California Air Resources Board

Co-benefit Assessment Methodology for Energy and Fuel Cost Savings

California Climate Investments
Greenhouse Gas Reduction Fund

FINAL
July 2, 2024

Table of Contents

List of Acronyms and Abbreviations

Acronym	Term
AB	Assembly Bill
B5	Biodiesel fuel blend of 5% biodiesel fuel and 95% diesel or other hydrocarbon by volume
B20	Biodiesel fuel blend of 20% biodiesel fuel and 80% diesel or other hydrocarbon by volume
Btu	British thermal unit
CARB	California Air Resources Board
CARE	California Alternate Rates for Energy
CNG	compressed natural gas
DGE	diesel gallon equivalent
E85	Ethanol fuel blend of 85% ethanol fuel and 15% gasoline or other hydrocarbon by volume
EF	energy and fuel
Funding Guidelines	Funding Guidelines for Agencies Administering California Climate Investments
GGE	gasoline gallon equivalent
GGRF	Greenhouse Gas Reduction Fund
GHG	greenhouse gas
IOU	investor-owned utility
kWh	kilowatt hour
LNG	liquefied natural gas
MPGGE	miles per gallons of gasoline equivalent
scf	standard cubic foot
UC Berkeley	University of California, Berkeley
VMT	vehicle miles traveled

Section A. Introduction

The goal of California Climate Investments is to reduce GHG emissions and further the objectives of the California Global Warming Solutions Act of 2006, AB 32. CARB is responsible for providing guidance on reporting and quantification methods for all State agencies that receive appropriations from the Greenhouse Gas Reduction Fund. Guidance includes developing methodologies for estimating GHG emission reductions and other economic, environmental, and public health benefits of projects, referred to as "co-benefits."

The Center for Resource Efficient Communities at UC Berkeley, in consultation with CARB staff, developed this Co-benefit Assessment Methodology to estimate energy and fuel cost savings for relevant California Climate Investments programs.

Co-benefit Assessment Methodologies are intended for use by administering agencies, project applicants, and/or funding recipients to estimate the outcomes of California Climate Investments. Co-benefit estimates can be used to inform project selection and track results of funded projects. In addition to this methodology, general guidance on assessing California Climate Investment co-benefits is available in CARB's Funding Guidelines for Agencies Administering California Climate Investments (Funding Guidelines).

Energy and Fuel Cost Savings Co-benefit Description

Energy and fuel cost savings refers to a change in the overall cost of energy or fuel to project applicants and funding recipients as a result of a California Climate Investments project. Energy and fuel costs are affected by energy and fuel prices, fuel and equipment efficiency, and average useful lifetimes of equipment. This methodology uses the most up-to-date energy and fuel price data available at the time of publication; CARB may modify default price values as the original source material is updated.

California Climate Investments can cause positive or negative energy and fuel cost savings co-benefits. These co-benefits may accrue directly (as a central objective of the project) or indirectly (as a consequence of project activities).

A ***positive*** energy and fuel cost savings co-benefit results when a California Climate Investments project decreases the total cost of energy or fuel used within the project area, by: a) reducing total energy or fuel consumption; b) converting to a less expensive or more efficient energy or fuel source; c) generating less expensive renewable energy or fuel; d) offsetting costs associated with increased consumption or generation of energy or fuel via additional revenue, such as transit fares or sale of surplus energy or fuel.

A ***negative*** energy and fuel cost savings co-benefit results when a California Climate Investments project increases the total cost of energy or fuel used within the project area, by: a) increasing total energy or fuel consumption without offsetting costs via additional revenue; b) converting to a more expensive energy or fuel source; or c) generating more expensive renewable energy or fuel without offsetting costs via additional revenue.

Energy and Fuel Cost Savings Co-benefit Project Categories

This Co-benefit Assessment Methodology may apply to California Climate Investments[1] projects that involve:

- Transit service expansion;
- Fuel switching;
- Energy or fuel efficiency measures;
- Energy or fuel savings measures; and
- Renewable energy generation.

California Climate Investments that result in energy and fuel cost savings fall into three categories covered by this Co-benefit Assessment Methodology.

