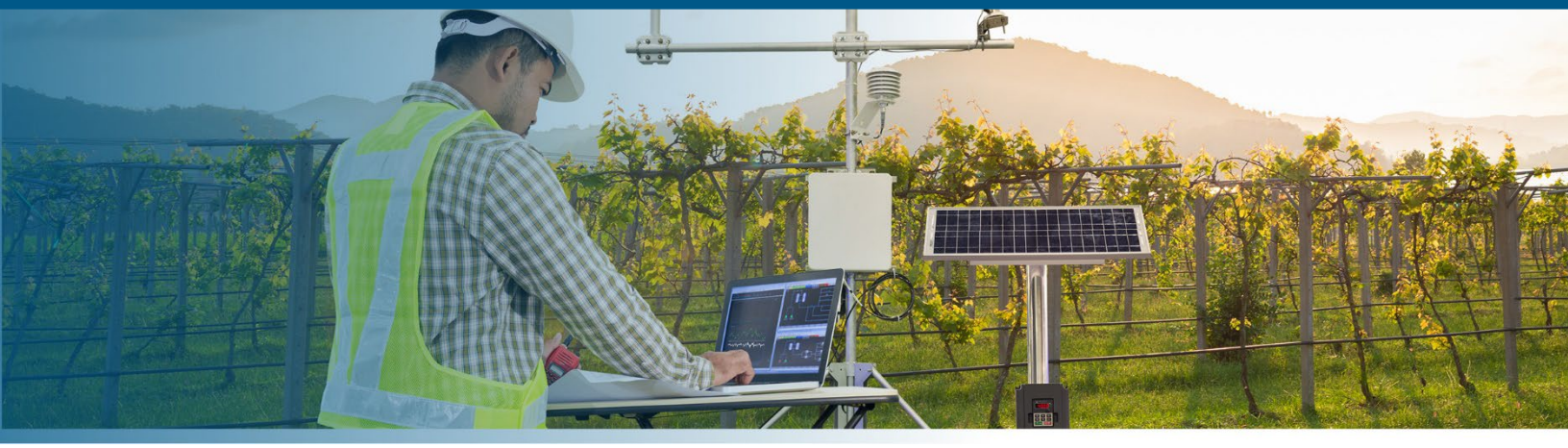
Emission Factors and Data Tables

APPENDIX



Acknowledgments

The structure of this Appendix is derived from the California Air Pollution Control Officers Association (CAPCOA) *Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity*, available at CalEEMod.com.

The CAPCOA *Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity* is hosted at CalEEMod.com

ICF has adapted that document here, under permission granted by CAPCOA, to apply to the five western states that contributed to its development. We thank the staff at CAPCOA and the five states: Arizona, Colorado, New Mexico, Oregon, and Washington. The data included here is updated to default values for use by these states as of publication date.

This project was completed with support from the U.S. Climate Alliance.

Release Version

This is Appendix version 2, corresponding to the final version of the Handbook for Analyzing Greenhouse Gas Emission Reductions in Western States, version 1 released August 28, 2025. Appendix version 2 includes updates to T3.1, T9.1, T10.1,

T10.2, T11.1, and T20.1, incorporating new data from the 2024 Oregon Travel Study.

Each table and figure below is ordered by the first emission reduction measure for which it is used.

Tables and Figures

Transportation

Energy

Water

Lawn and Landscaping

Solid Waste

Natural and Working Lands

Construction

Refrigerants

Table T-3.1. Average Transit and Vehicle Mode Share of All Trips by Geographic Scope

		Mode Share	
Source	Geographic Area	Transit	Vehicle
StateFocus	Denver-Aurora-Centennial, CO	2.73%	97.27%
StateFocus	Colorado Springs, CO	0.68%	99.32%
StateFocus	Fort Collins-Loveland, CO	1.19%	98.81%
StateFocus	Greeley, CO	0.45%	99.55%
StateFocus	Pueblo, CO	0.74%	99.26%
StateFocus	Grand Junction, CO	1.06%	98.94%
StateFocus	Rifle, CO	0.42%	99.58%
StateFocus	Durango, CO	0.02%	99.98%
StateFocus	Edwards, CO	0.23%	99.77%
StateFocus	Canon City, CO	0.03%	99.97%
StateFocus	Montrose, CO	0.02%	99.98%
StateFocus	Breckenridge, CO	0.06%	99.94%
StateFocus	Steamboat Springs, CO	0.09%	99.91%
StateFocus	Fort Morgan, CO	0.00%	100.00%
StateFocus	Alamosa, CO	0.03%	99.97%
StateFocus	Sterling, CO	0.00%	100.00%
Travel Study	Albany MPO, OR	0.4%	92.8%
Travel Study	Bend MPO, OR	0.8%	89.1%
Travel Study	Corvalis MPO, OR	2.4%	70.1%
Travel Study	Eugene/Springfield MPO, OR	1.7%	80.1%
Travel Study	Medford MPO, OR	1.3%	89.4 %
Travel Study	Portland Metro, OR	3.6%	79.2%
2023 RTP (Metro)	Portland Metro (2023), OR	3.0%	84.0%
Travel Study	Middle Rogue MPO, OR	1.8%	88.8%
Travel Study	Salem/Keizer MPO, OR	1.5%	86.3%
Travel Study	Walla Walla Valley MPO, OR	0.6%	94.5%
FHWA 2017	Phoenix-Mesa-Scottsdale, AZ	1.41%	95.98%
FHWA 2017	Portland-Vancouver-Hillsboro, OR-WA	2.64%	94.99%
FHWA 2017	Seattle-Tacoma-Bellevue, WA	8.44%	88.74%
FHWA 2017	New Mexico (Statewide)	5.65%	93.03%
2019-2023 ACS	New Mexico (Statewide)	1.00%	N/A

Source (except Colorado, Oregon MPOs, Portland Metro 2023, and New Mexico ACS): Federal Highway Administration. 2017. *National Household Travel Survey–2017 Table Designer*. Annual Person Miles of Travel by TRPTRANS by HH_CBSA/HH_STATE. Accessed February 2025. https://nhts.ornl.gov/.

Colorado: StateFocus Travel Demand Model, provided by Colorado.

Oregon MPOs: 2024 Oregon Travel Study results, provided by Oregon.

State-collected transportation data was not available for Arizona, so all data for Arizona came from national sources such as NHTS, MOVES, or the National Transit Database; local data should be used instead if available.

Portland Metro 2023: MPO provided values sourced from its 2023 Regional Transportation Plan (RTP) in February 2025.

New Mexico: Provided additional estimate based on American Community Survey 2019-2023 data, February 2025.

Table T-8.1. Reduction in Employee Commute Vehicle Miles Traveled by Place Type

Place Type	Reduction in Employee Commute VMT
Urban	-8%
Suburban	-4%
Rural	—

Source: San Diego Association of Governments (SANDAG). 2019. Mobility Management VMT Reduction Calculator Tool–Design Document. June. Accessed January 2021.

— = measure not applicable in this place type; VMT = vehicle miles traveled.

Table T-9.1. Average Transit Mode Share of Work Trips by Geographic Scope

Source	Geographic Area	Transit Mode Share of Work Trips
StateFocus	Denver-Aurora-Centennial, CO	2.82%
StateFocus	Colorado Springs, CO	0.62%
StateFocus	Fort Collins-Loveland, CO	0.89%
StateFocus	Greeley, CO	0.31%
StateFocus	Pueblo, CO	0.49%
StateFocus	Grand Junction, CO	0.98%
StateFocus	Rifle, CO	0.48%
StateFocus	Durango, CO	0.04%
StateFocus	Edwards, CO	0.16%
StateFocus	Canon City, CO	0.01%
StateFocus	Montrose, CO	3.35%
StateFocus	Breckenridge, CO	0.06%
StateFocus	Steamboat Springs, CO	0.17%
StateFocus	Fort Morgan, CO	0.00%
StateFocus	Alamosa, CO	0.01%
StateFocus	Sterling, CO	0.00%
FHWA 2017	Phoenix-Mesa-Scottsdale, AZ	2.54%
Travel Study	Albany MPO, OR	0.4%
Travel Study	Bend MPO, OR	0.1%
Travel Study	Corvalis MPO, OR	2.4%
Travel Study	Eugene/Springfield MPO. OR	1.9%
Travel Study	Medford MPO, OR	0.3%
Travel Study	Portland Metro, OR	3.9%
Travel Study	Middle Rogue MPO, OR	0.0%
Travel Study	Salem/Keizer MPO, OR	1.5%
Travel Study	Walla Walla Valley MPO, OR	1.0%

Source	Geographic Area	Transit Mode Share of Work Trips
FHWA 2017	Portland-Vancouver-Hillsboro, OR-WA	4.99%
FHWA 2017	Seattle-Tacoma-Bellevue, WA	14.11%
WA CTR Survey	Clark County, WA	0.88%
WA CTR Survey	King County, WA	20.21%
WA CTR Survey	Pierce County, WA	1.16%
WA CTR Survey	Snohomish County, WA	2.11%
WA CTR Survey	Spokane County, WA	3.20%
WA CTR Survey	Thurston County, WA	1.41%
WA CTR Survey	Washington (Statewide)	13.04%
FHWA 2017	New Mexico (Statewide)	5.65%[a]
2019-2023 ACS	New Mexico (Statewide)	1.02%

Note: a. Due to the limited number of responses recorded in NHTS data for New Mexico, the transit mode share in New Mexico here is not limited to work trips to get a larger sample size.

Source (except Colorado areas, Washington counties, Oregon MPOs, New Mexico ACS): Federal Highway Administration. 2017. *National Household Travel Survey–2017 Table Designer*. Annual Person Miles of Travel, TRIPPURP (Work), by HH_CBSA/HH_STATE. Accessed February 2025. https://nhts.ornl.gov/.

Colorado areas: StateFocus Travel Demand Model, provided by Colorado February 2025.

Washington (county-level): Commute Trip Reduction Program Survey Cycle 2021-2022, received from Washington State February 2025.

Oregon MPOs: 2024 Oregon Travel Study results, provided by Oregon.

New Mexico: Provided additional estimate based on American Community Survey 2019-2023 data, February 2025.

Table T-10.1. Average One-Way Bicycle and Vehicle Trip Length of All Trips by Geographic Scope

		Trip Length (miles)	
Source	Geographic Area	Bicycle	Vehicle
StateFocus	Denver-Aurora-Centennial, CO	3.71	10.99
StateFocus	Colorado Springs, CO	3.44	10.07
StateFocus	Fort Collins-Loveland, CO	2.89	10.07
StateFocus	Greeley, CO	2.98	14.09
StateFocus	Pueblo, CO	2.61	10.14
StateFocus	Grand Junction, CO	2.65	9.38
StateFocus	Rifle, CO	2.00	13.28
StateFocus	Durango, CO	2.63	13.11
StateFocus	Edwards, CO	2.62	11.85
StateFocus	Canon City, CO	2.19	13.09
StateFocus	Montrose, CO	2.29	12.61
StateFocus	Breckenridge, CO	2.56	11.05
StateFocus	Steamboat Springs, CO	2.08	12.36
StateFocus	Fort Morgan, CO	1.93	13.05
StateFocus	Alamosa, CO	1.53	8.78
StateFocus	Sterling, CO	1.73	11.48
FHWA 2017	Phoenix-Mesa-Scottsdale, AZ	2.6	10.4
Travel Study	Albany MPO, OR	6.35	6.64
Travel Study	Bend MPO, OR	14.71	5.58
Travel Study	Corvalis MPO, OR	1.5	7.78
Travel Study	Eugene/Springfield MPO, OR	4.08	6.84
Travel Study	Medford MPO, OR	5.2	6.37
2023 RTP (Metro)	Portland Metro, OR	1.85	6.07
Travel Study	Portland Metro, OR	2.82	6.84
Travel Study	Middle Rogue MPO, OR	3.35	6.73
Travel Study	Salem/Keizer MPO, OR	2.47	7.28
Travel Study	Walla Walla Valley MPO, OR	0.0	8.85
FHWA 2017	Portland-Vancouver-Hillsboro, OR-WA	3.5	10.8
FHWA 2017	Seattle-Tacoma-Bellevue, WA	2.8	8.3
FHWA 2017	New Mexico (Statewide)	0.6	7.5

Source (except Colorado, Oregon MPOs, and Portland Metro): Federal Highway Administration. 2017. *National Household Travel Survey–2017 Table Designer*. Annual Person Miles of Travel divided by Annual Person Trips, by TRPTRANS by HH_CBSA/HH_STATE. Accessed February 2025. https://nhts.ornl.gov/.

Colorado areas: StateFocus Travel Demand Model, provided by Colorado February 2025.

Oregon MPOs: 2024 Oregon Travel Study results, provided by Oregon.

Portland Metro: MPO provided values sourced from their 2023 Regional Transportation Plan (RTP) in February 2025.

Table T-10.2. Average Bicycle and Vehicle Mode Share of Work Trips by Geographic Scope

		Mode Share	
Source	Geographic Area	Bicycle	Vehicle
StateFocus	Denver Regional Council of Governments, CO	4.32%	95.68%
StateFocus	Grand Valley MPO, CO	5.29%	94.71%
StateFocus	North Front Range MPO, CO	4.49%	95.51%
StateFocus	Pikes Peak Area Council of Governments, CO	4.31%	95.69%
StateFocus	Pueblo MPO, CO	5.07%	94.93%
FHWA 2017	Phoenix-Mesa-Scottsdale, AZ	0.1%	96.8%
Travel Study	Albany MPO, OR	0.7%	92.8%
Travel Study	Bend MPO, OR	4.3%	91.5%
Travel Study	Corvalis MPO, OR	5%	73.8%
Travel Study	Eugene/Springfield MPO, OR	5.1%	78.7%
Travel Study	Medford MPO, OR	1.2%	90.7%
Travel Study	Portland Metro, OR	2.2%	81.4%
Travel Study	Middle Rogue MPO, OR	2.8%	86.1%
Travel Study	Salem/Keizer MPO, OR	2%	86.5%
Travel Study	Walla Walla Valley MPO, OR	0.0%	93.2%
FHWA 2017	Portland-Vancouver-Hillsboro, OR-WA	1.5%	93.5%
FHWA 2017	Seattle-Tacoma-Bellevue, WA	1.0%	84.2%
WA CTR Survey	Clark County, WA	0.67%	95.52%
WA CTR Survey	King County, WA	3.95%	67.51%
WA CTR Survey	Pierce County, WA	0.65%	96.60%
WA CTR Survey	Snohomish County, WA	0.89%	94.56%
WA CTR Survey	Spokane County, WA	0.84%	92.17%
WA CTR Survey	Thurston County, WA	1.71%	83.01%
FHWA 2017	Washington (Statewide)	2.73%	77.60%
FHWA 2017	New Mexico (Statewide)	0.00%	78.18%
ACS 2019-2023	New Mexico (Statewide)	0.64%	89.11%

Source (except Colorado, Washington counties, Oregon MPOs, and New Mexico ACS): Federal Highway Administration. 2017. *National Household Travel Survey–2017 Table Designer*. Annual Person Miles of Travel by TRIPPURP (Work) by HH_CBSA/HH_STATE. Accessed February 2025. https://nhts.ornl.gov/.

Colorado: StateFocus Travel Demand Model, provided by Colorado.

Washington (county-level): Commute Trip Reduction Program Survey Cycle 2021-2022, received from Washington State February 2025.

Oregon MPOs: 2024 Oregon Travel Study results, provided by Oregon.

New Mexico: Provided additional estimate based on American Community Survey 2019-2023 data, February 2025.

Table T-11.1. Average One-Way Vehicle Commute Trip Length by Geographic Scope

Source	State	Geographic Area	Vehicle Trip Length (miles)
StateFocus	CO	Denver-Aurora-Centennial, CO	11.7
StateFocus	CO	Colorado Springs, CO	10.7
StateFocus	CO	Fort Collins-Loveland, CO	11.9
StateFocus	CO	Greeley, CO	15.4
StateFocus	CO	Pueblo, CO	12.1
StateFocus	CO	Grand Junction, CO	11.9
StateFocus	CO	Rifle, CO	18.5
StateFocus	CO	Durango, CO	16.2
StateFocus	CO	Edwards, CO	14.2
StateFocus	CO	Canon City, CO	14.3
StateFocus	CO	Montrose, CO	16.3
StateFocus	CO	Breckenridge, CO	11.9
StateFocus	CO	Steamboat Springs, CO	13.8
StateFocus	CO	Fort Morgan, CO	14.4
StateFocus	CO	Alamosa, CO	10.3
StateFocus	CO	Sterling, CO	12.2
FHWA 2017	AZ	Phoenix-Mesa-Scottsdale, AZ	13.97
FHWA 2017	OR-WA	Portland-Vancouver-Hillsboro, OR-WA	11.51
Travel Study	OR	Albany MPO, OR	6.64
Travel Study	OR	Bend MPO, OR	5.58
Travel Study	OR	Corvalis MPO, OR	7.28
Travel Study	OR	Eugene/Springfield MPO. OR	6.86
Travel Study	OR	Medford MPO, OR	6.37
Travel Study	OR	Portland Metro, OR	6.84
Travel Study	OR	Middle Rogue MPO, OR	6.73
Travel Study	OR	Salem/Keizer MPO, OR	7.28
Travel Study	OR	Walla Walla Valley MPO, OR	5.53
FHWA 2017	WA	Seattle-Tacoma-Bellevue, WA	12.17
FHWA 2017	NM	New Mexico (Statewide)	10.97

Source (except Colorado and Oregon MPOs): Federal Highway Administration. 2017. *National Household Travel Survey–2017 Table Designer*. Annual Person Miles of Travel divided by Annual Person Trips, by TRPTRANS by TRIPPURP (Work) by HH_CBSA/HH_STATE. Accessed February 2025. https://nhts.ornl.gov/.

Colorado: StateFocus Travel Demand Model, provided by Colorado.

Oregon MPOs: 2024 Oregon Travel Study results, provided by Oregon.

Table T-11.2. Average Emission Factor for Employee Commuter Vehicles

State	Value (g CO2e per mile)
Washington	366.6
Oregon	394.3
Colorado	347.9
New Mexico	360.8
Arizona	380.0

Source (except Colorado, Oregon): U.S. Environmental Protection Agency (EPA). 2024. Motor Vehicle Emission Simulator: MOVES5. Office of Transportation and Air Quality. U.S. Environmental Protection Agency. Ann Arbor, MI. November 2024.

Colorado: Provided value based on state values processed through MOVES5.

Oregon: Provided county-level MOVES 5 input databases. Processed to determine values.

Table T-11.3. Average Emission Factor for Vanpool Vehicles

Data Source	State	Value (g CO2e per mile)
Default MOVES5	WA	734.707
Default MOVES5	OR	732.375
State-provided values	OR	750.100
Default MOVES5	CO	732.369
State-provided values	CO	409.8
Default MOVES5	NM	722.443
Default MOVES5	AZ	748.683

Source (except Colorado): U.S. Environmental Protection Agency (EPA). 2024. Motor Vehicle Emission Simulator: MOVES5. Office of Transportation and Air Quality. U.S. Environmental Protection Agency. Ann Arbor, MI. November 2024.

Colorado: Provided value based on state values processed through MOVES5.

Oregon: Provided county-level MOVES 5 input databases. Processed to determine values.

Table T-11.4. Average Fuel Efficiency of Employee Commuter Vehicle and Vanpool Vehicle

State	Fuel Efficiency of Average Employee Vehicle (gallon of gasoline equivalent per mile)	Fuel Efficiency of Vanpool Vehicle (gallon of gasoline equivalent per mile)
Washington	0.0433	0.0484
Oregon	0.0432	0.0482
Colorado	0.0431	0.0482
New Mexico	0.0426	0.0474
Arizona	0.0449	0.0501

Source: U.S. Environmental Protection Agency (EPA). 2024. Motor Vehicle Emission Simulator: MOVES5. Office of Transportation and Air Quality. U.S. Environmental Protection Agency. Ann Arbor, MI. November 2024.

Table T-11.5. Vanpool Commute Length

Geographic Area	Average Length of One-way Vanpool Commute Trip (miles per trip)
Washington	26.8
Oregon	28.8
Colorado	40.2
Denver Regional Council of Governments	51.56
New Mexico	22.5
Arizona	42.1

Source (all except New Mexico, Denver Regional Council of Governments): U.S. Department of Transportation Federal Transit Administration. *National Transit Database 2023-2024*. Accessed February 2025. https://www.transit.dot.gov/ntd/data-product/monthly-module-adjusted-data-release.

New Mexico: Provided values through correspondence in February 2025.

Denver Regional Council of Governments: Colorado DOT provided values through correspondence in February 2025.

Table T-11.6. Average Vanpool Occupancy

Geographic Area	Average Vanpool Occupancy (including driver) (occupants)
Washington	7.1
Oregon	5.4
Colorado	5.35
Denver Regional Council of Governments	5.07
New Mexico	5.2
Arizona	9.2

Source (Oregon, Colorado, Arizona): U.S. Department of Transportation Federal Transit Administration. *National Transit Database 2023-2024*. Accessed February 2025. https://www.transit.dot.gov/ntd/data-product/monthly-module-adjusted-data-release.

Washington: WSDOT provided values through correspondence in February 2025.

New Mexico: NMDOT provided values through correspondence in February 2025.

Denver Regional Council of Governments: CDOT provided values through correspondence in February 2025.

Table T-14.1. Average Emission Factor of Light-Duty Vehicles

State	Average Well-to-Wheel Emission Factor of Non-Electric Vehicles Accessing the Site (g CO2e per mile)
Washington	524.2
Oregon	523.2
Colorado	521.4
New Mexico	515.6
Arizona	543.4

Source (except Colorado, Oregon): U.S. Environmental Protection Agency (EPA). 2024. Motor Vehicle Emission Simulator: MOVES5. Office of Transportation and Air Quality. U.S. Environmental Protection Agency. Ann Arbor, MI. November 2024. Default database values were used in a state-level MOVES5 run.

Argonne National Laboratory. 2025. Research and Development (R&D) GREET Life Cycle Assessment Model. Accessed March 2025. https://www.energy.gov/eere/rd-greet-life-cycle-assessment-model.

Colorado: CDOT provided values through correspondence in February 2025. Corrected to include GREET upstream emissions from GREET.

Oregon: Provided county-level MOVES 5 input databases. Processed to determine statewide values. Correction was made to include upstream emissions from GREET.

Table T-14.2 Average Light-Duty BEV Efficiency

State	Light-Duty BEV Efficiency (kWh per mile)
Washington	0.396
Oregon	0.392
Colorado	0.397
New Mexico	0.391
Arizona	0.384

Source: U.S. Environmental Protection Agency (EPA). 2024. Motor Vehicle Emission Simulator: MOVES5. Office of Transportation and Air Quality. U.S. Environmental Protection Agency. Ann Arbor, MI. November 2024. For chargers used by heavy-duty vehicles, consult Table T-30.1. All MOVES5 default values.

Table T-15. Commute VMT Fraction

Geographic Area	Percent of Household VMT (Commute Based) (%)
Seattle-Tacoma-Bellevue, WA	39%
Portland-Vancouver-Hillsboro, OR-WA	37%
Spokane-Spokane Valley, WA	35%
Salem, OR	39%
Eugene-Springfield, OR	34%
Kennewick-Richland, WA	38%
Phoenix-Mesa-Chandler, AZ	38%
Denver-Aurora-Lakewood, CO	39%
Tucson, AZ	35%
Albuquerque, NM	37%
Colorado Springs, CO	41%
Greeley, CO	43%
Fort Collins, CO	38%
Prescott Valley-Prescott, AZ	40%
Boulder, CO	34%
Lake Havasu City-Kingman, AZ	37%
Flagstaff, AZ	33%
Las Cruces, NM	34%
Yuma, AZ	36%
Santa Fe, NM	32%
Sierra Vista-Douglas, AZ	30%
Farmington, NM	31%
Pueblo, CO	39%
Grand Junction, CO	34%

Source: Replica Data from spring 2024.

Table T-16.1. Typical Monthly Parking Prices by Facility Type

Facility Type	Monthly Cost per Space
Suburban, Surface	$36
Urban, Surface	$65
Urban, Structure	$133
Urban, Underground	$191

Source: Litman, T. 2020. *Parking Requirement Impacts on Housing Affordability*. Victoria Transport Policy Institute. June 2020. Accessed January 2021. https://www.vtpi.org/park-hou.pdf.

Table T-19.1. Active Transportation Adjustment Factors

Average Daily Traffic (vehicle trips per day)	One-way Facility Length[1]	Adjustment Factor for a Population > 250,000 or a Non-university Town with Population < 250,000	Adjustment Factor for a University Town with Population <250,000
1 to 12,000	≤1	0.0019	0.0104
	1.02 to 2	0.0029	0.0155
	>2	0.0038	0.0207
12,001 to 24,000	≤1	0.0014	0.0073
	1.02 to 2	0.0020	0.0109
	>2	0.0027	0.0145
24,001 to 30,000	≤1	0.0010	0.0052
	1.02 to 2	0.0014	0.0078
	>2	0.0019	0.0104

Source: California Air Resources Board. 2020. Quantification Methodology for the Strategic Growth Council's Affordable Housing and Sustainable Communities Program. September 2020. Accessed March 2025. https://ww2.arb.ca.gov/sites/default/files/auction-proceeds/carb_clean-mobility-qm_draft_july2023.pdf.

< = less than; > = greater than; ≤ = less than or equal to

[1]Measurements of bike facilities should not include the length of crosswalks.

Table T-19.2. Key Destination Credits[1,2]

Number of Key Destinations[3]	Credit within ½ Mile of Facility	Credit within ¼ Mile of Facility
0 to 2	0.0000	0.000
3	0.0005	0.001
4 to 6	0.0010	0.002
≥ 7	0.0015	0.003

Source: California Air Resources Board. 2020. *Quantification Methodology for the California Natural Resources Agency Urban Greening Grant Program*. March 2020. Accessed January 2021. https://ww2.arb.ca.gov/sites/default/files/classic/cc/capandtrade/auctionproceeds/cnra_ug_finalqm.pdf.

≥ = greater than or equal to

[1] The largest value from either credit column that matches the project activities should be used. For example, if there are 3 activity centers within ¼ mile of the facility and 7 activity centers within ½ mile of the facility, the correct value to use is 0.0015.

[2] These metrics should be evaluated for the project location site and surrounding area, which can extend a distance not to exceed a ½ mile. If a shopping center has multiple activity centers, each of those activity centers would count individually. For example, if a bank, grocery store, and post office are all located in a

shopping center, they would be input as three activity centers for the purposes of this quantification methodology.

[3] Key destination examples: banks, post offices, grocery stores, medical centers, pharmacies, office parks, places of worship, public libraries, schools, universities, colleges, and light rail stations (park & ride).

Table T-19.3. Growth Factor Adjustment

Facility Type	Growth Factor Adjustment
New Class I Bike Path[1] or Class IV Bikeway[2]	1.54
New Class II Bike Lane[3]	1.0
Conversion from Class II to IV	0.54

Source: California Air Resources Board. 2020. *Quantification Methodology for the Strategic Growth Council's Affordable Housing and Sustainable Communities Program.* September 2020. Accessed March 2021. https://ww2.arb.ca.gov/sites/default/files/classic/cc/capandtrade/auctionproceeds/sgc_ahsc_qm_022521.pdf.

[1] Class I bike paths are physically separated from motor vehicle traffic.

[2] Class IV bikeways are protected on-street bikeways, also called cycle tracks.

[3] Class II bike lanes are striped bicycle lanes that provide exclusive use to bicycles on a roadway.

Table T-19.4. Bike Facility Default Days of Use per Year

		Estimated Yearly Days in Use			
State	WFO	2021	2022	2023	Overall
Arizona	FGZ	298	287	335	307
Arizona	PSR	279	302	337	306
Arizona	TWC	294	295	332	307
Arizona	VEF	330	315	349	331
Colorado	BOU	309	296	308	304
Colorado	GJT	280	272	291	281
Colorado	GLD	335	321	326	327
Colorado	PUB	276	279	298	284
New Mexico	ABQ	266	237	276	260
New Mexico	EPZ	334	333	348	338
New Mexico	MAF	343	349	344	345
Oregon	BOI	357	358	356	357
Oregon	MFR	321	339	339	333
Oregon	PDT	340	326	345	337
Oregon	PQR	328	326	351	335
Washington	OTX	324	310	325	320
Washington	PDT	343	332	360	345
Washington	PQR	342	346	354	347
Washington	SEW	327	337	355	340

Source: National Oceanic and Atmospheric Administration. Storm Events Database 2021-2023. https://www.ncei.noaa.gov/pub/data/swdi/stormevents/csvfiles/. Event types excluded: Astronomical low tide, cold/wind chill, drought, dust devil, frost/freeze, funnel cloud, heat, high surf, lake effect snow, marine dense fog, marine hail, marine high wind, marine strong wind, marine thunderstorm wind, marine tropical depression, rip current, seiche, sleet, tropical depression, waterspout, and winter weather. Days impacted by included events were subtracted from 365 to estimate yearly days in use by weather forecast office (WFO).

Table T-20.1. Bicycle Mode Share of All Trips by Geographic Scope

Source	State	Geographic Area	Bicycle Mode Share
StateFocus	CO	Denver-Aurora-Centennial	2.89%
StateFocus	CO	Colorado Springs	3.52%
StateFocus	CO	Fort Collins-Loveland	3.23%
StateFocus	CO	Greeley	4.38%
StateFocus	CO	Pueblo	3.17%
StateFocus	CO	Grand Junction	3.81%
StateFocus	CO	Rifle	4.62%
StateFocus	CO	Durango	5.45%
StateFocus	CO	Edwards	4.87%
StateFocus	CO	Canon City	3.81%
StateFocus	CO	Montrose	4.94%
StateFocus	CO	Breckenridge	4.50%
StateFocus	CO	Steamboat Springs	5.58%
StateFocus	CO	Fort Morgan	3.69%
StateFocus	CO	Alamosa	4.18%
StateFocus	CO	Sterling	3.54%
FHWA 2017	AZ	Phoenix-Mesa-Scottsdale CBSA	1.54%
FHWA 2017	OR-WA	Portland-Vancouver-Hillsboro CBSA	2.47%
FHWA 2017	WA	Seattle-Tacoma-Bellevue CBSA	1.34%
Travel Study	OR	Albany MPO	0.9%
Travel Study	OR	Bend MPO	2.6%
Travel Study	OR	Corvallis MPO	6.4%
Travel Study	OR	Eugene/Springfield MPO	3.8%
Travel Study	OR	Medford MPO	1.2%
Travel Study	OR	Portland Metro MPO	2.1%
2023 RTP Metro	OR	Portland Metro MPO	5.50%
Travel Study	OR	Middle Rogue MPO	1.9%
Travel Study	OR	Salem/Keizer MPO	1.4%
Travel Study	OR	Walla Walla Valley MPO	0.20%
Provided value	NM	Statewide	0.12%
FHWA 2017	NM	Statewide	2.44%
FHWA 2017	AZ	Statewide	1.45%
FHWA 2017	CO	Statewide	2.50%
FHWA 2017	OR	Statewide	2.30%
FHWA 2017	WA	Statewide	1.15%

Source (except Colorado, Oregon MPOs, Portland Metro 2023, and New Mexico estimate): Federal Highway Administration. 2017. *National Household Travel Survey–2017 Table Designer*. Annual Person Miles of Travel by TRPTRANS by HH_CBSA/HH_STATE. Accessed February 2025. https://nhts.ornl.gov/.

