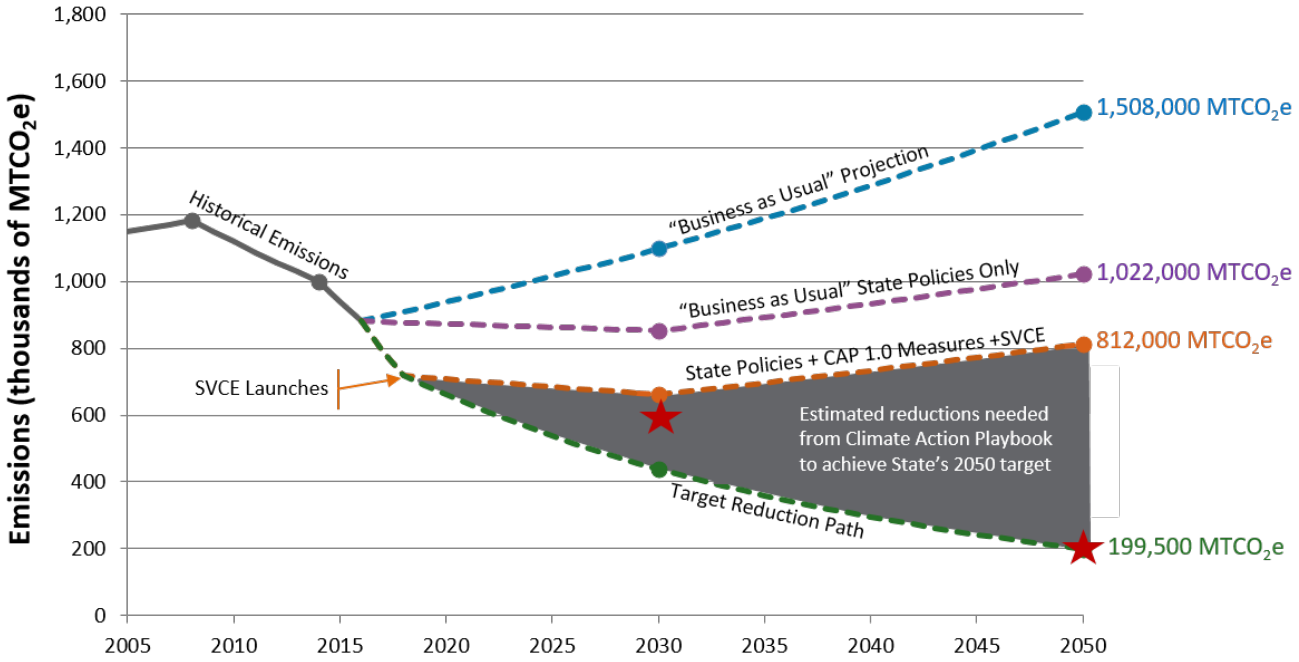
Growth Variable	2016 Estimated (LUTE*)	2030 (CAP)	2035 (LUTE)	2050 (CAP)
Population	149,471	167,533	174,500	197,187
Housing Units	58,318	68,436	72,460	86,009
Jobs	85,321	112,655	124,410	167,560
Non-residential million square feet	48.3	56.1	59.2	69.5
Vehicle miles travelled	869,828,540	1,126,403,395	1,235,341,167	1,629,542,923

*2016 values for growth variables were estimated based on 2014 values from the LUTE.

The growth variables in Table 2 were utilized to project business-as-usual growth on a sector-by-sector basis as described below.

- **Residential energy consumption:** Projected based on an average of the compound annual growth rate of population and compound annual growth rate of housing units.
- **Commercial energy consumption:** Projected based on an average of the compound annual growth rate of jobs and compound annual growth rate of non-residential built environment square footage.
- **On-road transportation:** Projected based on the compound annual growth rate of vehicle miles traveled (VMT) growth.
- **Solid waste, water and wastewater, off-road equipment, and Caltrain**: Projected based on an average of the compound annual growth rate of population, housing units, jobs, and non-residential built environment square footage.

Figure 2: Historical & Forecasted GHG Emissions: 2005 - 2050



★ = State Targets: 40% by 2030; 80% by 2050

The business-as-usual (BAU) forecast utilizes Sunnyvale-specific growth projections from the City's Land Use and Transportation Element (LUTE), adopted in 2017. These growth projections are available through 2035 when the City is projected to achieve complete buildout. This BAU forecast, however, assumes continued growth in the absence of future projections between 2035-2050.

The following four forecasts were developed to support the Playbook:

(1) **Business-as-usual (BAU) forecast** analyzes how emissions will grow if per capita consumption trends and efficiencies remain at their 2016 level, while the number of people, jobs, and housing units, VMT, and square footage of commercial/industrial space in Sunnyvale continues to grow. In other words, the BAU is the status quo scenario before State, regional and local GHG emissions reduction efforts are taken into consideration.

The BAU projection utilizes the demographic projections for population, households, jobs and traffic (measured by vehicle miles travelled or VMT) as specified in the Land Use and Transportation Element (LUTE, adopted in 2017) of the City's General Plan. The LUTE includes projections out to year 2035, when the City is assumed to have reached complete buildout. As such, the 2017 LUTE does not contain projections for these growth variables for years 2030 and 2050, which define the interim and final planning horizons for climate action planning in the Playbook.