Project Category 1. Change in Energy Use or Fuel Use: Projects that either increase or decrease the total quantity of energy or fuel used.

Project Category 2. Energy or Fuel Type Conversion: Projects that convert to an alternative energy or fuel source.

Project Category 3. Renewable Energy or Fuel Generation: Projects that generate renewable energy or fuel.

A single California Climate Investments project may fall into more than one of the above categories. In such cases, users should estimate the cost savings from each and add them together.[2]

For transit projects, this methodology is intended for use by transit agencies or operators only. Cost savings for commuters is estimated using the Travel Cost Savings Co-benefit Assessment Methodology[3] and are not included here to avoid double-counting of co-benefits.

---

[1] This list is based on project types funded by the Greenhouse Gas Reduction Fund as of June 2023 and may be modified as California Climate Investments evolve or expand.

[2] To avoid double counting, each project component that results in energy and fuel use change should be calculated in only one project category.

[3] California Air Resources Board. Travel Cost Savings Co-benefit Assessment Methodology. www.arb.ca.gov/cci-cobenefits

Methodology Development

UC Berkeley developed this Co-benefit Assessment Methodology, consistent with the guiding principles of California Climate Investments. The methodology is developed to:

- Support calculating the applicable co-benefits for individual projects;
- Apply to the project types proposed for funding;
- Provide uniform methods that can be applied statewide and are accessible by all applicants and funding recipients;
- Use existing and proven tools or methods, where available;
- Include the expected period of time for when co-benefits will be achieved; and
- Identify the appropriate data needed to calculate co-benefits.

UC Berkeley assessed peer-reviewed literature and consulted with experts, as needed, to identify:

- The direction and magnitude of the co-benefit;
- Project types to which the co-benefit is relevant;
- The limitations of existing empirical literature;
- Existing assessment methods and tools; and
- Knowledge gaps and other issues to consider in developing co-benefit assessment methods.

This work is summarized in a literature review on this co-benefit, available on the California Climate Investments Co-benefit Assessment Methodologies webpage. UC Berkeley also considered ease of use, specifically the availability of project-level inputs from users for the applicable California Climate Investments programs.

CARB released the Draft Energy and Fuel Cost Savings Co-benefit Assessment Methodology for public comment in June 2024. This Final Energy and Fuel Cost Savings Co-benefit Assessment Methodology has been updated to address public comments, where appropriate. CARB staff periodically review each methodology to evaluate its effectiveness and update methodologies to make them more robust, user-friendly, and appropriate to the projects being quantified.

Administering agencies, project applicants, and/or funding recipients estimate GHG emission reductions using CARB GHG Quantification Methodologies and Calculator Tools. Some of the data used for estimating GHG emission reductions may also be used to estimate energy and fuel cost savings co-benefits. CARB anticipates incorporating methods used to estimate the energy and fuel cost savings co-benefit into CARB Calculator Tools.

Updates

CARB staff periodically review each methodology to evaluate its effectiveness and update methodologies to make them more robust, user-friendly, and appropriate to the projects being quantified. CARB updated the Co-benefit Assessment Methodology for Energy and Fuel Cost Savings from the previous version to enhance the analysis and provide additional clarity. The changes include:

- Updated fuel and energy costs to 2021 and 2022 annual averages; and
- Added fuel costs for aviation fuels.

Program Assistance

For assistance with this Co-benefit Assessment Methodology, send questions to the GGRF email. For more information on CARB's efforts to support implementation of California Climate Investments, visit the California Climate Investments webpage.

Section B. Co-benefit Assessment Methods

This section describes how users estimate energy and fuel cost savings co-benefits by project category. Overall, the methods for assessing the energy and fuel cost savings are quantitative, amounting to estimating the change in energy or fuel use during the project quantification period[4] compared to a no-project scenario and multiplying by the corresponding average energy or fuel price: dollars per kilowatt hour (kWh), standard cubic foot (scf), gallon, gasoline gallon equivalent (GGE),[5] diesel gallon equivalent (DGE),[6] or therm.