Colorado: StateFocus Travel Demand Model, provided by Colorado.

Oregon MPOs: 2010 Oregon Travel Study results, provided by Oregon.

Portland Metro 2023: MPO provided values sourced from their 2023 Regional Transportation Plan (RTP).

New Mexico: Provided estimated value based on scaling bicycle travel commute mode share to all trips in February 2025.

Table T-22.1. Shared Micromobility Trips per Resident

Source	City	State	Population	Bikeshare	Scooter Share	Overall Shared Micromobility
Ride Report	Phoenix	AZ	1,608,139	0.000010	0.00058	0.00059
Ride Report	Tempe	AZ	180,587	N/A	0.0078	0.0078
Ride Report	Fort Collins	CO	169,810	0.00066	0.0032	0.0038
CDOT	Denver	CO	715,522	N/A	N/A	0.024
Ride Report	Denver	CO	715,522	0.0019	0.017	0.019
Ride Report	Boulder	CO	108,250	0.012	0.0086	0.012
Ride Report	Aurora	CO	386,261	N/A	0.00010	0.00010
Ride Report	Thornton	CO	141,867	N/A	0.00023	0.00023
Ride Report	Brighton	CO	40,083	N/A	0.00048	0.00048
Ride Report	Littleton	CO	45,652	N/A	0.00053	0.00053
Ride Report	Arvada	CO	124,402	N/A	0.00068	0.00068
Ride Report	Colorado Springs	CO	478,961	N/A	0.0013	0.0013
Ride Report	Portland	OR	652,500	0.0022	0.0046	0.0068
City of Seattle	Seattle	WA	737,015	0.0033	0.012	0.016
Ride Report	Spokane	WA	228,989	0.00024	0.0054	0.0055
N/A	Overall Average			0.0066	0.0045	0.0054

Source (all except Seattle and Denver): Ride Report, 2021-2023 data as available by city. Average daily trips divided by number of city residents. https://public.ridereport.com.

Seattle: Scooter and Bike Share Data Dashboard. https://www.seattle.gov/transportation/projects-and-programs/programs/new-mobility-program/scooter-bike-share-data.

Denver: Colorado DOT provided values through correspondence in February 2025.

Table T-22.2. Bikeshare and Scooter Share Average Trip Lengths

City	State	Population	Bikeshare (miles)	Scooter Share (miles)	Overall Shared Micromobility (miles)
Arvada	CO	124,402	N/A	1.09	1.09
Aurora	CO	386,261	N/A	1.32	1.42
Boulder	CO	108,250	2.65	0.98	1.17
Brighton	CO	40,083	N/A	1.13	1.13
Colorado Springs	CO	478,961	N/A	1.32	1.32
Denver	CO	715,522	1.48	1.17	1.20
Fort Collins	CO	169,810	1.51	1.37	1.39
Littleton	CO	45,652	N/A	1.10	1.10
Phoenix	AZ	1,608,139	1.45	1.02	1.02
Portland	OR	652,500	1.88	1.26	1.46
Seattle	WA	737,015	1.50	1.00	N/A
Spokane	WA	228,989	1.28	1.13	1.11
Tempe	AZ	180,587	N/A	1.86	1.86
Thornton	CO	141,867	N/A	1.27	1.27
Overall Average			1.68	1.22	1.27

Source (all except Seattle): Ride Report, 2021-2023 data as available by city. Average daily trips divided by number of city residents. https://public.ridereport.com.

Seattle: Scooter and Bike Share Data Dashboard. https://www.seattle.gov/transportation/projects-and-programs/programs/new-mobility-program/scooter-bike-share-data.

Table T-25.1. Mode Shift Factor by Geographic Scope

Geographic Area	Mode Shift Factor
Arizona	73.5%
Colorado	71.4%
Oregon	62.9%
New Mexico	56.8%
Washington	61.7%
Portland Metro	73.0%

Source (except Colorado and Portland Metro): Federal Highway Administration. 2017. *National Household Travel Survey–2017 Table Designer*. Average Vehicle Occupancy by HH_STATE. Accessed February 2025. https://nhts.ornl.gov/.

Colorado: CDOT provided values through correspondence in February 2025.

Portland Metro: MPO provided values sourced from its 2023 Regional Transportation Plan (RTP) in February 2025.

Table T-26.1. Transit Bus Fuel Economy by Fuel Type

Fuel Type	AZ	CO	NM	OR	WA	Unit
Gasoline	0.155	0.156	0.157	0.156	0.156	gal/mile
Diesel	0.166	0.167	0.170	0.167	0.167	gal/mile
Natural gas[1]	0.143	0.144	0.147	0.144	0.144	gal/mile
Electric[2]	0.521	0.504	0.533	0.510	0.505	kWh/mile

Source: U.S. Environmental Protection Agency (EPA). 2024. Motor Vehicle Emission Simulator: MOVES5. Office of Transportation and Air Quality. U.S. Environmental Protection Agency. Ann Arbor, MI. November 2024.

gal = gallon; kWh = kilowatt hour

[1] Natural gas fuel economy is based on a conversion of natural gas fuel consumption to gallons of gasoline equivalent.

Table T-30.1. Battery Electric Vehicle Efficiency by Vehicle Type

Vehicle Type	AZ (kWh/mile)	CO (kWh/mile)	NM (kWh/mile)	OR (kWh/mile)	WA (kWh/mile)
Combination Long-Haul Truck	3.17	3.29	3.13	3.25	3.28
Combination Short-Haul Truck	2.85	2.94	2.78	2.90	2.94
Other Buses	2.55	2.63	2.48	2.59	2.63
Passenger Car	0.32	0.33	0.32	0.32	0.33
Passenger Truck	0.45	0.46	0.45	0.45	0.46
Refuse Truck	1.82	1.88	1.78	1.86	1.88
School Bus	1.25	1.29	1.21	1.27	1.29
Single Unit Long-haul Truck	0.97	1.01	0.96	1.00	1.01
Single Unit Short-haul Truck	0.93	0.96	0.92	0.95	0.96
Transit Bus	1.92	1.98	1.88	1.96	1.98

Source: U.S. Environmental Protection Agency (U.S. EPA). 2024. Motor Vehicle Emission Simulator: MOVES5. Office of Transportation and Air Quality. U.S. Environmental Protection Agency. Ann Arbor, MI. November 2024. Default values.

Table T-30.2. Vehicle Fuel Efficiency, Energy Density, and Well-to-Wheels Carbon Intensity and Emission Factor by Vehicle Category and Fuel Type

Lifecycle carbon emissions from electricity are not provided for each state, as they vary by utility. To calculate those emission factors in units of grams per mile, take the relevant electricity emissions factor value for power generation measured at the plug from Tables E-4.5 through E-4.10 for the appropriate utility, convert units, and multiply by the fuel efficiency for the relevant vehicle type.

EV Lifecycle Emission Factor (g/mi)=$EF_{Electricity}$ (lb/MWh) ×453.6 g/lb×(1MWh/1000 kWh)×Vehicle Fuel Efficiency (kWh/mi)

Arizona (AZ):

Vehicle Type	Fuel Type	Fuel Efficiency		Energy Density		Carbon Intensity (CO_2e/MJ)[1]	Tailpipe Emission Factor (g CO_2e /mile)[2]	Lifecycle Emission Factor (g CO_2e /mile)[3]
		Value	Units	Value	Units			
Combination Long-Haul Truck	CNG[4]	5.2	mpgge	120.3	MJ/GGE	71.3	1,648.3	2,028.4
	Diesel	6.1	mpg	137.1	MJ/gal	76.5	1,706.7	2,067.0
	EV	3.2	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
Combination Short-Haul Truck	CNG[4]	4.7	mpgge	120.3	MJ/GGE	77.4	1,972.6	2,391.7
	Diesel	6.3	mpg	137.1	MJ/gal	76.8	1,685.4	2,039.5
	EV	2.8	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
	Gasoline	5.6	mpg	120.3	MJ/gal	73.7	1,569.8	2,151.6
Other Buses	CNG[4]	4.6	mpgge	120.3	MJ/GGE	81.1	2,125.8	2,556.7
	Diesel	6.1	mpg	137.1	MJ/gal	76.1	1,711.1	2,074.3
	EV	2.5	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
	Gasoline	5.3	mpg	120.3	MJ/gal	72.9	1,668.5	2,293.4
Passenger Car	Diesel	27.1	mpg	137.1	MJ/gal	74.4	376.3	458.0
	E-85	19.7	mpg	93.8	MJ/gal	71.5	340.2	565.5
	EV	0.3	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
	Gasoline	26.4	mpg	120.3	MJ/gal	73.0	332.9	457.4
Passenger Truck	Diesel	18.0	mpg	137.1	MJ/gal	75.5	576.7	700.1

Vehicle Type	Fuel Type	Fuel Efficiency		Energy Density		Carbon Intensity (CO_2e/MJ)[1]	Tailpipe Emission Factor (g CO_2e /mile)[2]	Lifecycle Emission Factor (g CO_2e /mile)[3]
		Value	Units	Value	Units			
	E-85	15.7	mpg	93.8	MJ/gal	71.5	428.1	711.7
	EV	0.4	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
	Gasoline	20.6	mpg	120.3	MJ/gal	73.1	427.1	586.6
Refuse Truck	CNG[4]	4.2	mpgge	120.3	MJ/GGE	84.6	2,400.6	2,867.2
	Diesel	6.0	mpg	137.1	MJ/gal	76.6	1,760.3	2,131.3
	EV	1.8	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
	Gasoline	6.3	mpg	120.3	MJ/gal	73.7	1,404.8	1,925.2
School Bus	CNG[4]	5.5	mpgge	120.3	MJ/GGE	86.8	1,893.3	2,252.0
	Diesel	8.3	mpg	137.1	MJ/gal	76.5	1,268.2	1,535.9
	EV	1.3	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
	Gasoline	6.7	mpg	120.3	MJ/gal	72.9	1,308.3	1,798.2
Single Unit Long-haul Truck	CNG[4]	5.5	mpgge	120.3	MJ/GGE	82.9	1,808.6	2,167.2
	Diesel	12.4	mpg	137.1	MJ/gal	76.7	850.6	1,029.5
	EV	1.0	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
	Gasoline	9.2	mpg	120.3	MJ/gal	72.9	950.2	1,306.3
Single Unit Short-haul Truck	CNG[4]	5.2	mpgge	120.3	MJ/GGE	86.8	2,026.5	2,410.4
	Diesel	11.4	mpg	137.1	MJ/gal	76.7	923.2	1,117.6
	EV	0.9	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
	Gasoline	8.7	mpg	120.3	MJ/gal	73.4	1,016.0	1,393.8
Transit Bus	CNG[4]	4.8	mpgge	120.3	MJ/GGE	81.4	2,054.1	2,469.1
	Diesel	6.3	mpg	137.1	MJ/gal	76.7	1,662.6	2,012.5
	EV	1.9	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
	Gasoline	5.2	mpg	120.3	MJ/gal	72.9	1,690.4	2,323.8

Colorado (CO):

Vehicle Type	Fuel Type	Fuel Efficiency		Energy Density		Carbon Intensity (CO_2e/MJ)[1]	Tailpipe Emission Factor (g CO_2e /mile)[2]	Lifecycle Emission Factor (g CO_2e /mile)[3]
		Value	Units	Value	Units			
Combination Long-Haul Truck	CNG[4]	5.2	mpgge	120.3	MJ/GGE	71.2	1,637.9	2,015.9
	Diesel	6.2	mpg	137.1	MJ/gal	76.5	1,700.4	2,059.4
	EV	3.3	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
Combination Short-Haul Truck	CNG[4]	4.8	mpgge	120.3	MJ/GGE	77.0	1,947.8	2,363.4
	Diesel	6.3	mpg	137.1	MJ/gal	76.9	1,674.9	2,026.9
	EV	2.9	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
	Gasoline	5.7	mpg	120.3	MJ/gal	73.7	1,560.9	2,139.3
Other Buses	CNG[4]	4.6	mpgge	120.3	MJ/GGE	80.7	2,089.8	2,515.7
	Diesel	6.1	mpg	137.1	MJ/gal	76.1	1,697.1	2,057.3
	EV	2.6	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
	Gasoline	5.3	mpg	120.3	MJ/gal	72.9	1,662.1	2,284.5
Passenger Car	Diesel	28.5	mpg	137.1	MJ/gal	74.5	358.8	430.4
	E-85	20.6	mpg	93.8	MJ/gal	71.6	326.2	542.1
	EV	0.3	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
	Gasoline	27.5	mpg	120.3	MJ/gal	73.1	319.1	420.7
Passenger Truck	Diesel	18.9	mpg	137.1	MJ/gal	75.6	548.4	654.9
	E-85	16.3	mpg	93.8	MJ/gal	71.6	410.8	682.8
	EV	0.5	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
	Gasoline	21.5	mpg	120.3	MJ/gal	73.1	409.4	523.4
Refuse Truck	CNG[4]	4.3	mpgge	120.3	MJ/GGE	84.1	2,359.0	2,820.2
	Diesel	6.0	mpg	137.1	MJ/gal	76.6	1,746.2	2,114.3

Vehicle Type	Fuel Type	Fuel Efficiency		Energy Density		Carbon Intensity (CO_2e/MJ)[1]	Tailpipe Emission Factor (g CO_2e /mile)[2]	Lifecycle Emission Factor (g CO_2e /mile)[3]
		Value	Units	Value	Units			
School Bus	EV	1.9	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
	Gasoline	6.3	mpg	120.3	MJ/gal	73.7	1,397.8	1,915.8
	CNG[4]	5.6	mpgge	120.3	MJ/GGE	86.3	1,858.2	2,212.0
	Diesel	8.4	mpg	137.1	MJ/gal	76.5	1,237.9	1,520.4
	EV	1.3	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
	Gasoline	6.8	mpg	120.3	MJ/gal	72.9	1,296.4	1,781.9
Single Unit Long-haul Truck	CNG[4]	5.6	mpgge	120.3	MJ/GGE	82.6	1,771.7	2,124.4
	Diesel	12.5	mpg	137.1	MJ/gal	76.8	844.3	1,021.9
	EV	1.0	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
	Gasoline	9.3	mpg	120.3	MJ/gal	72.9	942.3	1,295.4
Single Unit Short-haul Truck	CNG[4]	5.2	mpgge	120.3	MJ/GGE	86.5	1,984.2	2,361.2
	Diesel	11.5	mpg	137.1	MJ/gal	76.8	917.6	1,110.4
	EV	1.0	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
	Gasoline	8.8	mpg	120.3	MJ/gal	73.4	1,008.6	1,383.7
Transit Bus	CNG[4]	4.8	mpgge	120.3	MJ/GGE	81.0	2,025.3	2,436.2
	Diesel	6.4	mpg	137.1	MJ/gal	76.7	1,650.2	1,997.4
	EV	2.0	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
	Gasoline	5.2	mpg	120.3	MJ/gal	72.9	1,683.8	2,314.8

New Mexico (NM):

Vehicle Type	Fuel Type	Fuel Efficiency		Energy Density		Carbon Intensity (CO_2e/MJ)[1]	Tailpipe Emission Factor (g CO_2e /mile)[2]	Lifecycle Emission Factor (g CO_2e /mile)[3]
		Value	Units	Value	Units			
Combination Long-Haul Truck	CNG[4]	5.3	mpgge	120.3	MJ/GGE	70.7	1,600.8	1,973.0
	Diesel	6.2	mpg	137.1	MJ/gal	76.5	1,685.3	2041.0
	EV	3.1	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
Combination Short-Haul Truck	CNG[4]	4.8	mpgge	120.3	MJ/GGE	76.2	1,889.0	2,296.7
	Diesel	6.4	mpg	137.1	MJ/gal	76.8	1,653.9	2,001.3
	EV	2.8	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
	Gasoline	5.7	mpg	120.3	MJ/gal	73.6	1,542.2	2,114.1
Other Buses	CNG[4]	4.8	mpgge	120.3	MJ/GGE	79.4	2,003.9	2,418.8
	Diesel	6.2	mpg	137.1	MJ/gal	76.1	1,669.0	2,023.3
	EV	2.5	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
	Gasoline	5.3	mpg	120.3	MJ/gal	72.9	1,649.9	2,267.9
Passenger Car	Diesel	28.8	mpg	137.1	MJ/gal	74.5	354.4	431.2
	E-85	20.9	mpg	93.8	MJ/gal	71.6	321.5	534.3
	EV	0.3	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
	Gasoline	28.0	mpg	120.3	MJ/gal	73.1	314.5	432.0
Passenger Truck	Diesel	19.3	mpg	137.1	MJ/gal	75.6	537.9	652.8
	E-85	16.6	mpg	93.8	MJ/gal	71.6	403.6	670.8
	EV	0.4	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
	Gasoline	21.9	mpg	120.3	MJ/gal	73.1	402.1	552.3
Refuse Truck	CNG[4]	4.4	mpgge	120.3	MJ/GGE	82.8	2,266.0	2,715.8
	Diesel	6.1	mpg	137.1	MJ/gal	76.6	1,720.2	2,082.8
	EV	1.8	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10

Vehicle Type	Fuel Type	Fuel Efficiency		Energy Density		Carbon Intensity (CO_2e/MJ)[1]	Tailpipe Emission Factor (g CO_2e /mile)[2]	Lifecycle Emission Factor (g CO_2e /mile)[3]
		Value	Units	Value	Units			
School Bus	Gasoline	6.4	mpg	120.3	MJ/gal	73.6	1,377.3	1,888.1
	CNG[4]	5.8	mpgge	120.3	MJ/GGE	84.9	1,765.7	2,107.4
	Diesel	8.6	mpg	137.1	MJ/gal	76.5	1,226.2	1,485.0
	EV	1.2	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
Single Unit Long-haul Truck	Gasoline	6.9	mpg	120.3	MJ/gal	72.9	1,263.8	1,737.1
	CNG[4]	5.8	mpgge	120.3	MJ/GGE	81.8	1,688.7	2,028.1
	Diesel	12.7	mpg	137.1	MJ/gal	76.8	831.0	1,005.9
	EV	1.0	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
Single Unit Short-haul Truck	Gasoline	9.5	mpg	120.3	MJ/gal	72.9	924.3	1,270.7
	CNG[4]	5.5	mpgge	120.3	MJ/GGE	85.4	1,872.4	2,233.0
	Diesel	11.7	mpg	137.1	MJ/gal	76.8	899.4	1,088.5
	EV	0.9	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
Transit Bus	Gasoline	9.0	mpg	120.3	MJ/gal	73.4	983.3	1,349.3
	CNG[4]	4.9	mpgge	120.3	MJ/GGE	80.0	1,958.6	2,361.1
	Diesel	6.5	mpg	137.1	MJ/gal	76.7	1,628.1	1,970.6
	EV	1.9	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
	Gasoline	5.2	mpg	120.3	MJ/gal	72.9	1,675.1	2,302.9

Oregon (OR):

Vehicle Type	Fuel Type	Fuel Efficiency		Energy Density		Carbon Intensity (CO_2e/MJ)[1]	Tailpipe Emission Factor (g CO_2e /mile)[2]	Lifecycle Emission Factor (g CO_2e /mile)[3]
		Value	Units	Value	Units			
Combination Long-Haul Truck	CNG[4]	5.3	mpgge	120.3	MJ/GGE	71.1	1805.7	2,005.0
	Diesel	6.2	mpg	137.1	MJ/gal	76.5	1722.8	2,055.7
	EV	3.2	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
Combination Short-Haul Truck	CNG[4]	4.8	mpgge	120.3	MJ/GGE	76.9	2140.2	2,355.8
	Diesel	6.3	mpg	137.1	MJ/gal	76.9	1734.9	2,024.3
	EV	2.9	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
	Gasoline	5.7	mpg	120.3	MJ/gal	73.7	1564.6	2,136.7
Other Buses	CNG[4]	4.6	mpgge	120.3	MJ/GGE	80.6	2087.3	2,510.6
	Diesel	6.2	mpg	137.1	MJ/gal	76.1	1724.0	2,054.9
	EV	2.6	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
	Gasoline	5.3	mpg	120.3	MJ/gal	72.9	1693.6	2,281.5
Passenger Car	Diesel	28.3	mpg	137.1	MJ/gal	74.5	374.2	438.5
	E-85	20.5	mpg	93.8	MJ/gal	71.6	338.1	544.4
	EV	0.3	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
	Gasoline	27.4	mpg	120.3	MJ/gal	73.1	340.5	440.1
Passenger Truck	Diesel	18.9	mpg	137.1	MJ/gal	75.6	614.9	666.4
	E-85	16.3	mpg	93.8	MJ/gal	71.6	436.5	682.9
	EV	0.5	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
	Gasoline	21.5	mpg	120.3	MJ/gal	73.1	451.1	562.4
Refuse Truck	CNG[4]	4.3	mpgge	120.3	MJ/GGE	84.1	2209.5	2,815.7
	Diesel	6.0	mpg	137.1	MJ/gal	76.6	1790.8	2,112.3
	EV	1.9	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10

Vehicle Type	Fuel Type	Fuel Efficiency		Energy Density		Carbon Intensity (CO_2e/MJ)[1]	Tailpipe Emission Factor (g CO_2e /mile)[2]	Lifecycle Emission Factor (g CO_2e /mile)[3]
		Value	Units	Value	Units			
School Bus	Gasoline	6.3	mpg	120.3	MJ/gal	73.7	1329.0	1,914.3
	CNG[4]	5.6	mpgge	120.3	MJ/GGE	86.2	1699.0	2,200.3
	Diesel	8.4	mpg	137.1	MJ/gal	76.5	1254.9	1,517.0
	EV	1.3	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
Single Unit Long-haul Truck	Gasoline	6.8	mpg	120.3	MJ/gal	72.9	1296.4	1,777.0
	CNG[4]	5.6	mpgge	120.3	MJ/GGE	82.5	1724.4	2,115.9
	Diesel	12.5	mpg	137.1	MJ/gal	76.8	872.4	1,020.5
	EV	1.0	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
Single Unit Short-haul Truck	Gasoline	9.3	mpg	120.3	MJ/gal	72.9	965.9	1,293.1
	CNG[4]	5.3	mpgge	120.3	MJ/GGE	86.4	1879.3	2,352.4
	Diesel	11.5	mpg	137.1	MJ/gal	76.8	934.7	1,108.3
	EV	0.9	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
Transit Bus	Gasoline	8.8	mpg	120.3	MJ/gal	73.4	1022.6	1,380.2
	CNG[4]	4.8	mpgge	120.3	MJ/GGE	81.0	2052.8	2,435.8
	Diesel	6.4	mpg	137.1	MJ/gal	76.7	1681.4	1,998.3
	EV	2.0	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
	Gasoline	5.2	mpg	120.3	MJ/gal	72.9	1647.2	2,314.4

Washington (WA):

Vehicle Type	Fuel Type	Fuel Efficiency		Energy Density		Carbon Intensity (CO_2e/MJ)[1]	Tailpipe Emission Factor (g CO_2e /mile)[2]	Lifecycle Emission Factor (g CO_2e /mile)[3]
		Value	Units	Value	Units			
Combination Long-Haul Truck	CNG[4]	5.2	mpgge	120.3	MJ/GGE	71.2	1,638.5	2,016.8
	Diesel	6.2	mpg	137.1	MJ/gal	76.5	1,701.3	2,060.5
	EV	3.3	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
Combination Short-Haul Truck	CNG[4]	4.8	mpgge	120.3	MJ/GGE	77.1	1,949.2	2,365.1
	Diesel	6.3	mpg	137.1	MJ/gal	76.9	1,676.2	2,028.4
	EV	2.9	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
	Gasoline	5.7	mpg	120.3	MJ/gal	73.7	1,562.4	2,141.4
Other Buses	CNG[4]	4.6	mpgge	120.3	MJ/GGE	80.7	2,092.5	2,518.9
	Diesel	6.1	mpg	137.1	MJ/gal	76.1	1,699.8	2,060.5
	EV	2.6	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
	Gasoline	5.3	mpg	120.3	MJ/gal	72.9	1,664.8	2,288.3
Passenger Car	Diesel	28.3	mpg	137.1	MJ/gal	74.5	360.6	438.8
	E-85	20.5	mpg	93.8	MJ/gal	71.6	328.1	545.1
	EV	0.3	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
	Gasoline	27.4	mpg	120.3	MJ/gal	73.1	320.8	440.6
Passenger Truck	Diesel	18.8	mpg	137.1	MJ/gal	75.6	551.4	669.1
	E-85	16.3	mpg	93.8	MJ/gal	71.6	413.4	687.0
	EV	0.5	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
	Gasoline	21.4	mpg	120.3	MJ/gal	73.1	411.9	565.6
Refuse Truck	CNG[4]	4.3	mpgge	120.3	MJ/GGE	84.1	2,361.2	2,822.8
	Diesel	6.0	mpg	137.1	MJ/gal	76.6	1,748.7	2,117.3
	EV	1.9	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10

Vehicle Type	Fuel Type	Fuel Efficiency		Energy Density		Carbon Intensity (CO_2e/MJ)[1]	Tailpipe Emission Factor (g CO_2e /mile)[2]	Lifecycle Emission Factor (g CO_2e /mile)[3]
		Value	Units	Value	Units			
School Bus	Gasoline	6.3	mpg	120.3	MJ/gal	73.7	1,398.1	1,916.2
	CNG[4]	5.6	mpgge	120.3	MJ/GGE	86.4	1,860.9	2,215.2
	Diesel	8.3	mpg	137.1	MJ/gal	76.5	1,257.5	1,522.9
	EV	1.3	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
Single Unit Long-haul Truck	Gasoline	6.8	mpg	120.3	MJ/gal	72.9	1,298.6	1,784.9
	CNG[4]	5.6	mpgge	120.3	MJ/GGE	82.6	1,775.3	2,128.6
	Diesel	12.5	mpg	137.1	MJ/gal	76.8	845.2	1,023.0
	EV	1.0	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
Single Unit Short-haul Truck	Gasoline	9.3	mpg	120.3	MJ/gal	72.9	943.3	1,296.7
	CNG[4]	5.2	mpgge	120.3	MJ/GGE	86.6	1,986.7	2,364.0
	Diesel	11.5	mpg	137.1	MJ/gal	76.8	918.9	1,112.0
	EV	1.0	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
Transit Bus	Gasoline	8.7	mpg	120.3	MJ/gal	73.4	1,009.8	1,385.3
	CNG[4]	4.8	mpgge	120.3	MJ/GGE	81.0	2,027.0	2,438.3
	Diesel	6.4	mpg	137.1	MJ/gal	76.7	1,652.1	1,999.8
	EV	2.0	kWh/mile	3.6	MJ/kWh	0.0	0.0	Modify Tables E-4.5-E-4.10
	Gasoline	5.2	mpg	120.3	MJ/gal	72.9	1,686.5	2,318.5

Source: U.S. Environmental Protections Agency (EPA). 2024. Motor Vehicle Emission Simulator: MOVES5. Office of Transportation and Air Quality. U.S. Environmental Protection Agency. Ann Arbor, MI. November 2024.

U.S. Department of Energy. 2024. R&D GREET 2024 Model. Energy Systems and Infrastructure Analysis. Argonne National Laboratory. Argonne, IL. July 2024.

Colorado School Bus Emission Factor (Diesel): CDOT provided value through correspondence in February 2025.

Oregon provided MOVES county input databases, which were used and then aggregated to the state level instead of using national defaults.

[1]Carbon intensity values are derived from MOVES5 state runs and therefore only consider tailpipe emissions. Thus, electric vehicles are shown to have zero carbon intensity. Full lifecycle values will compare emissions from electricity generation and distribution, which can be compared to that from other fuels.

[2]Taillpipe emission factors are also derived from MOVES5 state runs for 2025, which consider the direct emissions from the consumption of fossil fuels from the vehicle and consider emissions from starting, running, and idling.

[3]Lifecycle emissions factors are based off the 2025 tailpipe factors from MOVES5 with additional upstream emissions from R&D GREET 2024 for the same year. They consider emissions from the vehicle's use phase, the fuel's production, distribution, and sales. They do not consider emissions from vehicle manufacturing or vehicle end-of-life activities (such as disposal, reuse and recycling).
[4]CNG is shown in units of GGE, as that is how it is sold at filling stations. This was assumed to be 114,000 BTU.

Table T-40.1. School Bus Occupancy

Location	Average Student Occupancy of School Buses (students per bus)
Arizona	8.76
Colorado	11.7
New Mexico	8.76
Oregon	7.2
Washington	7.3

Source: School Bus Fleet Magazine. 2025. "U.S. State-by-State School Transportation Statistics 2023-24." Accessed February 2025. https://www.schoolbusfleet.com/management/10233821/u-s-state-by-state-school-transportation-statistics-2023-24.