To estimate population, households, jobs and VMT for 2030 and 2050, a compound annual growth rate was calculated for each variable based on the baseline year of data available (2014) and the farthest future year of data available (2035). This compound annual growth rate was applied to the base year (2014) data to interpolate values of these variables annually through 2030 and to extrapolate these variables annually through year 2050.

The above methodology is based on two key assumptions that:

- growth will continue between 2035 and 2050, even though the LUTE assumes complete buildout by 2035; and
- the compound annual growth rate remains constant over the period between 2014 and 2050.

Based on these assumptions, the BAU forecast predicts a continued increase in emissions through 2050, driven by local growth. In reality, growth after 2035 may be higher or lower than assumed. However, in the absence of growth projections beyond 2035, this forecast is conservative as it estimates higher GHG emissions in the future than may actually occur if growth slows down based on the premise of complete buildout by 2035. See Table 4 for the projected 2030 and 2050 emissions under this forecast scenario.

(2) **Business-as-usual with State policies forecast** analyzes how emissions will change under the moderating impact of state and federal policies currently in place that are expected to significantly reduce GHG emissions in Sunnyvale. Specifically, the impact of the following policies was accounted for:

- California Renewable Portfolio Standard (RPS) to achieve 50% renewable energy by 2030[1]
- California Energy Code, Title 24, Part 6[2] which contains energy conservation standards applicable to most residential and non-residential buildings throughout California, including goals related to zero net energy for residential new construction by 2020 and non-residential construction by 2030[3]
- Caltrain electrification, which will fully convert Caltrain to an electric fleet from the current diesel engines[4]
- Advanced Clean Cars Program[5] adopted by California Air Resources Board in 2012 to enact low emission vehicle and zero emission vehicle regulations and more stringent fuel economy standards for model years 2017 – 2025.

See Table 4 for the projected 2030 and 2050 emissions under this forecast scenario.

(3) **Business-as-usual with State policies and CAP 1.0 measures** represents the most likely emissions trajectory for Sunnyvale in the absence of new climate action. This forecast considers ongoing implementation of the City's CAP 1.0, including the launch of SVCE. Only CAP 1.0 measures where the City has made significant progress on implementation were attributed to CAP 1.0 emissions avoided. Table 3 shows emissions avoided from the following CAP 1.0 measures were attributed to the Playbook.

[1] Note: Since the completion of the City of Sunnyvale GHG forecast and technical analysis for the Playbook, the State of California passed SB 100 in September 2018, increasing the overall RPS requirement from 50% to 60% by 2030. The legislation also adopted an additional goal of 100% of all retail sales by 2045 to come from renewable energy resources and zero-carbon resources. These additional emissions reductions are accounted for in the current analysis but attributed to SVCE since the community choice aggregation (CCA) program is already providing zero-carbon electricity.
[2] California Energy Commission, 2016 Building Energy Efficiency Standards. https://www.energy.ca.gov/title24/2016standards/index.html
[3] California Public Utilities Commission, Energy Efficiency Strategic Plan. http://www.cpuc.ca.gov/general.aspx?id=4125
[4] Caltrain, Peninsula Corridor Electrification Project. http://www.caltrain.com/projectsplans/CaltrainModernization/Modernization/PeninsulaCorridorElectrificationProject
[5] California Air Resources Board, Advanced Clean Cars Program. ww2.arb.ca.gov/our-work/programs/advanced-clean-cars-program

Table 3: CAP 1.0 Measures Included in Emissions Forecast

CAP 1.0 Measure	2030 Emissions Avoided (MT CO2e)	2050 Emissions Avoided (MT CO2e)
Community Choice Aggregation	152,267	170,845
Commercial Outdoor Lighting Efficiency	184	200
Recycling and Composting	37,619	37,619
Water Conservation	286	477
Water Sources & Efficiency	140	345

The forecasts attribute emissions reductions in descending order as follows:

- emissions reductions resulting from statewide and federal policies.
- emissions reductions resulting from the implementation of local measures in Sunnyvale's CAP 1.0.

For example, the BAU forecast assumes that (non-direct access) electricity will be 33% renewable in 2030, because PG&E electricity in 2016 was 33% renewable. The BAU forecast with State measures assumes that electricity will be 50% renewable in 2030, because the State's RPS commits to 50% renewable electricity by 2030. The BAU forecast with CAP 1.0 measures included assumes that electricity will be 100% carbon free by 2030, because it factors in the impact of SVCE. The avoided emissions impact of moving from 33% to 50% renewable electricity in 2030 is attributed to the State RPS policy. The avoided emissions impact of moving from 50% renewable to 100% carbon free electricity in 2030 is attributed to the CAP 1.0 community choice aggregation measure. See Table 4 for the projected 2030 and 2050 emissions under this forecast scenario.

(4) **Target Reduction Path** is the path the City must be on to best ensure meeting the state's 2050 target (green dotted line in Figure 2). This target path is represented by a curved line interpolated between the current emissions and the 2050 target of 80% below 1990 levels. As such, this interpolated target path assumes a GHG reduction greater than 40% must be achieved by 2030. This is reflective of the fact that buildings and other infrastructure that are put into place now will likely still be in place in 2050. Emissions reductions achieved in the short-term (i.e., through 2030) will better position the City to meet its longer term 80x50 target. Therefore, it is very important that the City exceed the state's interim target by meeting a 56% reduction by 2030 to stay on the pathway to 2050. See Table 4 for the projected 2030 and 2050 emissions under this forecast scenario.

