DAS DEPARTMENT OF ADMINISTRATIVE SERVICES
SUSTAINABILITY PROGRAM

State of Oregon
Agency Climate Planning Guidebook

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GHG Inventory Guide

Introduction to the Inventory Process

Good Company partnered with the Oregon Department of Administrative Services (DAS), Oregon Sustainability Board (OSB), and Oregon Department of Transportation (ODOT) on a project to develop a Climate Planning Toolkit and Guidebook for Oregon state agencies. This document represents one of three primary deliverables that include:

- Oregon State Agency Greenhouse Gas (GHG) Inventory and Climate Action Planning Guidebook
- Good Company's Operational Carbon Calculator (G3C-Ops)
- Climate Action Dashboard with Climate Target and GHG Benefit Calculator

These resources are available to Oregon state agencies to support climate action across the state agency enterprise as directed by Governor Brown's Executive Order (EO) 20-04, and the continued leadership of Oregon in addressing climate change. These resources will allow agencies to lead by example by identifying GHG emissions in their operations, setting goals, and identifying actions to reduce emissions. These actions will also help agencies identify efficiencies save money by reducing the direct and indirect use of fossil fuels and other sources of GHGs.

What is a Greenhouse Gas Inventory?

A GHG inventory is an accounting of GHGs emitted to or removed from the atmosphere for a specified period of time by an organization or geographic boundary. Human-made GHGs or climate pollutants are colorless, odorless gases that are the primary drivers of climate change. These gases are in large part from the combustion of fossil fuels, but also include emissions from other sources like industrial production and waste disposal. A GHG inventory measures the weight of defined GHGs and converts them into a common reporting unit, metric tons of carbon dioxide equivalent (MT CO_2e). Public and private organizations use GHG inventories to:

- Understand sources of emissions;
- Set reduction goals;
- Develop reduction strategies; and
- Track progress toward goals over time.

Basic Process Steps

The following list summarizes high-level process steps involved in completing a GHG inventory. This guidebook provides guidance and links to additional resources for each step.

1. Identify relevant protocols and guidance documents
2. Become familiar with basic GHG accounting and reporting concepts
3. Set inventory boundaries
4. Collect data
5. Revisit inventory boundaries
6. Finish data collection
7. Calculate emissions
8. Prepare report
9. Share results with stakeholders
10. Set goals and develop a climate action plan

The steps above imply an inventory is a neat and tidy, linear process, but the reality – especially during a first-time inventory – is more circular for steps 3-7. Agencies may not have readily available and ideal data for a complete GHG inventory. An agency may intend to include a specific source of emissions but Is limited by available data and staff time. Revisiting organizational boundaries, finding alternative data sources, and recalculating the resulting emissions are all part of the process.

For these reasons, DAS has partnered with other agencies, such as the Oregon Department of Energy, to compile data and make creating a basic agency GHG Inventory simple and straightforward.

Protocol and Guidance Documents

GHG inventories are commonly based on protocol or guidance documents. This written guidance provides accounting context and principals as well as specifics about data collection and emissions calculations. An initial step in completing a GHG inventory is to identify and select the most suitable protocol to fit the needs. GHG protocols are available that provide guidance at the project-level for organizations, communities, states, and nations. At the highest level is the U.S. Public Sector Protocol, which was prepared in 2013. This is the protocol used in this guidance document.

- Greenhouse Gas Protocol, U.S. Public Sector Protocol
    - World Resource Institute, Scope 2 Guidance
    - Greenhouse Gas Protocol, Corporate Value Chain (Scope 3) Standard
        - Greenhouse Gas Protocol, Scope 3 Calculation Guidance

  All available online at https://ghgprotocol.org

GHG Accounting Concepts

This section includes high-level introductory GHG accounting concepts, but agencies wishing to develop a more comprehensive GHG Inventory are encouraged to also review a GHG protocol document (such as the U.S. Public Sector Protocol, link provided above) as the depth of information and guidance provided in those resources are not duplicated in this Guidebook.

Accounting Principles

The following design principles are applicable to all GHG inventory protocols and accounting:

- **RELEVANCE:** Ensure the inventory appropriately presents the GHG impacts of the organization and serves the internal decision-making and external reporting needs.
- **COMPLETENESS:** Account for and report on all GHG emission sources and activities within the chosen inventory boundary. Disclose and justify exclusions.
- **CONSISTENCY:** Use consistent methodologies over time to allow for comparison.
- **TRANSPARENCY:** Address all relevant issues in a factual and coherent manner, based on a clear audit trail of data sources and calculations. Transparently document any changes to the data, inventory boundaries, and accounting methods used over time.
- **ACCURACY:** Ensure the quantification of GHG emissions is systematically neither over nor under actual emissions, as far as can be judged, and that uncertainties are reduced as far as practicable. Achieve sufficient accuracy to enable users to make decisions with reasonable assurance as to the integrity of the reported information.

Scope Categories

Longstanding and internationally agreed-upon voluntary GHG protocols categorize emissions in a few ways: 1) Direct (owned) versus Indirect (shared); and 2) Scope Categories.