Table T-56.1. Percent of Students within Walking/Biking Distance to School

Location	Percent	Notes
Oregon	33%	One-mile threshold
California	62%	Two-mile threshold
Denver CBSA	31%	One-mile threshold
Phoenix CBSA	26%	One-mile threshold
Portland CBSA	16%	One-mile threshold
Seattle CBSA	12%	One-mile threshold
Denver CBSA	43%	Two-mile threshold
Phoenix CBSA	38%	Two-mile threshold
Portland CBSA	63%	Two-mile threshold
Seattle CBSA	30%	Two-mile threshold

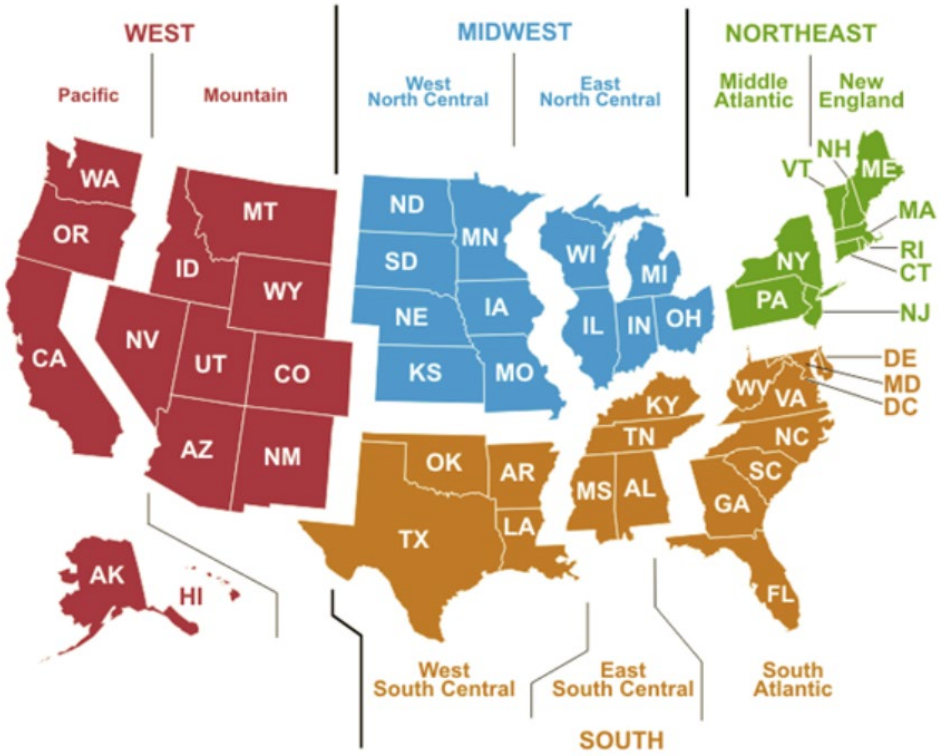
Sources: Data from Oregon provided by ODOT using its travel model. The remaining data are from the *National Household Travel Survey*. Sample sizes for the NHTS are quite small; school surveys will provide much better accuracy.

Table T-56.2. Percent of Students within Walking/Biking Distance Who Are Driven to School

Location	Percent	Notes
Oregon	20%	One-mile threshold
California	51%	Two-mile threshold
Denver CBSA	43%	One-mile threshold
Phoenix CBSA	33%	One-mile threshold
Portland CBSA	50%	One-mile threshold
Seattle CBSA	81%	One-mile threshold
Denver CBSA	51%	Two-mile threshold
Phoenix CBSA	53%	Two-mile threshold
Portland CBSA	65%	Two-mile threshold
Seattle CBSA	50%	Two-mile threshold

Sources: Data from Oregon provided by ODOT using its travel model. California data are from a report by the Safe Routes to Schools Partnership, and the remaining data are from the *National Household Travel Survey*. Sample sizes are quite small; school surveys will provide much better accuracy.

Figure E-2.1. Census Regions and Divisions for U.S. EIA Residential and Non-Residential Energy Data



Region	Division	States
Northeast	New England	Connecticut, Maine, Massachusetts, New Hampshire, Vermont, and Rhode Island
	Middle Atlantic	New Jersey, New York, and Pennsylvania
Midwest	East North Central	Illinois, Indiana, Michigan, Ohio, and Wisconsin
	West North Central	Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and South Dakota
South	South Atlantic	Delaware, the District of Columbia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, and West Virginia
	East South Central	Alabama, Kentucky, Mississippi, and Tennessee
	West South Central	Arkansas, Louisiana, Oklahoma, and Texas
West	Mountain*	Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming
	Pacific	Alaska, California, Hawaii, Oregon, and Washington

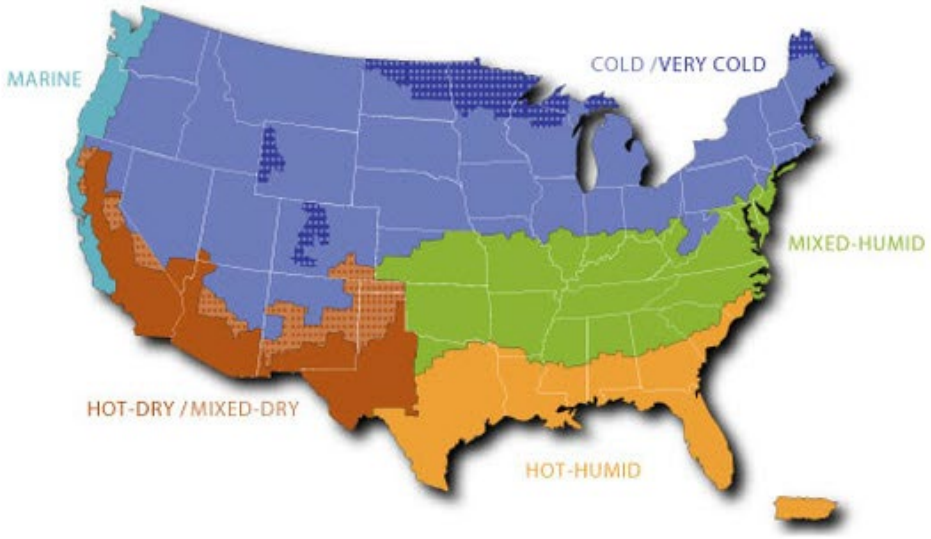
*Mountain South: Arizona, Nevada, and New Mexico; Mountain North: Colorado, Idaho, Montana, Utah, and Wyoming

Sources: U.S. Energy Information Administration (EIA). 2025a. *Residential Energy Consumption Survey (RECS) Terminology*. Accessed February 4, 2025. https://www.eia.gov/consumption/residential/terminology.php.

U.S. Energy Information Administration (EIA). 2025b. *Commercial Buildings Energy Consumption Survey (CBECS) Maps*. Accessed February 4, 2025. https://www.eia.gov/consumption/commercial/maps.php.

Note: The map is applicable to analyses being conducted using end-use energy consumption data from the U.S. EIA's RECS or CBECS. Energy data are provided in Tables E-2.2 through E-2.5 and E-15.1 and E-15.2 for U.S. Census regions and divisions covering the western states.

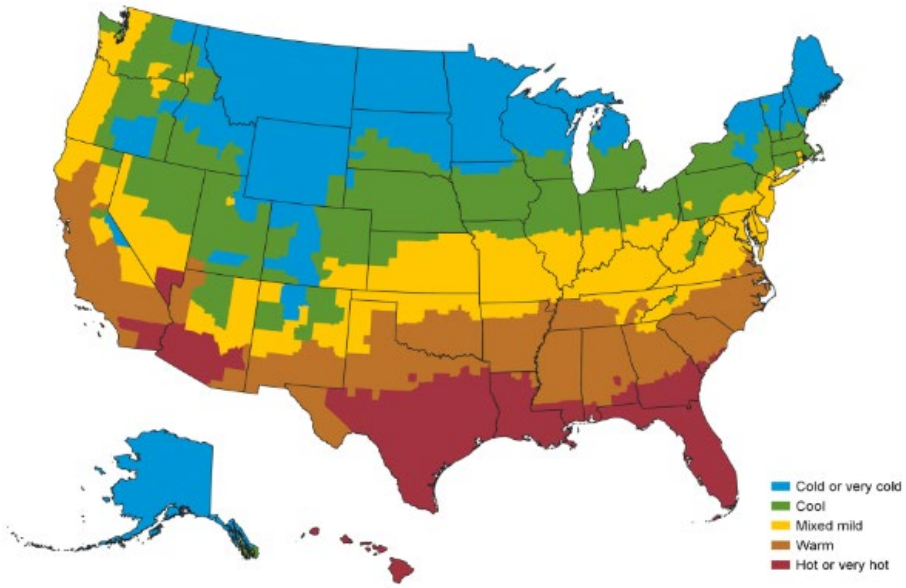
Figure E-2.2. Climate Zones for U.S. EIA Residential Energy Data



Source: U.S. Energy Information Administration (EIA). 2025. *Residential Energy Consumption Survey (RECS) Maps*. Accessed February 4, 2025. https://www.eia.gov/consumption/residential/maps.php.

Note: The map is applicable to analyses being conducted using end-use energy consumption data from the U.S. EIA's RECS. Residential energy data are provided in Tables E-2.2, E-2.4, and E-15.1 for climate zones covering the western states.

Figure E-2.3. Climate Zones for U.S. EIA Non-Residential Energy Data



Source: U.S. Energy Information Administration (EIA). 2025. *Commercial Buildings Energy Consumption Survey (CBECS) Maps*. Accessed February 4, 2025. https://www.eia.gov/consumption/commercial/maps.php.

Note: The map is applicable to analyses being conducted using end-use energy consumption data from the U.S. EIA's CBECS. Non-residential energy data are provided in Tables E-2.3, E-2.5, and E-15.2 for climate zones covering the western states.

Table E-2.1. Electricity Reduction of ENERGY STAR Appliance Compared to Conventional Appliance

Appliance Type	Electricity Reduction (%)
Commercial Refrigerator	-20%
Residential Refrigerator	-9%
Clothes Washer	-25%
Dishwasher	-12%
Ceiling Fan	-60%

Sources: ENERGY STAR. 2025a. "Refrigerators." Accessed February 4, 2025. https://www.energystar.gov/products/refrigerators.

ENERGY STAR. 2025b. "Commercial Refrigerators & Freezers." Accessed February 4, 2025. https://www.energystar.gov/products/commercial_refrigerators_freezers.

ENERGY STAR. 2025c. "Certified Residential Clothes Washers." Accessed February 4, 2025. https://www.energystar.gov/productfinder/product/certified-clothes-washers/results.

ENERGY STAR. 2025d. "Ceiling Fans." Accessed February 4, 2025. https://www.energystar.gov/products/ceiling_fans.

U.S. Department of Energy (DOE). 2025. "Dishwashers." Accessed February 4, 2024. https://www.energy.gov/energysaver/dishwashers#:~:text=An%20ENERGY%20STAR%20certified%20dishwasher,the%20best%20in%20energy%20savings.

Table E-2.2. Percent of Total Residential Building Electricity by Appliance and Housing Type (national average)

Housing Type	Residential Refrigerator	Clothes Washer	Dishwasher	Ceiling Fan
Single-Family Detached	7.8%	0.6%	0.8%	1.7%
Single-Family Attached	8.9%	0.6%	0.8%	1.4%
Apartments in Buildings with 2–4 Units	8.5%	0.5%	0.5%	1.1%
Apartments in Buildings with 5 or More Units	8.8%	0.4%	0.9%	1.3%
Mobile Homes	5.8%	0.6%	0.4%	1.3%

Source: U.S. Energy Information Administration (EIA). 2023. *Residential Energy Consumption Survey (RECS)*. Table CE2.1: Annual household site fuel consumption in the U.S.—totals and averages, 2020. Table CE5.1a: Detailed household site electricity end-use consumption, part 1—totals, 2020. Table CE5.1b: Detailed household site electricity end-use consumption, part 2—totals, 2020. Accessed January 2025. https://www.eia.gov/consumption/residential/data/2020/.

Table E-2.3. Percent of Total Non-Residential Building Electricity for Commercial Refrigerators by Building Type (national data)

Building Type	Commercial Refrigerator
Education	5%
Food Sales	48%
Food Service	26%
Health Care	4%
Inpatient	5%
Outpatient	3%
Lodging	8%
Mercantile	12%
Retail (other than mall)	7%
Enclosed and Strip Malls	15%
Office	3%
Public Assembly	7%
Public Order and Safety	5%
Religious Worship	7%
Service	2%
Warehouse and Storage	11%
Other	1%
Vacant	n/a

Source: U.S. Energy Information Administration (EIA). 2022. *Commercial Buildings Energy Consumption Survey (CBECS)*. Table B20: Energy sources, floorspace, 2018. Table E5: Electricity consumption (in kilowatt-hours [kWh]) by end use, 2018. Accessed January 2025. https://www.eia.gov/consumption/commercial/data/2018/.

Table E-2.4. Percent of Total Residential Building Electricity by Appliance Type and U.S. EIA Census Region/Division and Climate Zone (all housing types)

U.S. EIA Area	Residential Refrigerator	Clothes Washer	Dishwasher	Ceiling Fan
Census Region/Division				
West	9.7%	0.6%	0.9%	1.2%
Mountain	8.4%	0.6%	0.8%	1.4%
Mountain North	9.8%	0.7%	1.2%	1.2%
Mountain South	7.3%	0.5%	0.7%	1.6%
Pacific	10.6%	0.6%	1.0%	1.1%
Climate Zone				
Very Cold and Cold	8.9%	0.6%	0.9%	1.1%
Mixed-Dry and Hot-Dry	10.0%	0.6%	0.8%	1.6%
Marine	9.1%	0.5%	1.0%	0.5%

Source: U.S. Energy Information Administration (EIA). 2023. *Residential Energy Consumption Survey (RECS)*. Table CE2.1: Annual household site fuel consumption in the U.S.—totals and averages, 2020. Table CE5.1a: Detailed household site electricity end-use consumption, part 1—totals, 2020. Table CE5.1b: Detailed household site electricity end-use consumption, part 2—totals, 2020. Accessed January 2025. https://www.eia.gov/consumption/residential/data/2020/.

Table E-2.5. Percent of Total Non-Residential Building Electricity for Commercial Refrigerators by U.S. EIA Census Region/Division and Climate Zone (all building types)

U.S. EIA Area	Commercial Refrigerator
Census Region/Division	
West	11.2%
Mountain	11.6%
Pacific	10.9%
Climate Zone	
Cold or Very Cold	11.5%
Cool	9.4%
Mixed Mild	7.5%
Warm	9.4%
Hot or Very Hot	8.7%

Source: U.S. Energy Information Administration (EIA). 2022. *Commercial Buildings Energy Consumption Survey (CBECS)*. Table B20: Energy sources, floorspace, 2018. Table E5: Electricity consumption (in kilowatt-hours [kWh]) by end use, 2018. Accessed January 2025. https://www.eia.gov/consumption/commercial/data/2018/.

Table E-3-A.1. Average Annual Fuel Use and Savings by Boiler Type for Residential Boilers

AFUE by Boiler Type[1, 2]	Annual Fuel Use		
	Total (mmBTU/yr)[3]	Savings (mmBTU/yr)	Change (%)
Gas-fired[4] Hot Water Boiler			
84% (Standard)	82.1	—	—
85%	81.1	1.0	-1.2%
90%	75.2	6.9	-8.4%
92%	73.6	8.5	-10.4%
96% (Max Tech)	70.6	11.5	-14.0%
Gas-fired Steam Boiler			
82% (Standard)	83.9	—	—
83% (Max Tech)	82.9	1.0	-1.2%
Oil-fired Hot Water Boiler			
86% (Standard)	84.3	—	—
91% (Max Tech)	80.1	4.2	-5.0%
Oil-fired Steam Boiler			
85% (Standard)	82.9	—	—
86% (Max Tech)	81.9	1.0	-1.2%

Source: U.S. Department of Energy (U.S. DOE). 2015. *Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Residential Boilers*. March 2015. Accessed March 2025. https://www.regulations.gov/document/EERE-2012-BT-STD-0047-0036.

AFUE = Annual fuel utilization efficiency; mmBTU = 1 million British Thermal Units; yr = year

[1] "Standard" refers to the minimum AFUE required by the 2016 Conservation Standards for Residential Boilers.

[2] "Max Tech" refers to the maximum technologically feasible improvement in energy efficiency determined by DOE for each type of boiler.

[3] The average annual fuel use is based on historical consumption data.

[4] Gas-fired boilers refer to boilers that use natural gas and/or propane as fuel.

Table E-3-B.1. Average Annual Fuel Use and Savings for Boilers Installed Before January 10, 2023 for Commercial and Industrial Boilers

	Annual Fuel Use		
CE or TE by Boiler Type[1, 2]	Total (mmBTU/yr)[3]	Savings (mmBTU/yr)	Change (%)
Gas-fired Hot Water Boiler (≥300,000 BTU/hr and ≤2,500,000 BTU/hr)			
80% TE (Standard)	907.7	—	—
81% TE	896.3	11.4	-1.3%
82% TE	885.2	22.6	-2.5%
84% TE	863.7	44.0	-4.8%
85% TE	853.4	54.4	-6.0%
93% TE	815.7	92.0	-10.1%
95% TE	797.3	110.4	-12.2%
99% TE (Max Tech)	762.9	144.8	-16.0%
Gas-fired Hot Water Boiler (≥2,500,000 BTU/hr and ≤10,000,000 BTU/hr)			
82% CE (Standard)	6,008.8	—	—
83% CE	5,929.9	78.9	-1.3%
84% CE	5,853.1	155.7	-2.6%
85% CE	5,778.3	230.5	-3.8%
94% CE	5,442.5	566.3	-9.4%
97% CE (Max Tech)	5,252.2	756.6	-12.6%
Oil-fired Hot Water Boiler (≥300,000 BTU/hr and ≤2,500,000 BTU/hr)			
82% TE (Standard)	807.3	—	—
83% TE	797.4	9.9	-1.2%
84% TE	787.8	19.5	-2.4%
85% TE	778.4	28.9	-3.6%
87% TE	760.2	47.1	-5.8%
88% TE	751.5	55.8	-6.9%
97% TE (Max Tech)	709.5	97.8	-12.1%
Oil-fired Hot Water Boiler (≥2,500,000 BTU/hr and ≤10,000,000 BTU/hr)			
84% CE (Standard)	3,119.1	—	—
86% CE	3,047.7	71.4	-2.3%
88% CE	2,979.5	139.6	-4.5%
89% CE	2,946.5	172.6	-5.5%
97% CE (Max Tech)	2,854.2	264.9	-8.5%
Gas-fired Steam Boiler (≥300,000 BTU/hr and ≤2,500,000 BTU/hr)			
77% TE (Standard)	787.0	—	—
78% TE	776.7	10.3	-1.3%
79% TE	766.7	20.3	-2.6%
80% TE	757.0	30.0	-3.8%
81% TE	747.4	39.6	-5.0%
83% TE (Max Tech)	729.1	57.9	-7.4%

Table E-3-B.1. Average Annual Fuel Use and Savings for Boilers Installed Before January 10, 2023 for Commercial and Industrial Boilers (cont.)

CE or TE by Boiler Type[1, 2]	Annual Fuel Use		
	Total (mmBTU/yr)[3]	Savings (mmBTU/yr)	Change (%)
Gas-fired Steam Boiler (≥2,500,000 BTU/hr and ≤10,000,000 BTU/hr)			
77% TE (Standard)	4,956.9	—	—
78% TE	4,892.1	64.8	-1.3%
79% TE	4,829.0	127.9	-2.6%
80% TE	4,767.5	189.4	-3.8%
81% TE	4,707.6	249.3	-5.0%
82% TE	4,649.1	307.8	-6.2%
84% TE (Max Tech)	4,536.4	420.5	-8.5%
Oil-fired Steam Boiler (≥300,000 BTU/hr and ≤2,500,000 BTU/hr)			
81% TE (Standard)	845.7	—	—
83% TE	825.0	20.7	-2.4%
84% TE	815.0	30.7	-3.6%
86% TE (Max Tech)	795.8	49.9	-5.9%
Oil-fired Steam Boiler (≥2,500,000 BTU/hr and ≤10,000,000 BTU/hr)			
81% TE (Standard)	3,730.3	—	—
83% TE	3,639.0	91.3	-2.4%
85% TE	3,552.1	178.2	-4.8%
87% (Max Tech)	3,469.2	261.1	-7.0%

Source: U.S. Department of Energy (U.S. DOE). 2016. *Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Commercial Packaged Boilers*. December 2016. Accessed January 2025. https://www.regulations.gov/docket?D=EERE-2013-BT-STD-0030.

CE = combustion efficiency; mmBTU = 1 million British Thermal Unit; TE = thermal efficiency; yr = year; BTU = British Thermal Unit; ≥ = greater than or equal to; ≤ = less than or equal to

[1] "Standard" refers to the minimum CE or TE required by the 2012 Conservation Standards for Commercial Packaged Boilers.

[2] "Max Tech" refers to the maximum technologically feasible improvement in energy efficiency determined by DOE for each type of boiler.

[3] The average annual fuel use is based on historical consumption data.

Table E-3-B.2. Average Annual Fuel Use and Savings for Boilers Installed on or After January 10, 2023

CE or TE by Boiler Type[1, 2]	Annual Fuel Use		
	Total (mmBTU/yr)[3]	Savings (mmBTU/yr)	Change (%)
Gas-fired Hot Water Boiler (≥300,000 BTU/hr and ≤2,500,000 BTU/hr)			
84% TE (Standard)	863.7	—	—
85% TE	853.4	10.3	-1.2%
93% TE	815.7	48.0	-5.6%
95% TE	797.3	66.4	-7.7%
99% TE (Max Tech)	762.9	100.8	-11.7%
Gas-fired Hot Water Boiler (≥2,500,000 BTU/hr and ≤10,000,000 BTU/hr)			
85% CE (Standard)	5,778.3	—	—
94% CE	5,442.5	335.8	-5.8%
97% CE (Max Tech)	5,252.2	526.1	-9.1%
Oil-fired Hot Water Boiler (≥300,000 BTU/hr and ≤2,500,000 BTU/hr)			
87% TE (Standard)	760.2	—	—
88% TE	751.5	8.7	-1.1%
97% TE (Max Tech)	709.5	50.7	-6.7%
Oil-fired Hot Water Boiler (≥2,500,000 BTU/hr and ≤10,000,000 BTU/hr)			
88% CE (Standard)	2,979.5	—	—
89% CE	2,946.5	33.0	-1.1%
97% CE (Max Tech)	2,854.2	125.3	-4.2%
Gas-fired Steam Boiler (≥300,000 BTU/hr and ≤2,500,000 BTU/hr)			
81% TE (Standard)	747.4	—	—
83% TE (Max Tech)	729.1	18.3	-2.4%
Gas-fired Steam Boiler (≥2,500,000 BTU/hr and ≤10,000,000 BTU/hr)			
82% TE (Standard)	4,649.1	—	—
84% TE (Max Tech)	4,536.4	112.7	-2.4%
Oil-fired Steam Boiler (≥300,000 BTU/hr and ≤2,500,000 BTU/hr)			
84% TE (Standard)	815.0	—	—
86% TE (Max Tech)	795.8	19.2	-2.4%
Oil-fired Steam Boiler (≥2,500,000 BTU/hr and ≤10,000,000 BTU/hr)			
81% TE (Standard)	3,730.3	—	—
83% TE	3,639.0	91.3	-2.4%
85% TE	3,552.1	178.2	-4.8%
87% (Max Tech)	3,469.2	261.1	-7.0%

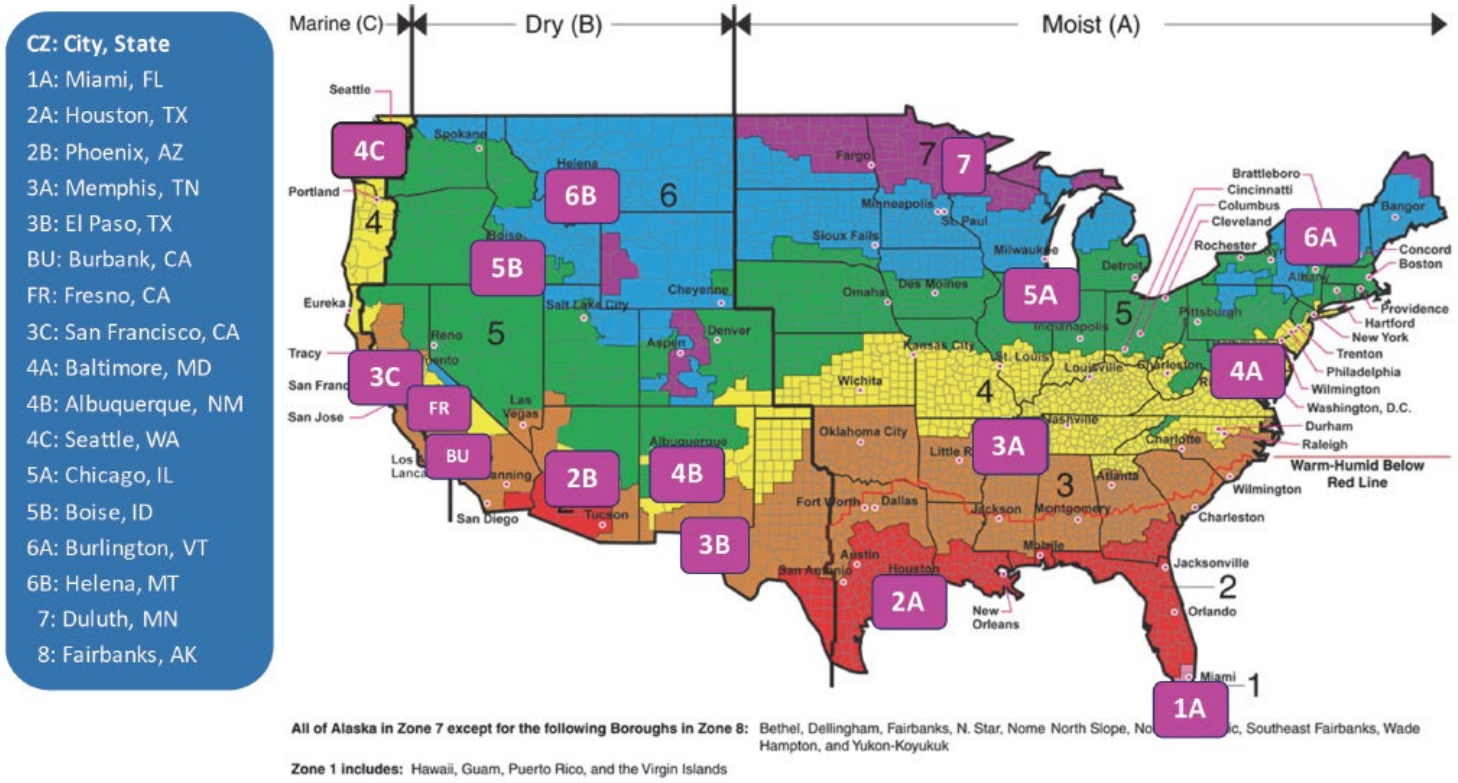
Source: U.S. Department of Energy (U.S. DOE). 2016. *Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Commercial Packaged Boilers*. December 2016. Accessed January 2021. https://www.regulations.gov/docket?D=EERE-2013-BT-STD-0030.

CE = combustion efficiency; mmBTU = 1 million British Thermal Units; TE = thermal efficiency; yr = year; BTU = British Thermal Unit; ≥ = greater than or equal to; ≤ = less than or equal to

[1] "Standard" refers to the minimum CE or TE required by the 2020 Conservation Standards for Commercial Packaged Boilers.

[2] "Max Tech" refers to the maximum technologically feasible improvement in energy efficiency determined by DOE for each type of boiler.[3] The average annual fuel use is based on historical consumption data.

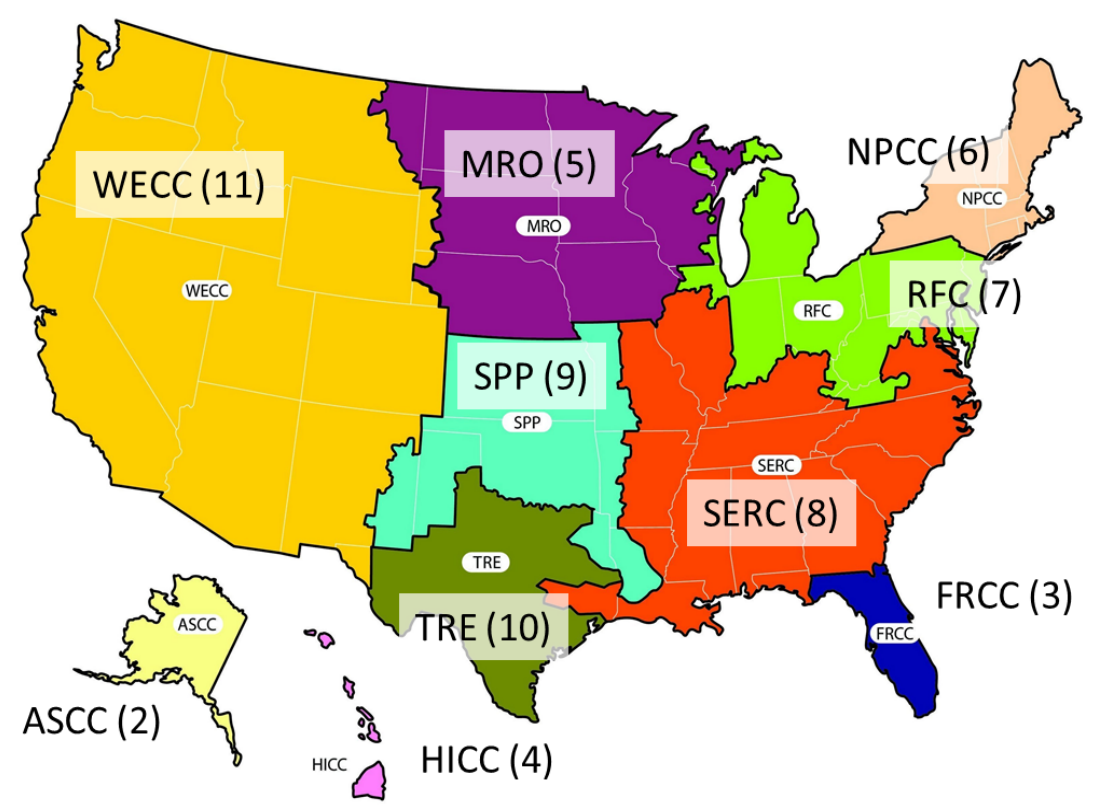
Figure E-4.1. Climate Zones for the Cool Surface Savings Explorer



Source: Levinson, R. 2019. "Using Solar Availability Factors to Adjust Cool-Wall Energy Savings for Shading and Reflection by Neighboring Buildings." *Solar Energy* 180: 717–734. March. https://escholarship.org/content/qt0hf5m90n/qt0hf5m90n.pdf.

Note: The climate zone map is applicable to analyses being conducted using Lawrence Berkeley National Laboratory's Cool Surface Savings Explorer (Explorer) (Levinson et al. 2019). The map shows United States climate zones in which solar availability factors were calculated and included in the Explorer. Climate zone 8 (Fairbanks, AK) is not shown. Table E-4.1 identifies applicable Explorer climate zones within each of the western states.

Figure E-4.2. Electricity Zones for GREET Data



Source: U.S. Department of Energy (U.S. DOE). 2024. *The Greenhouse Gases, Regulated Emissions, and Energy Use in Technologies Model*. 2024 Release. Accessed January 28, 2025. https://greet.anl.gov/.