Table 4: Emissions Forecast by Scenario and CAP 2.0 Emissions Reduction Targets

Description	2030 Remaining Emissions (MT CO2e)	2050 Remaining Emissions (MT CO2e)
Business-as-usual emissions	1,097,846	1,507,877
BAU with State policies	852,550	1,021,498
BAU with State policies + CAP 1.0	662,055	812,012
CAP 2.0 target	437,685	199,458

The Playbook contains Strategies and Plays that are designed to address the gap between the target reduction path and the business-as-usual emissions forecast that accounts for State policies and CAP 1.0 measure implementation (grey wedge in Figure 2).

C. Implications for the Future

Emissions forecasts represent a future view based on current technological, market and behavioral trends at the time of the analysis. The forecasts make assumptions about population, jobs and growth patterns as identified in the 2017 LUTE. However, growth may happen at a different pace than planned for, and new State and federal policies will influence expected GHG emissions. Therefore, regular GHG communitywide inventories are necessary to account for unforeseen exogenous factors to better ensure that the City remains on track to meeting State climate goals and the commitments of the Paris Agreement.

Scenario Analysis: Estimating Reductions

When it comes to issues as complex and uncertain as climate change, scenario development is a valuable tool for stimulating debate, and inspiring action and innovation. The Playbook relies on two scenario analyses for the target years 2030 and 2050. DNV GL's Climate Scenario Analysis Tool was customized based on Sunnyvale's 2008 baseline GHG emissions inventory, subsequent inventories for 2014 and 2016, anticipated SVCE impact and future projections. The tool also integrates Fehr & Peers' TrendLab+ tool outputs related to transportation to explore different emissions scenarios for 2030 and 2050. These scenarios were analyzed using stakeholder input to explore different options and pathways for emissions reductions. Stakeholder input included feedback from the community, CAP 2.0 Advisory Committee (CAC), and City staff.

A. Scenario Analysis for 2030 and 2050

The DNV GL Climate Scenario Analysis Tool (Climate Tool) is an Excel-based workbook that integrates Sunnyvale's GHG emissions for 2008, 2014 and 2016. The DNV GL Climate Tool utilizes the BAU forecast with the impact of State policies and CAP 1.0 implementation as the base scenario for attributing further emissions reductions associated with specific strategies and targets.

The Climate Tool lays out a possible scenario to achieve each of the targets on Sunnyvale's aforementioned target reduction path:

- 56% below 1990 levels by 2030 (exceeding the State's 40x30 target), in order to reach
- 80% below 1990 levels by 2050 (equal to the State's target)

In each scenario, the Climate Tool analyzes possible GHG reduction strategies and the targets that need to be achieved in each of the following four sectors:

- Natural gas
- Electricity
- Transportation
- Waste

These four sectors are largely aligned with the City's GHG inventory sectors and contribute most significantly to total community-wide GHG emissions.

B. Setting Targets for Energy and Waste

Within each sector, the Climate Tool identifies a set of strategies related to conservation and efficiency (e.g., source reduction) as well as shifting to cleaner sources (e.g., electrification and renewable resources). Each strategy is associated with an implementation target level that may be adjusted by users – that is, the target may be dialed up or dialed down. Table 5, parts (a) through (c), provide examples of the strategies and targets that may be adjusted for these sectors.

Targets are set separately for 2030 and 2050. The City's focus is to achieve the 2050 emissions reduction target. Simultaneously running the analysis for 2030 helps to develop a better understanding of the emissions reductions that are achievable by 2030 and the trade-off between strategy-level targets that will be necessary to achieve the

2050 target. As targets for each sector are dialed up or down based on user input, the total projected GHG emissions for each scenario will be altered.

Table 5. DNV GL Climate Scenario Analysis Tool – Example Natural Gas Strategies and Target Level Inputs by Sector

(a) Natural Gas Sector Targets

Strategy	Target Level Description	2030 Target Level (User Input)	2050 Target Level (User Input)
Improve efficiency of residential natural gas use	% reduction in natural gas before electrification	5%	30%
Improve efficiency of non-residential natural gas use	% reduction in natural gas before electrification	5%	30%
Electrify residential water heating equipment	% equipment electrified after energy efficiency	20%	50%
Electrify residential space heating equipment	% equipment electrified after energy efficiency	20%	50%
Electrify non-residential water heating equipment	% equipment electrified after energy efficiency	20%	50%
Electrify non-residential space heating equipment	% equipment electrified after energy efficiency	20%	50%
Electrify non-residential cooking equipment	% equipment electrified after energy efficiency	20%	50%

(b) Electricity Sector Targets

Strategy	Target Level Description	2030 Target Level (User Input)	2050 Target Level (User Input)
Improve efficiency of residential electricity use	% reduction in electricity	5%	10%
Improve efficiency of non-residential electricity use	% reduction in electricity	5%	10%
Expand rooftop solar	% remaining electricity emissions eliminated with Photovoltaics (PV)	3%	5%
Increased participation in SVCE's carbon free electricity offering	% of electricity carbon free	100%	100%