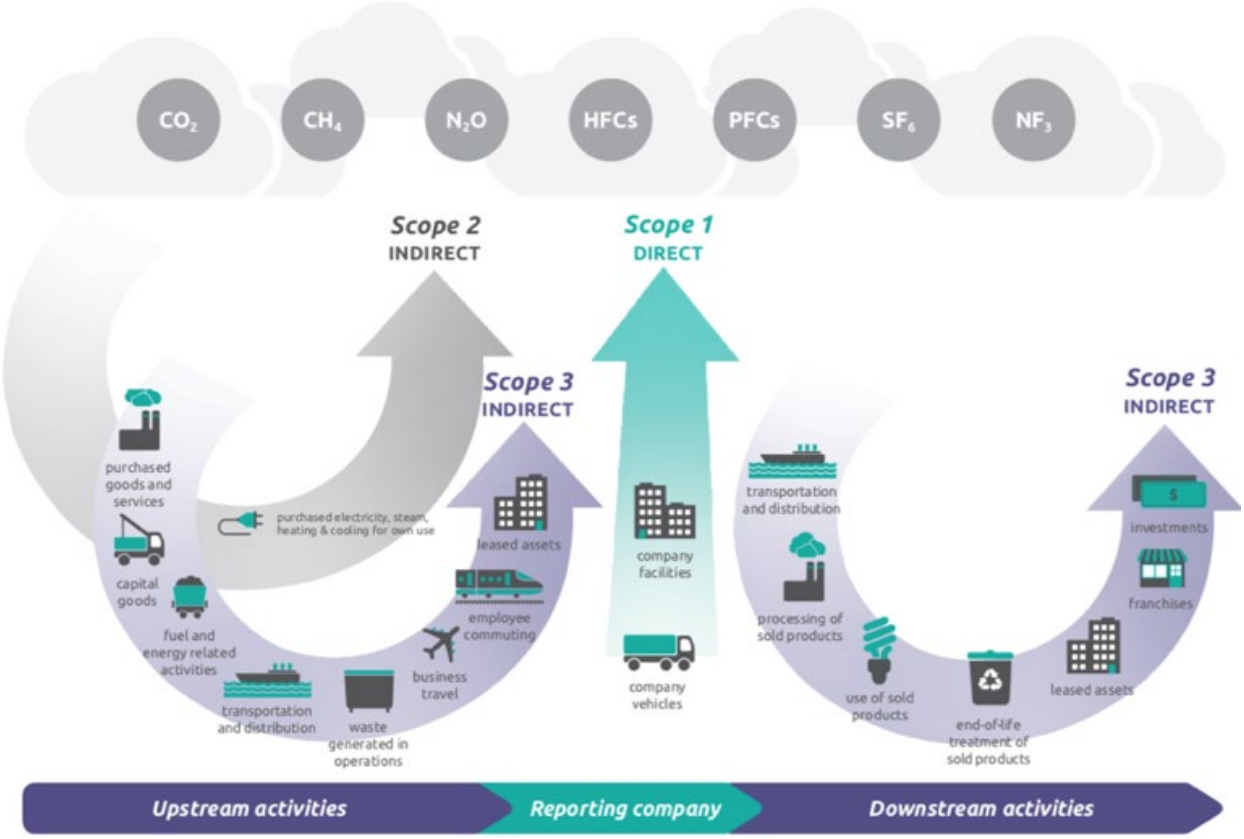
- **Direct emissions** are from "tailpipe" sources owned or operationally controlled by an agency. Common examples include natural gas combustion by buildings and gasoline or diesel combustion by vehicles.
- **Indirect emissions** occur because of the agency's actions, but the sources of indirect emissions are controlled by a separate entity. An example includes electricity generated by a power plant that produces emissions to generate the electricity. Oregon's state agencies can influence indirect emissions through their purchasing power.

To further classify emissions, three "scopes" categories are used in GHG reporting.[1]

- **Scope 1:** All direct GHGs from equipment and facilities operated by an agency. Emissions include those from fossil fuel combustion by buildings and vehicles, and fugitive emissions from air conditioning or refrigeration equipment.
- **Scope 2:** Indirect GHG emissions from electricity purchased for operational needs.
- **Scope 3:** All other indirect emission sources that result from an agency's activities but occur from sources owned or controlled by another company or entity, including: business travel, "embodied" emissions in material goods purchased and services contracted by agencies, upstream emissions from energy production (vehicle fuels, electricity, natural gas), and emissions associated with employee commuting.

[1] Source: WRI/WBSCD Greenhouse Gas Protocol, Corporate Accounting & Reporting Standard, Chapter 4.

Figure 1: GHG Scope categories and the types of emissions sources included in each. [2]



Setting GHG inventory boundaries is an important early step in the process. Defining inventory boundaries for the time period, geography, and sources of emissions are included in the inventory – for data collection, calculations, and reporting – versus those excluded. The following sections provide context and details for setting inventory boundaries.

The following links provide GHG inventory examples (including how others set boundaries) for various Oregon governments:

- City of Bend, OR
- Lane County, OR
- Portland Metro Regional Government

Inventory Year(s) and Setting a Baseline

Per GHG inventory protocol, an inventory must consider at least 12 consecutive months of data. Agencies should use the calendar year to aid in cross-agency reporting unless existing agency data systems and reporting better align with fiscal year reporting. In cases where it is possible, three years of data is best practice. A first or "baseline" GHG inventory will be used for all future comparisons, to set future goals,

[2] Source: Greenhouse Gas Protocol – Scope 3 Standard.

and to track progress, so it is important that the base year(s) accurately reflect the organization's operations.

Geography

Consider your agency's geographic footprint and how it will be defined in the inventory. The inventory should focus on owned and/or operationally controlled equipment (if leased), but may also consider other, more distant territories if the activities are mission critical for operations.

Organizational & Operational Boundaries

To determine the appropriate organizational boundaries, agencies should use the principal of **Operational Control.** An organization has operational control if it has the authority to introduce and implement operating policies. The operational control approach most accurately represents the emissions associated with the activities of public sector organizations, since their activities often consist of providing public services rather than gaining economic benefit from managing financial entities.

For agencies that lease all or part of their spaces from either DAS or a private landlord it is recommended that organizations include these facilities within their inventory (as leased Scope 3). Opportunities for action may be less compared to owned facilities, but this tracking provides a means to track the impact of available opportunities related to energy efficiency of equipment, plug load management, and behavioral changes over time. As well as allowing for informed communication with building owners to identify priority areas for building upgrades.

Agencies should also consider their operations and organizational structure when considering how to collect data and report. Agency-wide reporting may be selected if centralized data systems are used comprehensively. Others may want to see detail between specific divisions, departments, geographic locations, service areas, etc. If that level of detail is required – define the related internal, external, or other decisions making requirements prior to collecting data, so they may be consistently communicated during the inventory during data collection for all related emissions sources.

Emissions Sources

Minimum threshold reporting of GHG emissions is well defined in GHG protocol. State agencies are encouraged at a minimum to measure their "simple GHG emissions". These sources of emissions represent large, common sources of emissions with readily available, "simple" to collect data. Simple GHG inventories are best suited to smaller agencies with limited assets (buildings or fleet). For those interested in going deeper – advanced options are available for agencies that may produce significant impacts from those sources. Both options are described below.

Simple GHG Inventory

To support Oregon's climate goals – and the directives in EO 20-04 – DAS will help agencies complete a simple baseline GHG inventory and climate action planning process. This simple inventory will focus on buildings and fleet using data from ODOE and DAS that is already available to agencies. **Three years of data** should be collected to calculate GHGs for all stationary and transportation sources including; facilities, operations, vehicles, and other equipment within the state for **direct emissions from fossil fuel**

combustion (gasoline, diesel, natural gas, propane, etc.) and **indirect emissions from fossil fuels used in generating grid electricity.**

The DAS Sustainability Program will help provide agencies all required activity data to complete a simple GHG inventory. To get started with data collection for simple inventory contact:

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Advanced GHG Inventory

Simple emissions sources include large, common sources of GHG emissions with readily available and consistently reported data and feasible GHG reduction opportunities. For the purposes of agency climate action planning, advanced emissions include other sources - such as refrigerants, waste, air travel or purchased goods - where data availability and management opportunities are often more limited. DAS and partners have data for some of these advanced categories, while others may be supported by agency-specific data. See the CAP section of this guidebook for contact details for Advanced Inventory data collection.