Note: The climate zone map is applicable to analyses being conducted using electricity emission factors from the Greenhouse Gases, Regulated Emissions, and Energy Use in Technologies Model (GREET). Table E-4.9 provides the emission factors for the Western Electricity Coordinating Council (WECC) and Southwest Power Pool (SPP), which include the western states.

Table E-4.1. Representative Climate Zones by State for Solar Availability Factors from the Cool Surface Savings Explorer

State	Climate Zone(s)[1]
Washington	**4C: Seattle, WA** 5B: Boise, ID 6B: Helena, MT
Oregon	4C: Seattle, WA 5B: Boise, ID
Colorado	5B: Boise, ID 6B: Helena, MT 7: Duluth, MN
Arizona	**2B: Phoenix, AZ** 2A: Houston, TX 4B: Albuquerque, NM 5B: Boise, ID
New Mexico	**4B: Albuquerque, NM** 3B: El Paso, TX 5B: Boise, ID

Source: Levinson, R. 2019. "Using Solar Availability Factors to Adjust Cool-Wall Energy Savings for Shading and Reflection by Neighboring Buildings." *Solar Energy* 180: 717-734. March. Accessed January 2021. https://escholarship.org/content/qt0hf5m90n/qt0hf5m90n.pdf.

[1] **Bolded** zones are in-state locations included in the source study. Non-bolded zones are out-of-state proxy locations that may have similar climate characteristics as portions of the state. Refer to Figure E-4.1.

Table E-4.2. Canyon Aspect Ratios from the Cool Surface Savings Explorer

Ratio	Height (ft)	Width (ft)	Neighboring Building Types Represented
0.2	19.7	98.4	Two-story single-family homes across a residential street
1	19.7	19.7	Two-story single-family homes across small backyards
2	19.7	9.8	Two-story single-family homes on the same street side
10	98.4	9.8	Adjacent 10-story office buildings on the same street side

Source: Levinson, R. 2019. "Using Solar Availability Factors to Adjust Cool-Wall Energy Savings for Shading and Reflection by Neighboring Buildings." *Solar Energy* 180: 717-734. March. https://escholarship.org/content/qt0hf5m90n/qt0hf5m90n.pdf.

ft = foot

Table E-4.3. Mean Solar Availability Factors by Canyon Aspect Ratio for Conventional Neighboring Walls by Representative Climate Zones for the Cool Surface Savings Explorer

Cool Surface Savings Explorer Climate Zone[1]	Conventional Neighboring Wall (albedo = 0.25)			
	North	East	South	West
Canyon Aspect Ratio = 0.2				
2A: Houston, TX	0.91	0.91	0.93	0.91
2B: Phoenix, AZ	0.92	0.91	0.95	0.92
3B: El Paso, TX	0.93	0.94	0.95	0.93
4B: Albuquerque, NM	0.93	0.92	0.95	0.92
4C: Seattle, WA	0.91	0.91	0.94	0.90
5B: Boise, ID	0.92	0.91	0.95	0.91
6B: Helena, MT	0.92	0.91	0.95	0.90
7: Duluth, MN	0.91	0.90	0.94	0.90
Canyon Aspect Ratio = 1.0				
2A: Houston, TX	0.65	0.62	0.70	0.62
2B: Phoenix, AZ	0.68	0.61	0.72	0.62
3B: El Paso, TX	0.69	0.64	0.73	0.63
4B: Albuquerque, NM	0.70	0.61	0.71	0.62
4C: Seattle, WA	0.64	0.60	0.64	0.59
5B: Boise, ID	0.67	0.59	0.68	0.60
6B: Helena, MT	0.66	0.59	0.64	0.58
7: Duluth, MN	0.64	0.58	0.63	0.58
Canyon Aspect Ratio = 2.0				
2A: Houston, TX	0.45	0.42	0.47	0.41
2B: Phoenix, AZ	0.49	0.41	0.51	0.41
3B: El Paso, TX	0.50	0.42	0.51	0.42
4B: Albuquerque, NM	0.50	0.41	0.50	0.41
4C: Seattle, WA	0.44	0.40	0.43	0.39
5B: Boise, ID	0.47	0.39	0.47	0.39
6B: Helena, MT	0.46	0.38	0.44	0.37
7: Duluth, MN	0.45	0.38	0.43	0.38
Canyon Aspect Ratio = 10.0				
2A: Houston, TX	0.13	0.11	0.13	0.11
2B: Phoenix, AZ	0.14	0.10	0.14	0.10
3B: El Paso, TX	0.14	0.11	0.15	0.11
4B: Albuquerque, NM	0.14	0.10	0.14	0.11
4C: Seattle, WA	0.12	0.10	0.10	0.10
5B: Boise, ID	0.13	0.10	0.11	0.10
6B: Helena, MT	0.13	0.09	0.10	0.09

7: Duluth, MN	0.12	0.10	0.10	0.10

Source: Levinson, R. 2019. "Using Solar Availability Factors to Adjust Cool-Wall Energy Savings for Shading and Reflection by Neighboring Buildings." *Solar Energy* 180: 717-734. March. https://escholarship.org/content/qt0hf5m90n/qt0hf5m90n.pdf.

[1] Refer to Table E-4.1 and Figure E-4.1 for representative climate zones by state.

Table E-4.4. Mean Solar Availability Factors by Canyon Aspect Ratio for Cool Neighboring Walls from the Cool Surface Savings Explorer

Ratio	Cool Neighboring Wall (albedo = 0.60)			
	North	East	South	West
0.2	1.02	0.95	0.96	0.95
1	0.94	0.72	0.75	0.72
2	0.73	0.52	0.55	0.52
10	0.22	0.15	0.16	0.15

Source: Levinson, R. 2019. "Using Solar Availability Factors to Adjust Cool-Wall Energy Savings for Shading and Reflection by Neighboring Buildings." *Solar Energy* 180: 717-734. March. https://escholarship.org/content/qt0hf5m90n/qt0hf5m90n.pdf.

Table E-4.5. Selected Electric Utility Emission Factors—Arizona (lb CO_2e per MWh)

Utility[1]	2023[2]	2024	2025	2024/2025 Method
Arizona Public Service Co.	814	774	765	forecast[3]
Salt River Project	1,015	871	—	actual
Tucson Electric Power Co.	1,100	1,088	1,076	forecast[3]
UNS Electric, Inc.	1,049	1,037	1,025	forecast[3]

Sources: Pinnacle West Capital Corporation. 2024. *Electric Company ESG/Sustainability Quantitative Information*. Arizona Public Services Co. Accessed February 4, 2024. https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fs22.q4cdn.com%2F464697698%2Ffiles%2Fdoc_downloads%2F2024%2FESG-Template-Pinnacle-West-2024-Final.xlsx&wdOrigin=BROWSELINK.

Salt River Project. 2024. "SRP Power Content Label–Fiscal Year 2023." Accessed February 24, 2025. https://www.srpnet.com/assets/srpnet/pdf/grid-water-management/sustainability-environment/FY23_Sustainability_Power_Content_Label.pdf.

Salt River Project. 2025. "SRP Power Content Label–Fiscal Year 2024." Accessed June 5, 2025. https://www.srpnet.com/assets/srpnet/pdf/grid-water-management/sustainability-environment/FY24_Sustainability_Power_Content_Label.pdf.

UNS Energy Corporation. 2024a. *Electric Company ESG/Sustainability Quantitative Information*. Tucson Electric Power Company. June 2024. Accessed February 4, 2024. https://docs.tep.com/wp-content/uploads/TEP-EEI-ESG-2024.pdf.

UNS Energy Corporation. 2024b. *Electric Company ESG/Sustainability Quantitative Information*. Tucson Electric Power Company and UniSource Energy Services (UNS Electric Inc. and UNS Gas Inc.). November 2024. Accessed February 4, 2024. https://docs.tep.com/wp-content/uploads/UNS-EEI-ESG-2024.pdf.

Lawrence Berkely National Laboratory (LBNL). 2024. RPS and CES Percentage Targets XLXS. Accessed January 30, 2025. https://emp.lbl.gov/publications/us-state-renewables-portfolio-clean-0; Clean Air Task Force. 2025. "Clean Electricity Standards: Tracking Clean Energy in U.S. States." Accessed January 30, 2025. https://www.catf.us/us/state-policy/clean-electricity-standards/.

lb. = pounds; MWh = megawatt-hour; CO2e = carbon dioxide equivalent; RPS = renewables portfolio standard

Notes: **Bolded utilities** are subject to the state's RPS.

[1] This table only includes a subset of Arizona electric utilities. A complete list of utilities serving Arizona is available from the U.S. Energy Information Administration (EIA). 2023. "Utility Bundled Retail Sales–Total." Accessed January 25, 2025. https://www.eia.gov/electricity/sales_revenue_price/pdf/table_10.pdf.

[2] Base year (2023) emission factors for each utility were obtained from the sources listed above. For Salt River Project, the 2024 actual (i.e. non-forecasted) emission factor is also available.

[3] Emission factors for utilities subject to the RPS were forecasted according to the following method. Future year emission factors for utilities not subject to the RPS were not forecasted.

- The percent of qualifying RPS load for the 2023 base year was obtained from the sources listed above. The percent of load supplied by non-RPS qualifying sources was calculated as the difference from 100%.
- The 2023 base year emission factor was divided by the percent of non-RPS qualifying sources to calculate an average emission factor for non-RPS qualifying power generation.
- The estimated percent of qualifying RPS load in 2024 and 2025 was obtained from the LBNL.
- The percent of load supplied by non-RPS qualifying sources in 2024 and 2025 was calculated as the difference from 100% and then multiplied by the calculated average emission factor for non-RPS qualifying power generation.
- Because the horizon year for the state's RPS is 2025, emission factors beyond 2025 are not projected.

The forecasting approach holds the non-RPS qualifying power mix constant at 2023 levels. It does not account for utility-specific targets or generation plans. All four utilities listed in this table have a goal of 100% carbon free power by 2050 and have set interim targets to support attainment for this goal (e.g., Arizona Public Service Co. seeks to achieve 65% clean energy by 2030 and eliminate coal-fired generation by 2031). Thus, emission factors for all utilities are expected to be lower than presented in this table. ***Users should consult their local electricity provider for updated emission factors available at the time of their analysis before proceeding with the defaults provided in this table.***

Table E-4.6. Selected Electric Utility Emission Factors—Colorado (lb CO_2e per MWh)

Utility[1]	2022[2]	2023[2]
Holy Cross Electric Assn, Inc.	920	957
Public Service Co. of Colorado	973	929

Sources: Holy Cross Energy. 2024. *2023 CO_2 Emissions Report*. September 2024. Accessed February 24, 2025. https://www.holycross.com/wp-content/uploads/2024/09/HCE_Co2-Report-2023_web-1.pdf.

Holy Cross Energy. 2023. *2022 CO2 Emissions Report*. July 2023. Accessed February 24, 2025. https://www.holycross.com/wp-content/uploads/2023/07/HCE_Co2-Report-2022.pdf.

Xcel Energy. 2023. *Carbon Dioxide (CO2) Emission Intensities*. Accessed February 24, 2025. https://www.xcelenergy.com/staticfiles/xe-responsive/Company/Sustainability%20Report/2023_Xcel_Energy_Carbon_Intensities_Info_Sheet.pdf.

lb. = pounds; MWh = megawatt-hour; CO2e = carbon dioxide equivalent; RPS = renewables portfolio standard

Notes: All utilities listed in this table are subject to the state's RPS.

[1] This table only includes a subset of Colorado electric utilities. A complete list of utilities serving Colorado is available from the U.S. Energy Information Administration (EIA). 2023. *Utility Bundled Retail Sales-Total*. Accessed January 25, 2025. https://www.eia.gov/electricity/sales_revenue_price/pdf/table_10.pdf.)

[2] Emission factors for each utility were obtained from the sources listed above. Because the horizon year for the state's RPS is 2020, future-year emission factors were not projected.

This table does not account for utility-specific emission reduction targets or generation plans. Nor does it account for the state's CES, which requires 1) non-municipal utilities serving more than 500,000 customers to reduce GHG emissions by 80% by 2030 (from 2005) and 2) 100% clean energy (statewide) by 2040. Thus, emission factors for all utilities are expected to be lower than presented in this table***. Users should consult their local electricity provider for updated emission factors available at the time of their analysis before proceeding with the defaults provided in this table.***

Table E-4.7. Selected Electric Utility Emission Factors—New Mexico (lb CO_2e per MWh)

Utility [1]	2021	2022	2023	2024	2025
El Paso Electric Co. [2]	518	490	462	435	315
Public Service Co. of NM [2]	—	—	395	315	316
Southwestern Public Service Co. [3]	—	—	—	841	731
Tri-State Generation and Transmission Assoc. Inc.[4]	1,459	1,383	1,394	1,263	1,341
Utility	**2026**	**2027**	**2028**	**2029**	**2030**
El Paso Electric Co. [2]	318	321	313	306	299
Public Service Co. of NM [2]	293	285	276	247	224
Southwestern Public Service Co. [3]	651	595	594	587	574
Tri-State Generation and Transmission Assoc. Inc.[4]	1,345	1,304	1,293	1,198	998
Utility	**2031**	**2032**	**2033**	**2034**	**2035**
El Paso Electric Co.[2]	292	283	274	265	257
Public Service Co. of NM[2]	139	36	29	21	16
Southwestern Public Service Co.[3]	561	546	531	514	498
Tri-State Generation and Transmission Assoc. Inc.[4]	947	949	938	893	908
Utility	**2036**	**2037**	**2038**	**2039**	**2040**
El Paso Electric Co.[2]	270	283	294	306	316
Public Service Co. of NM[2]	7	6	8	9	0
Southwestern Public Service Co.[3]	496	507	530	552	573
Tri-State Generation and Transmission Assoc. Inc.[4]	914	890	870	864	821

Sources: New Mexico Energy Conservation and Management (ECAM). 2025. Excel database with utility emission factors, provided to ICF in March 2025.

lb. = pounds; MWh = megawatt-hour; CO_2e = carbon dioxide equivalent; RPS = renewables portfolio standard

Notes: All utilities listed in this table are subject to the state's RPS.

[1] This table only includes a subset of New Mexico electric utilities. A complete list of utilities serving New Mexico is available from the U.S. Energy Information Administration (EIA). 2023. *Utility Bundled Retail Sales-Total*. Accessed January 25, 2025. https://www.eia.gov/electricity/sales_revenue_price/pdf/table_10.pdf.

[2] Future year emission factors account for compliance with the state's RPS and CES and implementation of utility-specific renewable procurement or GHG reduction plans.

[3] Future year emission factors do not account for compliance with the state's RPS or CES (would not accurately reflect member carbon intensity in the regional transmission organization market).

[4] Future year emission factors assume the carbon intensity for the whole generating region and incorporate compliance with Colorado's RPS and New Mexico's RPS.

Users should consult their local electricity provider for updated emission factors available at the time of their analysis before proceeding with the defaults provided in this table.

Table E-4.8. Selected Electric Utility Emission Factors—Oregon (lb CO_2e per MWh)

Utility	2019	2020	2021	2022	2023+[1]
Consumer-Owned Utility					
Ashland Electric Department	45	26	44	35	37
Bandon	45	26	44	35	37
Blachly-Lane Electric Cooperative	82	180	106	75	67
Canby Utility Board	45	26	44	35	37
Cascade Locks	45	26	44	35	37
Central Electric Cooperative	57	115	87	67	62
Central Lincoln PUD	45	26	50	60	56
Clatskanie PUD	118	35	57	50	116
Clearwater Power Company	46	27	47	41	42
Columbia Basin Cooperative	45	26	44	35	37
Columbia Power Cooperative	45	26	44	35	37
Columbia River PUD	45	26	44	35	37
Columbia Rural Electric (Columbia REA)	45	26	44	35	37
Consumers Power	62	99	105	97	93
Coos-Curry Electric Cooperative, Inc.	45	26	44	35	37
Douglas Electric Cooperative	45	26	47	40	41
Drain	45	26	44	35	37
Emerald PUD	319	97	152	137	186
Eugene Water & Electric Board (EWEB)	121	57	88	75	80
Forest Grove Light & Power	41	55	69	60	55
Harney Electric Cooperative	45	26	44	35	37
Hermiston Energy Services	45	26	44	35	37
Hood River Electric Cooperative	45	26	44	35	37
Lane Electric Cooperative	45	26	44	35	37
McMinnville Water & Light	45	25	42	34	36
Midstate Electric Cooperative	45	26	44	35	37
Milton-Freewater City Light & Power	34	20	34	27	29
Monmouth	45	26	44	35	37
Northern Wasco PUD	64	149	338	449	501
Oregon Trail Electric Cooperative	45	26	44	35	37
Salem Electric	45	26	44	35	37
Springfield Utility Board	45	26	44	35	37
Surprise Valley Electrification Corporation	45	26	44	35	37

Utility	2019	2020	2021	2022	2023+[1]
Tillamook PUD	45	26	44	35	37
Umatilla Electric Cooperative	404	392	751	666	235
Umpqua Indian Utility Co-op	45	26	44	35	37
USDOE ARC	45	26	44	35	37
Wasco Electric Cooperative	45	26	44	35	37
West Oregon Electric Cooperative, Inc.	45	26	46	39	39
Electricity Service Supplier					
3 Phases Renewables	0	0	—	—	—
Avangrid Renewables	25	25	22	19	12
Calpine Energy Solutions	944	944	944	944	944
Constellation New Energy	944	944	944	944	944
Shell Energy North America	668	222	605	548	816
Investor-Owned Utility					
Idaho Power Company	545	680	734	774	614
Pacific Power (PacifiCorp)	1,520	1,403	1,321	1,255	1,186
Portland General Electric (PGE)	921	774	694	648	705

Sources: Oregon Department of Environmental Quality 2025. Excel database with utility emission factors, provided to ICF in March 2025.

lb. = pounds; MWh = megawatt-hour; CO_2e = carbon dioxide equivalent; PUD = public utility district; RPS = renewables portfolio standard

[1] Future year emission factors are not available. ***Users should consult their local electricity provider for updated emission factors available at the time of their analysis before proceeding with the defaults provided in this table.***

Table E-4.9. Selected Electric Utility Emission Factors—Washington (lb CO_2e per MWh)

		Forecasted with RPS[2]		
Utility	2022[1]	2023	2024	2025+
Alder Mutual Light	39	—	—	—
Asotin County PUD #1	39	—	—	—
Avista Corp	**740**	**740**	**740**	**740**
Benton County PUD #1	**116**	**116**	**116**	**116**
Benton Rural Electric Assn	39	—	—	—
Big Bend Electric Coop	139	—	—	—
Centralia City Light	193	—	—	—
Chelan County PUD #1	**189**	**189**	**189**	**189**
Cheney Light Department	39	—	—	—
Chewelah Electric Department	39	—	—	—
City of Blaine	39	—	—	—
Clallam County PUD #1	**39**	**38**	**39**	**39**
Clark County PUD #1	**358**	**346**	**320**	**320**

Utility	2022[1]	Forecasted with RPS[2]		
		2023	2024	2025+
Clearwater Power (WA)	45	—	—	—
Columbia Rural Electric Assn (WA)	141	—	—	—
Consolidated Irrigation District #19	39	—	—	—
Town of Coulee Dam	39	—	—	—
Cowlitz County PUD #1	**103**	**103**	**103**	**103**
Douglas County PUD #1	727	—	—	—
Eatonville Electric Department	39	—	—	—
Ellensburg Electric Division	39	—	—	—
Elmhurst Mutual Power & Light	39	—	—	—
Energy Northwest	39	—	—	—
Fairchild Airforce Base	39	—	—	—
Ferry County PUD #1	39	—	—	—
Franklin County PUD #1 [3]	**119**	**119**	**119**	**104**
Grant County PUD #2	800	—	—	—
Grant County PUD #2 (Rate Schedule 13)	0	—	—	—
Grays Harbor County PUD #1	**62**	**62**	**62**	**62**
Inland Power & Light	**40**	**40**	**39**	**39**
Jefferson County PUD #1	39	—	—	—
Kalispel Tribal Utility	39	—	—	—
Kittitas County PUD #1	40	—	—	—
Klickitat County PUD #1	189	—	—	—
Lakeview Light & Power	39	—	—	—
Lewis County PUD #1	**94**	**94**	**94**	**94**
Mason County PUD #1	37	—	—	—
Mason County PUD #3	**38**	**38**	**38**	**38**
McCleary Light & Power	39	—	—	—
Milton Electric Division	39	—	—	—
Modern Electric Water Company	39	—	—	—
Nespelem Valley Elec Coop	39	—	—	—
Northern Lights (WA)	51	—	—	—
Ohop Mutual Light	39	—	—	—
Okanogan County Electric Coop	53	—	—	—
Okanogan County PUD #1	439	—	—	—
Orcas Power & Light Coop	43	—	—	—
Pacific County PUD #2	**120**	**114**	**111**	**120**
Pacific Power (WA)	1,245	—	—	—

Utility	2022[1]	Forecasted with RPS[2] 2023	2024	2025+
Parkland Light & Water	39	—	—	—
Pend Oreille County PUD #1	589	—	—	—
Peninsula Light	**38**	**34**	**34**	**34**
Port Angeles Light Operations	39	—	—	—
Port of Seattle	39	—	—	—
Puget Sound Energy	**851**	**850**	**851**	**851**
Puget Sound Energy Green Direct Program	0	—	—	—
Richland Energy Services	102	—	—	—
Town of Ruston	25	—	—	—
Seattle City Light	**29**	**27**	**26**	**26**
Skamania County PUD #1	39	—	—	—
Snohomish County PUD #1	**43**	**43**	**43**	**43**
Steilacoom Electric Utility	39	—	—	—
City of Sumas	39	—	—	—
Tacoma Power	**25**	**25**	**25**	**25**
Tanner Electric Coop	39	—	—	—
Vera Water & Power	86	—	—	—
Wahkiakum County PUD #1	39	—	—	—
Whatcom County PUD #1	39	—	—	—
Yakama Power	39	—	—	—

Sources: Washington State Department of Commerce. 2025. Excel file provided to ICF with utility emission factors. January.

Washington State Department of Commerce. 2025. EIA Reports. Accessed January 2025. https://deptofcommerce.app.box.com/s/y27oz4btzu41qjzorjijhy44xquuoa1u.

lb. = pounds; MWh = megawatt-hour; CO2e = carbon dioxide equivalent; RPS = renewables portfolio standard

Notes: **Bolded utilities** are subject to the state's RPS.

[1] Base year (2022) emission factors for each utility were provided by WSDOT (2025).

[2] Emission factors for utilities subject to the RPS were forecasted according to the following method. Future year emission factors for utilities not subject to the RPS were not forecasted.

- The percent of qualifying RPS load for the 2022 base year was obtained from U.S. EIA. The percent of load supplied by non-RPS qualifying sources was calculated as the difference from 100%.
- The 2022 base year emission factor was divided by the percent of non-RPS qualifying sources to calculate an average emission factor for non-RPS qualifying power generation.
- The percent of qualifying RPS load in 2023 and 2024 was obtained from U.S. EIA. The percent of qualifying RPS load in 2025 was set to 15% per the RPS. Note that many utilities have achieved the 2025 RPS requirement of 15% before 2025.
- The percent of load supplied by non-RPS qualifying sources in 2023, 2024, and 2025 was calculated as the difference from 100% and then multiplied by the calculated average emission factor for non-RPS qualifying power generation.
- Because the horizon year for the state's RPS is 2025, emission factors beyond 2025 are not projected.

The forecasting approach holds the non-RPS qualifying power mix constant at 2022 levels. It does not account for utility-specific targets or generation plans. Nor does it account for the state's CES, which requires that all retail sales of electricity be carbon neutral by 2030 and utilities achieve 100% clean energy by 2045. Thus, emission factors for all utilities are expected to be lower than presented in this table. ***Users***

should consult their local electricity provider for updated emission factors available at the time of their analysis before proceeding with the defaults provided in this table.

[3] Franklin PUD's first period of compliance with the renewable requirements was 2022. Its target through 2025 is 3% of load.

Table E-4.10. Grid Average Electricity Emission Factors from GREET (lb per MWh)

Generating Region	2025	2030	2035	2040	2045	2050
WECC	585	314	261	210	203	201
SPP	821	291	275	306	308	320

Source: U.S. Department of Energy (U.S. DOE). 2024. *The Greenhouse Gases, Regulated Emissions, and Energy Use in Technologies Model*. 2024 Release. Accessed January 28, 2025. https://greet.anl.gov/.

WECC = Western Electricity Coordinating Council; SPP= Southwest Power Pool

Notes: Grid electricity emission factors are available for two geographies as defined in the U.S. DOE's GREET model—the Western Electricity Coordinating Council (WECC) and Southwest Power Pool (SPP). Arizona, Colorado, Oregon, and Washington are wholly within WECC. New Mexico is split between WECC and SPP. Refer to Figure E-4.2. Emission factors for WECC and SPP are provided in five-year increments between 2025 and 2050. If the analysis year falls within a five-year time period, users should select the earlier time period. For example, if the analysis year is 2037, users should use the emission factor for 2035. Alternatively, users may interpolate an emission factor for their specific analysis year based on the data provided in the table.

Table E-4.11. Natural Gas Emission Factors

	Emission Factor by Land Use Type (lb/mmBTU)	
Pollutant	Residential	Non-Residential
TOG	0.011	0.011
ROG	0.005	0.005
SO_2	0.001	0.001
NO_x	0.092	0.098
PM_{10}	0.007	0.007
$PM_{2.5}$	0.007	0.007
CO	0.039	0.082
CO_2	116.977	117.647
CH_4	0.010	0.010
N_2O	0.000	0.002
CO_2e	117.325	118.549

Sources: U.S. Environmental Protection Agency (U.S. EPA). 1998. "Chapter 1: External Combustion Sources. 1.4, Natural Gas Combustion." In *AP 42*, Fifth Edition, Volume I. July. https://www3.epa.gov/ttnchie1/ap42/ch01/final/c01s04.pdf.

U.S. Environmental Protection Agency (U.S. EPA). 2020. *Emission Factors for Greenhouse Gas Inventories*. March 2020. Accessed March 2021. https://www.epa.gov/sites/production/files/2020-04/documents/ghg-emission-factors-hub.pdf.

TOG = total organic gases; ROG = reactive organic gases; CO = carbon monoxide; SO_2 = sulfur dioxide; NOx = nitrogen oxides; PM_{10} = particulate matter less than or equal to 10 microns; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns; CO_2 = carbon dioxide; CH_4 = methane; N_2O = nitrous oxide; CO_2 = carbon dioxide equivalent; lb = pound; mmBTU = 1 million British Thermal Units

Table E-5.1. Change in Energy Use for Green Roofs Compared to Dark Roofs by Building Type and City[1]

Building Type	Flagstaff, AZ	Phoenix, AZ	Prescott, AZ	Boulder, CO	Denver, CO	Grand Junction, CO	Albuquerque, NM	Astoria, OR	Portland, OR	Olympia, WA	Seattle, WA	Spokane, WA
						Electricity Savings (kWh/yr/KSF)[2]						
Office[3]	343.0	110.8	190.1	216.6	216.2	200.3	206.0	68.2	78.4	101.4	68.1	150.4
Residential[4]	74.6	13.0	-0.8	18.2	27.2	10.4	20.7	19.1	24.6	27.3	12.9	4.6
						Gas Savings (therm/yr/KSF)						
Office[3]	1.4	0.03	0.5	1.0	0.9	0.9	0.5	0.3	0.4	0.7	0.4	1.2
Residential[4]	26.6	6.4	18.7	19.4	18.9	18.2	17.8	6.6	6.6	9.5	6.8	15.0

Source: Sailor, D., B. Brass, S. Peck. 2008. *Green Roof Energy Calculator*. Accessed December 2024. https://globalfutures.asu.edu/urban-climate-research-center/green-house-energy-calculator/.

kWh = kilowatt-hour; KSF = thousand square feet; yr = year

[1] The Green Roof Energy calculator was run for the above building types and cities using conservative values for the remaining tool inputs: growing media depth (2 inches), leaf area index (0.5), irrigation (no), green roof coverage (50%), remaining roof material (dark). A "dark roof" is defined as having an albedo of 0.15.

[2] Negative electricity savings represent an increase in electricity use.

[3] The value defined in the Green Roof Energy Calculator is "New Office Bldg."

[4] The value defined in the Green Roof Energy Calculator is "New Residence Bldg."

Table E-7.1. Outdoor Lighting Power Consumption and Efficacy by Lamp Type[1]

La.mp Type	Typical Power Rating (W)	Source Efficacy (LPW)
High-Pressure Sodium	70-400	80-120
Low-Pressure Sodium	55-180	130-170
Ceramic Metal Halide	20-400	75-110
Metal Halide	70-400	40-70
CFL	20-70	80-85
Linear Fluorescent	25-32	80-100
Induction	70-250	50-85
LED	40-250	Up to 130

Source: California Lighting Technology Center. 2014. *2013 Title 24, Part 6 Outdoor Lighting Guide*. University of California, Davis. March 2014. Accessed December 2024. https://cltc.ucdavis.edu/sites/g/files/dgvnsk12206/files/media/documents/2013-title-24-outdoor-lighting-guide-mar15.pdf.

CFL = compact fluorescent lamp; LED = light emitting diode; LPW = lumens per watt; W = watts

[1] Values are based on lamp sizes typically used in outdoor applications. These numbers are subject to change as technologies improve. Source efficacy is based on initial lumen output; system efficacy depends on the specifications of the luminaires and ballasts or drivers employed. Some outdoor applications may be best served by products with characteristics that fall outside of the ranges listed in this table.