Additional information about the specific data inputs (e.g., default values and data sources) is provided in Section C and Appendix A. Examples of how to apply the methods and data inputs needed for Project Categories 1, 2, and 3 are provided in Appendices B, C, and D respectively.

Project Category 1. Change in Energy Use or Fuel Use

Project Category 1 includes projects that result in an increase or decrease in the total quantity of energy or fuel used by the applicant or funding recipient.

Equation 1 estimates the energy and fuel cost savings co-benefits for California Climate Investments in Project Category 1.

[4] The project quantification period varies for the different programs and is defined in each of CARB's GHG Quantification Methodologies and Calculator Tools.

[5] GGE is used for Compressed Natural Gas (CNG).

[6] DGE is used for Liquefied Natural Gas (LNG).

Equation 1: Energy and Fuel Cost Savings from Changes in Energy or Fuel Use

$$EF\ Cost\ Savings\ or\ Increase = \sum(EF\ Use\ Change_{EF\ type} \times EF\ Price_{EF\ type}) + Fare$$

Table 1. Variables for Equation 1

Variable	Variable Definition	Units
EF Cost Savings or Increase	Energy and fuel (EF) cost savings or cost increase during the project quantification period as a result of the project. Cost savings should be reported as a positive (+) dollar value and cost increase should be reported as a negative (-) dollar value.	$
EF Use Change$_{EF\ type}$	Estimated change in energy or fuel use during the project quantification period (kWh, scf, gallons, GGE, DGE, or therm).	unit
EF Price$_{EF\ type}$	Average energy or fuel unit price (dollars per kWh, scf, gallon, GGE, DGE, or therm).	$/unit
Fare	Estimated increase in revenue from transit fares associated with increased ridership during the quantification period as a result of the project (For transit projects only).	$

Project Category 2. Energy or Fuel Type Conversion

Project Category 2 includes projects that convert from using conventional energy or fuels to an alternative energy or fuel source.

Equation 2 estimates the energy or fuel cost savings co-benefits for California Climate Investments in Project Category 2.

Equation 2: Energy and Fuel Cost Savings from Energy or Fuel Conversion

$$EF\ Cost\ Savings\ or\ Increase = (EF\ Use_{Conv} \times Price_{Conv}) - (EF\ Use_{Alt} \times Price_{Alt})$$

Table 2. Variables for Equation 2

Variable	Variable Definition	Units
EF Cost Savings or Increase	Energy and fuel (EF) cost savings or cost increase during the project quantification period as a result of the project. Cost savings should be reported as a positive (+) dollar value and cost increase should be reported as a negative (-) dollar value.	$
$EF\ Use_{Conv}$	Quantity of conventional fuel that would be used during the project quantification period in the absence of the project (gallons, GGE, DGE, kWh, scf, therm, or cord).	unit
$EF\ Use_{Alt}$	Quantity of alternative energy or fuel used during the project quantification period with the project (gallons, GGE, DGE, kWh, scf, or therm).	unit
Price	Average unit price for the conventional or alternative energy or fuel.	$/unit

Project Category 3. Renewable Energy or Fuel Generation

Project Category 3 includes projects that generate renewable energy or fuel.

Equation 3 estimates the energy of fuel cost savings co-benefits for California Climate Investments in Project Category 3.

Equation 3: Energy and Fuel Cost Savings from Renewable Energy or Fuel Generation

$$EF\ Cost\ Savings\ or\ Increase = (EF\ Gen_{Ren} \times Price_{Conv}) - \ Gen\ Cost_{Ren} + Sales_{Ren}$$

Table 3. Variables for Equation 3

Variable	Variable Definition	Units
EF Cost Savings or Increase	Energy and fuel (EF) cost savings or cost increase during the project quantification period as a result of the project. Cost savings should be reported as a positive (+) dollar value and cost increase should be reported as a negative (-) dollar value.	$
$EF\ Gen_{Ren}$	Quantity of renewable energy or fuel that would be generated during the project quantification period as a result of the project.	unit
$Price_{Conv}$	Average unit price for the conventional energy or fuel displaced by the energy generated.	$/unit
$Gen\ Cost_{Ren}$	Operating costs to generate renewable energy or fuel incurred during the project quantification period, if applicable.	$
$Sales_{Ren}$	Estimated revenue from sale of surplus renewable energy or fuel generated during the project quantification period.	$

When the quantity of renewable energy or fuel is not directly known, it can be calculated based upon converting the quantity of conventional energy or fuel on an energy-equivalent basis using the energy or fuel densities, as shown in Equation 4.