Inventory Data Collection

Table 1, below, summarizes various sources of emissions and available data sources. Note that much of this data is readily available from existing state of Oregon reports and sources. The DAS Sustainability Program will be your agency's primary point of contact for collecting any data that is not listed as "agency specific".

Table 1: Summary of emissions data sources by inventory type

Inventory Type	Scope	Emissions Source	Data Source
Simple (S)	1	Gasoline	DAS Fleet and Parking Services
S	1	Diesel	DAS Fleet and Parking Services
S	1	Natural Gas	DAS/ODOE
S	2	Electricity	DAS/ODOE
Advanced (A)	1	Other Fossil Fuels	DAS Fleet and Parking Services
A	1	Fugitive Refrigerants[1]	Agency-specific data required.
A	3	Business Travel	DAS (working with Travel Services)
A	3	Employee Commute	DAS GIS Program
A	3	Purchased Goods & Services	DAS Procurement Services

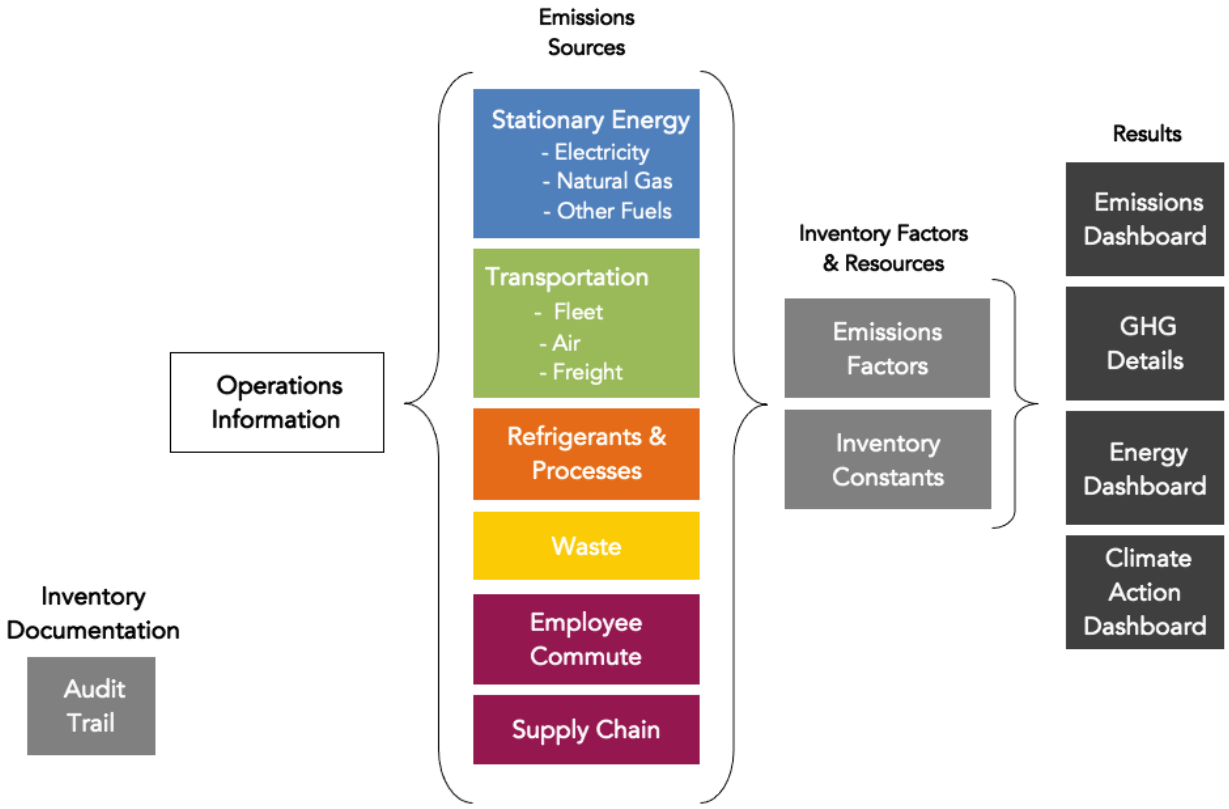
Inventory Type	Scope	Emissions Source	Data Source
A	3	Upstream Fuel Production	Automatically calculated in G3C using ODEQ lifecycle emissions factor from the Clean Fuels program. No additional data required.
A	3	Waste Disposal	Agency-specific data required (records from waste haulers, recycling providers, or an agency specific waste audit.

Good Company's Carbon Calculator (G3C-Ops)

Introduction

The following information is designed to introduce GHG accounting resources – Good Company's Carbon Calculator, basic components of the calculator's data flow, and descriptions for all worksheets. Figure 2 provides an illustration of how the data flow works in the calculator. Each box in Figure 2 represents an individual worksheet on the G3C calculator. Sections 1 through 8 later in this guide will provide step-by-step instructions for entering GHG inventory data.

Figure 2: G3C calculator categories (See G3C-Ops > Introduction worksheet for more details)



- **Operations Information** is where to start entering data. This worksheet contains fundamental data regarding facility descriptions and locations, full-time employees, market-based electricity information, and the primary activities that take place in the buildings being analyzed. Entering this data is critical to ensuring G3C-Ops fully functions. Enter facility/emissions sources descriptions and associated employee headcounts, building area, electricity generation emissions factors, and select primary building use and climate zone used to benchmark building energy consumption and solid waste generation. The information entered on this tab is used by the six emissions source tabs to populate cells (such as facility names) and in performing emissions calculations.
- **Emissions Sources** are the six categories of GHG emissions calculation modules included in G3C-Ops. They include:
    - Stationary Energy (Buildings and stationary sources)*
    - Transportation (Mobile sources)*
    - Refrigerants & Process Emissions
    - Waste
    - Employee Commute
    - Supply Chain (Procured Good and Services)

    *Sources included in Simple approach. All others included in Advanced.
- The **Emissions Dashboard** presents inventory results in two forms: 1) absolute emissions by year; and 2) year-over-year comparisons and as emissions intensities (per square foot, million dollars, population served, etc.) depending on user data and preferences.
- The **Climate Action Dashboard** is used to calculate net GHG benefits from planned or proposed climate actions and compare the results to a selected baseline year. This sheet uses results from data entered into other sections of G3C-Ops. Climate actions are grouped into Stationary, Transportation, Employee Commute, and Air Travel, with options to manually add climate action benefits for any of the categories shown in the Emissions Dashboard, Scopes 1-3.
- The **Audit Trail** module, while not part of G3C's calculations, is valuable to catalog received data files and corresponding calculation and resource files used in the inventory. The G3C worksheet is a summary table of contents for a corresponding agency's organized files and folders. Careful tracking of data ensures consistency between inventories and years and allows for understanding by new staff in the case of turnover.

