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2022 RTP/SCS Off-Model Strategy Quantification for the Shasta Region

INTRODUCTION

The RTP/SCS for the Shasta Region identifies regional actions that the region may take to reduce greenhouse gas (GHG) emissions from cars and light trucks over and above efforts employed by the State of California. A number of regional strategies proposed for the 2022 RTP/SCS, as well as various enhancing aspects of these strategies, cannot be adequately quantified using a travel-demand model. Thus, the GHG reductions from these strategies were quantified utilizing 'off-model' methods based primarily on the California Air Resources Board's (CARB) *Final Sustainable Communities Strategy Program and Evaluation Guidelines Appendix E* (CARB 2019). Table 1 below summarizes the region's five 'off-model strategies'. A more detailed explanation of each strategy and the methodology proposed to quantify their GHG emission reductions – are provided in the following sections and in Appendix A, *Off-Model Calculations*.

Table 1: Summary of Off-Model Strategies

Strategies		Description	**CO_2 estimation**	
1	**Transit Improvements**	Improving bus stops	**2035**	**2040**
2	**Bicycle and Pedestrian Facility Enhancement**	Implementation of GoShasta Regional Active Transportation Plan		
3	**EV Charging Infrastructure**	Accelerating utilization of regional Zero-Emission Vehicle Charging Infrastructure		
4	**Car Share**	Accelerating car sharing in TAZs that have sufficient residential densities to support car sharing		
5	**Bike Share**	Implementation of the planned bike share programs		

Consistent with CARB guidance, the 2014 version of CARB's EMission FACtor model (EMFAC2014) was used to quantify all off-model GHG reduction strategies. This is consistent with the previous 2018 RTP/SCS. Emissions are quantified for 2035 and 2040. All factors can be found in Appendix A, *Off-Model Calculations,* and can be adjusted using STRA's Off-Model Calculation tool.

***Please note that all assumptions, figures, and methods found in this draft memo and appendices are preliminary and will be updated consistently with the final 2022 RTP/SCS.

Off-Model Strategies

This document presents the calculation procedures and data sources used for the off-model calculations. Details associated with each off-model strategy calculation can be found in Appendix A. It is anticipated that Appendix A, Off-Model Calculations, and further details will be added, and calculator inputs refined during the development of the 2022 RTP/SCS and as information becomes available.

Strategy 1 – Transit Improvements

Description: Currently, transit bus stops in the Shasta Region do not have shelters, seating, wayfinding signage, and walking and cycling related amenities. Improving bus stops by providing shelters, seating, signage, and sidewalks is associated with changes in ridership in the areas immediately surrounding improved bus stops. SRTA regional travel demand model is not sensitive to improving bus stops, and an off-model calculation based on the existing studies can be used for quantification. SRTA defines a bus stop index based on the availability of required amenities (e.g., bus stop signs, shelters, seating areas, maps, trash cans, lighting, bike racks, schedule, and real-time information,…), paved landing area, and sidewalk leading to the stop. SRTA anticipates at least one unit increase in the bus stop index for 2035 and a two-unit increase for 2040.

Objectives: A study by Kim et al. (2020) compares ridership from before and after improvements at the treated stops and at a set of unimproved stops while controlling for demographic, land use, and regional accessibility influences. The results show that the improved bus stops are associated with a statistically significant increase in overall ridership. Shi et al. (2021) conducted a similar study for Bus Rapid Transit (BRT) ridership and concluded that stop amenities are positively associated with higher transit ridership. Brown et al. (2006) also support the same relationship between improved bus stops and overall ridership. This study shows that a unit increase in the bus stop index is associated with a 31% unit increase in ridership. In addition, there are many studies that support the positive effects of walking and cycling improvements around the stations on the overall ridership.

Trip and Emission Needs: All information used for Strategy 1 quantification can be found in the table below and in Appendix A. It should be mentioned that this strategy also can facilitate walking and bicycle use in addition to increasing transit by encouraging more transit trips and providing related facilities like bike racks.