Equation 4: Quantity of Renewable Energy or Fuel Generated

$$EF\ Gen_{Ren} = EF\ Dis_{Conv} \times \left(\frac{ED_{Conv}}{ED_{Ren}}\right)$$

Table 4. Variables for Equation 4

Variable	Variable Definition	Units
$EF\ Gen_{Ren}$	Quantity of renewable energy or fuel that would be generated during the project quantification period as a result of the project.	unit
$EF\ Dis_{Conv}$	Quantity of conventional energy or fuel that would be displaced during the project quantification period as a result of the project.	unit
ED_{Conv}	Energy density of the conventional energy or fuel.	MJ/unit
ED_{Ren}	Energy density of the conventional energy or fuel.	MJ/unit

Section C. Data Requirements and Tools

This section describes the data requirements and tools required for the Energy and Fuel Cost Savings Co-benefit Assessment Methodology. The data that a user will need to provide to apply the methods above will vary by project category and may include the following:

- **Type of energy and/or fuel used:** The type of energy or fuel is provided by the applicant in order to quantify energy or fuel reductions and GHG emission reductions using a CARB Quantification Methodology and Calculator Tool.
- **Quantity of energy and/or fuel used:** Depending upon the project type, the quantity of energy or fuel used is either provided by the applicant in order to quantify energy or fuel reductions and GHG emission reductions using a CARB Quantification Methodology or provided as an output from a CARB Calculator Tool.
- **Average unit cost of energy and/or fuel:** The average cost of energy and fuel unit prices are provided in Appendix A.
- **Fare Revenue:** Transit projects that are expected to increase ridership will estimate the revenue associated with that increase using the same ridership estimates used to estimate GHG emission reductions. Users will multiply the increase in transit ridership (trips) during the project quantification period by the average transit system one-way fare ($ per trip). Fare revenue is $0 if no increase in transit ridership is expected.
- **Type of energy and/or fuel generated:** The type of energy or fuel is provided by the applicant in order to quantify energy or fuel reductions and GHG emission reductions using a CARB Quantification Methodology and Calculator Tool.
- **Quantity of energy and/or fuel generated:** The quantity of energy or fuel generated is provided as an output from a CARB Calculator Tool.
- **Cost of generating renewable energy and/or fuel:** The cost of generating alternative energy or fuel during the project quantification period (dollars) is the operating cost (as opposed to the capital cost) of the system incurred during that period. For example, for energy produced from methane, this is an estimate of the cost of production, capture, handling, and combustion of methane gas); for energy produced from a solar PV system, this is an estimate of the maintenance costs that may be incurred.
- **Revenue from the sale of surplus renewable energy or fuel:** If the project will generate surplus renewable energy or fuel and has existing contracts for the sale of that surplus, enter the expected revenue. Revenue is the estimated surplus amount (unit of energy) multiplied by the per unit cost ($ per unit)

When inputs required to estimate the energy and fuel cost savings are inputs to, or outputs from, a CARB GHG Quantification Methodology or Calculator Tool (e.g., energy savings), the values used in estimation of GHGs and this co-benefit must be identical.

Appendix A. Average Energy and Fuel Prices

West coast average unit prices of conventional and alternative fuels are presented below in Table 5. Prices are provided in terms of public and private refueling stations. Public refueling stations are open to the general public, while private fueling stations are privately-owned or available only to selected fleets (e.g., transit agencies, utility operators, government agencies, educational institutions, military facilities).