- **Emissions Factors** includes sources and links to the emissions factors used in the Emissions Source calculation modules. Primary sources for factors include values as reported in EPA's *Emissions Factors for Greenhouse Gas Inventories* and The Climate Registry's *Default Emissions Factors*. Significant values include EPA's eGRID electricity factors for each inventory year. Many of these factors remain static for many years (e.g. gasoline, natural gas, etc.), while some need to be updated in the future so that the calculator remains current and the results accurate (e.g. electricity and lifecycle fuel emissions factors).

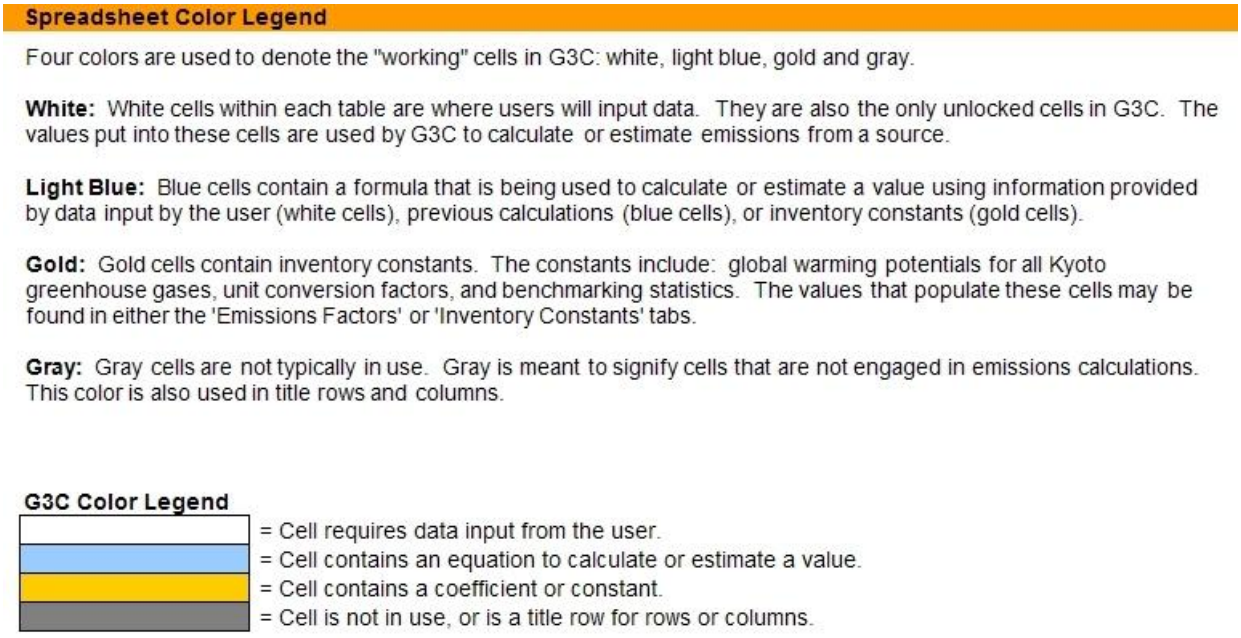
An **emissions factor** is a value that relates the quantity of a GHG released to the atmosphere with an activity associated with the release of that emission. Such factors facilitate estimation of GHG emissions from various sources, such as fuel used to generate electricity in power plants, or the tailpipe GHG emissions from different types of fuels.

- **Inventory Constants** provides other background information used by the calculator. On this worksheet, you will find information like the global warming potential (GWP) of specific GHGs and the unit conversion factors that are used in the calculator's formulas. These values either do not change (physical facts) or change rarely based on new science (GWP values) but may need to be updated in the future so that the calculator remains current, and the results accurate.

G3C Color Legend

The legend consists of four colors: white, light blue, gold, and gray. More detailed information about what each color represents can be found in the legend's description itself. A brief summary of each of the four colors is provided in Figure 3.

Figure 3: G3C spreadsheet color legend



Unprotecting a Worksheet

While it is not recommended, for certain operations within G3C, it may be necessary to unprotect a worksheet. The default password for the G3C calculator is "G3C" (letter, number, letter). Enter that into the Password field and hit the OK button to unprotect the worksheet.

Caution: Do not add rows or columns anywhere in the workbook. All the worksheets in G3C are connected and function using identical layouts. If rows are added to any one worksheet, the structure of the calculator is disrupted and will cause functional errors.

1. Operations Information

Description

The **Operations Information** worksheet is where to start entering data. This worksheet contains fundamental data regarding facility descriptions and locations, full-time employees, facility ownership/scope, market-based electricity information, and the primary activities that take place in your agency's buildings being analyzed.

Caution: G3C-OPS will not function without completing this first worksheet.

Set-Up Data

- **Baseline Inventory Year:** Enter the baseline (or first) inventory year. **DAS is advising agencies to select 2018 as the baseline year to allow for uniform reporting across agencies.**
- **Inventory Frequency:** Enter the number of years between inventories.
- **GHG Source / Activity Description:** Enter descriptions for GHG sources, activities, and/or stationary facilities. Once entered, the descriptions will automatically populate throughout G3C-Ops. Up to 100 separate descriptions may be entered for each inventory year, which allows the tool to be set up simply or in greater detail depending on organizational context, operations, and available data.
- **Facility Details**
    - **Emissions Source Description:** Name the GHG source, activity, and/or facility.
    - **Location (Optional):** Enter a geographic location for the facility.
    - **Owned or Leased:** For stationary facilities – specify if it's Owned or Leased. If your agency has operational control (pay utility bills directly and / or can specify and control operation of lighting and equipment), even if leased, select owned. Select leased if energy bills are included in rent and your agency does not have operational control over building energy equipment. Leased facilities should be included in the inventory, but climate action opportunities may be limited or different than for owned facilities.
    - **Employees:** Number of employees commuting to each facility.
    - **Building Area:** Enter the square footage occupied.
    - **Total Building Area:** If your agency occupies only a portion of larger facility, enter the Total Building Area square footage occupied. This input is optional if your agency occupies 100% of the building.
    - **Market-based Emissions Factors:**
        - **Retail purchases:** DAS Sustainability will provide your agency the appropriate emissions factors for your utilities. You can also refer to **Oregon Department of Environmental Quality's Greenhouse Gas Emissions from Electricity Use, 2010 – 2019**, available online at: https://www.oregon.gov/deq/aq/programs/Pages/GHG-Emissions.aspx. This resource provides annual emissions factors (MT CO_2e / MWh) for 2010 – 2019. Enter the utility name and factor for the appropriate corresponding year. For facilities outside Oregon, contact your electric utility for this factor(s).
        - **Renewable Energy Purchases:** Renewable electricity may be purchased through your local utility or by developing a power purchase agreement. Enter a description of the power source contract and enter the corresponding emissions factor.

