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HRGP Emissions Impact Study
prepared for the California Department of Food and Agriculture

v1

Glossary (Part 1)

HRGP: Healthy Refrigeration Grant Program

Greenhouse Gas: A gas in the Earth's atmosphere that traps heat, contributing to the greenhouse effect.

tCO2e: Stands for 'tonnes of carbon dioxide equivalent', a unit of measurement used to compare the global warming potential of different greenhouse gases (such as refrigerants).

Self contained: A type of refrigeration system where all the necessary components are housed within a single unit making it a standalone solution that can be easily plugged in and used without the need for additional external components or complex installation.

Condensing unit: A condensing unit is a type of refrigeration system that combines a compressor and condenser into a single outdoor unit. It's commonly used in split systems where the evaporator is located indoors and the condensing unit is placed outside.

Glossary (Part 2)

Global Warming Potential (GWP): A measure of how much a given mass of greenhouse gas is estimated to contribute to global warming. It compares the heat-trapping ability of a specific greenhouse gas to that of carbon dioxide (CO_2) over a defined period, typically 100 years. Refrigerants often have global warming potentials thousands of times greater than CO_2.

Refrigerant Charge: Refers to the specific amount of refrigerant gas required to operate a refrigeration or air conditioning system effectively.

Introduction

The Healthy Refrigerant Grant Program has provided grants for refrigeration equipment to stock California-grown fresh produce, nuts, dairy, meat, eggs, minimally processed, and culturally appropriate foods in corner stores, small businesses, and food donation programs in low-income or low-access areas throughout the state.

The program has incentivized and required the use of the most climate-friendly refrigeration options available to limit the climate impact from indirect (energy use) and direct emissions (refrigerant leakage). The RFA (request for application) laid out equipment guidelines to support this effort including requiring units have the lowest GWP (global warming potential) refrigerant possible and requiring units to have doors or night curtains to improve energy efficiency.

This report estimates the future reduction in direct (refrigerant leakage) and indirect emissions (associated with energy usage) that may be achieved as a result of this program.

Refrigeration System Emissions - Direct

Refrigeration systems emit both direct and indirect greenhouse gases.

1. **Lifetime Direct Emissions** occur when refrigerants leak, whether during operation or at end of life with their impact depending on the refrigerant GWP (Global Warming Potential), leak rate, and charge. Common refrigerants are thousands of times more potent than CO_2 but using low-GWP refrigerants significantly reduces these emissions.

Lifetime Direct Emissions (tCO2e) = Operational emissions + End of Life emissions

Operational emissions = GWP x Charge (tonnes) x Operational Leak Rate (%) x Lifetime (yrs)

End of life emissions = GWP x Charge (tonnes) x End of Life Leak Rate (%)

Refrigeration System Emissions - Indirect

2. **Indirect emissions** come from the electricity used to power refrigeration systems, varying by region based on the energy mix of the power grid. These emissions can be reduced by using energy-efficient equipment and adopting efficiency-improving practices.

Lifetime Indirect emissions (tCO2e) = Energy use (kWh) x Grid Emission factor (tCO2e/kWh)

Method for Estimating Direct Emissions Reductions

1. Grant-funded equipment has been grouped according to the type of equipment; self contained/small retail food, condensing units, transport refrigeration or refrigerated food processing and dispensing equipment.

2. Using this categorization, the global warming potential, charge (weight of refrigerant contained in the system), leak rate (annual and end-of-life) and lifetime could be estimated using information provided by the US GHG Inventory vintaging model and thus the direct emissions estimated.

3. The potential direct emission reduction could be determined by comparing the emissions of the new equipment with either a generic new market option (a unit the grantee would have ordinarily purchased without the grant program) or existing option (if the grantee had existing equipment).

Method for Estimating Indirect Emissions Reductions

1. To estimate the energy savings as a result of the grant program equipment was again categorized into whether the equipment was an 'energy star' unit (products that meet strict energy-efficiency guidelines set by the EPA), or whether it has night blinds.

2. Energy star units are on average 20% more energy efficient than generic market options and night blinds have been estimated to save on average 628 kWh/ft/yr of the energy use of an open-air case.

3. The indirect emission savings could therefore be estimated from the daily energy use (of those grant-funded units that are energy star) and the size of an open-air case for those units with night curtains.