Table 5. 2023 West Coast average fuel prices[7, 8]

Fuel Type	Retail Station Price	Private Station Price	Units
Gasoline	\$4.92	\$4.42	per gallon
Diesel	\$5.47 \$4.71	\$4.82 \$4.15	per gallon per GGE
Compressed Natural Gas (CNG)	\$3.86	\$2.86	per GGE
Liquefied Natural Gas (LNG)	\$5.68 \$4.89	\$3.12 \$2.69	per DGE per GGE
Ethanol (E85)	\$3.47 \$4.64	\$4.74 \$6.33	per gallon per GGE
Propane	\$3.78 \$4.89	\$3.72 \$4.80	per gallon per GGE
Biodiesel (B5/B20)	\$4.71 \$4.11	\$4.03 \$3.51	per gallon per GGE
Hydrogen	\$26.59 \$25.66	N/A	per kilogram per GGE

West Coast and US average prices for aviation fuels are presented in Table 6.

Table 6. Average aviation fuel prices[9]

Fuel Type	US Retail Price	West Coast Retail Price	Units
Aviation Gasoline	\$3.73	N/A	per gallon
Kerosene-Type Jet Fuel	\$2.22	\$2.20	per gallon

[7] U.S. Department of Energy (average from January 2023 to October 2023). The West Coast region defined by the U.S. Energy Information Administration includes California, Oregon, Washington, Nevada, Arizona, Hawaii, and Alaska.
[8] GGE are calculated based upon fuel specific energy densities contained in the CCI Quantification Methodology Emission Factor Database. www.arb.ca.gov/cci-quantification
[9] U.S. Energy Information Administration (average from April 2021 to March 2022). The West Coast region defined by the U.S. Energy Information Administration includes California, Oregon, Washington, Nevada, Arizona, Hawaii, and Alaska.

California average unit prices of electricity and natural gas, to customers by end-use sector are presented in Table 7 and Table 8. Prices for low-income residential customers are calculated based upon discount rates provided by large investor-owned utility companies (IOUs) through the California Alternate Rates for Energy (CARE) Program. Note that public utility agencies and smaller IOUs may provide their own low-income rate programs and vary by structure and incentive amount. To provide a consistent, conservative estimate that would apply to the majority of Californians, the CARE rates for large IOUs are used.

Table 7. 2023 California average price of electricity to customers by end-use sector[10, 11, 12]

Sector	Standard Customers		Low-Income Customers	
	$ per kWh	$ per GGE	$ per kWh	$ per GGE
Residential	$0.2891	$9.30	$0.2024	$6.51
Commercial	$0.2370	$7.63		
Industrial	$0.1863	$6.00		
Transportation	$0.1296	$4.17		

Table 8. 2023 California average retail price of natural gas by end-use sector[11, 13]

Sector	Standard Customers		Low-Income Customers	
	$ per 1000 scf	$ per therm	$ per 1000 scf	$ per therm
Residential	$18.49	$1.79	$14.79	$1.43
Commercial	$14.29	$1.38		
Industrial	$12.14	$1.17		

California price estimates for wood, by end-use sector are presented in Table 9.

[10] U.S. Energy Information Administration (2024a). Electricity Data Browser (as of June 5, 2024).
[11] CPUC (2018). Electrical corporations with 100,000 or more customer accounts in California offer low-income customers a minimum 30 percent discount on their electric bill and a 20 percent discount on their natural gas bill through the California Alternate Rates for Energy Program.
[12] Conversion factor: GGE = Electricity kWh x 0.031 (USDOE 2017).
[13] U.S. Energy Information Administration (2024b). Natural Gas Prices (as of June 5, 2024).

Table 9. 2022 California wood price estimates[14, 15]

Sector	$ per million Btu	$ per cord
Residential	$17.59	$351.80
Commercial	$3.35	$67.00
Industrial	$2.99	$59.80

[14] U.S. Energy Information Administration (2024d). State Energy Data System (as of June 5, 2024).
[15] Conversion factor: Cord = 20 million Btu (EIA 2018).

Appendix B. Project Examples

This section provides several examples of how to calculate the energy and fuel cost savings for a variety of project types.