    - **On-Site Generation:** Renewable electricity may be installed onsite. Enter a description of the power source contract and enter the corresponding emissions factor.
  - **Regional Electricity Grid:** Use the drop-down menu to select regional utility grid. If in Oregon, select Northwest Power Pool (NWPP) regional electricity grid. If outside of Oregon – click the link in the column header to view a map of U.S. regional electricity grids and select the appropriate grids for the various row items. The **EPA's Emissions & Generation Resource Integrated Database (eGRID)** is a comprehensive source of data on the environmental characteristics of almost all electric power generated in the United States. More details online at. http://cfpub.epa.gov/egridweb/ghg.cfm.
  - **Primary Building Activity:** Use drop-down menu to select the appropriate building activity type. NOTE: You must select a primary building activity for the calculator to benchmark or estimate (when data is unavailable) building energy use and solid waste generation.
  - **Climate Zone:** Use drop-down menu to select the appropriate climate zone, see the column header for a link to a map.

NOTE: Use "click here for map" in the column heading to be brought to a U.S. map of climate zones.

NOTE: You must select a primary building activity for the calculator to benchmark or estimate (when data is unavailable) building energy.

2. Stationary Energy (Buildings)

Description

How an agency heats, cools, and powers its buildings commonly represent significant sources of GHGs. Stationary, or Stationary Energy, also known as Building Energy in G3C-Ops calculates emissions for electricity, natural gas, stationary diesel and propane, and steam. Stationary energy includes both direct Scope 1 emissions (natural gas, diesel, propane) and indirect Scope 2 emissions (electricity and steam); leased facilities are also included as Scope 3. Make sure all facilities and stationary equipment data is included. Always use actual data; do not adjust for heating/cooling degree days.

The calculator may be set up in a variety of ways. The simplest way is to create a single "Emissions Source Description" (in 1. Operations Info) row in G3C titled "agency-wide". DAS reported information may be input for all facilities to an agency-wide row for simple accounting. The calculator can also be set up (for up to 100 sources) to include individual buildings and facilities in order to track the data and emissions at a more granular level.

Activity Data

Note: DAS will work with ODOE to provide agencies with their building energy use data.

- **Electricity:** Enter kilowatt-hours (kWh) by type for the following categories.
  - Retail: See monthly bills by facility and meter or contact the utility. (Do not enter purchased *renewable* electricity from your utility here.)

  - Purchased Renewables: See monthly or annual bills by facility and meter or contact your utility or renewable energy provider.
  - On-site Generation: See system meter for annual generation.
- **Natural Gas:** Enter quantity in therms, cubic feet, or MMBTU (with drop-down menu). See monthly bills by facility and meter or contact the utility.
- **Diesel:** Enter gallons. Contact the facility manager for this information.
- **Propane:** Enter gallons. Contact the facility manager for this information.

Tips & Tricks

Estimate or Benchmark electricity and natural gas use: If building energy and fuel data is not available, G3C-Ops can estimate or benchmark using Commercial Buildings Energy Consumption Survey (CBECS)[3] data. To use this function, enter energy facility square footage, primary building type, and climate zone in Operations Info, and leave the white input cell in Stationary blank.

Caution: If your facility does not use electricity or natural gas, enter 0. If the cell is left blank, with operational info data on area, primary activity and climate zone, G3c-ops will automatically populate and will automatically default to use of estimated electricity.

3. Transportation

Description

The 'Transportation' worksheet includes common Scope 1 fuel types as well as Scope 2 electricity for owned fleet. There are also inputs on this worksheet for Scope 3 transportation modes used for freight and business travel.

Note: DAS Sustainability, working with DAS Fleet and Parking Services, can provide this data to agencies.

Activity Data

- **DAS or agency owned fleet vehicle use**:
  - Consumption in gallons (or specified measurement unit) and average fuel economy (miles per gallon) for the following fuel types:
    - Gasoline
    - Ethanol
    - Diesel
    - Biodiesel
    - Renewable Diesel
    - Natural Gas
    - Liquified Natural Gas
    - Electricity
  - **For blended fleet fuels**, separate the fossil fuel from the biofuel volume and enter under the applicable fuel type. For example, for 100 gallons of E10 gasoline (which is a blend of

[3]CBECS provides building characteristics information for the estimated 5.9 million U.S. commercial buildings in 2018 https://www.eia.gov/consumption/commercial/

90% motor gasoline and 10% ethanol), enter 90 gallons for gasoline and 10 gallons for ethanol.
    - For electricity, data may be entered as kWh of electricity or miles along with a fuel economy. The Regional Electricity Grid will need to be selected on the Operations Info worksheet. To calculate market-based emissions, enter the requested factors (emissions factor for the utility or other electricity source, T&D loss percentage, and fuel production percentage). **Make sure to subtract this electricity consumption from Stationary energy data (if included in that data set) to avoid double counting.**
- **Contracted Freight:** Annual short ton-miles by mode. This data may be available from vendors or may be calculated from other organizational freight logistical data. For guidance see EPA's *SmartWay*[4] resources or EDF's *Green Freight Handbook*[5]. Contracted freight data may also be entered using gallons if data in that form is available.
- **Other Business Travel**
    - **Rental Vehicles:** Vehicle miles traveled.
    - **Employee-owned vehicles:** Vehicle miles traveled. Data may be tracked internally, typically by accounting, either by mileage or by dollars ($) spent on reimbursement. Dollars for any year may be divided by the average per mile reimbursement values set by the IRS in Standard Mileage Rates.[6]
    - **Air Travel:** Passenger miles traveled. DAS can provide this data from the air travel vendor servicing agencies.
    - **Bus Travel:** Passenger miles traveled. This data may be available from internal tracking or a travel service vendor.
    - **Intercity Diesel Rail Travel (e.g., Amtrak):** Passenger miles traveled. This data may be available from internal tracking or a travel service vendor.
    - **Transit Electric Rail Travel (e.g., subway or tram):** Passenger miles traveled. This data may be available from internal tracking or a travel service vendor.

