Shasta Region Sustainable Communities Strategy Off-Model Calculator

Off-model Emission Reduction Emissions Summary Information

Table 1. Summary Of Annual Emission Reductions				
			CO_2 Reduction	
Strategy Number	Activity Description	Emission Calculation Template Type	2035	2040
			Annual Emissions (MT)	
1	Bus Stop Improvement	Transit Improvements	230	444
2	GoShasta Regional Active Transportation Plan	Bicycle and Pedestrian Facility Enhancement	30	48
3	Zero-emission Vehicle Infrastructure	Electric Vehicle Charing Infrastructure	558	570
4	Rural Mobility	Car Sharing	769	848
5	Commute Trip Reduction	Bike/Scooter Share	78	76
		Total Tons Per Year (MT)	**1,666**	**1,985**
			Daily Emissions	
		Total Tons Per Day (MT)	**4.56**	**5.44**
		EMFAC SB 375 Total Per Day (tons)	1,789	1,851
		EMFAC SB 375 Total Per Day (MT)	1,623	1,679
		Percentage Reduction Modeled CO2 Emissions	**0.28%**	**0.32%**

Notes and Acronyms:

Acronyms

CO_2	Carbon Dioxide	tons	Standard Tons
MT	Metric Ton		

Shasta Region Sustainable Communities Strategy Off-Model Calculator

Strategy 1 - Transit Improvement GHG Reductions

Table 2a. Input Data for Transit Improvements				
Parameter	**Symbol**	**Value**	**Units**	**Source/Justification**
Current Baseline ridership	$Ridership_{Base}$	2,155	trips/day	Transit Operators Ridership Data
Ridership increase (2035)	$Ridership_{Inc}$	31.00	%	Brown et al. (2006)
Ridership Increase (2040)	$Ridership_{Inc}$	62.00	%	Brown et al. (2006)
Mode shift factor	MSF	0.50	unitless	Travel Demand Model
Land use multiplier	LU	1.9	unitless	CARB SCS Appendices, 2019
Average regional HW Round Trip Length	TL	7.3	miles/trip	Travel Demand Model
Average vehicle occupancy	AVO	1.4	unitless	Travel Demand Model
Grams in Metric Ton	g/MT	1,000,000	grams/MT	
Days per year adjusted for worktrips	dpy	326	days/yr	2017 NHTS
Increase in transit activity	$Transit_{Inc}$	0.010	NA	Caltrans Division of Research, Innovation and System Information

Equation 1: $VMT_{Dsp} = Ridership_{Base} \times Ridership_{Inc} \times MSF \times LU \times TL \div AVO$

Calculated VMT Values:

	2035	**2040**	
Calculated displaced VMT_{DSP}:	1,080,906	2,161,811	miles/yr
Calculated $Transit_{Inc}$:	10,992	21,985	miles/yr

Table 2b. Displaced Private Automobile Trip CO_2 Emission Rates		
	EMFAC2014 CO_2 Emission Factor (grams/mile)	
Vehicle Type	**2035**	**2040**
Passenger Vehicle HW Trips	226	218
BUS	1,303	1,295

Equation 2: $CO_{2Net} = ((VMT_{Dsp} * EMFAC_{Dsp}) - (Transit_{Inc} * Transit_{ER})) \div 1{,}000{,}000$ (grams/MT)

Year:	**2035**	**2040**	
Net CO_2 Decrease 2035:	230	444	MT CO_2

Shasta Region Sustainable Communities Strategy Off-Model Calculator
Strategy 1 - Transit Improvement GHG Reductions

Notes and Acronyms:

Notes

Equations 1 and 2 from CARB Final Sustainable Communities Strategy Appendices (CARB, 2019).
Increase in Transit VMT is in passenger vehicle equivalent miles (CalTrans, 2015).

Acronyms

CO_2	Carbon Dioxide	HW	Home Work Trip
DSP	Displaced	MT	Metric Ton
EMFAC	EMission FACtor	VMT	Vehicle Miles Traveled
INC	Increased		