(c) Waste Sector Targets

Strategy	Target Level Description	2030 Target Level (User Input)	2050 Target Level (User Input)
Decrease amount of waste sent to landfill	% waste diverted from landfills	90%	90%

C. Setting Targets for Transportation

Transportation emissions are typically estimated based on vehicle miles traveled (VMT), which is the total miles driven by private or public vehicles. VMT is calculated using the origin-destination (OD) VMT method. An OD VMT estimate tracks all the vehicle trips generated within a geographic area across the entire network to their ultimate destinations and isolates the VMT as follows:

- Internal-internal (II): All trips made entirely within the study jurisdiction.
- One-half of internal-external (IX): One-half of trips with an origin within the study jurisdiction and a destination outside of this jurisdiction. This assumes that the study jurisdiction shares half the responsibility for trips traveling from other jurisdictions.
- One-half of external-internal (XI): One-half of trips with an origin outside the study jurisdiction and a destination within this jurisdiction. Similar to the IX trips, this assumes that the study jurisdiction shares the responsibility of trips traveling to other jurisdictions.
- External-external (XX): Trips through the study jurisdiction are not included because the study jurisdiction cannot implement policies that influence the trip-making behavior. Rather, through trips are assigned to other jurisdictions that can influence either the origin or destination side of the trip-making behavior.

As population and jobs in Sunnyvale grow, total annual VMT will naturally increase. Therefore, a more reliable assessment of changes in VMT is the VMT per service population[6]. VMT per service population is defined as the annual VMT divided by the service population.

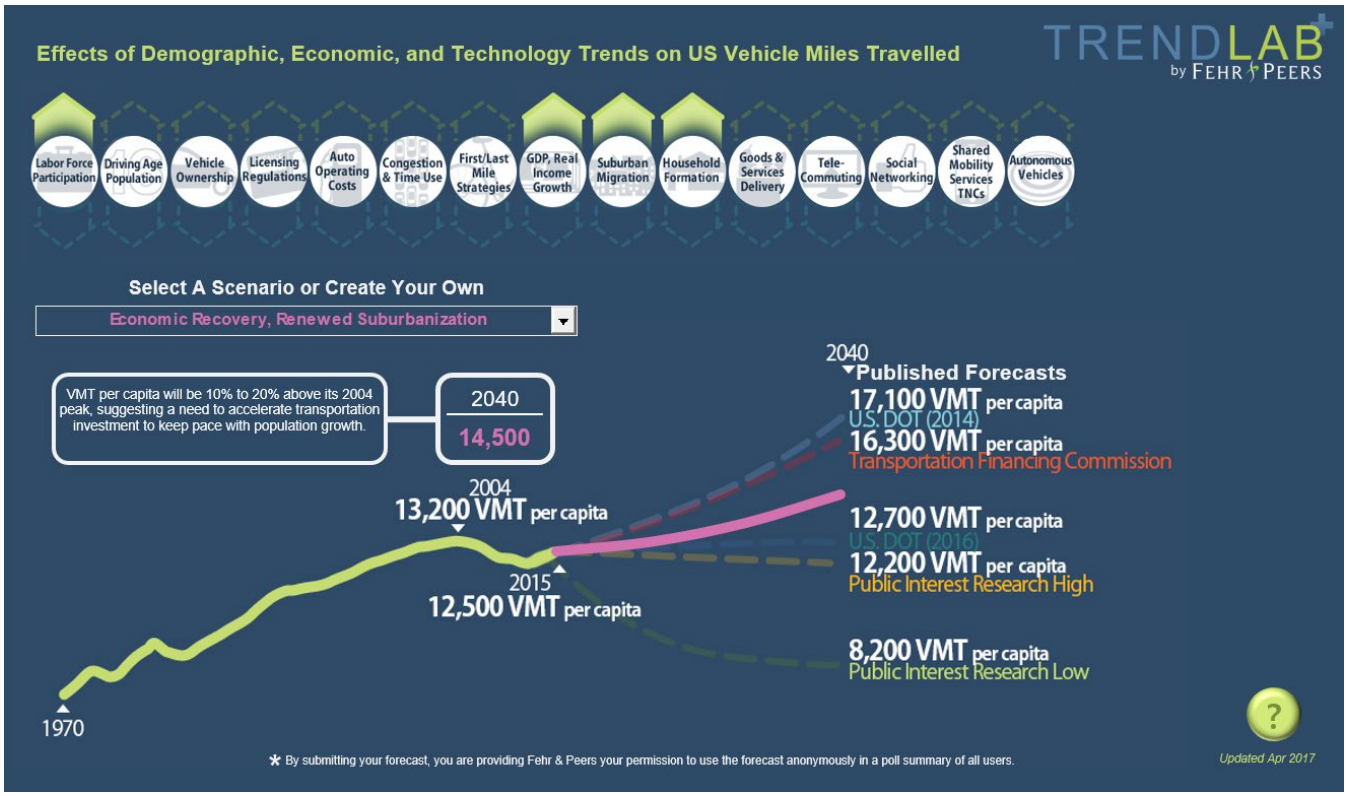
To determine VMT per service population targets for the Playbook, the City used Fehr & Peers' TrendLab+ tool. The Fehr & Peers TrendLab+ tool is a scenario tool that tests how changes from the business-as-usual trends could influence VMT per service population. Fehr & Peers first developed TrendLab+ in 2016 to evaluate the effects of evolving trends on 2040 national average VMT per service population under different future scenarios, such as economic recovery and millennial preferences. The tool (Figure 3) documents the historical annual VMT per service population from 1970 to 2015 in the United States and estimates future year VMT per service population based on the user's input on how they believe the trends might change in the future. Each trend has three possible changes that users can select from: up, level and down. Each scenario estimates future VMT per service population based on the combined effect of each trend. Since user preferences on the future trends might differ, the VMT per service population estimate varies within a range. The tool also includes VMT per service population forecasts published by U.S. Department of Transportation and other public interest research groups for comparison.