Example Methods and Data Inputs for Project Category 1

The following is a hypothetical project[16] to demonstrate how the Energy and Fuel Cost Savings Co-benefit Assessment Methodology would be used to estimate the benefits of a Transit and Intercity Rail Capital Program project in Project Category 1. This example does not include the supporting documentation that may be required of actual project applicants.

Overview of the Proposed Project

The applicant is proposing the following project components:

- Expand capacity of the regional (commuter) transit orange and purple line by extending the existing daily light rail service; and
- Operate new service for one year.

The proposed project has the following relevant project features:

- Daily light rail service will be extended by 35.5 miles;
- Vehicle type: commuter rail;
- Fuel type: electric (rail service);
- The project quantification period is one year;
- Increase daily one-way ridership by 350 riders; and
- One-way fare is $2.50.

Methods to Apply

Based on project specifications above, this user would use Equation 1 from Section B.

$$EF\ Cost\ Savings\ \text{or}\ Increase = \sum (EF\ Use\ Change_{EF\ type} \times EF\ Price_{EF\ type}) + Fare$$

Step 1: Calculate energy or fuel use for each fuel type during the project quantification period in the absence of the project.

This project is an expansion of new service, so energy and fuel use in the absence of the project is zero.

[16] The hypothetical project has not undergone verification of any program requirements; all assumptions about location type and features are for demonstration purposes only.

Step 2: Calculate project energy or fuel use for each fuel type during the project quantification period with the project.

The daily light rail service will be extended by 35.5 miles, and the service will be daily. First, the annual vehicle miles traveled (VMT) is calculated:

$$VMT = 365 \text{ days} \times 35.5 \frac{vehicle\ miles}{day} = 12{,}957.5\ miles$$

The fuel economy of electric-powered commuter rail, taken from the CARB California Climate Investments Quantification Methodology Emission Factor Database,[17] is 1.56 miles per gallons of gasoline equivalent (MPGGE). The electricity use with the project is then calculated:

$$EF\ Use_{Project} = \frac{12{,}957.5\ miles}{1.56\ MPGGE} = 8{,}306\ GGE$$

Step 3: Calculate EF Use Change$_{\text{Electricity}}$

$$EF\ Use\ Change_{Electricity} = EF\ Use_{Before\ \ Implementation} - EF\ Use_{After\ \ Implementation}$$

$$= 0\ GGE - 8{,}306\ GGE = -8{,}306\ GGE$$

Step 4: Look up EF Price

Look up the electricity price per GGE for transportation using Table 7 in Appendix A.

$$EF\ Price_{Electricity} = 4.17 \frac{dollars}{GGE}$$

Step 5: Calculate Fare Revenue

$$Fare = 2.50 \frac{dollars}{one - way\ trip} \times 2 \frac{trips\ per\ rider}{day} \times 350 \frac{riders}{day} \times 365\ days$$

$$= \$638{,}750$$

Step 6: Calculate EF Cost Savings or Increase

$$EF\ Cost\ Savings\ or\ Increase = EF\ Use\ Change_{\ Electricity} \times EF\ Price_{\ Electricity} + Fare$$

$$= -8{,}306 \text{ GGE} \times 4.17 \frac{dollars}{GGE} + \$638{,}750 = \$604{,}114$$

[17] California Air Resources Board. CCI Quantification, Benefits, and Reporting Materials. www.arb.ca.gov/cci-quantification

In this example, it is estimated that the project would result in a cost savings of $604,114 for the funding recipient during the one-year project quantification period. As noted above, potential transportation cost savings to transit passengers are calculated in the Travel Cost Savings Co-benefit Assessment Methodology.

Example Methods and Data Inputs for Project Category 2

The following is a hypothetical project[18] to demonstrate how the Energy and Fuel Cost Savings Co-benefit Assessment Methodology would be used to estimate the benefits of an Off-Road Vehicle Demonstration Project in Project Category 2. This example does not provide examples of the supporting documentation that may be required of actual project applicants.

Overview of the Proposed Project

The industrial port applicant is proposing the following project components:

- Replace a propane heavy-lift forklift with a hydrogen fuel cell heavy-lift forklift with the same energy requirements.