Table E-10-B.1. Estimated Electricity Generation from Typical PV Systems by Major City (kilowatt-hours per year)[1]

State	County	Major City	Zip Code	3 kW	5 kW	10 kW
AZ	Apache	Eagar	85925	5,182	8,636	17,269
AZ	Cochise	Sierra Vista	85635	5,438	9,066	18,131
AZ	Coconino	Flagstaff	86001	5,112	8,521	17,038
AZ	Gila	Payson	85541	5,044	8,407	16,811
AZ	Graham	Safford	85546	5,454	9,090	18,177
AZ	Greenlee	Clifton	85533	5,347	8,913	17,823
AZ	La Paz	Parker	85344	5,427	9,043	18,079
AZ	Maricopa	Phoenix	85003	5,294	8,824	17,644
AZ	Mohave	Lake Havasu City	86403	5,312	8,856	17,709
AZ	Navajo	Show Low	85901	5,290	8,817	17,631
AZ	Pima	Tucson	85701	5,362	8,937	17,873
AZ	Pinal	Maricopa	85138	5,284	8,806	17,608
AZ	Santa Cruz	Rio Rico	85648	5,380	8,968	17,935
AZ	Yavapai	Prescott Valley	86314	5,249	8,749	17,492
AZ	Yuma	Yuma	85364	5,410	9,019	18,034
CO	Adams	Thornton	80241	4,798	7,998	15,987
CO	Alamosa	Alamosa	81101	5,316	8,861	17,718
CO	Arapahoe	Aurora	80010	4,825	8,042	16,079
CO	Archuleta	Pagosa Springs	81147	5,036	8,391	16,780
CO	Baca	Springfield	81073	5,003	8,335	16,666

State	County	Major City	Zip Code	3 kW	5 kW	10 kW
CO	Bent	Las Animas	81054	5,040	8,401	16,801
CO	Boulder	Boulder	80301	4,417	7,361	14,718
CO	Broomfield	Broomfield	80020	4,602	7,671	15,343
CO	Chaffee	Salida	81201	5,035	8,390	16,780
CO	Cheyenne	Cheyenne Wells	80810	4,979	8,297	16,594
CO	Clear Creek	Idaho Springs	80452	4,587	7,644	15,285
CO	Conejos	Manassa	81141	5,160	8,602	17,197
CO	Costilla	San Luis	81152	5,302	8,836	17,669
CO	Crowley	Ordway	81034	5,013	8,358	16,713
CO	Custer	Westcliffe	81252	4,960	8,265	16,527
CO	Delta	Delta	81416	4,897	8,160	16,321
CO	Denver	Denver	80202	4,795	7,991	15,978
CO	Dolores	Dove Creek	81324	5,158	8,595	17,187
CO	Douglas	Castle Rock	80104	4,833	8,055	16,106
CO	Eagle	Gypsum	81637	4,652	7,751	15,500
CO	El Paso	Colorado Springs	80902	4,912	8,188	16,371
CO	Elbert	Elizabeth	80107	4,878	8,132	16,259
CO	Fremont	Canon City	81212	4,968	8,279	16,554
CO	Garfield	Rifle	81650	4,717	7,859	15,720
CO	Gilpin	Central City	80427	4,646	7,744	15,488
CO	Grand	Granby	80446	4,451	7,419	14,833
CO	Gunnison	Gunnison	81230	4,962	8,271	16,536
CO	Hinsdale	Lake City	81235	4,657	7,762	15,520
CO	Huerfano	Walsenburg	81089	5,095	8,495	16,984
CO	Jackson	Walden	80480	4,391	7,318	14,629
CO	Jefferson	Arvada	80002	4,559	7,599	15,195
CO	Kiowa	Eads	81036	5,071	8,453	16,897
CO	Kit Carson	Burlington	80807	4,877	8,128	16,253
CO	La Plata	Durango	81301	5,077	8,460	16,915
CO	Lake	Leadville	80461	4,810	8,017	16,028
CO	Larimer	Fort Collins	80521	4,443	7,405	14,806
CO	Las Animas	Trinidad	81082	5,032	8,387	16,770
CO	Lincoln	Limon	80828	4,949	8,247	16,488
CO	Logan	Sterling	80751	4,625	7,710	15,414
CO	Mesa	Grand Junction	81501	4,812	8,023	16,042
CO	Mineral	Creede	81130	5,089	8,484	16,960
CO	Moffat	Craig	81625	4,567	7,615	15,225
CO	Montezuma	Cortez	81321	5,045	8,406	16,813
CO	Montrose	Montrose	81401	4,844	8,070	16,136
CO	Morgan	Fort Morgan	80701	4,731	7,885	15,767
CO	Otero	La Junta	81050	5,082	8,472	16,941

State	County	Major City	Zip Code	3 kW	5 kW	10 kW
CO	Ouray	Ridgway	81432	4,515	7,527	15,049
CO	Park	Fairplay	80440	5,225	8,711	17,413
CO	Phillips	Holyoke	80734	4,684	7,809	15,614
CO	Pitkin	Aspen	81611	4,618	7,697	15,391
CO	Prowers	Lamar	81052	4,994	8,326	16,648
CO	Pueblo	Pueblo	81001	5,016	8,357	16,708
CO	Rio Blanco	Meeker	81641	4,631	7,721	15,435
CO	Rio Grande	Del Norte	81132	5,174	8,620	17,234
CO	Routt	Steamboat Springs	80487	4,299	7,165	14,328
CO	Saguache	Saguache	81149	5,194	8,658	17,312
CO	San Juan	Silverton	81433	4,644	7,739	15,469
CO	San Miguel	Telluride	81435	4,868	8,110	16,216
CO	Sedgwick	Julesburg	80737	4,656	7,764	15,519
CO	Summit	Silverthorne	80498	4,621	7,701	15,399
CO	Teller	Woodland Park	80863	4,842	8,070	16,136
CO	Washington	Akron	80720	4,850	8,084	16,162
CO	Weld	Greeley	80631	4,682	7,805	15,607
CO	Yuma	Yuma	80759	4,766	7,944	15,883
NM	Bernalillo	Albuquerque	87101	5,359	8,934	17,864
NM	Catron	Reserve	87830	5,173	8,620	17,239
NM	Chaves	Roswell	88201	5,301	8,835	17,667
NM	Cibola	Grants	87020	5,327	8,876	17,749
NM	Colfax	Raton	87740	5,207	8,680	17,354
NM	Curry	Clovis	88101	5,274	8,793	17,582
NM	De Baca	Fort Sumner	88119	5,379	8,968	17,928
NM	Dona Ana	Las Cruces	88001	5,499	9,167	18,333
NM	Eddy	Carlsbad	88220	5,314	8,856	17,710
NM	Grant	Silver City	88061	5,324	8,873	17,744
NM	Guadalupe	Santa Rosa	88435	5,371	8,952	17,900
NM	Harding	Roy	87743	5,375	8,960	17,917
NM	Hidalgo	Lordsburg	88045	5,594	9,322	18,642
NM	Lea	Hobbs	88240	5,354	8,924	17,848
NM	Lincoln	Ruidoso	88345	5,169	8,615	17,226
NM	Los Alamos	Los Alamos	87544	5,163	8,605	17,208
NM	Luna	Deming	88030	5,599	9,334	18,661
NM	Mckinley	Gallup	87301	5,327	8,881	17,757
NM	Mora	Wagon Mound	87752	5,250	8,750	17,495
NM	Otero	Alamogordo	88310	5,340	8,899	17,795
NM	Quay	Tucumcari	88401	5,316	8,859	17,718
NM	Rio Arriba	Espanola	87532	5,167	8,610	17,220
NM	Roosevelt	Portales	88130	5,279	8,800	17,598

State	County	Major City	Zip Code	3 kW	5 kW	10 kW
NM	San Juan	Farmington	87401	5,288	8,811	17,622
NM	San Miguel	Las Vegas	87701	5,288	8,814	17,620
NM	Sandoval	Rio Rancho	87124	5,321	8,870	17,737
NM	Santa Fe	Santa Fe	87501	5,306	8,843	17,684
NM	Sierra	Truth Or Consequences	87901	5,450	9,084	18,159
NM	Socorro	Socorro	87801	5,346	8,909	17,815
NM	Taos	Taos	87571	5,083	8,471	16,938
NM	Torrance	Moriarty	87035	5,373	8,955	17,904
NM	Union	Clayton	88415	5,252	8,754	17,503
NM	Valencia	Los Lunas	87031	5,317	8,860	17,717
OR	Baker	Baker City	97814	4,053	6,755	13,506
OR	Benton	Corvallis	97330	3,671	6,117	12,231
OR	Clackamas	Portland	97222	3,329	5,547	11,093
OR	Clatsop	Astoria	97103	3,200	5,332	10,665
OR	Columbia	Saint Helens	97051	3,209	5,352	10,701
OR	Coos	Coquille	97423	3,608	6,010	12,023
OR	Crook	Prineville	97754	4,301	7,167	14,333
OR	Curry	Gold Beach	97444	3,946	6,575	13,149
OR	Deschutes	Bend	97701	4,472	7,453	14,903
OR	Douglas	Roseburg	97470	3,566	5,944	11,887
OR	Gilliam	Condon	97823	4,286	7,142	14,281
OR	Grant	Canyon City	97820	4,090	6,815	13,629
OR	Harney	Burns	97720	4,441	7,403	14,801
OR	Hood River	Hood River	97031	3,876	6,457	12,914
OR	Jackson	Medford	97501	4,112	6,853	13,705
OR	Jefferson	Madras	97741	4,314	7,190	14,376
OR	Josephine	Grants Pass	97526	3,974	6,623	13,245
OR	Klamath	Klamath Falls	97601	4,660	7,768	15,534
OR	Lake	Lakeview	97630	4,589	7,646	15,288
OR	Lane	Eugene	97401	3,562	5,936	11,872
OR	Lincoln	Newport	97365	3,498	5,831	11,660
OR	Linn	Albany	97321	3,638	6,064	12,128
OR	Malheur	Ontario	97914	4,329	7,215	14,429
OR	Marion	Salem	97301	3,568	5,947	11,893
OR	Morrow	Heppner	97836	4,138	6,896	13,790
OR	Multnomah	Portland	97201	3,375	5,625	11,247
OR	Polk	Dallas	97338	3,674	6,123	12,249
OR	Sherman	Moro	97039	4,296	7,160	14,317
OR	Tillamook	Tillamook	97141	3,352	5,585	11,170
OR	Umatilla	Hermiston	97838	4,089	6,815	13,624

State	County	Major City	Zip Code	3 kW	5 kW	10 kW
OR	Union	La Grande	97850	3,962	6,602	13,201
OR	Wallowa	Enterprise	97828	3,977	6,629	13,254
OR	Wasco	The Dalles	97058	3,998	6,663	13,325
OR	Washington	Hillsboro	97123	3,433	5,721	11,440
OR	Wheeler	Fossil	97830	4,238	7,060	14,117
OR	Yamhill	Mcminnville	97128	4,118	6,864	13,723
WA	Adams	Othello	99344	4,118	6,865	13,731
WA	Asotin	Clarkston	99403	3,749	6,248	12,490
WA	Benton	Kennewick	99337	4,154	6,923	13,845
WA	Chelan	Wenatchee	98801	3,981	6,636	13,268
WA	Clallam	Port Angeles	98362	3,361	5,601	11,200
WA	Clark	Vancouver	98662	3,373	5,617	11,233
WA	Columbia	Dayton	99328	4,079	6,797	13,591
WA	Cowlitz	Longview	98632	3,200	5,333	10,663
WA	Douglas	East Wenatchee	98802	3,981	6,636	13,268
WA	Ferry	Republic	99166	3,590	5,983	11,964
WA	Franklin	Pasco	99301	4,061	6,767	13,533
WA	Garfield	Pomeroy	99347	4,054	6,759	13,514
WA	Grant	Moses Lake	98837	4,109	6,843	13,683
WA	Grays Harbor	Aberdeen	98520	3,083	5,143	10,281
WA	Island	Oak Harbor	98277	3,414	5,687	11,374
WA	Jefferson	Port Townsend	98368	3,003	5,005	10,013
WA	King	Seattle	98101	3,282	5,467	10,938
WA	Kitsap	Bremerton	98310	3,256	5,430	10,857
WA	Kittitas	Ellensburg	98926	4,077	6,793	13,583
WA	Klickitat	Goldendale	98620	4,268	7,111	14,217
WA	Lewis	Centralia	98531	3,111	5,183	10,364
WA	Lincoln	Davenport	99122	3,951	6,589	13,176
WA	Mason	Shelton	98584	3,202	5,339	10,673
WA	Okanogan	Omak	98841	3,866	6,441	12,880
WA	Pacific	Raymond	98577	3,107	5,179	10,355
WA	Pend Oreille	Newport	99156	3,484	5,089	11,612
WA	Pierce	Tacoma	98402	3,270	5,450	10,899
WA	San Juan	Friday Harbor	98250	3,475	5,793	11,591
WA	Skagit	Mount Vernon	98273	3,067	5,113	10,224
WA	Skamania	Stevenson	98648	3,325	5,543	11,081
WA	Snohomish	Everett	98201	3,164	5,274	10,546
WA	Spokane	Spokane	99201	3,773	6,286	12,571
WA	Stevens	Colville	99114	3,492	5,280	11,633
WA	Thurston	Olympia	98506	3,170	5,282	10,562

State	County	Major City	Zip Code	3 kW	5 kW	10 kW
WA	Wahkiakum	Cathlamet	98612	3,084	5,141	10,283
WA	Walla Walla	Walla Walla	99362	3,789	6,315	12,626
WA	Whatcom	Bellingham	98225	3,171	5,283	10,565
WA	Whitman	Pullman	99163	3,914	6,524	13,046
WA	Yakima	Yakima	98901	4,138	6,894	13,783

Source: National Renewable Energy Laboratory (NREL). 2024. *NREL's PVWatts® Calculator*. Version 8.4.0. Accessed December 2024. https://pvwatts.nrel.gov/index.php.

kW = kilowatt; PV = photovoltaic

[1]Default inputs for system information were used to run the simulation.

Table E-14.1. Oregon Woodstove and Fireplace Inventory

		Wood Stoves					Fireplaces[1]				Wood Stoves					Fireplaces[1]	
Housing Type	Location	Conventional (E_1)	Catalytic (E_2)	Non-catalytic (E_3)	Pellet (E_4)	Wood Mass (lb/yr) (G)	Wood (F_1)	Wood Mass (lb/yr) (H)	Housing Type	Location	Conventional (E_1)	Catalytic (E_2)	Non-catalytic (E_3)	Pellet (E_4)	Wood Mass (lb/yr) (G)	Wood (F_1)	Wood Mass (lb/yr) (H)
S	Baker County	5%	7%	7%	2%	7,225	3.8%	4,362	M	Baker County	0.05%	0.07%	0.07%	0.002%	7,225	0.2%	4,362
S	Benton County	3%	4%	4%	1%	6,738	4.1%	4,602	M	Benton County	0.17%	0.22%	0.22%	0.024%	6,738	1.0%	4,602
S	Clackamas County	3%	5%	5%	1%	6,108	5.5%	3,940	M	Clackamas County	0.12%	0.16%	0.16%	0.013%	6,108	0.7%	3,940
S	Clatsop County	4%	5%	5%	2%	7,561	3.6%	4,904	M	Clatsop County	0.12%	0.16%	0.16%	0.014%	7,561	0.6%	4,904
S	Columbia County	5%	6%	6%	2%	7,394	4.4%	4,442	M	Columbia County	0.06%	0.08%	0.08%	0.007%	7,394	0.3%	4,442
S	Coos County	4%	6%	6%	2%	7,352	4.2%	4,599	M	Coos County	0.08%	0.10%	0.10%	0.014%	7,352	0.4%	4,599
S	Crook County	5%	6%	7%	2%	6,929	4.3%	4,179	M	Crook County	0.05%	0.06%	0.06%	0.006%	6,929	0.2%	4,179
S	Curry County	5%	6%	6%	2%	7,689	3.7%	4,877	M	Curry County	0.07%	0.09%	0.09%	0.013%	7,689	0.4%	4,877
S	Deschutes County	4%	5%	5%	2%	6,433	4.8%	3,938	M	Deschutes County	0.09%	0.11%	0.12%	0.009%	6,433	0.5%	3,938
S	Douglas County	5%	6%	6%	2%	7,474	4.2%	4,564	M	Douglas County	0.06%	0.09%	0.09%	0.008%	7,474	0.3%	4,564
S	Gilliam County	6%	8%	8%	3%	7,632	2.9%	5,106	M	Gilliam County	0.02%	0.03%	0.03%	0%	7,632	0.1%	5,106
S	Grant County	6%	8%	8%	3%	7,635	2.9%	5,121	M	Grant County	0.03%	0.04%	0.04%	0%	7,635	0.1%	5,121
S	Harney County	6%	8%	8%	2%	7,668	2.7%	5,294	M	Harney County	0.05%	0.07%	0.07%	0%	7,668	0.2%	5,294
S	Hood River County	4%	6%	6%	2%	7,256	4.4%	4,394	M	Hood River County	0.08%	0.10%	0.10%	0.008%	7,256	0.4%	4,394
S	Jackson County	4%	5%	5%	1%	6,610	5.0%	4,129	M	Jackson County	0.12%	0.15%	0.16%	0.014%	6,610	0.7%	4,129
S	Jefferson County	5%	7%	7%	2%	7,469	3.2%	4,969	M	Jefferson County	0.05%	0.07%	0.07%	0.012%	7,469	0.3%	4,969
S	Josephine County	5%	6%	6%	2%	7,253	4.6%	4,300	M	Josephine County	0.07%	0.09%	0.09%	0.007%	7,253	0.4%	4,300
S	Klamath County	4%	6%	6%	2%	6,588	4.7%	3,993	M	Klamath County	0.07%	0.09%	0.09%	0.011%	6,588	0.4%	3,993
S	Lake County	6%	8%	8%	2%	7,287	3.8%	4,440	M	Lake County	0.03%	0.04%	0.04%	0.003%	7,287	0.1%	4,440
S	Lane County	3%	4%	4%	1%	6,253	5.0%	4,075	M	Lane County	0.14%	0.18%	0.19%	0.009%	6,253	0.8%	4,075
S	Lincoln County	4%	6%	6%	2%	7,608	3.5%	5,083	M	Lincoln County	0.09%	0.12%	0.12%	0.022%	7,608	0.5%	5,083
S	Linn County	4%	5%	6%	2%	7,123	4.4%	4,400	M	Linn County	0.10%	0.13%	0.14%	0.011%	7,123	0.6%	4,400
S	Malheur County	4%	6%	6%	2%	6,963	3.8%	4,471	M	Malheur County	0.08%	0.10%	0.10%	0.015%	6,963	0.4%	4,471
S	Marion County	3%	4%	4%	1%	5,985	5.4%	3,925	M	Marion County	0.14%	0.18%	0.18%	0.008%	5,985	0.8%	3,925
S	Morrow County	5%	7%	7%	2%	7,477	3.2%	4,925	M	Morrow County	0.04%	0.06%	0.06%	0.005%	7,477	0.2%	4,925
S	Multnomah County	2%	3%	3%	1%	4,596	5.4%	3,790	M	Multnomah County	0.21%	0.28%	0.28%	0.003%	4,596	1.2%	3,790
S	Polk County	4%	5%	5%	1%	6,355	5.2%	4,012	M	Polk County	0.12%	0.16%	0.17%	0.013%	6,355	0.7%	4,012
S	Sherman County	6%	8%	8%	3%	7,648	2.8%	5,187	M	Sherman County	0.04%	0.05%	0.05%	0%	7,648	0.1%	5,187
S	Tillamook County	5%	7%	7%	2%	8,057	3.1%	5,298	M	Tillamook County	0.07%	0.09%	0.09%	0.004%	8,057	0.3%	5,298
S	Umatilla County	4%	6%	6%	2%	6,791	4.2%	4,187	M	Umatilla County	0.10%	0.13%	0.13%	0.012%	6,791	0.5%	4,187
S	Union County	5%	6%	6%	2%	7,013	4.0%	4,289	M	Union County	0.09%	0.11%	0.11%	0.007%	7,013	0.5%	4,289
S	Wallowa County	6%	8%	8%	3%	7,651	2.8%	5,205	M	Wallowa County	0.04%	0.05%	0.05%	0.000%	7,651	0.1%	5,205
S	Wasco County	5%	6%	6%	2%	6,939	4.1%	4,257	M	Wasco County	0.09%	0.11%	0.12%	0.017%	6,939	0.5%	4,257

S	Washington County	3%	3%	3%	1%	5,085	5.5%	3,848	M	Washington County	0.19%	0.25%	0.25%	0.010%	5,085	1.1%	3,848
S	Wheeler County	7%	9%	9%	3%	7,609	3.1%	4,986	M	Wheeler County	0.01%	0.01%	0.01%	0%	7,609	0.02%	4,986
S	Yamhill County	4%	5%	5%	2%	6,844	4.7%	4,233	M	Yamhill County	0.10%	0.13%	0.14%	0.008%	6,844	0.6%	4,233
S	Statewide	3%	4%	5%	1%	6,277	5.0%	4,043	M	Statewide	0.14%	0.18%	0.18%	0.009%	6,277	0.8%	4,043

Source: Oregon Department of Environmental Quality 2025. Excel database of appliance usage and inventory statistics, provided to ICF in February 2025.

M = multi-family housing; S = single-family housing; lb = pound; yr = year; hr = hour

[1]Percent of du with natural gas and propane fireplaces not available.

Table E-14.2. Woodstove and Fireplace Emission Factors (pound per ton of dry wood burned, unless noted)

Type	TOG	ROG	CO	SO2	NOx	PM_{10}	$PM_{2.5}$	CO2 (BIO)	CO2 (NBIO)	CH4	N2O	CO_2e
Woodstoves Conventional	83	53	230.8	0.4	2.8	30.6	30.6	2,952	0	64.0	0	4,744
Woodstoves Catalytic	26.6	11.2	92.3	0.3	1.5	15.2	1.52	2,952	0	19.4	0	3,495
Woodstoves Noncatalytic	28	8.9	122.6	0.3	1.7	14.5	14.5	2,952	0	21.0	0	3,540
Woodstoves Pellet	—	2.2	15.9	0.3	3.8	3.06	3.06	2,952	0	0.25	0	2,959
Wood Fireplace	—	18.9	149	0.4	2.6	23.6	23.6	3,400	0	14.4	0.3	3,883
Natural Gas Fireplace (lb/mmBTU)	0.0108	0.0054	0.0392	0.0006	0.0922	0.0075	0.0075	0	11	0.0022	0.0002	117.1
Propane Fireplace (lb/mmBTU)	0.0109	0.0109	0.0820	0.0000	0.1421	0.0077	0.0077	0	135	0.0066	0.0013	136.1

Sources: Abt Associates. 2016. "Residential Wood Combustion: Documentation for EPA's Nonpoint Emissions Estimation Tool." Prepared for the U.S. Environmental Protection Agency. October 2016.

U.S. Environmental Protection Agency (U.S. EPA). 1996a. "Section 1.10 Residential Wood Stoves" in *AP-42*. October 1996. Accessed February 2025. https://www.epa.gov/sites/default/files/2020-09/documents/1.10_residential_wood_stoves.pdf.

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U.S. Environmental Protection Agency (U.S. EPA). 1998. "Section 1.4 Natural Gas Combustion" in *AP-42*. July 1998. Accessed February 2025. https://www.epa.gov/sites/default/files/2020-09/documents/1.4_natural_gas_combustion.pdf.

U.S. Environmental Protection Agency (U.S. EPA). 2020. *Emission Factors for Greenhouse Gas Inventories*. March 2020. Accessed March 2021. https://www.epa.gov/sites/production/files/2020-04/documents/ghg-emission-factors-hub.pdf.

TOG = total organic gases; ROG = reactive organic gases; CO = carbon monoxide; SO_2 = sulfur dioxide; NOx = nitrogen oxides; PM_{10} = particulate matter less than or equal to 10 microns; $PM_{2.5}$ = particulate matter less than or equal to 10 microns; CO_2 = carbon dioxide; CH_4 = methane; N_2O = nitrous oxide; BIO = biogenic; NBIO = non-biogenic; lb = pound; mmBTU = 1 million British Thermal Units

Table E-15.1. Residential Energy Consumption Intensities for Natural Gas End Uses That May Be Electrified by Housing Type and U.S. EIA Census Region/Division and Climate Zone

		Electricity (kWh/unit/year)						Natural Gas (therm/unit/year)						
U.S EIA Area[1]	Housing Type	Space heating[2]	Water heating	Clothes dryers	Cooking[3]	Hot tub heaters	Other[4]	Space heating[2]	Water heating	Clothes dryers	Cooking[3]	Pool heat	Hot tub heat	Other[4]
Census Region/ Division														
West	Single-family detached	978	1,000	432	182	89	720	244	165	6	13	8	1	12
	Single-family attached	667	681	295	124	61	491	202	136	5	11	6	1	10
	Apartments in buildings with 2–4 units	524	535	231	97	48	385	159	108	4	8	5	1	8
	Apartments in buildings with 5 or more units	480	490	212	89	44	353	66	44	2	3	2	<1	3
	Mobile homes	982	1,003	433	183	89	722	69	47	2	4	2	<1	3
Mountain	Single-family detached	981	1,044	599	229	102	841	385	167	4	10	10	1	13
	Single-family attached	669	712	408	156	69	573	318	138	3	8	9	1	11
	Apartments in buildings with 2–4 units	525	559	320	123	55	450	251	109	3	7	7	1	9
	Apartments in buildings with 5 or more units	481	512	294	112	50	412	104	45	1	3	3	<1	4
	Mobile homes	984	1,048	601	230	102	843	109	47	1	3	3	<1	4
Mountain North	Single-family detached	1,144	915	661	254	127	712	576	209	3	9	Q	Q	21
	Single-family attached	780	624	450	173	87	485	477	173	3	8	Q	Q	17

		Electricity (kWh/unit/year)						Natural Gas (therm/unit/year)						
U.S EIA Area[1]	Housing Type	Space heating[2]	Water heating	Clothes dryers	Cooking[3]	Hot tub heaters	Other[4]	Space heating[2]	Water heating	Clothes dryers	Cooking[3]	Pool heat	Hot tub heat	Other[4]
	Apartments in buildings with 2–4 units	612	490	354	136	68	381	376	136	2	6	Q	Q	14
	Apartments in buildings with 5 or more units	561	449	324	125	62	349	156	56	1	3	Q	Q	6
	Mobile homes	1,147	918	663	255	127	714	164	59	1	3	Q	Q	6
Mountain South	Single-family detached	817	1,174	536	204	77	944	192	124	4	11	14	2	15
	Single-family attached	557	800	365	139	52	644	159	103	4	9	12	1	13
	Apartments in buildings with 2–4 units	437	628	287	109	41	505	125	81	3	7	9	1	10
	Apartments in buildings with 5 or more units	401	576	263	100	38	463	52	34	1	3	4	<1	4
	Mobile homes	820	1,178	538	205	77	948	54	35	1	3	4	<1	4
Pacific	Single-family detached	977	971	349	159	89	679	173	164	8	14	6	1	11
	Single-family attached	666	662	238	108	61	463	143	136	6	12	5	1	9
	Apartments in buildings with 2–4 units	523	519	187	85	48	363	113	107	5	9	4	1	7
	Apartments in buildings with 5 or more units	479	476	171	78	44	333	47	44	2	4	2	<1	3
	Mobile homes	980	974	350	159	89	681	49	47	2	4	2	<1	3
Climate Zone														
Very cold and Cold	Single-family detached	1,415	1,091	497	210	80	613	516	137	5	10	5	<1	7
	Single-family attached	964	744	339	143	55	418	427	113	4	9	4	<1	6
	Apartments in buildings with 2–4 units	757	584	266	112	43	328	337	89	3	7	3	<1	5
	Apartments in buildings with 5 or more units	694	535	244	103	39	301	139	37	1	3	1	<1	2
	Mobile homes	1,419	1,095	499	211	80	615	147	39	1	3	1	<1	2
Mixed-dry and Hot-dry	Single-family detached	476	655	343	140	55	600	157	165	8	15	11	1	16
	Single-family attached	324	446	234	96	37	409	130	136	7	12	9	1	13
	Apartments in buildings with 2–4 units	255	350	184	75	29	321	103	108	5	10	7	1	10
	Apartments in buildings with 5 or more units	233	321	168	69	27	295	42	44	2	4	3	<1	4
	Mobile homes	477	657	344	141	55	602	45	47	2	4	3	<1	4
Marine	Single-family detached	1,760	1,624	444	205	120	837	201	150	5	12	Q	1	9
	Single-family attached	1,200	1,107	303	140	82	571	167	124	4	10	Q	1	8
	Apartments in buildings with 2–4 units	942	869	238	110	64	448	132	98	3	8	Q	<1	6
	Apartments in buildings with 5 or more units	864	797	218	101	59	411	54	41	1	3	Q	<1	3
	Mobile homes	1,766	1,629	446	206	120	840	57	43	1	3	Q	<1	3

Sources: U.S. Energy Information Administration (EIA). *Residential Energy Consumption Survey (RECS)*. Table CE2.1: Annual household site fuel consumption in the U.S.—totals and averages, 2020. Table CE5.1a: Detailed household site electricity end-use consumption, part 1—totals, 2020. Table CE5.1b: Detailed household site electricity end-use consumption, part 2—totals, 2020. Table CE5.2: Detailed household natural gas and propane end-use consumption—totals, 2020. Accessed January 2025. https://www.eia.gov/consumption/residential/data/2020/.

yr = year; yr = year; KSF = thousand square feet

Notes: End-use consumption data by housing type and geographic zone were calculated by combining dataset from the RECS. The method includes applying some national averages to regional data. Refer to the Measure E-15 factsheet for additional information.

Q = Data withheld in the RECS because 1) the relative standard error was greater than 50%, 2) the reporting sample had fewer than 20 buildings, or 3) value rounded to zero in the units displayed.

[1] See Figure E-2.1 for map of U.S. census regions/division and climate zones.

[2] Includes main (primary) and secondary space heating.

[3] Includes ranges (units with both a cooktop and an oven), separate cooktops, and separate ovens. Microwaves, small kitchen appliances, and outdoor cooking are excluded.

[4] Difference between total consumption per unit and the sum of consumption across the RECS end-use categories.