Fehr & Peers adapted TrendLab+ for Sunnyvale to estimate VMT per service population in the target years of 2030 and 2050. Fifteen trends that have the greatest influence on Sunnyvale's VMT per service population were identified and used for the Sunnyvale TrendLab+ tool. Because some of trends are anticipated to continue to grow (e.g., clean-fuel vehicles) rather than fall, these trends have the possible changes of staying level, going up and or going "double up." The Sunnyvale TrendLab+ tool separates the citywide annual VMT into "clean" (i.e., miles traveled by vehicles that have zero emissions) and "non-clean" VMT (i.e., miles traveled for fossil fuel powered vehicles) to account for the decarbonization benefits of adopting a cleaner community-wide vehicle fleet. DNV GL's Climate Tool integrates a separate module based on TrendLab+ Tool to account for VMT impacts.

The VMT per service population used in Sunnyvale TrendLab+ tool is based on VMT and service population estimates from Sunnyvale's LUTE, adopted in 2017. See Table 2 for details on population, jobs and VMT projections incorporated into TrendLab+.

[6] The service population is the sum of resident population and employment.

Figure 3: National TrendLab+ Tool



Trends for Sunnyvale

The fifteen trends included in Sunnyvale TrendLab+ fall into five categories (Table 6): demographic trends, economic trends, land use trends, transportation infrastructure trends, and technology trends.

Table 6. Trends in TrendLab+ Tool

Demographic	**Infrastructure**
Local Labor Force Participation	Low-Stress Bicycle/ Pedestrian Network
Driver Population	Transit Corridors Enhancement
Economic	**Technology**
Vehicle Ownership	Goods & Service Delivery
Auto Operating Cost	Social Networking
Transportation Demand Management (TDM) Strategies	Clean-Fuel Vehicles
Telecommuting	Ride Hailing/Shared Mobility
Land Use	Autonomous Vehicles
Housing Affordability	
Densification/Mixed Use	

Table 7 lists each trend, its magnitude of impact, and its direction of influence (direct vs. inverse) on VMT per service population. The magnitude of impact is categorized as high, medium or low, which provides insights for prioritizing transportation policies.

Table 7: Magnitude of Impact for Trends on VMT Per Service Population

	Magnitude of Impact	Direction of Influence	Category
Local Labor Force Participation	High	Direct	Demographic
Auto Operating Cost	High	Inverse	Economic
Housing Affordability	High	Inverse	Land Use
Ride Hailing/Shared Mobility	High	Direct	Technology
Driver Population	Medium	Direct	Demographic
Low Stress Bicycle/Pedestrian Network	Medium	Inverse	Infrastructure
TDM Strategies	Medium	Inverse	Economic
Transit Corridors Enhancement	Medium	Inverse	Infrastructure
Densification/Mixed-Use	Medium	Inverse	Land Use
Goods & Services Delivery	Medium	Direct	Technology
Autonomous Vehicles	Medium	Direct	Technology
Vehicle Ownership	Low	Direct	Economic
Telecommuting	Low	Inverse	Economic
Social Networking	Low	Inverse	Technology
Clean-Fuel Vehicles	Low	Direct	Technology