Shasta Region Sustainable Communities Strategy Off-Model Calculator

Strategy 2 - Active Transportation GHG Reductions

Table 3a. Input Data for Bicycle and Pedestrian Facility Enhancement				
Parameter	**Symbol**	**Value**	**Units**	**Source/Justification**
2035 Increase in regional bike/pedestrian lane miles	lane mile$_{\%\ Inc}$	15%	percentage	GoShasta Plan
2040 Increase in regional bike/pedestrian lane miles	lane mile$_{\%\ Inc}$	25%	percentage	GoShasta Plan
Relationship between increased lanes and commutes	Bike/ped$_{Inc}$	0.007	NA	Marshall and Garrick (2010)
Reduction in VMT per 1% of sidewalk length increase	Bike/ped$_{Inc}$	0.02	NA	Fan (2007)
Regional HW Trips	HBW	83,117	trips/day	Travel Model
Average regional HW Trip Length for biking	HW	1.8	miles	2017 NHTS
Average regional HW Trip Length for walking	HW	0.98	miles	2017 NHTS
Days per year adjusted for worktrips	dpy	326	Trips	2017 NHTS
Grams in Metric Ton	g/MT	1,000,000	grams/MT	Conversion

Equation 1: VMT = Bike/ped lane mile% Inc x 100 x Bike/pedInc x Trips x TL

Table 3b. Calculated Reduction in VMT by Travel Mode:

	2035	2040	
Bike	51,225	85,376	miles
Pedestrian	79,684	132,807	miles

Table 3b. EMFAC Derived Displaced Private Automobile Trip CO_2 Emission Rates		
	CO_2 Emission Factor (grams/VMT)	
Vehicle Type	**2035**	**2040**
HW Trips	226.39	218.44

Equation 2: CO_{2Net} = VMT * $EMFAC_{Dsp}$ ÷ 1,000,000 (grams/MT)

Year:	2035	2040	
Net CO_2 Decrease:	29.6	47.7	MT CO_2

Shasta Region Sustainable Communities Strategy Off-Model Calculator

Strategy 2 - Active Transportation GHG Reductions

Notes and Acronyms:

Notes

Equations 1 and 2 from CARB Final Sustainable Communities Strategy Appendices (CARB, 2019).

Acronyms

CO_2	Carbon Dioxide	MT	Metric Ton
EMFAC	EMission FACtor	VMT	Vehicle Miles Traveled
HW	Home Work Trip		

Shasta Region Sustainable Communities Strategy Off-Model Calculator
Strategy 3 - Electric Vehicle Charging Infrastructure GHG Reductions

Table 4a. Input Data for Electric Vehicle Charging Infrastructure				
Parameter	**Symbol**	**Value**	**Units**	**Source/Justification**
Average # PHEVs per charger installed	$PHEV_{Charger}$	7	vehicles	Regional Data/(7) PHEVs per charger
eVMT increased per day per PHEV	eVMT	13	eVMT	CARB
Grams in Metric Ton		1,000,000	grams/MT	Conversion Factor

Table 4b. Regional Factors				
Service Area Name	**PHEV Chargers**		**Average Increase in eVMT per PHEV (mi.)**	
	2035	**2040**	**2035**	**2040**
Redding region	95	97	13	13

Source: MPO Estimate

Equation 1: $PHEV_{Region} = Charger_{Region} \times PHEV_{Charger}$

Equation 2: eVMTRegion = PHEVRegion x PHEVeVMT

Table 4c. Calculated Regional Values				
Service Area Name	**Charger Usage**		**Daily increase in eVMT (mi.)**	
	2035	**2040**	**2035**	**2040**
City of Redding	665	679	8,645	8,827
Total Daily VMT MPO Area			8,645	8,827

Shasta Region Sustainable Communities Strategy Off-Model Calculator
Strategy 3 - Electric Vehicle Charging Infrastructure GHG Reductions

Table 4d. EMFAC Emission Factors - cVMT to eVMT		
	CO2 Emission Factor (grams/mile)	
Vehicle Type	**2035**	**2040**
PHEV	198	198

Assume 198 grams of CO2 is avoided for each PHEV mile transferred from gasoline to electric operation (CARB, 2019).

Equation 3: $CO_{2\ PHEV} = eVMT_{Region} \times EF_{Gas \times Days\ per\ Year} \div 1{,}000{,}000$ (grams/MT)

Year:	2035	2040	
Net CO_2 Decrease:	558	570	MT CO_2

Notes and Acronyms:

Notes

Equations 1 and 3 from CARB Final Sustainable Communities Strategy Appendices (CARB, 2019).