Data	**Source**
Baseline regional ridership	Transit ridership data
Increase in ridership	Brown et al. (2006): 31% (the most conservative values in related studies)
Mode shift factor	Travel demand model
Land use multiplier	National default multiplier: 1.9
Average vehicle occupancy	Travel demand model
Average regional home-work trip lengths	Travel demand model
CO_2 emission reduction (ER) from displaced automobile trips	EMFAC
Increase in Transit activities	Caltrans Division of Research, Innovation and System Information (2015) + travel demand model
Transit ER	Travel demand model + EMFAC

Quantification Methodology: Quantification of this strategy will be based on the *SCS Program and Evaluation Guidelines, Appendix D, Transit Improvements (CARB 201*9). Calculations associated with this strategy can be found in Appendix A. The overall approach includes determining the increase in transit ridership, estimating the mode shift from private automobile to transit, estimating average trip lengths for the region, obtaining necessary emission rates, and estimating net emissions associated with decreased private automobile use and increased transit activity. Regarding the increase in transit ridership, SRTA used the most conservative values in related studies which is a 31% increase in ridership for a unit increase in the bus stop index (Brown et al., 2006). A study by Kim et al. (2020) proposes a 141% increase in boardings for stops with amenity improvement and another study by Shi et al. (2021) shows that compared with boardings at stops that had the smallest number of amenity changes, boardings at stops with new bike hoops were 203.5% higher; boardings at stops with new real-time information system were 199.1% higher; and boardings at stops with new or improved shelters were 81.4% higher. SRTA defines a bus stop index based on the availability of required amenities (e.g., bus stop signs, shelters, seating areas, maps, trash cans, lighting, bike racks, schedule, and real-time information,…), paved landing area, and sidewalk leading to the stop. SRTA anticipates at least one unit increase in the bus stop index for 2035 and a two-unit increase for 2040. The travel model is used to estimate the mode shift from private automobile to transit, average trip lengths for the region, average vehicle occupancy, and emission rates. Regarding increased transit activity, the hypothetical corridor bus frequency impacts on VMT and emissions that are suggested by the Caltrans Division of Research, Innovation and System Information (2015) and the proposed headway for 2035 and 2040 are used to convert the estimated car VMT to bus VMT.

Challenges, Constraints, and Strategy Implementation Tracking:

Challenges and Constraints

Currently, transit service in the Shasta Region is comprised of 60-minute headway fixed route service spread over a large area. Dispersed development patterns and segregated land uses are not conducive to transit. Ridership is consequently low and primarily serves individuals that are transit dependent. These limitations can reduce the positive effects of improving bus stops. However, the 2040 Long-Range Transit Plan calls for the reallocation of transit service hours, resulting in 15-minute fixed-route service on key corridors and between activity centers, supported by flexible on-demand transit services in low demand areas and during low demand days and times. SRTA will implement these changes in phases in response to increased transit-oriented development, public demand, documented unmet transit needs, access to appropriate transit vehicle fleet mix, and in coordination with other modal investments (e.g., first- and last-mile active transportation improvement, programmatic support, etc.). Another limitation could be related to the increased transit activity estimation. Applying today's emissions control technology and no- or low-emissions cars and buses might significantly change these results for the increased transit activity estimation.

Monitoring and Tracking

Tracking for this strategy can be performed utilizing annual Redding Area Bus Authority (RABA) and ShastaConnect ridership reports.

Strategy 2 – Bicycle and Pedestrian Facility Enhancement

Description: Currently, the Shasta Region has a small but growing number of high-quality Class I (separated trail) and Class IV (cycle track) facilities. New high-density, affordable infill mixed-use projects located in the downtown Redding and Shasta Lake strategic growth areas are increasing the number of households in proximity to major trip destination centers/corridors. Walking and bicycling are popular activities with great potential to convert recreational users to trips that replace motor vehicle trips. And several community-based organizations help to support and advocate for active transportation improvements. Decreased vehicle miles traveled (VMT) through displaced trips via active transportation are not easily reflected in the regional travel model without significant changes (e.g., adding 10+ miles of active transportation lanes), and the quality benefits of small active transportation projects are missed.