Table E-15.2. Non-Residential Energy Consumption Intensities for Natural Gas End Uses That May Be Electrified by Principal Building Activity and U.S. EIA Census Region/Division and Climate Zone

		Electricity (kWh/KSF/year)				Natural Gas (therm/KSF/year)			
U.S. EIA Area[1]	Principal Building Activity	Space heating	Water heating	Cooking	Other[2]	Space heating	Water heating	Cooking	Other[2]
Census Region/ Division									
West	Education	398	199	199	2,308	130	33	58	6
	Food sales	Q	Q	Q	Q	Q	Q	Q	Q
	Food service	1,596	798	798	9,259	632	161	285	31
	Health care	958	479	479	5,556	318	81	143	16
	Inpatient	1,303	652	652	7,559	498	127	225	25
	Outpatient	654	327	327	3,795	125	32	56	6
	Lodging	573	287	287	3,326	226	58	102	11
	Mercantile	750	375	375	4,348	219	56	99	11
	Retail (other than mall)	549	274	274	3,181	133	34	60	7
	Enclosed and strip malls	858	429	429	4,974	258	66	116	13
	Office	541	270	270	3,137	111	28	50	5
	Public assembly	406	203	203	2,357	198	50	89	10
	Public order and safety	534	267	267	3,096	210	53	95	10
	Religious worship	197	99	99	1,145	99	25	45	5
	Service	323	162	162	1,876	234	60	106	12
	Warehouse and storage	233	116	116	1,350	61	15	27	3
	Other	1,930	965	965	11,194	Q	Q	Q	Q
	Vacant	Q	Q	Q	Q	Q	Q	Q	Q
Mountain	Education	470	188	282	1,882	171	32	66	5
	Food sales	Q	Q	Q	Q	Q	Q	Q	Q
	Food service	2,005	802	1,203	8,020	766	143	297	22
	Health care	1,042	417	625	4,169	369	69	143	11
	Inpatient	Q	Q	Q	Q	Q	Q	Q	Q
	Outpatient	650	260	390	2,599	Q	Q	Q	Q
	Lodging	700	280	420	2,800	305	57	119	9
	Mercantile	842	337	505	3,368	240	45	93	7
	Retail (other than mall)	654	262	393	2,618	185	35	72	5
	Enclosed and strip malls	1,030	412	618	4,121	276	52	107	8
	Office	659	264	395	2,635	122	23	48	4
	Public assembly	554	222	332	2,216	301	56	117	9
	Public order and safety	Q	Q	Q	Q	Q	Q	Q	Q
	Religious worship	Q	Q	Q	Q	Q	Q	Q	Q
	Service	342	137	205	1,367	Q	Q	Q	Q
	Warehouse and storage	307	123	184	1,228	150	28	58	4
	Other	Q	Q	Q	Q	Q	Q	Q	Q
	Vacant	Q	Q	Q	Q	Q	Q	Q	Q
Pacific	Education	344	206	138	2,615	92	32	50	6

U.S. EIA Area[1]	Principal Building Activity	Electricity (kWh/KSF/year)				Natural Gas (therm/KSF/year)			
		Space heating	Water heating	Cooking	Other[2]	Space heating	Water heating	Cooking	Other[2]
	Food sales	Q	Q	Q	Q	Q	Q	Q	Q
	Food service	1,317	790	527	10,008	492	170	270	33
	Health care	872	523	349	6,627	274	95	150	18
	Inpatient	1,088	653	435	8,266	415	144	228	28
	Outpatient	643	386	257	4,883	113	39	62	8
	Lodging	486	291	194	3,690	159	55	87	11
	Mercantile	653	392	261	4,962	194	67	106	13
	Retail (other than mall)	480	288	192	3,650	78	27	43	5
	Enclosed and strip malls	735	441	294	5,582	235	81	129	16
	Office	459	275	183	3,486	99	34	54	7
	Public assembly	319	191	128	2,425	128	44	70	9
	Public order and safety	451	270	180	3,424	Q	Q	Q	Q
	Religious worship	138	83	55	1,047	86	30	47	6
	Service	302	181	121	2,292	Q	Q	Q	Q
	Warehouse and storage	192	115	77	1,461	27	9	15	2
	Other	Q	Q	Q	Q	Q	Q	Q	Q
	Vacant	Q	Q	Q	Q	Q	Q	Q	Q
Climate Zone									
Cold or very cold	Education	629	90	270	2,337	324	19	33	10
	Food sales	Q	Q	Q	Q	Q	Q	Q	Q
	Food service	2,457	351	1,053	9,125	Q	Q	Q	Q
	Health care	1,962	280	841	7,289	657	39	66	20
	Inpatient	Q	Q	Q	Q	Q	Q	Q	Q
	Outpatient	Q	Q	Q	Q	Q	Q	Q	Q
	Lodging	967	138	414	3,592	458	27	46	14
	Mercantile	976	139	418	3,625	339	20	34	10
	Retail (other than mall)	797	114	341	2,959	258	15	26	8
	Enclosed and strip malls	Q	Q	Q	Q	Q	Q	Q	Q
	Office	900	129	386	3,342	235	14	24	7
	Public assembly	925	132	396	3,435	412	25	42	12
	Public order and safety	Q	Q	Q	Q	Q	Q	Q	Q
	Religious worship	Q	Q	Q	Q	Q	Q	Q	Q
	Service	549	78	235	2,040	478	28	48	14
	Warehouse and storage	356	51	153	1,322	260	15	26	8
	Other	Q	Q	Q	Q	Q	Q	Q	Q
	Vacant	Q	Q	Q	Q	Q	Q	Q	Q
Cool	Education	547	156	182	1,902	304	27	56	14
	Food sales	3,159	902	1,053	10,980	602	54	110	27
	Food service	2,518	719	839	8,752	1583	143	290	71

U.S. EIA Area[1]	Principal Building Activity	Electricity (kWh/KSF/year)				Natural Gas (therm/KSF/year)			
		Space heating	Water heating	Cooking	Other[2]	Space heating	Water heating	Cooking	Other[2]
	Health care	1,650	471	550	5,735	437	39	80	20
	Inpatient	2,048	585	683	7,119	576	52	106	26
	Outpatient	1,042	298	347	3,622	231	21	42	10
	Lodging	1,055	301	352	3,667	310	28	57	14
	Mercantile	1,154	330	385	4,013	358	32	66	16
	Retail (other than mall)	896	256	299	3,116	198	18	36	9
	Enclosed and strip malls	1,405	402	468	4,886	474	43	87	21
	Office	891	255	297	3,099	201	18	37	9
	Public assembly	657	188	219	2,283	387	35	71	17
	Public order and safety	799	228	266	2,777	288	26	53	13
	Religious worship	195	56	65	677	210	19	38	9
	Service	415	118	138	1,441	279	25	51	13
	Warehouse and storage	350	100	117	1,218	205	18	38	9
	Other	1,581	452	527	5,494	222	20	41	10
	Vacant	327	93	109	1,135	Q	Q	Q	Q
Mixed mild	Education	684	156	187	2,364	258	37	50	17
	Food sales	Q	Q	Q	Q	Q	Q	Q	Q
	Food service	3,470	789	946	11,987	997	144	193	64
	Health care	1,470	334	401	5,078	432	62	84	28
	Inpatient	1,599	363	436	5,523	575	83	111	37
	Outpatient	1,180	268	322	4,076	217	31	42	14
	Lodging	964	219	263	3,330	332	48	64	21
	Mercantile	1,110	252	303	3,835	253	37	49	16
	Retail (other than mall)	882	200	240	3,045	174	25	34	11
	Enclosed and strip malls	1,335	303	364	4,613	324	47	63	21
	Office	975	222	266	3,367	143	21	28	9
	Public assembly	814	185	222	2,811	359	52	69	23
	Public order and safety	1,009	229	275	3,484	253	37	49	16
	Religious worship	451	103	123	1,559	234	34	45	15
	Service	579	132	158	2,000	289	42	56	19
	Warehouse and storage	398	91	109	1,377	142	20	27	9
	Other	2,332	530	636	8,055	276	40	53	18
	Vacant	178	40	48	614	Q	Q	Q	Q
Warm	Education	559	230	230	2,400	105	27	44	10
	Food sales	2,104	866	866	9,035	Q	Q	Q	Q
	Food service	2,511	1,034	1,034	10,782	746	191	311	69
	Health care	1,437	592	592	6,172	342	88	143	31
	Inpatient	1,828	753	753	7,850	442	114	185	41
	Outpatient	1,138	468	468	4,885	160	41	67	15

U.S. EIA Area[1]	Principal Building Activity	Electricity (kWh/KSF/year)				Natural Gas (therm/KSF/year)			
		Space heating	Water heating	Cooking	Other[2]	Space heating	Water heating	Cooking	Other[2]
	Lodging	763	314	314	3,278	171	44	71	16
	Mercantile	935	385	385	4,016	185	48	77	17
	Retail (other than mall)	785	323	323	3,370	104	27	43	10
	Enclosed and strip malls	1,067	440	440	4,584	222	57	93	20
	Office	743	306	306	3,189	108	28	45	10
	Public assembly	755	311	311	3,243	158	41	66	15
	Public order and safety	883	364	364	3,793	217	56	90	20
	Religious worship	266	110	110	1,143	86	22	36	8
	Service	412	170	170	1,770	298	76	124	27
	Warehouse and storage	318	131	131	1,365	65	17	27	6
	Other	1,300	535	535	5,582	105	27	44	10
	Vacant	297	122	122	1,274	Q	Q	Q	Q
Hot or very hot	Education	192	192	256	2,301	41	25	56	11
	Food sales	Q	Q	Q	Q	Q	Q	Q	Q
	Food service	880	880	1,174	10,563	358	218	489	96
	Health care	436	436	581	5,226	215	131	294	58
	Inpatient	582	582	776	6,988	253	154	346	68
	Outpatient	204	204	272	2,448	Q	Q	Q	Q
	Lodging	257	257	343	3,085	82	50	112	22
	Mercantile	316	316	422	3,794	80	49	109	21
	Retail (other than mall)	292	292	389	3,499	68	42	93	18
	Enclosed and strip malls	340	340	453	4,080	84	51	115	23
	Office	267	267	356	3,205	34	21	46	9
	Public assembly	248	248	331	2,980	68	42	94	18
	Public order and safety	Q	Q	Q	Q	Q	Q	Q	Q
	Religious worship	107	107	142	1,278	45	28	62	12
	Service	199	199	266	2,392	Q	Q	Q	Q
	Warehouse and storage	126	126	169	1,517	16	10	22	4
	Other	Q	Q	Q	Q	Q	Q	Q	Q
	Vacant	Q	Q	Q	Q	Q	Q	Q	Q

Sources: U.S. Energy Information Administration (EIA). *Commercial Buildings Energy Consumption Survey (CBECS)*. Table B20: Energy sources, floorspace, 2018. Table E6: Electricity consumption (in kilowatt-hours [kWh]) by end use, 2018. Table E8: Natural gas consumption and conditional energy intensities (in cubic feet) by end use, 2018. Table C25: Natural gas consumption and conditional energy intensity by census region, 2018. Table C29: Natural gas consumption and conditional energy intensity by census division (part 3), 2018. Table C30: Natural gas consumption and conditional energy intensity by climate zone, 2018. Accessed January 2025. https://www.eia.gov/consumption/commercial/data/2018/.

yr = year; yr = year; KSF = thousand square feet

Notes: End-use consumption data by building activity and geographic zone were calculated by combining dataset from the CBECS. The method includes applying some national averages to regional data. Refer to the Measure E-15 factsheet for additional information. See Figure E-2.1 for map of U.S. census regions/division and climate zones.

Q = Data withheld in the CBECS because 1) the relative standard error was greater than 50%, 2) the reporting sample had fewer than 20 buildings, or 3) value rounded to zero in the units displayed.

[1] See Figure E-2.1 for map of U.S. census regions/division and climate zones.

[2] Includes wood, coal, solar, and all other energy sources.

Table E-18.1. Landfill Disposed Organic Carbon (DOC)

Location	Percent Disposed Organic Carbon (DOC)
Colorado[1]	37.1
Oregon[2]	21.6
Washington[3]	16.9
National[4]	31.3

Sources: See footnotes.

[1] Colorado Department of Public Health and Environment. 2018. *Waste Composition of Municipal Solid Waste Disposal*. Accessed February 4, 2025. https://oitco.hylandcloud.com/CDPHERMPop/docpop/docpop.aspx?clienttype=html&docid=3261683.

[2] Oregon Dept. of Environmental Quality. 2025. Excel file provided to ICF with waste disposal rates and waste stream data. February.

[3] Washington State Department of Ecology. 2025. Excel file provided to ICF with waste disposal rates and waste stream data. January.

[4] U.S. EPA. 2020. *Advancing Sustainable Materials Management: 2018* Tables and Figures. December. https://www.epa.gov/sites/default/files/2021-01/documents/2018_ff_fact_sheet_dec_2020_fnl_508.pdf.

Table E-21.1. Available Cool Pavement Maximum Yearly Electricity Savings

EIA Climate Zone[1]	Cooling Savings (kWh/m^2/year)[2]	Additional Heating (therms/m^2/year)[2]
Hot or Very Hot	0.9000	—[3]
Warm	1.0030	0.0069

Sources: Lawrence Berkely National Laboratory (LBNL). 2017a. *Are Cooler Surfaces a Cost-Effect Mitigation of Urban Heat Islands?* April 2017. https://eta-publications.lbl.gov/sites/default/files/cooler_surfaces.pdf.

Lawrence Berkely National Laboratory (LBNL). 2017b. *Energy and Environmental Consequences of a Cool Pavement Campaign.* May 2017. https://eta-publications.lbl.gov/sites/default/files/e-b-cool-pavement-campaign.pdf.

U.S. Energy Information Administration (U.S. EIA). 2025. *Commercial Buildings Energy Consumption Survey (CBECS) Maps.* Accessed February 4, 2025. https://www.eia.gov/consumption/commercial/maps.php.

[1] Users should refer to the EIA climate zone map to see if their project is within one of the applicable zones. See Figure E-2.3.

[2] Values were calculated based on available data from Lawrence Berkely National Laboratory (LBNL) (2017a, 2017b). The LBNL study presents cooling and heating values for nine locations in California. The California locations were mapped to the U.S. EIA climate zones. Average cooling and heating values were then calculated for each of the cross-walked EIA climate zones based on the mapped cities. Note that data are not available for all U.S. EIA climate zones.

[3] Data on potential additional gas consumption for cool pavement installation in the hot or very hot climate zone was not quantified in the LBNL studies. Users could consider applying the gas consumption value for the "warm" climate zone to approximate a minimum increase in heating. However, please note that additional heating requirements for projects in hot or very hot climates may be greater than for projects located in more mild climates.

Table E-26.1. Capacity Factors for Biomass Electricity Generation in the United States

Fuel Type	Capacity Factor[1]
Other Biomass[2]	62%
Wood	59%

Source: U.S. Energy Information Agency (EIA). 2023. Table 6.07.B: "Capacity Factors for Utility Scale Generators Primarily Using Non-Fossil Fuels." *Electric Power Monthly*. Accessed December 2023. https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=table_6_07_b.

[1] Capacity factors are based on an average of the last five years of generation.

[2] Other biomass includes landfill gas, non-biogenic municipal solid waste, sludge waste, biogenic municipal solid waste, black liquor, and agricultural byproducts.

Table E-26.2. Lifecycle Emission Factors for Biomass Electricity Generation in the United States

Fuel Type	Life Cycle GHG Emission Factors (lbs CO_2e/MWh)[1]		
	Mean	Median	Standard Deviation
Dedicated Woody Crops	189.6	114.7	308.7
Dedicated Herbaceous Crops	617.4	119.1	882
Agricultural Residues	573.3	123.5	882
Forest Residues	374.8	79.4	683.6
Urban Residues	904.1	108	859.9
Mill Residues	202.9	33.1	485.1
Animal Wastes & Processing Residues	1,367.1	286.6	859.9
Other Wastes & Residues	132.3	92.6	108

Source: Electric Power Research Institute (EPRI). 2013. *Literature Review and Sensitivity Analysis of Biopower Life-Cycle Assessments and Greenhouse Gas Emissions*. Accessed December 2023. https://www.epri.com/research/products/1026852.

[1] Emission factors exclude the effects of land use change. Use the mean value.

Table E-26.3. Lifecycle Carbon Intensity Factors from GREET (pounds CO_2e per megawatt-hour)

Year	WECC	SPP
2025	651	905
2030	356	324
2035	297	305
2040	242	340
2045	234	343
2050	232	359

Source: U.S. Department of Energy (U.S. DOE). 2024. *The Greenhouse Gases, Regulated Emissions, and Energy Use in Technologies Model*. 2024 Release. Accessed January 28, 2025. https://greet.anl.gov/.

WECC = Western Electricity Coordinating Council; SPP= Southwest Power Pool

Notes: Emission factors are available for two geographies as defined in the U.S. DOE's GREET model—the Western Electricity Coordinating Council (WECC) and Southwest Power Pool (SPP). Arizona, Colorado, Oregon, and Washington are wholly within WECC. New Mexico is split between WECC and SPP. Refer to Figure E-4.2. Emission factors for WECC and SPP are provided in five-year increments between 2025 and 2050. If the analysis year falls within a five-year time period, users should select the earlier time period. For example, if the analysis year is 2037, users should use the emission factor for 2035. Alternatively, users may interpolate an emission factor for their specific analysis year based on the data provided in the table.

Table W-1.1. Water Energy Intensity Factors (Total Supply)

State	Region	kWh per AF
AZ	Statewide	419
AZ	Apache County	296
AZ	Cochise County	358
AZ	Coconino County	370
AZ	Gila County	345
AZ	Graham County	358
AZ	Greenlee County	395
AZ	La Paz County	210
AZ	Maricopa County	444
AZ	Mohave County	382
AZ	Navajo County	370
AZ	Pima County	358
AZ	Pinal County	395
AZ	Santa Cruz County	382
AZ	Yavapai County	333
AZ	Yuma County	432
U.S.	Nationwide	419

Sources: Paraschiv, S., L. Paraschiv, and A. Serban. 2023. "An Overview of Energy Intensity of Drinking Water Production and Wastewater Treatment." *Energy Reports* 9 (11):118-123.

Bartos, M., and C. Mikhail. n.d. Supporting Information for *The Conservation Nexus: Valuing Interdependent Water and Energy Savings in Arizona*. Accessed February 21, 2025. https://pubs.acs.org/doi/suppl/10.1021/es4033343/suppl_file/es4033343_si_001.pdf.

kWh = kilowatt-hours; AF = acre feet

Table W-2.1. Greywater Flows (gallons per day per occupant)

	Source	
Flow Source	Oregon	Uniform Plumbing Code
Showers, bathtubs, and lavatories	35	25
Laundry	23	15

Sources: Oregon Department of Land Conservation. 2025. Email message to ICF with greywater data. February 2025.

Uniform Plumbing Code (UPC). Section 1503.8.1.

Table W-2.2. Wastewater Energy Intensity Factors (kWh per AF)

Location	Wastewater Treatment
Arizona	439
Washington	816
National	530

Sources: Bartos, M. and C. Mikhail. n.d. Supporting Information for *The Conservation Nexus: Valuing Interdependent Water and Energy Savings in Arizona*. Accessed February 21, 2025. https://pubs.acs.org/doi/suppl/10.1021/es4033343/suppl_file/es4033343_si_001.pdf.

Paraschiv, S., L. Paraschiv, and A. Serban. 2023. "An Overview of Energy Intensity of Drinking Water Production and Wastewater Treatment." *Energy Reports* 9 (11):118-123.

Washington State Department of Commerce (WA DOC). 2025. Excel file of wastewater treatment electricity provided to ICF. January 2025.

Table W-4.1. Residential Water Consumption Percentages by End Use

End-Use/Fixture (z)	% of Indoor Water Use[1]
Toilet	24%
Showerhead	19%
Bathroom and Kitchen Faucet	19%
Dishwashers	1%
Clothes Washers	16%
Leaks and Other	18%
Bath	3%

Source: Water Research Foundation. 2016. *Residential End Uses of Water, Version 2*. Accessed January 2021. https://www.waterrf.org/research/projects/residential-end-uses-water-version-2.

[1] Indoor water use percentages calculated based on data from the Water Research Foundation 2016.

Table W-4.2. Non-Residential Water Consumption Percentages by End Use

End-Use/Fixture (z)	Office		Hotel		Restaurant		Grocery Store		Non-Grocery Retail Store		K-12 School		Other School	
	Total[1]	Indoor[2]	Total[1]	Indoor[2]	Total[1]	Indoor[2]	Total[1]	Indoor[2]	Total[1]	Indoor[2]	Total[1]	Indoor[2]	Total[1]	Indoor[2]
Restroom	26%	—	51%	—	34%	—	17%	—	26%	—	20%	—	20%	—
Toilets (72% of Restroom)	—	48%	—	46%	—	27%	—	26%	—	46%	—	51%	—	37%
Urinals (17% of Restroom)	—	11%	—	11%	—	6%	—	6%	—	11%	—	12%	—	9%
Faucets (4% of Restroom)	—	3%	—	3%	—	1%	—	1%	—	3%	—	3%	—	2%
Showers (7% of Restroom)	—	5%	—	4%	—	3%	—	2%	—	4%	—	5%	—	4%
Kitchen	3%	—	10%	—	46%	—	9%	—	4%	—	2%	—	1%	—
Faucets (57% of Kitchen)	—	4%	—	7%	—	29%	—	11%	—	6%	—	4%	—	1%
Dishwashers (24% of Kitchen)	—	2%	—	3%	—	12%	—	5%	—	2%	—	2%	—	1%
Ice Making (19% of Kitchen)	—	1%	—	2%	—	10%	—	4%	—	2%	—	1%	—	0%
Laundry	0%	0%	14%	18%	0%	0%	0%	0%	0%	0%	0%	0%	1%	3%
Other	10%	26%	5%	6%	12%	13%	22%	46%	11%	27%	6%	21%	17%	44%
Landscaping	38%	—	10%	—	6%	—	3%	—	38%	—	72%	—	61%	—
Cooling	23%	—	10%	—	2%	—	49%	—	21%	—	*[3]	—	*[3]	—
Total[4]	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Source: Pacific Institute. 2003. *Waste Not, Want Not: The Potential for Urban Water Conservation in California*. November 2023. https://pacinst.org/wp-content/uploads/2013/02/waste_not_want_not_full_report3.pdf.

[1] Water end-use data from Figures E-1, E-2, E-5, E-6, E-7, E-8, and E-9 of Appendix E of the Pacific Institute report.

[2] Indoor end-use data calculated based on the total water use data for the relevant building category and Figure 4-3 and Figure 4-4 of the Pacific Institute report. Figure 4-3 shows the breakdown of restroom water use by end-use in the commercial and industry sector. Figure 4-4 shows the breakdown of kitchen water-use by end-use in the commercial and industry sector; it was assumed that all end-uses except dishwashing and ice making are associated with faucet water use.

[3] No data.

[4] Totals may not add to 100% due to rounding.

Table W-4.3. Residential Baseline and Reduced Flow Rates by Fixture Type

End-Use/Fixture (z)	Baseline Flow Rate [1]					Reduced Flow Rate [2]	Units
	Arizona	Colorado	New Mexico	Oregon	Washington		
Toilet	1.6	1.28	1.6	1.28 1.6 (remote areas)	1.28	1.28	gal/flush
Showerhead	2.0	2.0	2.5	1.8	1.8	2.0	gal/min @ 80 psi
Bathroom Faucet	2.2	1.5	2.2	1.5	1.2	1.5	gal/min @ 60 psi
Kitchen Faucet	2.2	2.2	2.2	1.8	1.8	—	gal/min @ 60 psi
Dishwashers							
Standard			5.0			3.2	gal/cycle
Compact			3.5			2.0	gal/cycle
Clothes Washers							
Top-loading, Compact			12.0			4.2	gal/cycle/ft^3
Top-loading, Standard			6.5			4.3	gal/cycle/ft^3
Front-loading, Compact			8.3			4.2	gal/cycle/ft^3
Front-loading, Standard			4.7			3.2	gal/cycle/ft^3

Sources: See footnote (1) for state codes.

EnergyStar. 2021. *Clothes Washers Key Product Criteria*. Accessed February 3, 2025. https://www.energystar.gov/products/clothes_washers/key_product_criteria.

EnergyStar. 2023. *Dishwashers Key Product Criteria*. Accessed February 3, 2025. https://www.energystar.gov/products/dishwashers/key_product_criteria.

U.S. Environmental Protection Agency (EPA). 2024. *WaterSense Products*. Last revised November 13, 2024. Accessed February 13, 2025. https://www.epa.gov/watersense/watersense-products.

[1] Flow rates established per the following codes and regulations. Where no state requirement, the minimum federal efficiency standard is shown.

- Arizona = 2024 International Plumbing Code
- Colorado = Senate Bill 14-103 (compliance with EPA WaterSense plumbing fixture)
- New Mexico = 2021 International Plumbing Code
- Oregon = 2023 Oregon Plumbing Specialty Code (OPSC)
- Washington = Chapter 51-56-0400 WAC
- Federal standards for dishwashers and clothes washers (all states) = DOE 10 CFR Part 430

[2] EPA WaterSense for toilet, showerhead, and bathroom faucet. Energy Star for all other fixtures.

Table W-4.4. Non-Residential Baseline and Reduced Flow Rates by Fixture Type

End-Use/Fixture (z)	Baseline Flow Rate [1]					Reduced Flow Rate [2]	Units
	Arizona	Colorado	New Mexico	Oregon	Washington		
Toilet	1.6	1.28	1.6	1.28 1.6 (remote areas)	1.28	1.28	gal/flush
Urinals							
Wall-Mounted	1.0	0.5	1.0	0.5	0.125	0.5	gal/flush
Floor-Mounted	1.0	0.5	1.0	0.5	0.5	0.5	gal/flush
Showerhead	2.0	2.0	2.5	1.8	1.8	2.0	gal/min. @ 80 psi
Bathroom Faucet	0.5	0.5	0.5	0.5	0.5	—	gal/min. @ 60 psi
Kitchen Faucet	2.2	2.2	2.2	2.2	1.8	—	gal/min. @ 60 psi
Dishwashers - High Temperature							
Under Counter			1.1			0.86	gal/rack
Single Tank Door			1.3			0.89	gal/rack
Single Tank Conveyor			0.9			0.7	gal/rack
Multi-Tank Conveyor			1.0			0.54	gal/rack
Dishwashers - Low Temperature							
Under Counter			1.7			1.19	gal/rack
Single Tank Door			2.1			1.18	gal/rack
Single Tank Conveyor			1.3			0.79	gal/rack
Multi-Tank Conveyor			1.0			0.54	gal/rack
Clothes Washer							
Top-loading			8.8			—	gal/cycle/ft^3
Front-loading			4.1			4.00	gal/cycle/ft^3

Sources: See footnote (1) for state codes.

EnergyStar. 2021a. *Commercial Dishwashers Key Product Criteria*. Accessed February 3, 2025. https://www.energystar.gov/products/commercial_food_service_equipment/commercial_dishwashers/key_product_criteria.

EnergyStar. 2021b. *Clothes Washers Key Product Criteria*. Accessed February 3, 2025. https://www.energystar.gov/products/clothes_washers/key_product_criteria.

U.S. Environmental Protection Agency (EPA). 2024. *WaterSense Products*. Last revised November 13, 2024. Accessed February 13, 2025. https://www.epa.gov/watersense/watersense-products.

[1] Flow rates established per the following codes and regulations. Where no state requirement, the minimum federal efficiency standard is shown.

- Arizona = 2024 International Plumbing Code
- Colorado = Senate Bill 14-103 (compliance with EPA WaterSense plumbing fixture)
- New Mexico = 2021 International Plumbing Code
- Oregon = 2023 Oregon Plumbing Specialty Code (OPSC)
- Washington = Chapter 51-56-0400 WAC
- Federal standards for dishwashers (all states) = U.S. EPA and U.S. DOE. Savings Calculator for ENERGY STAR Certified Commercial Kitchen Equipment.
- Federal standards for clothes washers (all states) = DOE 10 CFR Part 431

[2] EPA WaterSense for toilet, urinals, and showerhead. Energy Star for all other fixtures.

