S-3. Require Edible Food Recovery Program Partnerships with Food Generators

GHG Mitigation Potential

99%

Up to 99% of GHG emissions associated with edible food waste

Co-Benefits (icon key on pg. 34)

Climate Resilience

Food recovery programs can have health benefits and improve community resilience. Additionally, food recovery conserves resources, reduces waste, and lowers methane emissions.

Health and Equity Considerations

Edible foods diverted from landfills and redistributed for consumption can increase community food security and improve the nutritional status of vulnerable populations.

Measure Description

This measure requires that food service establishments, wholesale providers, and retail sources of edible food waste partner with food recovery programs. Food recovery programs collect edible foods, which would otherwise be landfilled or composted, from commercial production and distribution channels and redistribute the food for consumption by those in need. This measure avoids emissions from the decomposition of non-diverted organic material in landfills. This measure's reductions are lifecycle emissions, as it results in reductions in up-stream and down-stream emissions, such as production and transportation related emissions.

Scale of Application

All—Project/Site and Plan/Community

Implementation Requirements

Implementation of this measure requires having data on the following: (1) total edible food recovered, (2) vehicle(s) used for the food recovery and total VMT, and (3) total square footage of the refrigeration systems used and type of refrigerants used.

Cost Considerations

Establishing edible food recovery program partnerships with food generators can generate costs from the collection of edible food. Specifically, edible recovery requires the use of vehicles that have maintenance and fuel costs, electricity costs from the use of large refrigeration systems, costs from refrigerant leakages and recharges, and in some cases, labor costs. However, edible food recovery programs can reduce food costs for households within a community and improve food security.

Expanded Mitigation Options

Pair with Measure E-10, *Procure Electricity from Lower Carbon Intensity Power Supply*, to ensure that the energy supplied to power the electrified equipment has a lower carbon intensity than the local grid, thereby further reducing GHG emissions. Also pair with Measure R-1, *Use Alternative Refrigerants Instead of High-GWP Refrigerants*, to ensure that refrigeration systems are responsible for less emissions and increase the benefit of this measure.

GHG Reduction Formula

$$A=\sum_{E}\left[\left(\frac{G\times H}{L}\right)+\left(\frac{I\times J\times K}{M}\right)\right]$$

$$B=\sum_{F}\left[\left((N\times O+P)\times\left(\frac{Q}{R\times M}\right)\right)+\left(\frac{S\times T\times U}{M}\right)\right]$$

$$C=-\left(\frac{V}{W}\right)\times X$$

$$D= C+ A + B$$

GHG Calculation Variables

ID	Parameter	Value	Unit	Source
Output				
A	GHG emissions from transportation vehicles	[ ]	MT CO_2e/year	calculated
B	GHG emission from refrigeration equipment	[ ]	MT CO_2e/year	calculated
C	GHG emission reductions from recovery of edible food	[ ]	MT CO_2e/year	calculated
D	Net GHG emissions from the recovery of edible foods	[ ]	MT CO_2e/year	calculated
User Inputs				
E	Number and type of identical delivery vehicle(s)	[ ]	unitless	user input and Table S-3.1
F	Number and type and number of identical refrigeration unit(s)	[ ]	unitless	user input and Table S-3.1
H	Average miles per year for the delivery vehicle(s)	[ ]	miles/year	user input
I	Leakage rate of the Transportation Refrigeration Unit (TRU), if applicable	[ ]	%	user input
J	The TRU refrigerant charge size, if applicable	[ ]	lbs/year	user input
N	Volume of refrigeration compartment	[ ]	ft^3	user input

ID	Parameter	Value	Unit	Source
T	Refrigerant charge size, if known	[ ] or Table S-3.1 (Appendix A)	lbs	user input or CARB 2020a
V	Amount of edible food recovered per year	[ ]	lbs	user input
How Constants, Assumptions, and Available Defaults				
G	Delivery vehicle GHG emission factor	Table T-30.2	g CO_2e per mile	CARB 2020b, 2020c, 2020d; U.S. DOE 2021
L	Grams to metric ton conversion factor	1,000,000	g/MT	conversion
K	GWP of refrigerant (default of R-134A is assumed for TRU)	Table R-1.1; default value is 1,430	unitless	IPCC 2007 and WMO 2018
M	Pounds to metric ton conversion factor	2,204.62	lbs/MT	conversion
O	Electricity consumption of refrigeration unit per year per cubic feet	Table S-3.1	kWh/year per ft^3	CARB 2020e and 10 CFR 431.66
P	Constant electricity consumption of a refrigeration unit per year	Table S-3.1	kWh/year	CARB 2020e and 10 CFR 431.66
Q	Carbon intensity of local electricity provider	Table E-4.3 and Table E-4.4	lbs CO_2e per MWh	CA Utilities 2021
R	Converting MWh to kWh	1,000	kWh/MWh	conversion
S	Annual Average Leakage rate per year of the refrigeration unit	Table S-3.1	%	CARB 2020e
U	GWP of refrigerant	Table R-1.1	unitless	IPCC 2007 and WMO 2018
W	Pounds to short ton conversion factor	2,000	lbs/ton	Conversion
X	Edible food waste recovery emission reduction factor (Landfill or Composting)	1.78 (Landfill) 1.49 (Composting)	MT CO_2e/ton	CARB 2020f and Venkat 2012