Objectives: Consistent with the GoShasta Regional Active Transportation Plan, SRTA will continue to provide technical assistance and financial support to local agencies for the development of a direct, contiguous, and low-stress network of active transportation trunk lines with local feeders and connections to public transportation. A number of trunk line projects have been successfully planned and funded in this manner. Trunk line routes are largely comprised of Class I (separate trail) and Class IV (cycle track) facilities: feature protected intersections and/or grade-separated crossings; and will be supported by complementary programs such as free bike parking, public information/education campaigns, and other actions designed to remove barriers and encourage active transportation for residents of all ages and abilities. Under this scenario and considering the current proposed and funded projects, bike and pedestrian lane miles are forecast to increase by 15% by 2035 and 25% by 2040. This can potentially reduce GHG emissions by reducing short work-related motor vehicle trips and VMT, promoting alternative means of transportation, and connecting the first and last mile of transit trips.

Trip and Emission Needs: All information used for Strategy 2 quantification can be found in the table below and in Appendix A.

Data	**Source**
Increase bike lane	GoShasta Regional Active Transportation Plan and the regional proposed projects
Reduction in drive commuting per 1% of bike lane increase	Marshall and Garrick (2010): 0.007
Reduction in VMT per 1% of sidewalk length increase	Fan (2007): 0.02
Home-Based Work (HBW) purpose vehicle trips	Travel demand model
Average regional home-work (HW) trip lengths for biking	National Household Transportation Survey: 1.8 miles
Average regional HW trip lengths for walking	National Household Transportation Survey: 0.98 miles
CO_2 ER from displaced automobile trips	EMFAC

Quantification Methodology: The quantification methodology for Strategy 2 will be based on *SCS Program and Evaluation Guidelines, Appendix D, 'Bicycle and Pedestrian Facility Enhancement'*. Calculations associated with this strategy can be found in Appendix A. Typically, GHG emission for this strategy is a result of VMT reductions due to the mode shift from vehicle trips to nonmotorized trips. SRTA estimated the percent increase in regional bicycling and pedestrian lane miles resulting from the strategy compared to the base year. Consistent with the GoShasta Regional Active Transportation Plan, complementary programs such as free bike parking, public information/education campaigns, and other actions designed to remove barriers and encourage active transportation for residents of all ages and abilities, and the current proposed and funded projects, SRTA estimates 15% by 2035 and 25% by 2040 increase for bike and pedestrian lane miles. The Marshall and Garrick (2010) and Fan (2007) studies are used for quantifying the relationship between the increase in bike and pedestrian lane miles and commute trips. The travel demand model is used as a source for the HBW purpose vehicle trips and the National Household Transportation Survey results are used for the average regional HW trip lengths for biking and walking.

Challenges, Constraints, and Strategy Implementation Tracking:

Challenges and Constraints

Measuring the effectiveness of this strategy can be one of the main challenges. SRTA will deal with this challenge by applying count-based, survey-based, and model-based approaches in estimating bicycle and pedestrian miles traveled at the regional level.

Implementation Tracking

This strategy will be tracked using the development of active transport routes, funding made available from the enhancement quantifications, and bicycle and pedestrian counts performed every three years by SRTA.

Strategy 3 – EV Charging Infrastructure

Description: To accelerate public adoption of zero-emission vehicles the region will facilitate the expansion of electric vehicle charging stations, located in rural towns, urban activity centers, and regional corridors.

Objectives: Estimate CO_2 emission reductions from plug-in hybrid electric vehicles (PHEV) VMT based on the estimated average VMT shift per PHEV from gasoline to electricity as a result of the increased charge stations. Four main areas are identified for charging infrastructure improvements and the number of EV chargers to be installed in these areas is estimated by considering the current proposed and funded projects. Here we use the term eVMT to distinguish VMT from cars and light trucks with internal combustion engines versus those with electric drive trains.