4. Refrigerants & Process Emissions

Description

The 'Refrigerants & Process Emissions' worksheet is used to capture the fugitive emissions from stationary or mobile air conditioners, chillers or refrigeration units, as well as other non-energy process emissions that may be significant. Refrigerants, otherwise known as Hydrofluorocarbons (HFC), are human-made substances made up of carbon, hydrogen, and fluorine atoms that are very efficient at transferring heat. The main use of HFCs is in refrigerators and air conditioners, but HFCs can also be used as a propellant in aerosol cans as an alternative to ozone-depleting substances. HFCs have a climate impact up to thousands of times greater than other GHGs. Refrigerants are commonly a small source of emissions for many office-based facilities, but can be large for facilities with district cooling systems or other large-scale refrigeration requirements (e.g. grocery, refrigerated freight, etc.). Fugitive refrigerant emissions are considered a Scope 1 emissions source for owned facilities.

[4] EPA SmartWay online at https://www.epa.gov/smartway/smartway-sustainability-accounting-and-reporting
[5] EDF Handbook online at https://supplychain.edf.org/resources/the-green-freight-handbook/
[6] IRS Standard Mileage Rates available online at https://www.irs.gov/tax-professionals/standard-mileage-rates

Activity Data

- **Refrigerant Type:** Select the appropriate refrigerant from the drop-down menu. Reporting from building managers or external vendors should include an inventory of refrigerant types and corresponding weights used to recharge cooling systems. Once both the type of refrigerant is selected and the recharge quantity is entered, the worksheet will calculate emissions. Up to five types of refrigerants can be entered into G3C-Ops for each individual facility; you may need to unlock the sheet to show hidden columns to enter more than two types.
- **Refrigerant Weight:** Enter weights for the corresponding refrigerant type selection.
- **Process Emissions:** Enter other known fugitive process emissions in MT CO_2e.

Tips & Tricks

Estimating Loss: The Climate Registry's General Reporting Protocol v3.0 includes a Screening method to estimate refrigerant loss when data is not available. See the Chapter on Direct Fugitive Emissions – Method C: Screening for details.

5. Waste

Description

Landfilled solid waste produces methane during the decomposition and degradation of organic materials (food waste, paper, wood, etc.) in the landfill environment. Depending on the methane management system at the landfill, the amount of GHG emissions that results may vary. The 'Waste' worksheet in G3C-Ops is used to calculate the emissions associated with solid waste disposal, Scope 3 emissions.

Activity Data

- **Solid waste:** Short tons or cubic yards of landfilled solid waste. If unknown, specify facility square footage and primary building activity in Operations Info to estimate.
- **Methane management system at destination landfill:** Note custom option

Tips & Tricks

- **Estimating landfilled solid waste:** This worksheet calculates both actual emissions and a benchmark (based on the primary building activity and number of employees entered in the Operations Info worksheet) that may be used (with caution) as a sense-of-scale estimate for this emissions source. Similar to energy use, if a facility produces zero (0) solid waste, enter a "0" for the weight or G3C will estimate.
- **Recycling and Composting:** G3C-Ops focuses on landfilled solid waste disposal and does not include recycled and composted emissions impacts or benefits in the calculations. However, you can think about the quantity of materials recycled or composted as reducing landfilled waste totals and reducing the associated emissions. DAS can provide annual recycling data from state recycling service providers to a number of agencies.

6. Employee Commute

Description

The 'Employee Commute' worksheet is used to calculate emissions associated with employee commutes to and from work. This can be a significant emission source and larger agencies in particular are encouraged to include this in their inventory.

This sheet uses data on the number of employees, commute distance, and mode of transportation. The user will need to input information about the number of full-time employees (and the equivalent for part-time employees), number of workdays, percent mode of transportation (drove alone, carpooled, telecommuted, etc.), and average one-way trip mileage. DAS will be providing much of this data to agencies, as described below. Conducting an employee survey can also be a useful tool to get the required data needed to calculate emissions from this source. See the 'Commute' worksheet to determine what information is required to complete the emissions calculations. Employee commute emissions are considered a Scope 3 emissions source.

Activity Data

DAS will provide data to support agency measurement of employee commute emissions. This data is derived from GIS information on primary office location, home zip code, timesheet coding, and estimates of percentage of commuting types (e.g., drive alone, bus, carpool, bike) from U.S. census data. This will include commute distance, mode split, and fuel economy.

If an agency would like to collect more detailed data related to employee commute, the best way to obtain this data is to have employees complete a commute survey. Aim for 50-70% response rate for best results[7] and use a survey tool that allows for an Excel download of results for convenience. Recommended survey questions are included in Appendix A.

Once data is collected from your survey, enter results as follows:

- **Full-time employee equivalent:** Enter full time employees plus full-time equivalent values for part-time or temporary employees (enter part-time employees working 20 hours per week as .5 FTE, temporary employees working full-time for three months as .25 FTE, etc.). Enter values on the Operations Info worksheet. This information is typically available from an agency's human resources department.
- **Average annual workdays:** Average workdays per year for all employees adjusted for holidays and paid time off. Like FTE, this information is oftentimes available from an agency's human resources department.
- **Average one-way commute distance:** This data point can be the most challenging to acquire. Ideally this data will come from an agency survey. Alternatively, an estimate may be conducted using a source like StreetLight Data[8] that uses "big data" like in-board navigation systems and cellphones to calculate average commute distances by state and zip code in the U.S. If no better data exist use a default value of 2.

[7] Washington Department of Transportation considers a minimum response rate of 50% acceptable and 70% ideal. https://wsdot.wa.gov/sites/default/files/2019/08/30/PT-Guide-CommuteTripReduction-SurveyResponseRatePolicy.pdf

[8] StreetLight's Commutes Across America – Where are the Longest Trips to Work? Available online at https://www.streetlightdata.com/wp-content/uploads/2018/03/Commutes-Across-America_180201.pdf

- **Transportation mode split:** Percent of total commute trips taken by mode. Ideally this data will come from an agency survey. Alternatively, the American Community Survey, Means of Transportation to Work (Table BO8301) provides information on mode of commute for a variety of jurisdictional boundaries.
    - Single Occupancy Vehicles refers to driving alone
    - Non-fossil fuel modes include walking, biking, other non-fuel active transportation, and telecommuting.
- **Average fuel economy:** As miles per gallon. Ideally this will come from an agency survey. Alternatively, The U.S. Bureau of Transportation Statistics estimates an average Fuel Efficiency of U.S. Light Duty Vehicles[9].
- **Average carpool occupants:** Ideally this will come from an agency survey. If not, enter a proxy value of 2.
- **Average Vanpool occupants:** Ideally this will come from an agency survey. If not, enter a proxy value of 7.