Acronyms

CO_2	Carbon Dioxide	HW	Home Work Trip
cVMT	Combustion VMT	MT	Metric Ton
EMFAC	EMission FACtor	PHEV	Plugin Hybrid Electric Vehicle
eVMT	Electric VMT	VMT	Vehicle Miles Traveled

Shasta Region Sustainable Communities Strategy Off-Model Calculator
Strategy 4 - Car Sharing GHG Reductions

Table 5a. Regional Factors for Car Sharing				
Parameter	**Symbol**	**Value**	**Units**	**Source/Justification**
Estimated Adoption Rate 2035	AR	2.93%	Percentage	10% of people 25 to 45
Estimated Adoption Rate 2040	AR	2.93%	Percentage	10% of people 25 to 46
VMT Shed / Member	$VMT_{Memb\ Shed}$	8,200	mi/day/member	MPO Estimate
Grams in Metric Ton		1,000,000	grams/MT	Conversion Factor

Table 5b. Service Area Population		
Service Area Name	**Area Population**	
	2035	**2045**
Total population of identified TAZs	14,145	16,159

Equation 1: Membership Population = AR * Area Population
Equation 2: Total VMT Shed = Membership Population * $VMT_{Memb\ Shed}$

Table 5c. Calculated Regional Values				
Service Area Name	**Membership Population**		**VMT Shed**	
	2035	**2045**	**2035**	**2045**
Total population of identified TAZs	414	473	3,398,478	3,882,361
Total Daily VMT Area			3,398,478	3,882,361

Table 5d. EMFAC Emission Factors		
	CO2 Emission Factor (grams/mile)	
Vehicle Type	**2035**	**2045**
HW Trips	226.39	218.44

Equation 3: $CO_{2\ Shed} = VMT_{Region} \times EF_{Gas\ x\ Days\ per\ Year} \div 1{,}000{,}000$ (grams/MT)

Year:	**2035**	**2045**	
Net CO_2 Decrease:	769.4	848.1	MT CO_2

Notes and Acronyms:

Notes

Equations 1 and 2 from CARB Final Sustainable Communities Strategy Appendices (CARB, 2019).

Acronyms

CO_2	Carbon Dioxide	HW	Home Work Trip
EMFAC	EMission FACtor	MT	Metric Ton
HW	Home Work Trip	VMT	Vehicle Miles Traveled

Shasta Region Sustainable Communities Strategy Off-Model Calculator
Strategy 5 - Bike/Scooter Share GHG Reductions

Table 6a. Bike/Scooter Share Station Service Area Information

Service Area Name	Service Area Size (km^2)	Share Stations in Service Area	Service Area Population		Average HW Trip in Service Area (miles)
			2035	2040	
City of Redding	5	80	96,160	96,761	1.8
City of Anderson	19	5	11,631	11,704	1.8
City of Shasta Lake	28	5	10,653	10,720	1.8
Shasta County (uninc)	102	5	2,090	1,343	1.8

Equation 1: Station Density (stations/km^2) = Bike Share Stations (#/service area) / Service Area (km^2)

Equation 2: Daily Bike Share Trips per 1,000 residents = 1.74 * station density + 17.2

Equation 3: Future bike share trips = Daily Bike Share Trips x Service Area Population [Step 5 note above]

Table 6b. Bike Share Station Calculated Values

Service Area Name	Density (stations/km^2)	Daily Bike Share Trips per 1,000 Residents	Bike Share Trips per Service Area	
			2035	2040
City of Redding	16.00	45.04	4,331	4,358
City of Anderson	0.26	17.66	205	207
City of Shasta Lake	0.18	17.51	187	188
Shasta County (uninc)	0.05	17.29	36	23
Regional Total			4,759	4,776

Table 6c. EMFAC 2014 Displaced Private Automobile Trip CO_2 Emmission Rates

Vehicle Type	Fleet Percentage	CO_2 EF (g/mi)	
		2035	2040
Aggregate Emission Factor		226	218

Equation 4: $VMT_{Reduced}$ = Bike Share $Trips_{SA}$ x $TL_{(Bike\ and\ Walk)}$ * 326 dpy

Equation 5: $CO_{2Reduced}$ = $VMT_{Reduced}$ X $EMFAC_{DSP}$ X 12.4%

Shasta Region Sustainable Communities Strategy Off-Model Calculator
Strategy 5 - Bike/Scooter Share GHG Reductions

Table 6d. Bike Share Station Reduced VMT and Emissions				
Service Area Name	VMT Reduced (mi/yr)		$CO_{2Reduced}$ (MT)	
	2035	2040	2035	2040
City of Redding	2,541,458	2,557,342	71.3	69.3
City of Anderson	120,516	121,273	3.4	3.3
City of Shasta Lake	109,463	110,151	3.1	3.0
Shasta County (uninc)	21,199	13,622	0.6	0.4
Regional Total			78.4	75.9

Notes and Acronyms:

Notes

Equation 2: Regression formula derived from Institute for Transportation and Development Policy (CARB, 2019)

Acronyms

CO_2	Carbon Dioxide	MT	Metric Ton
EMFAC	EMission FACtor	VMT	Vehicle Mile Traveled
HW	Home Work Trip		