The proposed project has the following relevant project features:

- The propane forklift has a tier 4 final engine (110 horsepower) with a 19,000 pound lift capacity;
- The propane forklift uses 2.5 gallons of propane per hour and operates for 1,500 hours per year;
- The hydrogen usage of the fuel cell forklift for 1,500 hours of operation per year is 1,200 kg per year, as calculated using the CARB GHG Quantification Methodology and Calculator Tool;
- The facility uses its own private stations to refuel their vehicles; and
- The project quantification period is two years, per the CARB GHG Quantification Methodology and Calculator Tool.

Methods to Apply

Based on the project specifications above, this user would apply Equation 2 from Section B:

$$EF\ Cost\ Savings\ or\ Increase = (Fuel\ Use_{Conv} \times Price_{Conv}) - (EF\ Use_{Alt} \times Price_{Alt})$$

Step 1: Calculate Fuel Use$_{Conv}$ during the project quantification period

$$Fuel\ Use_{Conv} = 2.5\,\frac{gallons\ propane}{hour} \times 1{,}500\,\frac{hours}{year} \times 2\ years = 7{,}500\ gallons\ propane$$

[18] The hypothetical project has not undergone verification of any program requirements; all assumptions about location type and features are for demonstration purposes only.

Step 2: Look up the cost of the conventional energy or fuel

Look up the propane price per gallon for private stations using Table 5 in Appendix A:

$$Price_{Conv} = 3.72 \frac{dollars}{gallon\ propane}$$

Step 3: Calculate EF Use$_{Alt}$ during the project quantification period

The energy or fuel use in the project scenario is calculated within and obtained from the CARB GHG Quantification Methodology and Calculator Tool.

$$Fuel\ Use_{New\ Fuel} = 1{,}200\ \frac{kg}{year} \times 2\ years = 2{,}400\ kg\ hydrogen$$

Step 4: Look up the project cost of the alternative energy or fuel type

Look up the hydrogen price per kg for industrial equipment using Table 5 in Appendix A. The retail price of hydrogen is used as a surrogate due to lack of data for the industrial sector.

$$Price_{New\ Fuel} = 26.59 \frac{dollars}{kg\ hydrogen}$$

Step 5: Calculate EF Cost Savings or Increase

$$EF\ Cost\ Savings\ or\ Increase$$

$$= (Fuel\ Use_{Conv} \times Price_{Conv}) - \ (EF\ Use_{New\ Fuel} \times Price_{\ New\ Fuel})$$

$$= \left(7{,}500\ gallons\ propane \times 3.72 \frac{dollars}{gallon\ propane}\right) - \left(2{,}400\ \text{kg hydrogen} \times 26.59 \frac{dollars}{kg\ hydrogen}\right)$$

$$= (\$27{,}900) - (\$63{,}816) = -\$35{,}916$$

In this example, it is estimated that the project would result in energy and fuel cost increase for the funding recipient of \$35,916 during the two-year project quantification period.

Example Methods and Data Inputs for Project Category 3

The following is a hypothetical project[19] to demonstrate how the Energy and Fuel Cost Savings Co-benefit Assessment Methodology would be used to estimate the benefits of an Organic Waste Anaerobic Digestion Project in Project Category 3. This example does not provide examples of the supporting documentation that may be required of actual project applicants.

Overview of the Proposed Project

The applicant is proposing the following project components:

- Divert organic waste from landfills to a standalone anaerobic digester generating electricity on-site.

The proposed project has the following relevant project features:

- The project is expected to divert and digest 5,000 tons of green and food waste material from landfills per year;
- The project is expected to produce 1,080,000 kWh in energy per year, as calculated using the CARB GHG Quantification Methodology and Calculator Tool;
- The operational costs for the project are $30,000 per year for fuel and labor;
- The project quantification period is ten years, per the CARB GHG Quantification Methodology and Calculator Tool; and
- The project intends to sell surplus energy generated but does not have a contract in place at the time of assessment.