Tips & Tricks

- **Enter agency-wide activity data:** G3C-Ops can calculate commute emissions based on agency-wide data or for specific facilities. Collecting data for specific facilities is more challenging than agency-wide but will lead to more accurate baseline measurement and tracking of this source over time. Many times, the choice of agency-wide versus facility-specific is determined by existing data availability, available staff time to complete a survey, and success at reaching the desired survey response rates.

7. Supply Chain (Purchased Goods and Services)

Description

Procurement, or supply chain emissions, can include a wide variety of agency purchases, including both goods and services. To better understand the climate impact of procurement, many agencies consider all purchases within the inventory year. Emissions from this source are often large for public agencies – at times representing over 50% of total Scope 1 – Scope 3 emissions. Supply chain emissions are indirect and can be thought of as "shared" between the supplier (producer) and buyer. The buyer creates the production demand but does not have direct control over energy use and efficiency.

Once the appropriate Purchased Good or Service Category is identified, G3C-Ops includes two activity data inputs for supply chain:

- **Expense:** Enter dollars spent on each category. Spend data is supported by the EPA's Supply Chain Greenhouse Gas Emissions Factors,[10] which provides emissions factors per dollar for over 400 purchasing categories. G3C allows for selection of a specific purchasing category and with a corresponding input for spend calculates the associated GHG emissions from that purchase.

[9] Bureau of Transportation Statistics https://www.bts.gov/content/average-fuel-efficiency-us-light-duty-vehicles
[10] US EPA Supply Chain Greenhouse Gas Emission Factors for US Industries and Commodities. Online at https://pasteur.epa.gov/license/sciencehub-license.html. Full report at https://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryId=349324&Lab=CESER

- **Weight:** Enter weight and emissions factor for each category. Allows the user to enter total weight and a more specific corresponding factor to calculate emissions. G3C-Ops does not include a database of weight-based factors. The user is required to identify and input the most appropriate factor for the circumstances.

In 2020 DAS and DEQ completed a study evaluating the GHG emissions associated with state agency purchases to identify the categories with the highest potential emissions reductions. Among the top categories were IT equipment, fuels, vehicles, construction materials, and paper. DAS Sustainability will work with DAS Procurement to provide agencies with annual spend data on IT and paper. Fuels and vehicles are already covered under the Transportation section of this guide. Construction materials are very project specific, and agencies are advised to evaluate lower carbon alternatives with their design-construction teams when constructing new buildings or conducting major renovations.

Supply chain emissions can be conceptually and analytically challenging. To support those new to this accounting, West Coast Climate Forum sponsored the creation of a written step-by-step guide to complete a supply chain GHG inventory titled, *How to Complete a Supply Chain GHG Inventory*.[11] We recommend users of G3C-Ops also become familiar with this free and publicly available resource to better understand the purpose and analytical approach for supply chain accounting. Estimating GHG emissions for the upstream production of an agency's purchased goods can be a challenging during a first GHG inventory year. G3C-Ops includes a calculation worksheet, but depending on the complexity of the data set, this may be best suited to a separate analysis spreadsheet.

Activity Data

- **Option 1: Annual expense, by purchasing category:** Spend data for the inventory year is commonly available within an agency, or from DAS Procurement for individual price agreements. See *How to Complete a Supply Chain GHG Inventory* sections on data collection and processing. Collecting spend data is the simplest path to better understanding of an agency's supply chain "hotspots".
- **Option 2: Annual material consumption and vendor specific emission factors:** Weight-based data may be available in your agency or from DAS Procurement for year-over-year production. This data is most common for private companies that use a set of specific materials to produce a product. This data might also be available for a public works agency for materials like concrete or asphalt. Weight-based accounting is more accurate than spend-based accounting, but typically requires more time for data collection (both the weight-based material use and vendor-specific emissions factors or Environmental Product Disclosures (EPDs)).

[11] West Coast Climate & Materials Management Forum, *How to Complete a Supply Chain GHG Inventory*: This guide provides step-by-step instructions to measure emissions from purchased good or services. Online at https://westcoastclimateforum.com/sites/westcoastclimateforum/files/related_documents/A%20How%20To%20Guide.pdf

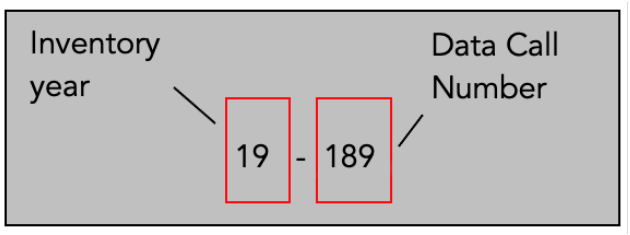
8. Audit Trail

Description

The **Audit Trail** module, while not part of G3C's calculations, is valuable to catalog the received data files and corresponding calculation and resource files used in the inventory. The G3C module is a summary table of contents for a corresponding agency's organized files and folders. Careful tracking of data ensures consistency between inventories and years, allows for understanding by new staff in the case of turnover, and provides the information required for third party verification.

Call numbers should be assigned to files according to the following protocol: each call number begins with a two-digit number to signify the current inventory year (for an inventory conducted using 2019 data, the number is "19"). This is followed by a three-digit code that signifies the data category and record. Figure 4 provides a visual description of the call number system. See the three data categories below for more detail on call number assignment.

Figure 4: Call number visual description



Included in the Audit Trail are summary tables for four types of files:

- **Data Source Files:** The Data Source Files contain raw data as received for the inventory. This would include sources like utility bills or a spreadsheet with annual fleet fuel consumption or miles. These documents are numbered XX-001 through XX-199.
- **Calculation Files:** Calculation Files are typically Microsoft Excel spreadsheets that have been used to perform data inventory calculations and analysis beyond the raw data. These documents are numbered XX-201 through XX-299.
- **Reference Files:** Reference Files are works by other authors and agencies that provided inventory guidance, emissions factors, statistics, or unit conversions used while conducting the inventory. These documents are numbered XX-501 through XX-599.
- **Data Contacts:** This table in the Audit Trail worksheet is included to capture information about those people who provide data for a given year's inventory, useful both for transparency and inventory replication.