Sunnyvale TrendLab+ Scenario Summary

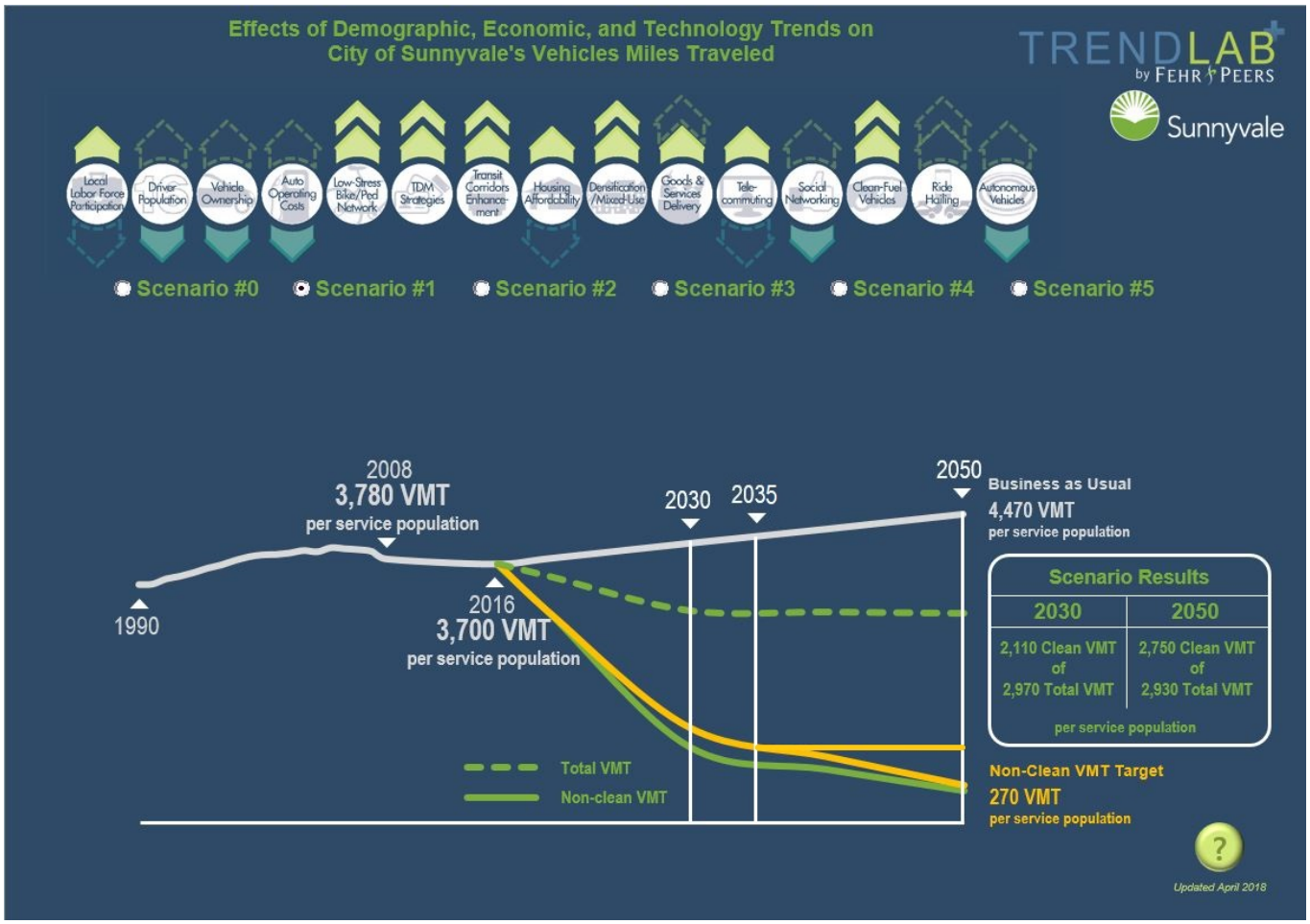
As a part of the community and staff outreach, community members, the City's staff, and the Climate Action Committee (CAC) members were asked to vote on what trends (shown in Table 7) they wished to see in Sunnyvale in the future for each of the variables. The following six scenarios were generated using the Sunnyvale TrendLab+ tool during the community and staff outreach phase of the project:

- **Scenario #0: Business-as-Usual** – This scenario summarizes the citywide annual VMT per service population for business-as-usual conditions under 2008, 2016, 2030, 2035, and 2050 conditions. This scenario represents a scenario similar to the 2035 Land Use and Transportation Element (LUTE).
- **Scenario #1: Ideas Workshop** – This scenario summarizes the citywide annual VMT per service population based on the most common trends voted on at the March 3, 2018 *Innovate Climate Action in Sunnyvale* Workshop.
- **Scenario #2: Transportation Focus Meeting** – This scenario summarizes the citywide annual VMT per service population for the most common trends voted on at the City staff workshop focused on transportation.
- **Scenario #3: CAP 2.0 Advisory Committee (CAC) Meeting** – This scenario summarizes the citywide annual VMT per service population for the most common trends voted on at the April 5, 2018 CAC meeting.
- **Scenario #4: CAP 2.0 (Composite Results)** – This scenario summarizes the citywide annual VMT per service population from the composite of the trends from Scenarios 1, 2 and 3, as noted above.
- **Scenario #5: CAP 2.0 (Alternate Results)** – This scenario summarizes the citywide annual VMT per service population from moderating the composite results of Scenario #4 for TDM strategies, transit corridor enhancements, housing affordability and densification/mixed-use.

For each scenario, service population forecasts and the citywide annual VMT (including clean and non-clean VMT) were estimated using the TrendLab+ tool. The output VMT per service population from these scenarios were used as input into the DNV GL Climate Tool to estimate citywide GHG emissions.

After viewing the projected VMT per service population and emissions resulting from each of these scenarios and with further feedback from the CAC and the City's Commissions[7], City staff selected a modified Scenario #1 (**Figure 4**) because it most closely reflected the balance between the targets proposed by these advisory groups and setting a goal that was realistic. The final targets for reductions in vehicle miles per person were set at a 20% reduction by 2030 (identical to Scenario #1) and a 25% reduction by 2050 (modification to Scenario #1, which predicts a 21% reduction by 2050).