Results

Summary Table of Grants Awarded

Equipment Category	Refrigerant	GWP	Energy Saving Category	Number of units	Percentage of units
Condensing Units (Medium Retail Food)	R-290	3	Energy Star	2	0.35%
Condensing Units (Medium Retail Food)	R-290	3	Night curtain	1	0.17%
Condensing Units (Medium Retail Food)	R-290	3	No savings	1	0.17%
Condensing Units (Medium Retail Food)	R-448A	1273	Night curtain	1	0.17%
Condensing Units (Medium Retail Food)	R-448A	1273	No savings	15	2.60%
Condensing Units (Medium Retail Food)	R-744	1	No savings	3	0.52%
Refrigerated Food Processing and Dispensing Equipment	R-290	3	No savings	1	0.17%
Small Retail Food	R-290	3	Energy Star	357	61.87%
Small Retail Food	R-290	3	Night curtain	24	4.16%
Small Retail Food	R-290	3	No savings	134	23.22%
Small Retail Food	R-32	675	No savings	7	1.21%
Small Retail Food	R-448A	1273	Night curtain	1	0.17%
Small Retail Food	R-448A	1273	No savings	9	1.56%
Small Retail Food	R-600a	1	No savings	14	2.43%
Small Retail Food	R-744	1	No savings	2	0.35%
Transport Refrigeration	N/A	0	No savings	3	0.52%
Transport Refrigeration	R-290	3	No savings	2	0.35%

Reduction in Direct Carbon Emissions

The expected reduction in direct emissions has been determined by comparing the estimated lifetime direct emissions with and without the grant program.

Lifetime direct emissions <u>without grant program</u>: 2,589 tCO2e

- Average GWP of existing equipment is 1,413
- Average GWP of generic market equipment is 516

Lifetime direct emissions <u>with grant program</u>: 393 tCO2e

- Average GWP of grant-funded equipment is 193

<u>Lifetime direct emission saving: 2,196 tCO2e</u>

<u>Equivalent to emissions from 458 homes' electricity use for 1 year[1]</u>

Reduction in Indirect Carbon Emissions

The expected reduction in indirect emissions has been determined by comparing the estimated lifetime indirect emissions with and without the grant program.

Indirect emissions (lbs CO2e) = Energy use (kWh) x Grid Emission factor (lbs CO2e/kWh)

Total lifetime estimated energy savings = 3,115,527 kWh

- Energy star units are on average 20% more efficient than their traditional counterparts.
- Night curtains, assuming they are used for 12 hours per day are estimated to save 628 kWh/ft of case.

California grid emission factor = 497.4 lbs CO2/MWh

Lifetime indirect emission saving = 703 tCO2e

Equivalent to the emissions from 147 homes' electricity use for 1 year*

[1] EPA Emissions Factor Hub

Conclusions

- Over 90% of grants awarded were for small retail food equipment (self contained)
- Of these a significant proportion were 'energy star' units which are 20% more efficient than their counterparts
- All open cases were required to have a night curtain, further increasing energy efficiency
- Over 90% of grant-funded equipment utilizes R-290, a low global warming potential hydrocarbon refrigerant. This is the major driver behind the direct emission saving.
- The total forecasted direct and indirect carbon emission saving as a result of the Healthy Refrigeration Grant Program is <u>2815 tCO2e; equivalent to emissions from 605 homes' electricity use for 1 year.</u>

Note: With regards to indirect emissions, this study focused on emissions associated with electricity generation. It is likely however that there are considerable more emissions that will be saved from encouraging the stocking of locally grown produce. Food will travel less miles from farm to fork and the food will likely also have considerably less emissions associated with it's production, coming from smaller farms which use less fertilizer and pesticides.

Appendix

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Assumptions/Caveats (Part 1)

1. Units listing 'hydrocarbons' as the refrigerant are assumed to use propane or a refrigerant with the same GWP.
2. Refrigerants listed as 'R-774 and R-775' are assumed to be R-744 (CO2).
3. Refrigerants listed as 'R-291, R-209' are assumed to be R-290 (Propane).
4. Whether a grantee has existing refrigeration that is being replaced has been estimated from the list of awardees on CDFA's website.
5. The US GHG inventory has been used to provide charge, leak rates and GWPs of equipment. These are generic values applicable to categories of equipment e.g. small retail food. The categories have been applied to the list of grant-funded equipment. The assumption is that the charge, leak rates and GWPs provided are representative of the grant-funded equipment.
6. Average Energy Star savings as listed on their website are assumed to be the same as the energy star equipment that has been awarded.
7. Manufacturing emissions have been excluded from the report due to insufficient access to data. However the emission differences associated with manufacturing new equipment or existing equipment are assumed to be minimal.

Assumptions/Caveats (Part 2)

8. Equipment not on [Energy star's database](#) are assumed to have no energy savings associated with them.
9. The solar kit has been excluded from the analysis as it is not evident what refrigeration unit it will be used to power.
10. Non refrigerant containing equipment is excluded from the direct emission analysis (the leak rate etc is applied to the refrigeration system e.g. the condensing unit that feeds the case)

Sources

1. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2022 – Annex 3 Part A (epa.gov)
2. Commercial and retail refrigeration equipment: Technology information leaflet ECA769 - Carbon Trust
3. Energy star savings and database
4. EPA emission factors hub

Night curtain savings calculation

Example Case Details

Length of case = 8.2ft

Daily energy consumption = 35.3 kWh

Yearly energy consumption = 12884.5 kWh

Savings with Night Curtain*

Annual savings: 5154 kWh

Annual savings/ft of case: 628 kWh

*Assuming the night curtain is used for 12 hours per day.