Trip and Emission Needs: All information used for Strategy 3 quantification can be found in the table below and in Appendix A.

Data	Source
Number of EV chargers to be installed	Regional proposed and funded projects
The average number of PHEVs per charger installed	National Renewable Energy Laboratory: 7
The average increase in eVMT per PHEV	Internal CARB analysis of Southern California vehicle trip data (2017): 13
Average emission factor for decreased PHEV gasoline consumption	CARB: 198 grams of CO_2

Quantification Methodology: The off-model quantification for this strategy will follow the *SCS Program and Evaluation Guidelines, Appendix D, 'Electric Vehicle Charging Infrastructure' methodology (CARB 2019)*. Calculations associated with this strategy can be found in Appendix A. Four areas are identified for charging infrastructure improvements. Area descriptions will be added at a later date. SRTA estimates CO_2 emission reductions from PHEV eVMT based on the estimated average VMT shift per PHEV from gasoline to electricity as a result of the increased charge stations. The number of EV chargers to be installed for years 2035 and 2040 is estimated considering the current proposed and funded projects. The National Renewable Energy Laboratory suggestion is used for the average number of PHEVs per charger installed and CARB suggestions are used for the average increase in eVMT per PHEV and the average emission factor for decreased PHEV gasoline consumption.

Challenges, Constraints, and Strategy Implementation Tracking:

Challenges and Constraints

Though VMT is not reduced, increasing acceptance of zero-emission vehicles provides an opportunity for the region to reduce emissions. This particular strategy proved to be the most effective strategy for reducing emissions in the 2018 RTP/SCS. However, the goal of the strategy is to increase PHEV eVMT per day and not to increase purchases of PHEVs and it is critical to the success of this strategy to have a low competitive price for electricity.

Implementation Tracking

The progress of this strategy can be tracked by the installation of charging stations through SRTA-backed programs, and by tracking the number of charging stations and the amount of electricity consumed by EV charging facilities in the region in collaboration with the utility providers.

Strategy 4 – Car Share

Description: In the Shasta Region, the number of required vehicles will significantly decrease if individuals share vehicles. In addition, individuals in this region use their cars only for a small portion of each day, as little as a few hours. This typical demand pattern can justify car sharing as one of the required strategies that can reduce car ownership and VMT. In addition, car sharing is expected to reduce the overall level of VMT. Car sharing makes individuals more mindful of the variable costs of each trip and since members are also required to reserve a vehicle in advance and have plans, they will use the car in a more efficient way.

Objectives: SRTA estimates the car share membership population of TAZs identified as having sufficient residential densities to support car sharing and the CO_2 emissions from car sharing members' discarded or shed vehicles VMT, CO_2 emission rates for shed private automobiles, and VMT from car share members driving car share vehicles.

Trip and Emission Needs: All information used for Strategy 4 quantification can be found in the table below and in Appendix A.

Data	**Source**
TAZs that have sufficient residential densities	Travel demand model
Total population of identified TAZs	Travel demand model
Car share adoption rate	Transportation Research Board: 10% of individuals aged 21 to 45
VMT reductions from vehicles discarded or shed by car sharing members	Martin & Shaheen (2010): 8,200 miles per year
CO_2 ER from displaced automobile trips	EMFAC
VMT from car share members driving car share vehicles	Martin & Shaheen (2010): 1,200 miles per year
CO_2 ER for shed private automobiles	CARB: EMFAC and reduce by 29%

Quantification Methodology: The off-model quantification for this strategy will follow the *SCS Program and Evaluation Guidelines, Appendix D, 'Car Sharing' methodology (CARB 2019).* Calculations associated with this strategy can be found in Appendix A. The overall approach is to quantify changes in VMT and their resultant effects on GHG emissions. SRTA estimates residential densities for each individual TAZ, as well as the population that is eligible and willing to adopt car sharing. The travel demand model is used to identify TAZs that have sufficient residential densities and the total population of identified TAZs. A study by Martin & Shaheen (2010) is used as a reference for VMT reductions from vehicles discarded or shed by car sharing members and VMT from car share members driving car share vehicles. The conservative car share adoption rate of 10% of individuals aged 21 to 45 is used as suggested by Transportation Research Board.