Figure 4. Sunnyvale TrendLab+ VMT Projections for 2030 and 2050 for Scenario #1



The final selected transportation sector targets (modified Scenario #1) reflect:

- A high rate of clean fuel fleet adoption, reaching 20% by 2030 and 75% by 2050;
- Aggressive growth in investment in active transportation and transit projects, given a progressively shrinking driver population;

[7] The VMT targets based on a modified Scenario #5 were presented to the CAC, Sustainability Commission, Bicycle and Pedestrian Advisory Commission, and Planning Commission. The CAC and Commissions proposed modifications to the VMT targets, which brought them in line with Scenario #1 modeled in the TrendLab+ tool.

- Greater densification and mixed-use development;
- A Transportation Demand Management (TDM) program that is mandatory and enforced actively by the City. TDM forms a core component of the City's transportation strategy moving forward.
- Decrease in driving population, vehicle ownership, automobile operating costs, and social networking;
- Increased reliance on the use of technology, including ride hailing, telecommuting, and goods and services delivery.

Table 8 summarizes the citywide annual VMT per service population for modified Scenario #1.

Table 8: Transportation targets with Modified Scenario #1

Metric	2016	2030	2050
Citywide Annual VMT	869,904,400	832,159,133	1,012,172,877
Percent Change in Annual VMT	0%	-4%	+16%
Citywide Annual VMT per Service Population	3,705	2,970*	2,775**
Percent Change in Citywide Annual VMT per Service Population (relative to 2016)	0%	-20%	-25%
Clean Fuel Vehicle Fleet Adoption Portion	0.5%	20%	75%
Clean Citywide Annual VMT per Service Population	17	2,110	2,081
Non-Clean Citywide Annual VMT per Service Population	3,688	860	694

Note: All VMT is citywide annual shared VMT per service population. Citywide annual shared VMT per service population: citywide daily shared VMT (100 % internal + 50% internal-external, and 50% external-internal) x 347 days/year.
*VMT per service population for 2030 is equal to that used in Scenario #1 modeled in the TrendLab+ tool and reflected in Figure 4.
**VMT k for 2050 is not equal to that used in Scenario #1 modeled in the TrendLab+ tool, as the modeled value of 21% reduction in VMT per capita relative to 2016 allowed the City to only incrementally increase VMT reduction targets. Instead, City staff increased the 2050 target to achieve a 25% reduction in VMT per capita relative to 2016 to ensure that this target reflects continued emphasis on reducing VMT and shifting to alternative transportation modes.

DNV GL's Climate Tool used the citywide VMT estimates from the TrendLab+ tool to calculate citywide GHG emissions from the transportation sector. The clean vehicle adoption rate and reduction in total VMT work in tandem to impact overall citywide GHG emissions. If other sectors are more effective at reducing GHG emissions, then the clean vehicle adoption rate can be lower. Table 8 summarizes the clean VMT as 20% of Sunnyvale's total VMT by 2030 and 75% of Sunnyvale's total VMT by 2050. If the targeted percent of total VMT accounted for by clean vehicles is reduced, then a greater reduction in VMT per service population will be required to achieve the 2050 emissions reduction target. The opposite is also true. If the targeted percent of total VMT accounted for by clean vehicles is higher, a lower reduction in VMT will be required to achieve the 2050 emissions reduction target. Therefore, although the 2050 target for VMT does not have a significant impact on overall 2030 emissions, since most of the remaining VMT (after the VMT reductions) are from clean vehicles.

As of 2016, Sunnyvale's total VMT is 3,705 per service population. The results of Scenario #1 with modifications is a target VMT per service population of 2,970 in 2030 (i.e., 20% reduction in VMT per service population relative to 2016) and a target VMT per service population of 2,775 VMT per service population (i.e., 25% reduction in VMT per service population relative to 2016).

D. Estimating Emissions Reductions Across Sectors

The Playbook strategies are applied to the current emissions by first prioritizing efficiency and conservation measures (e.g., strategies that reduce energy, transportation and waste) and then strategies that shift to cleaner sources are applied to the remaining emissions (e.g., strategies related to solar PV, electric vehicles, etc.). This general approach to climate action planning is in accordance with the CPUC's Energy Efficiency Strategic Plan, which acknowledges the State's "loading order" and identifies energy efficiency as California's top priority resource.[8]

The Climate Tool considers interactive factors between sectors e.g., increases in electricity consumption from electrification of buildings and transportation are taken into account. Furthermore, "dialing down" targets in one sector (e.g., transportation targets related to VMT) enables the user to see the overall impact on potential emissions reductions for 2030 and 2050 and allows for "dialing up" targets in other sectors (e.g., buildings) to meet State climate goals.

E. Selecting Final Scenario Targets

The DNV GL Climate Scenario Analysis Tool provides a summary output table for each target year (Table 9) that shows the overall GHG reduction target being achieved across sectors by the suite of emissions reduction strategies and targets selected.

Table 9. DNV GL Climate Scenario Analysis Tool Summary Table for 2030

Metric	2030	2050
Remaining emissions in target year	437,685	199,458
1990 baseline emissions	1,004,194	1,004,194
Sunnyvale projected % emissions reduction below 1990 levels by target year	56%	80%
State target % emissions reduction below 1990 levels by target year	40%	80%

F. Metrics to Measure Progress

To ensure the success of implementing the Plays in the Playbook, the City will integrate the Plays and Next Moves into its other local and regional plans, programs and activities. Playbook implementation requires tracking progress to ensure the City is on track to meeting the State's climate goals.