Table W-5.1. Annual Average Evapotranspiration (inches per year)

Station[1]	State	Period	Rate (B)	Station[1]	State	Period	Rate (B)
BARTLETT DAM	AZ	1939-2005	117.54	ELEPHANT BUTTE DAM	NM	1917-2005	112.41
BLACK RIVER PUMPS	AZ	1948-2005	50.53	ESTANCIA	NM	1914-2005	55.63
DAVIS DAM # 2	AZ	1958-1977	154.32	FARMINGTON AG SCIENCE C	NM	1978-2005	66.81
DAVIS DAM	AZ	1948-1961	101.53	FLORIDA	NM	1939-1992	99.93
DOUGLAS	AZ	1948-2005	73.63	GALLUP RANGER STN	NM	1966-1975	62.46
FORT VALLEY	AZ	1909-2005	27.52	JEMEZ DAM	NM	1953-2005	82.04
GRAND CANYON NATL PARK	AZ	1957-1977	46.04	JORNADA EXP RANGE	NM	1925-2005	88.82
GRAND CANYON N P 2	AZ	1976-2005	44.04	LAGUNA	NM	1914-2005	63.23
HAWLEY LAKE	AZ	1967-1988	33.17	LAKE AVALON	NM	1914-1979	112.93
MANY FARMS SCHOOL	AZ	1951-1975	90.77	LAKE MC MILLAN	NM	1941-1949	79.51
MC NARY 2 N	AZ	1933-2005	37.56	LOS LUNAS 3 SSW	NM	1923-2005	73.1
MESA	AZ	1896-2005	94.38	NARROWS	NM	1948-1964	104.88
NOGALES 6 N	AZ	1952-2005	91.2	NAVAJO DAM	NM	1963-2005	59.61
PAGE	AZ	1957-2005	80.57	PORTALES 7 WNW	NM	1934-1960	89.13
ROOSEVELT 1 WNW	AZ	1905-2005	96.49	HOOD RANGER STN	NM	1954-2005	56.7
SACATON	AZ	1908-2005	107.42	ROSWELL WSO AIRPORT	NM	1893-1972	75.96
SAFFORD AGRICULTURAL CTR	AZ	1948-2005	97.57	SANTA FE	NM	1867-1972	62.9

Station[1]	State	Period	Rate (B)	Station[1]	State	Period	Rate (B)
SAN CARLOS RESERVOIR	AZ	1948-2005	91.3	SANTA FE 2	NM	1972-2005	60.22
SIERRA ANCHA	AZ	1913-1979	75.39	SHIPROCK	NM	1926-2005	73.16
SNOWFLAKE 15 W	AZ	1965-1998	63.63	SOCORRO	NM	1914-2005	56.44
STEWART MOUNTAIN	AZ	1948-2005	106.23	STATE UNIVERSITY	NM	1959-2005	92.91
TEMPE ASU	AZ	1953-2005	74.29	SUMNER LAKE	NM	1921-2005	92.04
TUCSON UNIV OF ARIZONA	AZ	1894-2005	103.51	TUCUMCARI 4 NE	NM	1904-2005	74.3
TUCSON U OF ARIZ # 1	AZ	1982-2005	111.07	UTE DAM	NM	1965-2005	89.44
WAHWEAP	AZ	1961-2005	100.18	ASTOR EXPERIMENT STN	OR	1948-1973	27.82
WHITERIVER 1 SW	AZ	1900-2005	77.65	BEND 7 NE	OR	1991-2005	39.07
WINKELMAN 6 S	AZ	1942-1980	95.78	CORVALLIS STATE UNIV	OR	1889-2005	38.32
YUMA CITRUS STATION	AZ	1920-2005	99.21	COTTAGE GROVE DAM	OR	1943-2005	38.46
AKRON 4 E	CO	1918-2005	67.69	DETROIT DAM	OR	1954-2005	37.78
ALAMOSA WSO AP	CO	1948-2005	53.91	DORENA DAM	OR	1948-2005	39.00
ARBOLES	CO	1957-1963	47.83	FERN RIDGE DAM	OR	1943-2005	40.7
BONNY LAKE	CO	1949-2005	68.01	HERMISTON 2 S	OR	1928-1997	57.72
CLIMAX	CO	1949-2005	18.53	HOOD RIVER EXP STN	OR	1928-2005	35.51
CONEJOS 3 NNW	CO	1948-1960	48.32	KLAMATH FALLS AGR STN	OR	1949-2004	56.54
ESTES PARK	CO	1948-1994	40.49	LOOKOUT POINT DAM	OR	1955-2005	39.59
FORT COLLINS	CO	1900-2005	41.04	MADRAS 1 NNW	OR	1952-2005	50.97
GRAND JUNCTION WALKER	CO	1900-2005	92.34	MALHEUR BRANCH EXP STN	OR	1943-2005	52.99
GRAND JUNCTION 6 ESE	CO	1962-2005	64.13	VOLTAGE 2 NW	OR	1959-2005	45.41
GRAND LAKE 6 SSW	CO	1948-2005	35.51	MEDFORD EXP STN	OR	1937-2003	41.28
GREEN MOUNTAIN DAM	CO	1948-2005	31.9	MORO	OR	1928-2005	59.64
JOHN MARTIN DAM	CO	1941-2005	74.21	N WILLAMETTE EXP STN	OR	1963-2005	41.44
LAKE GEORGE 8 SW	CO	1948-2005	32.54	ODELL LAKE LAND PAN	OR	1948-1980	19.22
MEREDITH	CO	1963-2005	39.71	ODELL LAKE WATER PAN	OR	1945-1959	18.02
MONTROSE 1	CO	1948-1982	57.45	PELTON DAM	OR	1958-2005	45.32
PLATORO	CO	1949-1991	34.62	PENDLETON BR EXP STN	OR	1956-2005	57.69
PUEBLO WSO AP	CO	1954-2005	66.58	SUMMER LAKE 1 S	OR	1957-2005	53.71
PUEBLO CITY RESERVOIR	CO	1948-1971	74.62	UNION EXP STN	OR	1928-2005	35.34
PUEBLO RESERVOIR	CO	1975-2005	62.67	WARM SPRINGS RESERVOIR	OR	1931-1974	52.9

Station[1]	State	Period	Rate (B)	Station[1]	State	Period	Rate (B)
PUEBLO 6 SSW	CO	1971-1985	64.87	WICKIUP DAM	OR	1941-2005	36.56
SAN LUIS LAKES 3W	CO	1948-1955	56.32	WINCHESTER	OR	1950-2005	30.7
SPRINGFIELD 7 WSW	CO	1956-2002	72.38	WINCHESTER 3 W F STN	OR	1981-1989	45.32
SUGARLOAF RESERVOIR	CO	1948-2005	25.23	BELLINGHAM 2 N	WA	1948-1985	29.09
TRINIDAD LAKE	CO	1989-2005	64.44	BELLINGHAM 3 SSW	WA	1985-2005	22.31
TWIN LAKES RESERVOIR	CO	1949-2005	39.58	BUMPING LAKE	WA	1931-1967	23.88
VALLECITO DAM	CO	1948-2005	37.67	CONNELL 1 W	WA	1960-2003	56.22
WAGON WHEEL GAP 3 N	CO	1948-1972	35.46	ELTOPIA 6 W	WA	1954-1973	48.16
WALSH 1 W	CO	1951-2005	63.82	ELTOPIA 8 WSW	WA	1974-2005	39.82
WIGGINS 7 SW	CO	1960-1971	54.12	LAKE KACHESS	WA	1931-1977	25.41
ABIQUIU DAM	NM	1957-2005	72.13	LIND 3 NE EXP STN	WA	1931-2005	54.69
AGRICULTURAL COLLEGE	NM	1892-1959	93.06	MOSES LAKE 3 E	WA	1943-1979	48.5
ALAMOGORDO DAM	NM	1939-1975	104.86	OROVILLE 1 S	WA	1960-1970	36.58
ANIMAS	NM	1923-2005	100.68	OTHELLO 6 ESE	WA	1941-2002	50.95
ARTESIA 6 S	NM	1914-2005	87.68	PROSSER 4 NE	WA	1931-2005	45.82
BITTER LAKES WL REFUGE	NM	1950-2005	88.89	PUYALLUP 2 W EXP STN	WA	1931-1995	28.74
BOSQUE DEL APACHE	NM	1914-2005	92.51	QUINCY 1 S	WA	1941-2005	49.65
BRANTLEY DAM	NM	1987-2005	109.48	RIMROCK TIETON DAM	WA	1947-1977	39.88
CABALLO DAM	NM	1938-2005	107.06	SEATTLE MAPLE LEAF R	WA	1941-1960	34.52
CAPULIN NATL MONUMENT	NM	1966-1979	46.19	SPOKANE WSO AIRPORT	WA	1889-2005	48.41
CLOVIS 13 N	NM	1929-2005	86.68	WALLA WALLA 3 W ENT LA	WA	1931-1962	43.69
COCHITI DAM	NM	1975-2005	88.01	WENATCHEE EXP STN	WA	1950-1997	40.88
CONCHAS DAM	NM	1938-2005	80.89	WHITMAN MISSION	WA	1962-2005	47.11
EAGLE NEST	NM	1937-2005	42.96	WIND RIVER	WA	1901-1977	27.79
EL VADO DAM	NM	1923-2005	51.99	YAKIMA WSO AP	WA	1946-2005	47.21

Source: Western Region Climate Center (WRCC). 2025. *Evaporation Stations*. Accessed March 3, 2025. https://wrcc.dri.edu/Climate/comp_table_show.php?stype=pan_evap_avg>.

[1] For information on the city, county, and station latitude and longitude coordinates, visit the WRCC's Station Data Inventory Listing webpage.

Table W-5.2. Irrigation Efficiency Based on Assumed Distribution Uniformity

Irrigation Type	Efficiency (E)[1]
Drip - Standard	70%
Drip - Press Comp	90%
Fixed Spray	65%
Microspray	70%
Rotor (or rotating nozzles)	70%

Source: U.S. Environmental Protection Agency (EPA). 2020. *WaterSense Water Budget Tool Version 1.04*. Released June 2020. Accessed March 3, 2025. https://www.epa.gov/watersense/water-budget-tool.

[1] Factor represents the lower-quarter distribution uniformity (DU_{LQ}), which is the ratio of the lowest 25 percent water measurements compared to the overall average water measurement for the irrigation system.

Table W-5.3. Plant Factors (F_S) by Vegetation Type and General Water Requirement Category

	Water Requirement		
Vegetation Type	Low	Medium	High
Trees	0.2	0.5	0.9
Shrubs	0.2	0.5	0.7
Ornamental groundcover	0.2	0.5	0.7
Turfgrass	0.6	0.7	0.8

Source: U.S. Environmental Protection Agency (EPA). 2020. *WaterSense Water Budget Tool Version 1.04*. Released June 2020. Accessed March 3, 2025. https://www.epa.gov/watersense/water-budget-tool.

Table W-5.4. Annual Average Rainfall (inches per year)

Station[1]	Period	State	Rate (G)
Flagstaff WSO AP	1950-2006	AZ	21.32
Phoenix WSFO AP	1949-2006	AZ	7.53
Tucson WSO AP	1949-2006	AZ	11.42
Yuma WSO AP	1949-2006	AZ	2.95
Colorado Springs WSO AP	1949-2006	CO	16.08
Denver WSFO AP	1949-2006	CO	15.5
Grand Junction Walker	1949-2006	CO	8.69
Pueblo WSO AP	1954-2006	CO	11.86
Albuquerque WSFO AIRPORT	1949-2006	NM	8.71
State University	1959-2006	NM	9.35
Eugene WSO AIRPORT	1949-2006	OR	46.76
Medford WSO AP	1949-2006	OR	19.31
Portland WSFO	1949-2006	OR	37.58
Seattle Tacoma WSCMO AP	1949-2006	WA	38.17
Spokane WSO AIRPORT	1949-2006	WA	16.72
Yakima WSO AP	1949-2006	WA	8.15

Source: Western Region Climate Center (WRCC). 2025. *Mean Monthly and Annual Precipitation*. Accessed March 3, 2025. https://wrcc.dri.edu/Climate/comp_table_show.php?stype=ppt_means.

AP = airport; WSO = weather service office; WFO = weather forecast office

[1] For information on the city, county, and station latitude and longitude coordinates, visit the WRCC's Station Data Inventory Listing webpage.

Table LL-1.1. Average Landscape Equipment Horsepower

Equipment	Tech Type	Average HP
Chain Saws < 6 HP (commercial)	G2	2.8
Chain Saws < 6 HP (commercial)	G4	1.4
Chain Saws < 6 HP (residential)	G2	1.4
Chain Saws < 6 HP (residential)	G4	1.4
Chain Saws > 6 HP	G2	5.9
Chippers/Stump Grinders (commercial)	G4	22.7
Turf Equipment (commercial)	G2	1.2
Turf Equipment (commercial)	G4	7.7
Front Mowers (commercial)	G4	9.4
Lawn Mowers (commercial)	G4	1.5
Lawn Mowers (residential)	G2	2.8
Lawn Mowers (residential)	G4	1.5
Leaf Blowers/Vacuums (commercial)	G2	2.6
Leaf Blowers /Vacuums (commercial)	G4	8.7
Leaf Blowers /Vacuums (residential)	G2	1.7
Leaf Blowers /Vacuums (residential)	G4	2.4
Other Lawn & Garden Equipment (commercial)	G2	11.9
Other Lawn & Garden Equipment (commercial)	G4	3.0
Other Lawn & Garden Equipment (residential)	G2	11.9
Other Lawn & Garden Equipment (residential)	G4	3.0
Rear Engine Riding Mowers (commercial)	G4	4.1
Rear Engine Riding Mowers (residential)	G4	4.1
Rotary Tillers < 6 HP (commercial)	G2	0.7
Rotary Tillers < 6 HP (commercial)	G4	1.8
Rotary Tillers < 6 HP (residential)	G2	0.7
Rotary Tillers < 6 HP (residential)	G4	1.8
Shredders < 6 HP (commercial)	G4	2.9
Shredders > 6 HP	G2	16.4
Shredders > 6 HP	G4	7.3
Trimmers/Edgers/Brush Cutter (commercial)	G2	2.0
Trimmers/Edgers/Brush Cutter (commercial)	G4	2.1
Trimmers/Edgers/Brush Cutter (residential)	G2	1.4

Equipment	Tech Type	Average HP
Trimmers/Edgers/Brush Cutter (residential)	G4	2.1

Source: U.S. Environmental Protection Agency (EPA). 2024. Latest Version of Motor Vehicle Emissions Simulator (MOVES). Released November 2024. Accessed December 2024. https://www.epa.gov/moves/latest-version-motor-vehicle-emission-simulator-moves#guidance.

HP = horsepower; G2 = two-stroke gasoline; G4= four-stroke gasoline

Note: Operating hours used to define an activity-based average of horsepower for each equipment category. The activity distribution is the same across states and years analyzed (2025 through 2050). Horsepower values are inclusive of equipment load.

Table S-1.1. Washington State Annual Waste Disposal Rates by County (2021) (tons landfilled per person)

County	Tons per Person	County	Tons per Person
Adams	1.06	Lewis	0.37
Asotin	0.85	Lincoln	0.42
Benton	1.22	Mason	1.10
Chelan	1.27	Okanogan	0.93
Clallam	0.17	Pacific	1.00
Clark	0.77	Pend Oreille	0.59
Columbia	2.74	Pierce	1.52
Cowlitz	3.71	San Juan	0.78
Douglas	0.88	Skagit	1.07
Ferry	0.46	Skamania	0.58
Franklin	1.32	Snohomish	1.00
Garfield	0.78	Spokane	2.25
Grant	1.29	Stevens	1.42
Grays Harbor	1.03	Thurston	0.79
Island	0.68	Wahkiakum	0.09
Jefferson	1.79	Walla Walla	1.54
King	1.16	Whatcom	0.95
Kitsap	0.83	Whitman	0.67
Kittitas	1.95	Yakima	1.90
Klickitat	1.13	Statewide	1.25

Sources: Washington State Department of Ecology. 2025. Excel file provided to ICF with waste disposal rates and waste stream data. January.

Washington State Office of Financial Management. 2022. Projections of the Total Resident Population for Growth Management: 2022 GMA Projections–Middle Series. Last Revised December 2022. Accessed February 6, 2025. https://ofm.wa.gov/tags/population.

Note: Total waste disposal by county provided by Washington State. County values exclude waste sent to the Spokane Regional Waste to Energy Facility. County population statistics obtained from Washington State Office of Financial Management.

Table S-1.2. Oregon State Annual Waste Disposal Rates by Wasteshed (2022) (tons landfilled per person)

Wasteshed	Tons per Person	Wasteshed	Tons per Person
Baker	0.82	Lane	0.74
Benton	0.83	Lincoln	0.89
Clatsop	0.99	Linn	0.77
Columbia	0.62	Malheur	0.77
Coos	0.91	Marion	0.96
Crook	1.06	Metro	0.79
Curry	0.92	Milton Freewater	0.67
Deschutes	1.09	Morrow	1.88
Douglas	0.93	Polk	0.62
Gilliam	1.41	Sherman	0.67
Grant	0.64	Tillamook	1.17
Harney	0.64	Umatilla	1.33
Hood River	1.09	Union	0.79
Jackson	1.02	Wallowa	0.68
Jefferson	0.82	Wasco	0.84
Josephine	0.96	Wheeler	0.32
Klamath	1.07	Yamhill	1.09
Lake	0.70	Statewide	0.86

Source: Oregon Department of Environmental Quality. 2025. Excel file provided to ICF with waste disposal rates and waste stream data. February 2025.

Note: Wastesheds defined per OAR 340-090-0050 (see https://oregon.public.law/rules/oar_340-090-0050).

Table S-1.3. Arizona, Colorado, and New Mexico Statewide Annual Waste Disposal Rates (2022) (tons landfilled per person)

State	Tons per Person
Arizona	0.61
Colorado	0.91
New Mexico	0.66

Source: U.S. Environmental Protection Agency (EPA). 2025. State Inventory Tool–Municipal Solid Waste. Version 2025.1.

Table S-1.4. Washington State Waste Profile (2021) (% of total waste by material type)

Material	Percent of Waste Stream
Paper	18.8%
Newspaper	0.4%
Cardboard & Mixed Recyclable Paper	10.3%
Compostable Food-Soiled Paper Products	6.1%
Other Paper	1.9%
Plastic	14.8%
Plastic Containers & Other Non-film Recyclable Plastic	4.6%
Film Plastic	6.2%
Other Plastic	4.1%
Glass	2.3%
Glass Containers	1.6%
Other Glass	0.7%
Metal	4.3%
Metal	4.3%
Organics	16.9%
Food Waste	13.1%
Yard Waste	3.8%
Construction Materials	18.5%
Construction and Demolition Debris	18.5%
Consumer Products	5.5%
E-Waste	1.0%
Textiles and Shoes	4.5%
Other Materials	18.8%
Diapers	3.5%
Vehicle Batteries	0.0%
Other Hazardous / Special Waste	2.3%
Other Material	13.0%

Source: Washington State Department of Ecology. 2025. Excel file provided to ICF with waste disposal rates and waste stream data. January 2025.

Table S-1.5. Oregon State Waste Profile (2022) (% of total waste by material type)

Material	Percent of Waste Stream
Paper	12.2%
Aseptic Containers	0.0%
Cardboard	3.0%
Gable Top Cartons	0.0%
Newsprint	0.4%

Material	Percent of Waste Stream
Paper Fiber	7.6%
Printing Writing Paper	1.0%
Plastic	10.3%
Plastic Film	3.4%
Plastic Other	5.4%
Rigid Plastic	1.5%
Glass	2.6%
Metal	2.8%
Aluminum	0.3%
Scrap Metal	2.0%
Tinned Can	0.5%
Organics	21.6%
Food Waste	17.0%
Yard Debris	4.7%
Construction Materials	10.0%
Asphalt Roofing	4.0%
Carpeting	2.4%
Gypsum Wallboard	3.6%
Consumer Products	3.9%
Electronics	0.5%
Textiles	3.4%
Other Materials	36.6%
Other	21.0%
Wood	15.7%

Source: Oregon Department of Environmental Quality. 2025. Excel file provided to ICF with waste disposal rates and waste stream data. February 2025.

Table S-1.6. Colorado State Waste Profile (2018) (% of total waste by material type)

Material	Rural	Urban	Statewide
Paper	19.3%	19.1%	19.2%
Cardboard/Kraft	6.6%	6.2%	6.5%
Newspaper	1.2%	2.2%	1.4%
Office Paper	1.6%	1.4%	1.6%
Chip/Paperboard	2.8%	1.6%	2.5%
Junk Mail/Aseptics	1.5%	1.6%	1.5%
Magazines	1.6%	1.2%	1.6%
Other Paper	3.9%	5.7%	4.3%
Plastic	13.8%	11.4%	13.2%
#1 Bottles	1.9%	1.2%	1.7%
#2 Bottles	1.5%	1.1%	1.4%

Material	Rural	Urban	Statewide
Rigid #3-#7	1.3%	0.8%	1.1%
Film, Bags & Wrap	3.4%	4.2%	3.5%
Other Plastic	5.8%	4.1%	5.4%
Glass	4.5%	3.0%	4.2%
Glass Containers	3.7%	2.9%	3.5%
Other Glass	0.8%	0.1%	0.7%
Metal	4.8%	4.3%	4.7%
Aluminum	1.0%	1.0%	1.0%
Steel/Tin	1.3%	1.0%	1.2%
Other Metal	2.5%	2.4%	2.5%
Organics	38.1%	33.8%	37.1%
Food Waste	19.9%	12.5%	18.2%
Yard Waste	10.1%	11.8%	10.5%
Clean Wood	0.7%	1.6%	0.9%
Other Organics	7.5%	7.9%	7.6%
Other	18.1%	15.6%	17.5%
Textiles	5.8%	4.2%	5.4%
Electronics	1.0%	2.2%	1.3%
Batteries	0.3%	0.1%	0.2%
Paint	0.0%	0.0%	0.0%
Motor Vehicle Waste	1.0%	0.4%	0.8%
C&D (non-industrial)	8.6%	8.4%	8.6%
Other HHW/Special	2.1%	0.4%	1.7%
Waste/Residue	1.5%	13.3%	4.2%

Source: Colorado Department of Public Health and Environment. 2018. Waste Composition of Municipal Solid Waste Disposal. Accessed February 4, 2025. https://oitco.hylandcloud.com/cdphermpop/docpop/docpop.aspx.

Table S-1.7. Arizona State Waste Profile (% of total waste by material type)

Material	% Landfilled
Construction & Demolition (C&D), excluding Wood	**9.3%**
Asphalt Roofing	1.1%
Carpet (including Padding)	1.7%
Drywall	1.2%
Fines/Dirt	1.9%
Inerts (Concrete/Brick/Rock/Asphalt)	1.4%
Other C&D	1.9%
Food	**17.3%**
Glass	**2.7%**
Amber Glass (Containers)	0.6%
Clear Glass (Containers)	1.1%

Material	% Landfilled
Green Glass (Containers)	0.4%
Other Glass	0.6%
Household Hazardous Waste (HHW)	**1.4%**
Lightbulbs	0.2%
Other HHW (Paint/Asbestos/Household Cleaner)	0.3%
Pharmaceutical/Medical	0.5%
Vehicle Fluids (including Motor Oil)	0.3%
Metal	**5.6%**
Aluminum Cans	0.7%
Appliances/White Goods	0.6%
Other Ferrous	2.1%
Other Non-Ferrous	1.3%
Steel Cans	0.9%
Other	**5.9%**
Batteries	0.2%
Bulky Items/ Furniture (including Mattresses)	2.6%
Electronics	1.0%
Other Inorganics	1.6%
Tires	0.5%
Other Organics	**6.2%**
Paper	**20.4%**
Corrugated Cardboard	6.3%
Magazine/Glossy	0.9%
Mixed Paper (Other Recyclable)	6.8%
Newspaper	1.3%
Office	1.7%
Other Paper (Non-recyclable)	2.2%
Paperboard	1.2%
Plastic	**14.0%**
#1 PET Bottles	1.4%
#2 HDPE Bottles	0.9%
#3 through #7 Bottles	0.9%
Expanded Polystyrene	1.3%
Film Plastic	5.8%
Other Rigid Plastic	3.7%
Textiles	**4.7%**
Wood (including Painted/Treated/etc.)	**5.3%**
Yard Waste	**7.1%**
Wood (non-C&D)	2.4%
Yard Waste	4.7%

Source: Arizona Circular Recycling Solutions. *Arizona County Waste*. https://azcres.org/arizona-waste/.

Table S-1.8. National Waste Profile (2018) (% of total waste by material type)

Material	% Landfilled
Paper	11.8%
Plastic	18.5%
Glass	5.2%
Metal	9.5%
Ferrous	7.2%
Aluminum	1.8%
Other Nonferrous	0.5%
Rubber and Leather	3.4%
Textiles	7.7%
Wood	8.3%
Other	2.0%
Food	24.1%
Yard Trimmings	7.2%
Miscellaneous Inorganics	2.3%

Source: U.S. Environmental Protection Agency (EPA). 2020. Advancing Sustainable Materials Management: 2018 Tables and Figures. December 2020.

Table S-3.1. Available Defaults for Analysis of Edible Food Recovery Programs

Food Waste Prevention[1]		
Refrigeration & Freezer Equipment - Energy Consumption	Factor	Unit
Residential Refrigerator/Freezer Combination	8.46	kWh/year per ft³ of volume
	335.7	kWh/year
Residential Freezer Only	7.85	kWh/year by ft³ of volume
	172.3	kWh/year
Residential Refrigerator Only	7.28	kWh/year by ft³ of volume
	206.7	kWh/year
Commercial Refrigerator with Solid Doors or Walk-in Commercial Refrigerator with Solid Doors	36.5	kWh/year per ft³ of volume
	744.6	kWh/year
Commercial Refrigerator with Transparent Doors or Walk-in Commercial Refrigerator with Transparent Doors	43.8	kWh/year by ft³ of volume
	1,219.1	kWh/year
Commercial Freezer with Solid Doors or Walk-in Commercial Freezer with Solid Doors	146.0	kWh/year by ft³ of volume
	503.7	kWh/year
Commercial Freezer with Transparent Doors or Walk-in Commercial Freezer with Transparent Doors	273.8	kWh/year by ft³ of volume
	1,496.5	kWh/year
	98.6	kWh/year by ft³ of volume

Commercial Refrigerator/Freezer with Solid Doors or Walk-in Commercial Refrigerator/Freezer with Solid Doors	-259.2	kWh/year
	255.5	minimum value kWh/year

Refrigerant Average Annual Leak Rate	Source	
	CARB[2]	U.S. EPA (Table R-1.3)[3]
Residential Refrigerator/Freezer Combination	1.0%	0.60%
Residential Freezer Only	1.0%	0.60%
Residential Refrigerator Only	1.0%	0.60%
Commercial Refrigeration Systems with Charge < 50 lbs	15.0%	1.0% to 7.5%
Commercial Refrigeration Systems with Charge 50 lbs to < 200 lbs	15.0%	1.0% to 7.5%
Commercial Refrigeration Systems with Charge 200 lbs to < 2,000 lbs	18.0%	1.0% to 7.5%
Commercial Refrigeration Systems with Charge ≥ 2,000 lbs	17.0%	—
Transportation Vehicle	24.0%	—

Refrigerant Charge Assumptions (pounds)	Source	
	CARB[2]	U.S. EPA (Table R-1.3)[3]
Residential Refrigerators/Freezers and Chest Freezers	0.34 lbs	0.2 lbs
Commercial Refrigerator/Freezers	7.10 lbs	0.4 lbs
Small Walk-in Refrigerator/Freezer	31.40 lbs	10.0 lbs
Large Walk-in Refrigerator/Freezer	122.00 lbs	565.0 lbs
Refrigerated Van	4.00 lbs	—
Refrigerated Box Truck	12.00 lbs	—
Refrigerated Heavy Duty Truck	22.00 lbs	—

Sources: See footnotes.

MJ = megajoules; mpg = miles per gallon; mpgde = miles per gallon of diesel equivalent; gal = gallon; kWh = kilowatt-hours; CO2e = carbon dioxide equivalent; g = grams

[1] 10 Code of Federal Regulations 431.66 and Venkat, K. 2012. *The Climate Change and Economic Impacts of Food Waste in the United States*. April 2012. Accessed January 2025. https://www.cleanmetrics.com/pages/ClimateChangeImpactofUSFoodWaste.pdf.

[2] California Air Resources Board (CARB). 2020. Benefits Calculator Tool for the Food Waste Prevention and Rescue Program. June 2020. Accessed January 2025. https://ww2.arb.ca.gov/sites/default/files/auction-proceeds/calrecycle_finalfoodcalc_19-20.xlsx.

[3] U.S. Environmental Protection Agency (U.S. EPA). 2016. *Accounting Tool to Support Federal Reporting of Hydrofluorocarbon Emissions: Supporting Documentation*. October 2016. Accessed May 2021. https://www.epa.gov/sites/production/files/2015-09/documents/hfc_emissions_accounting_tool_supporting_documentation.pdf.

Table S-3.2. Solid Waste Emission Factors for Analysis of Edible Food Recovery Programs

	Grid Zone	
Grid Electricity Emission Factors (lbs/kWh)[1]	WECC	SPP
ROG	0.000010	0.000027
NOx	0.000384	0.000505
$PM_{2.5}$	0.000036	0.000048
Avoided Landfill Flare Combustion Emission Factors (lbs/wet short ton of food waste)[2]		
ROG		0.092
NOx		0.033
$PM_{2.5}$		0.014
Avoided Transportation Emission Factors (lbs/short ton of food waste)[3]		
ROG		0.016
NOx		0.299
$PM_{2.5}$		0.009
Diesel		0.001

Sources: See footnotes.

ROG = reactive organic gases; NO_X = nitrous oxides; $PM_{2.5}$ = fine particulate matter; PM = particulate.

[1] U.S. Department of Energy (U.S. DOE). 2024. "The Greenhouse Gases, Regulated Emissions, and Energy Use in Technologies Model." 2024 Release. Accessed January 28, 2025. https://greet.anl.gov/

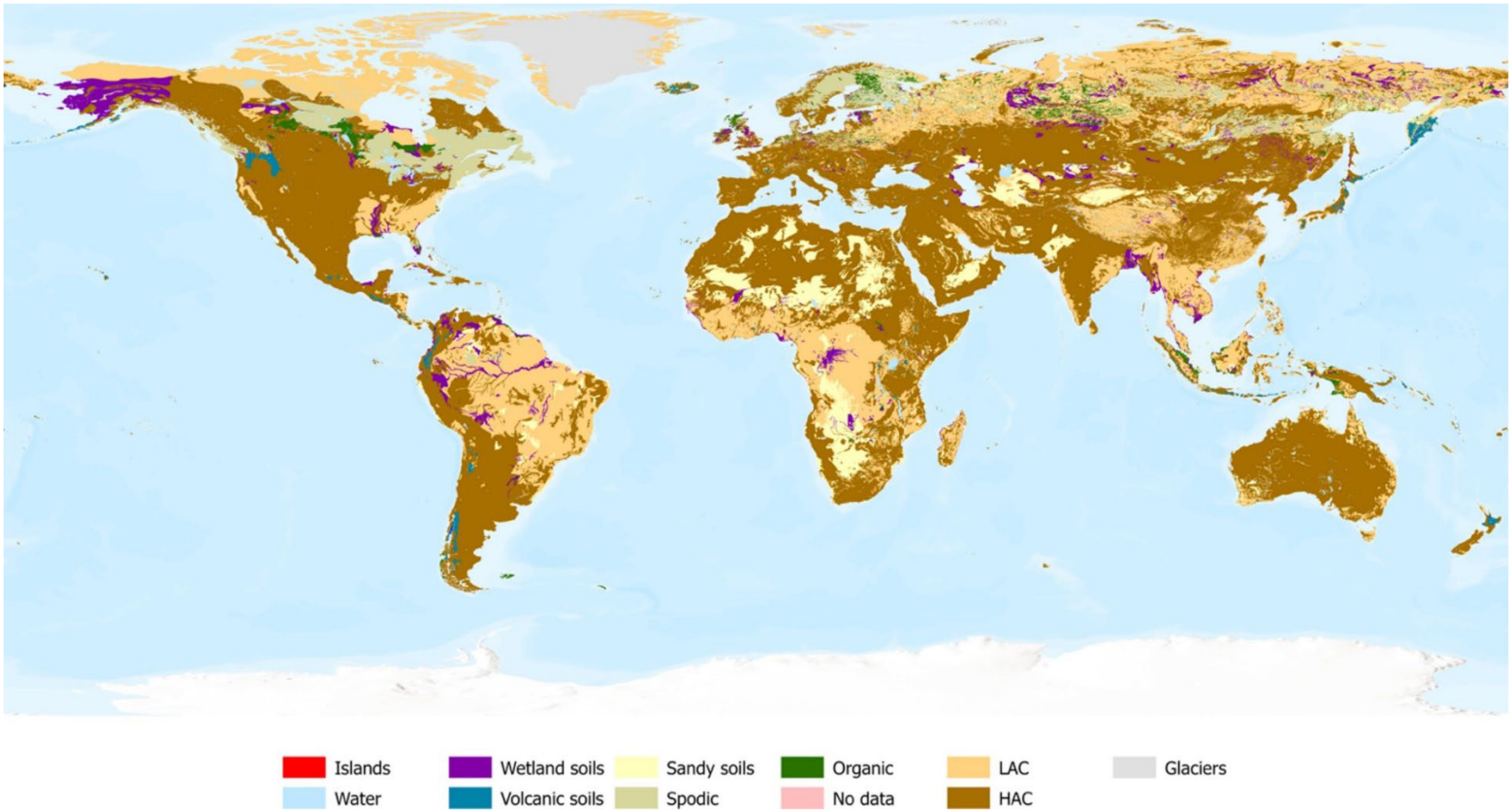
Grid electricity emission factors are defined for 2025 and available for two geographies as defined in the U.S. DOE's GREET model—the Western Electricity Coordinating Council (WECC) and Southwest Power Pool (SPP). Arizona, Colorado, Oregon, and Washington are wholly within WECC. New Mexico is split between WECC and SPP. Refer to Figure E-26.1 in Appendix A.