Challenges, Constraints, and Strategy Implementation Tracking:

Challenges and Constraints

Despite being a designated metropolitan region, the Shasta Region is largely rural. Even in the Redding Urbanized Area, where 80% of the population lives in 2% of the county's total land area, the population density is only two per acre. In addition, trip origins and destinations are largely segregated. As such, personal vehicles will continue to be the predominate travel mode. However, the identified TAZs that have sufficient residential densities have the potential of being less dependent on vehicles and it can be a starting point to change mobility attitudes and shifts to alternative means of transport that develop after one becomes a member of a car-sharing organization.

Implementation Tracking

The progress of this strategy can be tracked by monitoring TAZs that support car sharing and car share member statistics.

Strategy 5 – Bike Share

Description: Implementing bike share programs allows people to ride a bike or a scooter to their destinations for a small fee. This strategy can reduce GHG emissions by providing access to bicycles and scooters, and this accessibility can be used to encourage active transport modes and reduce auto trips. The efficiency can significantly increase by providing electric bikes and scooters to go farther distances. This strategy also can encourage public transportation usage by improving first and last-mile travel options. SRTA will provide programmatic support since this service is new and unfamiliar to the region. Examples of service may include subsidized membership in electric bicycles and scooters.

Objectives: SRTA estimates reducing VMT by providing access to bicycles and replacing auto trips with bike and scooter trips. This estimation can be used to calculate the potential reduction in GHG emissions. The area and number of stations for the planned service areas in Redding, Shasta Lake, Anderson, and other Shasta County regions are used for this estimation.

Trip and Emission Needs: All information used for Strategy 6 quantification can be found in the table below and in Appendix A.

Data	**Source**
Service areas	Planned bike share programs
Number of bike share stations	Planned bike share programs
Number of daily bike share trips per 1,000 residents	Institute for Transportation and Development Policy (ITDP)
Number of residents in each service area	Travel demand model
Average regional HW trip lengths	Travel demand model: 2.99
CO_2 ER from displaced automobile trips	EMFAC

Quantification Methodology: This off-model strategy will utilize the *'Bike Share' methods and factors identified in the latest guidance material (CARB 2019)*. Calculations associated with this strategy can be found in Appendix A. The overall approach is a VMT reduction-based approach for estimating GHG emission reductions associated with bike share/scooter share strategies. SRTA identifies the service areas and the number of stations considering the planned bike share programs. A regression formula derived from Institute for Transportation and Development Policy (ITDP) is used to estimate the number of daily bike share trips per 1,000 residents in each area. SRTA uses the 1.8 miles average regional HW trip lengths for biking as suggested by the National Household Transportation Survey and the travel demand model for the number of residents in each service area. EMFAC is used to estimate the related CO_2 emission factors.

Challenges, Constraints, and Strategy Implementation Tracking:

Challenges and Constraints

Although this strategy can be used to encourage active transport modes and reduce auto trips, it is important to have sufficient and suitable bike lanes and other facilities such as bike racks. Since sufficient and suitable bike lanes can be out of the scope of bike-sharing programs, consistent with the GoShasta Regional Active Transportation Plan, SRTA will continue to provide technical assistance and financial support to local agencies for the development of a direct, contiguous, and low-stress network of bike lanes. In addition, consistent with the GoShasta Regional Active Transportation Plan, SRTA will provide technical assistance and financial support to local agencies for the development of regional bike networks to address the needs of potential bike commuters who will need to plan for longer travel times without paying a premium for using bikes and other modes, such as transit, which may increase total commute cost. This can help bike share programs provide service at the regional level. Another potential challenge of bike sharing programs is rider safety and the safety issues need to be addressed in future safety policies to successfully implement bike sharing programs.

Implementation Tracking

The progress of this strategy can be tracked by monitoring the number of bikes in bike sharing programs and the number of miles logged through bike sharing programs.

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