Further explanation of key variables:

- (E) – The type of delivery vehicles that are supported for this measure are provided in Table S-3.1 in Appendix A. The user will need to specify how many of the individual delivery vehicle types are being used and run different calculations for each different type of delivery vehicle. The equation cannot be run without specifying (1) the delivery vehicle from Table S-3.1, and (2) the number of delivery vehicles.
- (F) – The type of refrigeration units that are supported for this measure are provided in Table S-3.1 in Appendix A. The user will need to specify how many of the individual refrigeration unit types are being used and run different calculations for each different

type of refrigeration unit. The equation cannot be run without specifying the (1) type of refrigeration unit from Table S-3.1, and (2) the number of refrigeration units.

- (G) – This value is used to calculate the emissions generated by delivery vehicles transporting the recovered food. Delivery vehicle GHG emission factors (grams CO_2e per mile) are provided in Table T-30.2 in Appendix C.
- (H) – This input represents the number of miles traveled by the delivery vehicle(s) used to transport the recovered food.
- (I) – This value represents the rate at which refrigerants leak from the transportation refrigeration unit in the delivery vehicle.
- (J) – This value represents the quantity of refrigerants used in the delivery vehicles.
- (K) – This value is the GWP for the refrigerants used in the delivery vehicles. GWP values are provided in Table R-1.1 in Appendix C.
- (N) – This value represents the volume of the refrigeration compartment used to store the recovered food.
- (O) – This value is used to calculate the emissions generated by refrigeration units where the recovered food is stored. The electricity consumption of the refrigeration unit per year per cubic feet are provided in Table S-3.1 in Appendix A.
- (P) – This value is used to calculate the quantity of energy consumed in the refrigeration units. The constant electricity consumption of a refrigeration unit per year are provided in Table S-3.1 in Appendix A.
- (Q) – Electricity GHG emission factors for the different utilities inCalifornia are provided in Tables E-4.3 and Table E-4.4 in Appendix C.
- (S) – This value represents the rate at which refrigerants leak from the refrigeration unit.
- (T) – This value represents the quantity of refrigerants used to store the recovered food.
- (U) – This value is the GWP for the refrigerants used in the refrigeration storage units. GWP values are provided in Table R-1.1 in Appendix C.
- (X) – This value represents the lifecycle GHG emissions that are reduced from one short ton of recovered food from a landfill or from a composting facility.

GHG Calculation Caps or Maximums

Measure Maximum

None. However, it is possible that the GHG emissions from transportation and refrigeration use exceed the emission reduction from the edible food recovery, resulting in a disbenefit for this measure.

Example GHG Reduction Quantification

A food bank located in the City of Los Angeles with a 960 cubic feet commercial walk-in refrigerator with solid doors (F, N) is recovering edible food waste from local restaurants. Based on the collection in 2023, the food bank is estimating that it will be able to recover and donate approximately 25,000 pounds of edible food in 2025 from the local restaurants (V). The food bank will be using a gasoline refrigerated van (E) to recover the edible food. The food bank is anticipating that the total distance traveled per day is approximately 20 miles, or approximately 7,300 miles per year (H). Following the equations above, the recovery of the 25,000 pounds of edible food would result in a reduction of 5.98 $MTCO_2e$/year.

The following default values from tables in Appendix C are used.