[2] California Air Resources Board. 2020. Benefits Calculator Tool for the Food Waste Prevention and Rescue Program. Accessed August 2023. https://ww2.arb.ca.gov/sites/default/files/auction-proceeds/calrecycle_finalfoodcalc_19-20.xlsx.

Avoided landfill flare emission factors were calculated by CARB for their Food Waste Prevention and Rescue Program using typical flare emissions rates from U.S. EPA's AP-42, Chapter 2.4, Municipal Solid Waste Landfills, and CARB's *Methods for Estimating Greenhouse Gas Emission Reductions from Diversion of Organic Waste from Landfills to Compost Facilities*. The AP-42 emissions rates are based on source test data. CARB's quantification method uses studies representing a variety of landfill conditions, locations (national and within California), years of operation, and degrees of controls. Thus, the emission factors are generally applicable.

[3] Venkat, K. 2012. *The Climate Change and Economic Impacts of Food Waste in the United States*. April 2012. Accessed January 2025. https://www.cleanmetrics.com/pages/ClimateChangeImpactofUSFoodWaste.pdf.

Figure N-1.1. IPCC Soil Classifications



Source: Sinitambirivoutin, M., E. Milne, L. Schiettecatte, I. Tzamtzis, D. Dionisio, M. Henry, I. Brierley, M. Salvatore, and M. Bernoux. 2024. An updated IPCC major soil types map derived from the harmonized world soil database v2.0. Catena, 244(108258).

Table N-1.1 Crosswalk of Statewide Land Cover Classes to Available Land Cover Types by IPCC Climate Zone for Measure N-1[1]

State	2019 IPCC Climate Zone[2]	Land Cover Class[3]	Crosswalk for Measure N-1	
			2006 IPCC Climate Zone	Land Cover Type
AZ	Cool Temperate Moist	Temperate or Subpolar Needleleaf Forest	Temperate Continental	Conifer Forest
AZ	Cool Temperate Moist	Temperate or Subpolar Shrubland	Temperate Continental	Shrubland
AZ	Cool Temperate Moist	Temperate or Subpolar Grassland	Temperate Continental (Cool Temperate Moist)	Grassland
CO	Cool Temperate Moist	Temperate or Subpolar Needleleaf Forest	Temperate Continental	Conifer Forest
CO	Cool Temperate Moist	Temperate or Subpolar Shrubland	Temperate Continental	Shrubland
CO	Cool Temperate Moist	Temperate or Subpolar Broadleaf Deciduous Forest	Temperate Continental	Broadleaf Forest
CO	Boreal Moist	Temperate or Subpolar Needleleaf Forest	Temperate Continental	Conifer Forest
CO	Cool Temperate Moist	Temperate or Subpolar Grassland	Temperate Continental (Cool Temperate Moist)	Grassland
CO	Boreal Moist	Temperate or Subpolar Shrubland	Temperate Continental	Shrubland
CO	Polar Moist	Temperate or Subpolar Needleleaf Forest	Temperate Continental	Conifer Forest
CO	Polar Moist	Temperate or Subpolar Grassland	Temperate Continental (Cool Temperate Moist)	Grassland
CO	Polar Moist	Temperate or Subpolar Shrubland	Temperate Continental	Shrubland
CO	Boreal Moist	Temperate or Subpolar Grassland	Temperate Continental (Cool Temperate Moist)	Grassland
CO	Cool Temperate Moist	Mixed Forest	Temperate Continental	Mixed Forest (Conifer Broadleaf)
CO	Boreal Moist	Temperate or Subpolar Broadleaf Deciduous Forest	Temperate Continental	Broadleaf Forest
CO	Boreal Moist	Mixed Forest	Temperate Continental	Mixed Forest (Conifer Broadleaf)
CO	Polar Moist	Temperate or Subpolar Broadleaf Deciduous Forest	Temperate Continental	Broadleaf Forest
NM	Cool Temperate Moist	Temperate or Subpolar Shrubland	Temperate Continental	Conifer Forest
NM	Cool Temperate Moist	Temperate or Subpolar Grassland	Temperate Continental	Mixed Forest (Conifer Broadleaf)

State	2019 IPCC Climate Zone[2]	Land Cover Class[3]	Crosswalk for Measure N-1	
			2006 IPCC Climate Zone	Land Cover Type
NM	Cool Temperate Moist	Mixed Forest	Temperate Continental	Broadleaf Forest
OR	Cool Temperate Moist	Temperate or Subpolar Needleleaf Forest	Temperate Oceanic	Conifer Forest
OR	Warm Temperate Moist	Temperate or Subpolar Needleleaf Forest	Temperate Oceanic	Conifer Forest
OR	Cool Temperate Moist	Temperate or Subpolar Shrubland	Temperate Oceanic	Shrubland
OR	Cool Temperate Moist	Temperate or Subpolar Grassland	Temperate Oceanic (Cool Temperate Moist)	Grassland
OR	Warm Temperate Moist	Mixed Forest	Temperate Oceanic	Mixed Forest (Conifer Broadleaf)
OR	Warm Temperate Moist	Temperate or Subpolar Shrubland	Temperate Oceanic	Shrubland
OR	Cool Temperate Moist	Mixed Forest	Temperate Oceanic	Mixed Forest (Conifer Broadleaf)
OR	Warm Temperate Moist	Temperate or Subpolar Grassland	Temperate Oceanic (Warm Temperate Moist)	Grassland
OR	Warm Temperate Moist	Temperate or Subpolar Broadleaf Deciduous Forest	Temperate Oceanic	Broadleaf Forest
OR	Cool Temperate Moist	Temperate or Subpolar Broadleaf Deciduous Forest	Temperate Oceanic	Broadleaf Forest
OR	Boreal Moist	Temperate or Subpolar Needleleaf Forest	Temperate Oceanic	Conifer Forest
OR	Boreal Moist	Temperate or Subpolar Grassland	Temperate Oceanic (Cool Temperate Moist)	Grassland
OR	Boreal Moist	Temperate or Subpolar Shrubland	Temperate Oceanic	Shrubland
WA	Cool Temperate Moist	Temperate or Subpolar Needleleaf Forest	Temperate Oceanic	Conifer Forest
WA	Cool Temperate Moist	Temperate or Subpolar Shrubland	Temperate Oceanic	Shrubland
WA	Cool Temperate Moist	Temperate or Subpolar Grassland	Temperate Oceanic (Cool Temperate Moist)	Grassland
WA	Warm Temperate Moist	Temperate or Subpolar Needleleaf Forest	Temperate Oceanic	Conifer Forest
WA	Cool Temperate Moist	Mixed Forest	Temperate Oceanic	Mixed Forest (Conifer Broadleaf)
WA	Warm Temperate Moist	Mixed Forest	Temperate Oceanic	Mixed Forest (Conifer Broadleaf)
WA	Cool Temperate Moist	Temperate or Subpolar Broadleaf Deciduous Forest	Temperate Oceanic	Broadleaf Forest

State	2019 IPCC Climate Zone[2]	Land Cover Class[3]	Crosswalk for Measure N-1	
			2006 IPCC Climate Zone	Land Cover Type
WA	Warm Temperate Moist	Temperate or Subpolar Shrubland	Temperate Oceanic	Shrubland
WA	Warm Temperate Moist	Temperate or Subpolar Broadleaf Deciduous Forest	Temperate Oceanic	Broadleaf Forest
WA	Warm Temperate Moist	Temperate or Subpolar Grassland	Temperate Oceanic (Warm Temperate Moist)	Grassland
WA	Boreal Moist	Temperate or Subpolar Shrubland	Temperate Continental	Shrubland
WA	Boreal Moist	Temperate or Subpolar Grassland	Temperate Continental (Cool Temperate Moist)	Grassland

Sources: See footnotes.

[1] Not all land cover classes and/or 2019 IPCC climate zones could be mapped to the available land cover type by 2006 IPCC climate zone combinations addressed in Measure N-1. See the IPCC climate zone map, available online from the IPCC at Publications - IPCC-TFI. The following are excluded from the table: Barren Land, Wetlands, Other, Water, and Urban (all western state climate zones); Cropland (Cool Temperate Moist, Warm Temperate Moist); Snow and Ice (Cool Temperate Moist, Polar Moist); Temperate or Subpolar Broadleaf Deciduous Forest (Cool Temperate Moist); and Temperate or Subpolar Needleleaf Forest (Cool Temperate Moist).

[2] Panagos, P., M. Van Liedekerke, P. Borrelli, J. Köninger, C. Ballabio, A. Orgiazzi, E. Lugato, L. Liakos, J. Hervas, A. Jones, and L. Montanarella. 2022. "European Soil Data Centre 2.0: Soil data and knowledge in support of the EU policies." *European Journal of Soil Science* 73 (6), e13315. DOI: 10.1111/ejss.13315.

[3] Commission for Environmental Cooperation (CEC). 2024. "2020 Land Cover of North America at 30 meters." North American Land Change Monitoring System. Canada Centre for Remote Sensing (CCRS), U.S. Geological Survey (USGS), Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO), Comisión Nacional Forestal (CONAFOR), Instituto Nacional de Estadística y Geografía (INEGI). Ed. 2.0, Raster digital data [30-m]. http://www.cec.org/north-american-environmental-atlas/land-cover-30m-2020/.

Table N-1.2. Above- and Belowground Biomass Carbon Accumulation (metric tons) per Hectare by Land Cover Type and IPCC Climate Zone

IPCC Climate Zone[1]	Cover Type[2]	MT C/ha	Source	MT C/ha/yr[3]
Temperate Continental	Broadleaf Forest	185	IPCC 2019	9.3
Temperate Continental	Conifer Forest	155	IPCC 2019	7.8
Temperate Continental (Warm Temperate Dry)	Grassland	6	IPCC 2006	0.3
Temperate Continental (Cool Temperate Dry)	Grassland	7	IPCC 2006	0.4

Temperate Continental	Mixed Forest (Conifer Broadleaf)[4]	170	IPCC 2019	8.5
Temperate Continental	Shrubland	186	Chopping et al. 2007	9.3
Temperate Oceanic	Broadleaf Forest	183	IPCC 2019	9.2
Temperate Oceanic	Conifer Forest	167	IPCC 2019	8.4
Temperate Oceanic (Warm Temperate Moist)	Grassland	14	IPCC 2006	0.7
Temperate Oceanic (Cool Temperate Moist)	Grassland	12	IPCC 2006	0.6
Temperate Oceanic	Mixed Forest (Conifer Broadleaf)[4]	175	IPCC 2019	8.8
Temperate Oceanic	Shrubland	81	Martin et al. 1981	4.1

Sources: IPCC (Intergovernmental Panel on Climate Change). 2019. *Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories*. Edited by C. Buendia, K. Tanabe, A. Kranjc, J. Baasansuren, M. Fukuda, S. Ngarize, A. Osako, Y. Pyrozhenko, P. Shermanau, and S. Federici. Switzerland: IPCC.

IPCC. 2006. *IPCC Guidelines for National Greenhouse Gas Inventories*. Prepared by the National Greenhouse Gas Inventories Programme. Edited by H. S. Eggleston, L. Buendia, K. Miwa, T. Ngara, and K. Tanabe. Japan: IGES.

Chopping, M., G. G. Moisen, L. Su, A. Laliberte, A. Rango, J. V. Martonchik, and D. P. C. Peters. 2007. "Large area mapping of southwestern forest crown cover, canopy height, and biomass using the NASA Multiangle Imaging Spectro-Radiometer." *Remote Sensing of Environment* 112 (5): 2051-2063.

Martin, R. E., D. W. Frewing, and J. L. McClanahan. 1981. "Average biomass of four Northwest shrubs by fuel size class and crown cover" (Research Note PNW-374). U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station.
MT = metric tons; C = carbon; ha = hectare; IPCC = Intergovernmental Panel on Climate Change; yr = year

[1] The Climatic zones are defined by the IPCC based on annual mean daily temperature, total annual precipitation, total annual potential evapotranspiration, and elevation.

[2] The land cover types are broad and include one or more land cover classes from the North American Environmental Atlas. Table N-1.1 identifies the IPCC climate zones and land cover classes within each western state and crosswalks those to available land cover types provided in this table.

[3] Assumes a carbon accumulation period of 20 years, per IPCC (2006).

[4] 50% average of broadleaf, conifer

Table N-1.3. Annualized Soil Carbon Accumulation (metric tons) per Hectare by Soil Type

		Soil Carbon Accumulation (MT C/ha/yr[1,2])		
Soil Type[3]	IPCC Soil Classification[4]	Conversion to Cropland	Conversion to Grazing Land	Conversion to Forest
Alfisols	High Activity Clay Soils	1.9	2.4	2.5
Andisols	Volcanic Soils	6.2	8.0	8.5
Aquic	Wetland Soils	2.4	3.1	3.3
Aridisols	High Activity Clay Soils	1.9	2.4	2.5
Entisols	Low Activity Clay Soils	1.3	1.6	1.7
Inceptisols	High Activity Clay Soils	1.9	2.4	2.5
Mollisols	High Activity Clay Soils	1.9	2.4	2.5
Oxisols	Low Activity Clay Soils	1.3	1.6	1.7
>70% Sand	Sandy Soils	0.8	1.0	1.1
Spodosols	Spodic Soils	4.3	5.5	5.9
Ultisols	Low Activity Clay Soils	1.3	1.6	1.7
Vertisols	High Activity Clay Soils	1.9	2.4	2.5
Histosol	N/A	0	0	0

Source: Intergovernmental Panel on Climate Change (IPCC). 2006. *IPCC Guidelines for National Greenhouse Gas Inventories*. Prepared by the National Greenhouse Gas Inventories Programme. Edited by H. S. Eggleston, L. Buendia, K. Miwa, T. Ngara, and K. Tanabe. Japan: IGES.

MT = metric tons; C = carbon; ha = hectare; IPCC = Intergovernmental Panel on Climate Change; yr = year

[1] Assumes a carbon accumulation period of 20 years, per IPCC (2006).

[2] Based on a carbon stock change factor of 1 for cropland, 1.28 for grazing land, and 1.37 for forest.

[3] Soil types for the user's project area can be obtained from the United States Department of Agriculture's Soil Survey Map.

[4] Refer to Figure N-1.1.

Table C-1-A.1. Tank-to-Wheels and Well-to-Wheels CO_2e Emission Factors for Diesel and Gasoline Equipment (kilograms CO_2e per horsepower-hour)

Category	Fuel Type	Less than or equal to 100 HP		Greater than 100 HP	
		TTW	WTW	TTW	WTW
Construction	Gasoline (2 stroke)	0.52	0.67	0.47	0.60
	Gasoline (4 stroke)	0.53	0.68	0.48	0.61
	Diesel	0.70	0.84	0.63	0.76
Lawn and Garden	Gasoline (2 stroke)	0.52	0.67	0.47	0.60
	Gasoline (4 stroke)	0.53	0.68	0.48	0.61
	Diesel	0.69	0.83	0.62	0.75
Agricultural	Gasoline (2 stroke)	0.52	0.67	0.47	0.60
	Gasoline (4 stroke)	0.53	0.67	0.47	0.61
	Diesel	0.71	0.85	0.63	0.76
Industrial and Commercial	Gasoline (2 stroke)	0.52	0.67	0.47	0.60
	Gasoline (4 stroke)	0.53	0.68	0.48	0.61
	Diesel	0.70	0.84	0.63	0.75

Source: Association of Petroleum Institute (API). 2021. *Compendium of Greenhouse Gas Emissions Methodologies for the Natural Gas and Oil Industry*. Released November 2021. Accessed June 2025. https://www.api.org/~/media/files/policy/esg/ghg/2021-api-ghg-compendium-110921.pdf.
U.S. Department of Energy (U.S. DOE). 2024. "The Greenhouse Gases, Regulated Emissions, and Energy Use in Technologies Model." 2024 Release. Accessed January 28, 2025. https://greet.anl.gov/
U.S. EPA (U.S. Environmental Protection Agency). 2018. "Exhaust and Crankcase Emission Factors for Nonroad Compression-Ignition Engines in MOVES2014b." Released July 2018. Accessed June 2025. https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100UXEN.pdf.
U.S. EPA. 2025. "General Conformity Training Modules: Appendix A Sample Emissions Calculations." Released February 2025. Accessed June 2025. https://www.epa.gov/general-conformity/general-conformity-training-modules-appendix-sample-emissions-calculations.

HP = horsepower; TWT = tank-to-wheels; WTW = well-to-wheels

Table C-1-B.1. Average Construction Equipment Horsepower

Equipment	Fuel Type	Horsepower
Bore/Drill Rigs	Diesel	76.1
Bore/Drill Rigs	Gasoline	2.7
Cement & Mortar Mixers	Diesel	13.5
Cement & Mortar Mixers	Gasoline	4.3
Concrete/Industrial Saws	Diesel	29.3
Concrete/Industrial Saws	Gasoline	5.2
Cranes	Diesel	101.5
Cranes	Gasoline	22.6
Crawler Tractor/Dozers	Diesel	155.1
Crushing/Processing Equipment	Diesel	68.1
Crushing/Processing Equipment	Gasoline	6.6
Dumpers/Tenders	Diesel	7.0
Dumpers/Tenders	Gasoline	4.0

Equipment	Fuel Type	Horsepower
Excavators	Diesel	103.0
Graders	Diesel	126.0
Off-Highway Tractors	Diesel	431.8
Other Construction Equipment	CNG	66.0
Other Construction Equipment	Diesel	194.2
Other Construction Equipment	Gasoline	64.1
Pavers	Diesel	76.8
Pavers	Gasoline	9.2
Plate Compactors	Diesel	3.1
Plate Compactors	Gasoline	2.9
Rollers	Diesel	56.9
Rollers	Gasoline	9.4
Rough Terrain Forklift	Gasoline	40.6
Rubber Tire Loaders	Diesel	146.9
Rubber Tire Loaders	Gasoline	45.6
Scrapers	Diesel	244.8
Signal Boards/Light Plants	Diesel	10.0
Signal Boards/Light Plants	Gasoline	4.8
Skid Steer Loaders	Diesel	12.0
Skid Steer Loaders	Gasoline	19.2
Surfacing Equipment	Diesel	64.5
Surfacing Equipment	Gasoline	4.4
Tampers/Rammers	Diesel	1.9
Tampers/Rammers	Gasoline	2.5
Tractors/Loaders/Backhoes	Diesel	20.8
Tractors/Loaders/Backhoes	Gasoline	10.0
Trenchers	Diesel	45.2
Trenchers	Gasoline	8.0

Source: U.S. Environmental Protection Agency (EPA). 2024. Latest Version of Motor Vehicle Emissions Simulator (MOVES). Released November 2024. Accessed December 2024. https://www.epa.gov/moves/latest-version-motor-vehicle-emission-simulator-moves#guidance.

CNG = compressed natural gas; HP = horsepower

Note: Operating hours used to define an activity-based average of horsepower for each equipment category. The activity distribution is the same across states and years analyzed (2025 through 2050). Horsepower values are inclusive of equipment load.

Table R-1.1 Global Warming Potentials of Commonly Used Refrigerants

Refrigerant Name	Trade/Common Name (if one exists)	GWP
R-717	Ammonia	0
R-1224yd(Z)	AMOLEA™ 1224yd	1
R-1234ze(E)	Solstice® ze	1
R-744	CO_2	1
R-1234zd(E)	Solstice® zd	1
R-514A	Opteon™ XP30	2
R-600a	Isobutane	3
R-290	Propane	4
R-161	HFC-161	4
R-601	Pentane	5
R-170	Ethane	6
R-123	HCFC-123	79
R-225ca	HCFC-225ca	127
R-152a	HFC-152a	138
R-454B	Opteon™ XL41	467
R-225cb	HCFC-225cb	525
R-124	HCFC-124	527
R-450A	Solstice® N13	547
R-513A	Opteon™ XP10	573
R-452B	Opteon™ XL55	676
R-32	HFC-32	677
R-466A	—	697
R-141b	HCFC-141b	782
R-365mfc	HFC-365mfc	804
R-245fa	HFC-245fa	858
R-401C	Suva® MP-52	876
R-416A	FRIGC FR-12	975
R-401A	MP39	1,130
R-401B	MP66	1,236
R-448A	Solstice® N40	1,273

Refrigerant Name	Trade/Common Name (if one exists)	GWP
R-414B	Hot Shot™	1,274
R-449A	Opteon™ XP40	1,282
R-134a	HFC-134a	1,300
R-426A	RS-24	1,371
R-414A	GHX4	1,375
R-420A	Choice® Refrigerant	1,382
Free Zone	—	1,403
Freeze 12	—	1,436
R-409A	FX-56	1,485
R-407D	—	1,487
R-411A	—	1,555
R-407C	—	1,624
R-453A	RS-70, RS-44b	1,636
R-437A	MO49 Plus	1,639
R-417C	Hot Shot™ 2	1,643
R-4310mee	HFC-43-10mee, HFC-4310mee, R-43-10mee	1,650
R-411B	—	1,659
R-407F	—	1,674
G2018C	—	1,683
GHG-HP	—	1,758
R-22	HCFC-22, Freon	1,760
R-406A	—	1,780
R-442AF	RS-50	1,888
R-407A	KLEA® 60	1,923
R-410A	Puron®, AZ-20	1,924
R-413A	MO49	1,945
R-142b	HCFC-142b	1,980
R-427A	—	2,024
R-410B	AC9100	2,048
R-438A	MO99	2,059
R-417A	MO59, NU22	2,127

Refrigerant Name	Trade/Common Name (if one exists)	GWP
R-452A	Opteon™ XP44	2,140
NARM-502	—	2,211
R-424A	RS-44	2,212
R-402B	HP-81	2,261
R-423A	39TC	2,274
R-422B	NU-22B	2,290
GHG-X5	—	2,359
R-421A	—	2,385
R-422D	MO29	2,473
R-407B	—	2,547
R-402A	HP-80	2,571
R-422C	One Shot™	2,795
R-422A	—	2,847
R-421B	Choice® 421B	2,890
R-434A	RS-45	3,076
R-125	HFC-125	3,170
R-408A	FX-10	3,257
R-227ea	HFC-227ea	3,350
R-428A	RS-52	3,417
Isceon MO89	—	3,527
R-404A	HP-62	3,943
R-507	AZ-50	3,985
R-403B	—	4,457
R-11	CFC-11	4,660
R-502	—	4,786
R-143a	HFC-143a	4,800
R-113	CFC-113	5,820
EP-88	—	6,427
R-14	PFC-14, CF4	6,630
R-13b1	Halon 1301	7,140
R-500	—	7,564

Refrigerant Name	Trade/Common Name (if one exists)	GWP
R-115	CFC-115	7,670
R-236fa	HFC-236fa	8,060
R-114	CFC-114	8,590
R-218	PFC-218	8,900
R-12	CFC-12	10,200
R-116	PFC-116	11,100
R-508B	—	11,698
R-23	HFC-23	12,400
R-503	—	13,300
R-13	CFC-13	13,900

Sources: California Air Resource Board (CARB). 2020. *Refrigerant Management Program: Service Technicians & Contractors*. Accessed January 2021. https://ww2.arb.ca.gov/our-work/programs/refrigerant-management-program/rmp-service-technicians-contractors.

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— = no common name; R= refrigerant; HCFC = hydrochlorofluorocarbons; HFC = hydrofluorocarbon; PFC = perfluorocarbon; CFC = Chlorofluorocarbons; GHG = greenhouse gas; GWP = global warming potential

Table R-1.2. Charge Size, Service Rate, and Leak Rate for Various Equipment Types by Land Use Type

Land Use Type	Equipment Type	Refrigerant Charge (kg)	Leak Rate	Service Rate	Total Leak Rate[1]
Apartments (any size) (retirement)	Average room A/C & Other residential A/C and heat pumps	2.75	2.50%	2.50%	5.00%
Apartments (any size) (retirement)	Household refrigerators and/or freezers	0.04	0.60%	0.00%	0.60%
Apartments in buildings with 2–4 units	Average room A/C & Other residential A/C and heat pumps	2.75	2.50%	2.50%	5.00%
Apartments in buildings with 2–4 units	Household refrigerators and/or freezers	0.15	0.60%	0.00%	0.60%
Apartments in buildings with 5 or more units	Average room A/C & Other residential A/C and heat pumps	2.75	2.50%	2.50%	5.00%
Apartments in buildings with 5 or more units	Household refrigerators and/or freezers	0.15	0.60%	0.00%	0.60%
Education	Other commercial A/C and heat pumps	13.00	4.00%	4.00%	8.00%
Education	Household refrigerators and/or freezers	0.15	0.60%	0.00%	0.60%
Education	Stand-alone retail refrigerators and freezers	0.40	1.00%	0.00%	1.00%
Education	Walk-in refrigerators and freezers	10.00	7.50%	7.50%	15.00%
Food sales	Other commercial A/C and heat pumps	13.00	4.00%	4.00%	8.00%
Food sales	Stand-alone retail refrigerators and freezers	0.40	1.00%	0.00%	1.00%
Food sales	Supermarket refrigeration and condensing units	1,360.00	16.50%	16.50%	33.00%
Food sales	Walk-in refrigerators and freezers	10.00	7.50%	7.50%	15.00%
Food service	Other commercial A/C and heat pumps	13.00	4.00%	4.00%	8.00%
Food service	Stand-alone retail refrigerators and freezers	0.40	1.00%	0.00%	1.00%
Food service	Walk-in refrigerators and freezers	10.00	7.50%	7.50%	15.00%
Health care - Inpatient	Household refrigerators and/or freezers	0.15	0.60%	0.00%	0.60%
Health care - Inpatient	Stand-alone retail refrigerators and freezers	0.40	1.00%	0.00%	1.00%
Health care - Inpatient	Walk-in refrigerators and freezers	10.00	7.50%	7.50%	15.00%

Land Use Type	Equipment Type	Refrigerant Charge (kg)	Leak Rate	Service Rate	Total Leak Rate[1]
Health care - Inpatient	Other commercial A/C and heat pumps	13.00	4.00%	4.00%	8.00%
Health care - Inpatient	Chillers	500.00	2.00%	2.00%	4.00%
Health care - Outpatient	Household refrigerators and/or freezers	0.15	0.60%	0.00%	0.60%
Health care - Outpatient	Other commercial A/C and heat pumps	13.00	4.00%	4.00%	8.00%
Lodging	Other commercial A/C and heat pumps	13.00	4.00%	4.00%	8.00%
Lodging	Walk-in refrigerators and freezers	10.00	7.50%	7.50%	15.00%
Mercantile - Enclosed and strip malls	Other commercial A/C and heat pumps	13.00	4.00%	4.00%	8.00%
Mercantile - Enclosed and strip malls	Stand-alone retail refrigerators and freezers	0.40	1.00%	0.00%	1.00%
Mercantile - Enclosed and strip malls	Walk-in refrigerators and freezers	10.00	7.50%	7.50%	15.00%
Mercantile - Retail (other than mall)	Household refrigerators and/or freezers	0.15	0.60%	0.00%	0.60%
Mercantile - Retail (other than mall)	Other commercial A/C and heat pumps	13.00	4.00%	4.00%	8.00%
Mercantile - Retail (other than mall)	Stand-alone retail refrigerators and freezers	0.40	1.00%	0.00%	1.00%
Mercantile - Retail (other than mall)	Walk-in refrigerators and freezers	10.00	7.50%	7.50%	15.00%
Mobile homes	Average room A/C & Other residential A/C and heat pumps	2.75	2.50%	2.50%	5.00%
Mobile homes	Household refrigerators and/or freezers	0.15	0.60%	0.00%	0.60%
Office	Household refrigerators and/or freezers	0.15	0.60%	0.00%	0.60%
Office	Other commercial A/C and heat pumps	13.00	4.00%	4.00%	8.00%
Other	Other commercial A/C and heat pumps	13.00	4.00%	4.00%	8.00%
Other	Stand-alone retail refrigerators and freezers	0.40	1.00%	0.00%	1.00%
Other	Walk-in refrigerators and freezers	10.00	7.50%	7.50%	15.00%
Public assembly	Other commercial A/C and heat pumps	13.00	4.00%	4.00%	8.00%
Public assembly	Stand-alone retail refrigerators and freezers	0.40	1.00%	0.00%	1.00%

Land Use Type	Equipment Type	Refrigerant Charge (kg)	Leak Rate	Service Rate	Total Leak Rate[1]
Public assembly	Walk-in refrigerators and freezers	10.00	7.50%	7.50%	15.00%
Public order and safety	Other commercial A/C and heat pumps	13.00	4.00%	4.00%	8.00%
Public order and safety	Stand-alone retail refrigerators and freezers	0.40	1.00%	0.00%	1.00%
Religious worship	Other commercial A/C and heat pumps	13.00	4.00%	4.00%	8.00%
Religious worship	Household refrigerators and/or freezers	0.15	0.60%	0.00%	0.60%
Religious worship	Stand-alone retail refrigerators and freezers	0.40	1.00%	0.00%	1.00%
Religious worship	Walk-in refrigerators and freezers	10.00	7.50%	7.50%	15.00%
Service	Other commercial A/C and heat pumps	13.00	4.00%	4.00%	8.00%
Service	Stand-alone retail refrigerators and freezers	0.40	1.00%	0.00%	1.00%
Single-family attached	Average room A/C & Other residential A/C and heat pumps	2.75	2.50%	2.50%	5.00%
Single-family attached	Household refrigerators and/or freezers	0.15	0.60%	0.00%	0.60%
Single-family detached	Average room A/C & Other residential A/C and heat pumps	2.75	2.50%	2.50%	5.00%
Single-family detached	Household refrigerators and/or freezers	0.15	0.60%	0.00%	0.60%
Warehouse and storage	Cold storage	565.00	7.50%	7.50%	15.00%
Warehouse and storage	Other commercial A/C and heat pumps	13.00	4.00%	4.00%	8.00%
Warehouse and storage	Stand-alone retail refrigerators and freezers	0.40	1.00%	0.00%	1.00%

Source: U.S. Environmental Protection Agency (EPA). 2016. *Accounting Tool to Support Federal Reporting of Hydrofluorocarbon Emissions: Supporting Documentation*. October 2016. Accessed January 2021. https://www.epa.gov/sites/production/files/2015-09/documents/hfc_emissions_accounting_tool_supporting_documentation.pdf.

A/C = air conditioning; yr = year

[1] Total leak rate is the sum of the operational leak rate and the service leak rate. This total value would only occur in those years in which servicing is required, which may not be every year of the equipment life.