Methods to Apply

Based on the project specifications above, this user would apply Equation 3 from Section B:

$$EF\ Cost\ Savings\ or\ Increase = (EF\ Gen_{Ren} \times Price_{Conv}) - \ Gen\ Cost_{Ren}\ + Sales_{Ren}$$

Step 1: Look up the cost of the conventional energy or fuel

Look up the electricity price per kWh using Table 7 in Appendix A:

$$Price_{Conv} = 0.1863\,\frac{dollars}{kWh\ (industrial)}$$

Step 2: Calculate EF Gen_{Ren} during the project quantification period

[19] The hypothetical project has not undergone verification of any program requirements; all assumptions about location type and features are for demonstration purposes only.

The energy generation in the project scenario is calculated within and obtained from the CARB GHG Quantification Methodology and Calculator Tool.

$$EF\ Gen_{Ren} = 1{,}080{,}000\ \frac{kWh}{year} \times 10\ years = 10{,}800{,}000\ kWh\ electricity$$

Step 3: Calculate Gen $Cost_{Ren}$ during the project quantification period.

$$Gen\ Cost_{Ren} = 30{,}000\ \frac{dollars}{year} \times 10\ years = 300{,}000\ dollars$$

Step 4: Calculate EF Cost Savings or Increase

$$EF\ Cost\ Savings\ or\ Increase = (EF\ Gen_{Ren} \times Price_{Conv}) - (Gen\ Cost_{Ren}) + (Sales_{Ren})$$

$$= \left(10{,}800{,}000\ kWh \times 0.1863\frac{dollars}{kWh}\right) - (300{,}000\ dollars) + 0\frac{dollars}{kWh}$$

$$= (\$2{,}012{,}040) - (\$300{,}000) + \$0 = \$1{,}712{,}040$$

In this example, it is estimated that the project would result in energy and fuel cost savings for the funding recipient of $1,712,040 during the ten-year project quantification period.

Bibliography

California Public Utilities Commission (CPUC). (2018). CARE/FERA Programs. Available at: http://www.cpuc.ca.gov/lowincomerates/

Energy Information Administration (EIA). (2024a). Electricity Data Browser. Pre-generated report 5.6 Average retail price of electricity to ultimate customers by end-use sector, by state. Available at: https://www.eia.gov/electricity/data/browser/#/topic/7?agg=0,1&geo=000000000004&endsec=vg&linechart=ELEC.PRICE.CA-ALL.M&columnchart=ELEC.PRICE.CA-ALL.M&map=ELEC.PRICE.CA-ALL.M&freq=M&ctype=linechart&ltype=pin&rtype=s&pin=&rse=0&maptype=0

Energy Information Administration (EIA). (2024b). Natural Gas Prices. Available at: https://www.eia.gov/dnav/ng/ng_pri_sum_dcu_SCA_m.htm

Energy Information Administration. (2024c). State Energy Data System (SEDS): 1960-2021 (complete). Available at: https://www.eia.gov/state/seds/seds-data-complete.php?sid=CA

Energy Information Administration. (2024d). State Energy Data System (SEDS): 2022 (updates by energy source). Available at: https://www.eia.gov/state/seds/seds-data-fuel.php?sid=CA

Energy Information Administration (EIA). (2023e). Aviation Gasoline Prices. Available at: https://www.eia.gov/dnav/pet/pet_sum_mkt_a_EPPV_PTG_dpgal_m.htm

Energy Information Administration (EIA). (2023f). Kerosene-Type Jet Fuel Prices. Available at: https://www.eia.gov/dnav/pet/pet_sum_mkt_a_EPJK_PTG_dpgal_m.htm

Energy Information Administration. (2016). Monthly Energy Review, November 2016. Appendix A3 for BTU to GGE conversion. Available at: http://www.eia.gov/totalenergy/data/monthly/pdf/sec13_3.pdf

Oak Ridge National Laboratory (ORNL). (2016). Transportation Energy Data Book 35. 2016. Table 2.14. Available at: http://cta.ornl.gov/data/index.shtml

United States Department of Energy (USDOE). (January 2023 – October 2023). Clean Cities Alternative Fuel Price Report. Available at: https://www.afdc.energy.gov/publications/search/keyword/?q=alternative%20fuel%20price%20report