- Carbon intensity of 556.3 grams CO_2e per mile for the gasoline refrigerated van (G).
- The average yearly leakage rate of 24 percent (RLeak), which is modeled as a percentage in the formula (i.e., 0.24).
- The average yearly refrigerant charge size of 4 lbs (J).
- The global warming potential (GWP) of 1,430 for R-134A (K).
- The electricity consumption per year per cubic foot of 36.5 kWh/year/ft^3 for the commercial refrigerator with solid doors (O).
- The yearly constant electricity consumption of 744.6 kWh/year (P).
- The Los Angeles Department of Water & Power carbon intensity of electricity of 694 lbs CO_2e per MWh (Q).
- The leakage rate of 15 percent for commercial refrigerators (S).
- The average yearly refrigerant charge size of 31.4 pounds (T).
- The GWP of 150 for refrigeration unit refrigerants (U) was assumed.
- The edible food waste recovery emission reduction factor of 1.78 MT CO_2e /ton (X).

$$A=\sum_{1}\left[\left(\frac{556.3\text{ g }CO_2e/\text{mi}\times\mathbf{7{,}300\text{ mi/year}}}{1{,}000{,}000\text{ g/MT}}\right)+\left(\frac{\mathbf{0.24}\times\mathbf{4\text{ lbs/yr}}\times1{,}430}{2{,}204.62\text{ lbs/MT}}\right)\right]$$

A= 4.68 $MTCO_2e$/yr

$$B=\sum_{1}\left[\left(\left((\mathbf{960ft^3}\times36.5\text{ kWh/year/ft}^3)+744.6\text{ kWh/year}\right)\times\left(\frac{694\text{ lbs }CO_2e/\text{MWh}}{2{,}204.62\frac{\text{lbs}}{\text{MT}}\times1{,}000\text{ kWh/MWh}}\right)\right)+\left(\frac{0.15\times\mathbf{31.4\text{ lbs/year}}\times150}{2{,}204.62\text{ lbs/MT}}\right)\right]$$

B= 11.59 $MTCO_2e$/year

$$C=-\left(\frac{\mathbf{25{,}000\text{ lbs}}}{2{,}000\text{ lbs/ton}}\right)\times1.78$$

C = -22.25 $MTCO_2e$/year

D= -22.25 $MTCO_2e$/year+4.68 $MTCO_2e$/year+11.59 $MTCO_2e$/year

D=- 5.98 $MTCO_2e$/year

Quantified Co-Benefits

Improved Air Quality

Edible food recovery may improve air quality emissions by reducing the total amount of organic waste that would be flared at a local landfill, by reducing electricity demand, and by reducing transportation emissions from collecting food waste and transporting waste to a landfill.

Criteria Pollutant Emission Reduction Formula

$$A2=\sum_{E}\left[\left(\frac{G\times H}{I}\right)\right]$$

$$B2=\sum_{F}((J\times K+L)\times M)$$

$$C2=-\left(\left(\frac{N}{O}\right)\times P\right)+\left(\left(\frac{N}{O}\right)\times Q\right)$$

$$D2=C2+A2+B2$$

Criteria Pollutant Emissions Increase Calculation Variables

ID	Parameter	Value	Unit	Source
Output				
A2	Air quality emissions from transportation vehicles	[ ]	lbs/year	calculated
B2	Air quality emission from refrigeration equipment	[ ]	lbs/year	calculated
C2	Air quality emission reductions from recovery of edible food	[ ]	lbs/year	calculated
D2	Air quality emissions from the recovery of edible foods	[ ]	lbs/year	calculated
User Inputs				
E	Number and type of identical delivery vehicle(s)	[ ]	unitless	user input and Table S-3.1
F	Number and type of identical refrigeration unit(s)	[ ]	unitless	user input and Table S-3.1
H	Average miles per year for the delivery vehicle(s)	[ ]	miles/year	user input
J	Volume of refrigeration compartment	[ ]	ft^3	user input
N	Amount of edible food rescued	[ ]	lbs	user input
How Constants, Assumptions, and Available Defaults				
G	ROG, NOX, PM2.5, and diesel PM10 exhaust emission factors	EMFAC2021	g/miles	CARB 2023
I	Grams to pounds conversion factor	453.6	g/lbs	conversion
F2	Type of refrigeration units	Table S-3.1	unitless	CARB 2020b
K	Electricity consumption of refrigeration unit per year per feet	Table S-3.1	kWh/year per ft^3	CARB 2020b
L	Constant electricity consumption of a refrigeration unit per year	Table S-3.1	kWh/Year	CARB 2020b
M	Electricity air quality emission factor	Table S-3.2	lbs/kWh	CAPCOA 2021
O	Pounds to short ton conversion factor	2,000	lbs/ton	conversion
P	Avoided transportation for food waste emissions reduction factor	Table S-3.2	lbs/ton	CARB 2020b
Q	Avoided landfill flare emission reduction factor	Table S-3.2	lbs/ton	CARB 2020b

Sources

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