The City will continue update its GHG communitywide emissions inventory every year with support from regional agencies including SVCE, Metropolitan Transportation Commission (MTC) and Valley Transportation Authority (VTA). In addition, the City will track key metrics as listed in Table 10; these key metrics directly influence community-wide GHG emissions and are, therefore, indicators of progress made towards implementing the Plays and achieving their associated targets.

[8] California Public Utilities Commission, 2008. "Energy Efficiency Strategic Plan." http://www.cpuc.ca.gov/general.aspx?id=4125

Table 10. Key Metrics and Data Sources for Tracking Progress Towards Play-level Targets

Play	Target	Metric	Metric Data Source
Strategy 1: Promoting Clean Electricity			
Play 1.1: Promote 100% clean electricity	2030: 100% participation in clean electricity 2050: 100% participation in clean electricity	Remaining direct access electricity consumption	SVCE, PG&E
Play 1.2: Increase solar photovoltaics (PV)	2030: 3% of load from local solar 2050: 5% of load from local solar	Distributed solar photovoltaics (PV) capacity	California Distributed Generation Statistics
Play 1.3: Increase distributed electricity storage	2030 Target: 2% of electricity demand stored in batteries locally 2050 Target: 5% of electricity demand stored in batteries locally	Cumulative communitywide battery storage capacity	CPUC Self-Generation Incentive Program (SGIP) data on battery storage installed capacity
Strategy 2: Decarbonizing Buildings			
Play 2.1: Reduce energy consumption in existing buildings	2030: 5% of existing homes and businesses receive deep energy retrofit 2050: 30% of existing homes and businesses receive deep energy retrofit	Energy efficiency program participation rates	PG&E, BayREN and SVCE
Play 2.2: Support electrification of existing buildings	2030: 20% of homes and businesses completely electrified 2050: 50% of homes and businesses completely electrified	Number of customers on all-electric rates or without associated gas account.	SVCE
Play 2.3: Achieve all-electric new construction	2030: 100% all-electric new buildings 2050: 100% all-electric new buildings	Number of new buildings that are all-electric Total area (sq. ft.) of buildings that are all-electric	City Community Development Department (CDD)
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	2030: 20% reduction in vehicle miles per person 2050: 25% reduction in vehicle miles per person	Modeled per service population VMT	Metropolitan Transportation Commission (MTC) or City DPW's Travel Demand Model
Play 3.2: Increase transportation options and support shared mobility			

Play	Target	Metric	Metric Data Source
Play 3.3: Increase zero-emission vehicles	2030: 20% of all vehicles on road are zero-emissions 2050: 75% of all vehicles on road are zero-emissions	Vehicle registrations by fuel type	Department of Motor Vehicles (DMV)
Strategy 4: Managing Resources Sustainably			
Play 4.1: Achieve Zero Waste goals for solid waste	2030: Reduce landfilled garbage to 1 lb per person per day 2050: Reduce landfilled garbage to <1 lb per person per day	Waste diversion rate	California Department of Resources, Recycling and Recovery (CalRecycle)
Play 4.2: Ensure resilience of water supply	Targets will be defined as per state requirement	Annual water consumption per capita relative to 2016 baseline	City of Sunnyvale Environmental Services Department (ESD)
Play 4.3: Enhance natural carbon sequestration capacity	Supports broader net carbon reductions	Net number of new trees added on public lands Acreage of land area treated by green stormwater infrastructure features	City of Sunnyvale Department of Public Works (DPW), CDD, and ESD
Play 4.4: Promote sustainable consumption	Supports broader emissions reductions	No defined metric	Not applicable
Strategy 5: Empowering Our Community			
Play 5.1: Enhance community awareness and engagement	Supports all other Plays	Social media engagement analytics Number of people participating in community engagement programs each year (e.g., CERT, Cool Blocks, etc.) Number of businesses engaged in CAP programs	City of Sunnyvale various departments and Office of City Manager (OCM)
Play 5.2: Track and share data and tools	Supports all other Plays	Annual GHG Inventory Number of people using online or mobile phone community engagement platforms (e.g., IGreenSunnvale)	City of Sunnyvale ESD

The City can also track additional secondary metrics as listed in Table **11**; while these metrics are not directly used to estimate GHG emissions, they indicate the performance of key programs that would be integral to the CAP.

Table 11. Secondary Metrics to Assess Progress

Metric	Data Source
Distributed local solar (kW) on all building types	Center for Sustainable Energy – California Solar Statistics
Number of residential units approved for voluntary Green Building Program incentives	City of Sunnyvale CDD
Total floor area (sqft) of commercial building space approved for voluntary Green Building Program incentives	City of Sunnyvale CDD
Electric vehicle charging infrastructure	DOE Alternative Fuels Data Center + direct communication with large businesses
Public transportation ridership	Caltrain + VTA ridership data
Bike or scooter share ridership	Lime ridership data
Percent of students using non-motorized transportation to school	City of Sunnyvale Department of Public Safety (DPS) – Safe Routes to School Program
Percent of commuters riding bicycles to work	American Community Survey 5-year estimates
Miles of bicycle lanes by class	City of Sunnyvale DPW
Train ridership	Caltrain annual ridership estimates
Percent of local water needs met by recycled water	City of Sunnyvale ESD
Waste disposed per capita	California Disposal Reporting System