Tips & Tricks

- **Catalog files in real time for accuracy and efficiency:** While this may not seem to be a priority during the inventory process, we highly recommend not waiting until the end as it can become increasingly challenging as time passes. Developing the Audit Trail can be an arduous task, but it will pay high dividends for an agency committed to long-term GHG tracking towards goals. It provides a highly effective means of replicating inventory methodology in future years' work and provides detailed guidance as agency staff and roles change over time.

Climate Action Plan Guide

Introduction to Climate Action Planning

This section of the Guidebook focuses on how agencies can take the findings from their GHG Inventories, set a goal, identify GHG reduction strategies, and tie all work together in a climate action plan.

What is a Climate Action Plan?

A climate action plan or CAP contains information and planning on how to reduce GHG emissions to achieve an agreed upon climate goal and rate of reduction. Climate action plans often include a report on an agency's GHG emissions to provide the planning basis. CAPs also include a review of best practices; planned actions based on agency context; and forecasting reductions compared to goals. As the CAP is implemented, regular measurement and reporting is recommended for performance tracking and communication.

For Oregon's state agencies, this process might include developing a stand-alone CAP, or incorporating climate actions into an existing sustainability plan. The Oregon Sustainability Board's Sustainability Plan Guidelines will include steps for how to incorporate climate actions into agency sustainability plans.

The Planning Process

Error! Reference source not found.5, shows the CAP process, which commonly begins with an initial "hotspot" analysis as a planning basis, then proceeds through regular measurement toward a goal.

Figure 5: Climate action planning process

Setting an Organizational Climate Goal

The State of Oregon has established climate goals (EO 20-04, 2020) that reduce emissions at the following rate:[12]

45% below 1990 levels by 2035 and 80% below 1990 levels by 2050

[12] https://www.oregon.gov/gov/Documents/executive_orders/eo_20-04.pdf

These goals translate to holding global warming to no more than **2ºC** above preindustrial levels.

Because reliable and complete agency data related to GHG emissions are not available back to 1990, for the purpose of this guidance document, Oregon's existing goals are adjusted to fit with a more recent emissions baseline. The adjusted **2ºC Goal** roughly equates to:

50% below 2015-2020[13] baselines by 2035 and 82% below by 2050

Keeping global average temperature increases below 2ºC above preindustrial levels is understood to be the minimum guardrail needed to avoid a feedback loop where increased temperatures cause droughts, wildfires, floods, and other impacts that will become more severe and more frequent as we approach or exceed the goal.

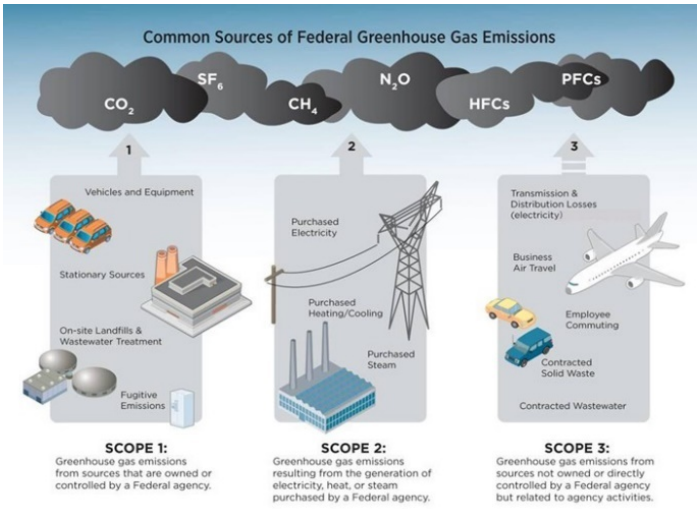
The Paris Climate Agreement attempts to target a **1.5ºC Goal** to stay as far back from that guardrail as possible. A **1.5ºC Goal** roughly equates to reducing emissions at the following rate:

50% below 2015-2020 baselines by 2030 and net-zero emissions by 2050

Which emissions sources should be included in the goal?

At a minimum, Scope 1 and 2 emissions from operations should be included to ensure your agency is doing its part to reduce global emissions. As described earlier in this Guide, at a minimum, agencies should address Scope 1 and 2 emissions from their buildings and fleet using already available data. Usually Scope 3 emissions, such as air travel and supply chain purchases, are considered optional, but agencies are provided methods for addressing some Scope 3 emissions in G3C-Ops.

Figure 6: Common sources of GHG emissions



Options for fossil fuel or energy use targets

In addition to overall GHG goals, an agency may wish to choose an additional target to address the most significant aspect of climate change – the use of fossil fuels. Scope 1 and 2 fossil fuel emissions sources typically include owned vehicle fuels, natural gas, other stationary fuels, and electricity. Options include reducing a percentage of emissions or reducing source consumption (quantity or % of therms, kWh, fossil gallons consumed).

[13] These % reductions are similar for baseline years throughout this period. The range is provided to give users flexibility in setting a baseline year or an average of years based on available data.

Climate Planning Guidance and Forecasting Reductions

The following sections describe current climate action best practices and instructions on how to set an agency GHG reduction goal, and then scale and forecast your agency's GHG emissions reductions by implementing various climate actions. These calculation modules work with existing data entered into the Carbon Calculator (G3C-Ops). Once a baseline year of data has been established, the climate actions can be scaled against baseline year data and show how planned climate actions compare to State of Oregon or Paris Agreement climate goals. **Appendix B** provides additional detail about cost ranges for the climate actions listed below.

Climate Action Dashboard Set Up

General Set Up

At the top of the Climate Action Dashboard worksheet **enter basic information** about the report author and agency. **Select the Baseline Year** for the CAP forecast reductions. G3C-Ops holds up to 8 years of inventory data. Any year may be selected as the baseline, though for consistency in reporting, **it is recommended that agencies select 2018 unless there are compelling reasons for selecting another year.** There are two dropdown menus for selecting a GHG baseline year and selecting a Climate Goal (State of Oregon's or the Paris Agreement).

Updating Emissions Factors

The Climate Action Dashboard automatically aligns emissions factors with the Baseline Year selected, but the **user will need to update the electricity emissions factors** in the worksheet as updated information becomes available in the future. See row 240 > column R > yellow highlighted cells. DAS can assist agencies with this effort.

- Oregon electric utility emissions factors are available from Oregon Department of Environmental Quality.
    1. Visit: https://www.oregon.gov/deq/aq/programs/Pages/GHG-Emissions.aspx
    2. Click the Excel document *2010-20XX - Greenhouse Gas Emissions from Electricity Use* under **Electricity Suppliers**
    3. Copy the value for the chosen utility and year for **Emission per megawatt hour ($MTCO_2e/MWh$)**.
- Regional Northwest Power Pool electricity grid factors are available from EPA's eGRID.
    1. Visit: https://www.epa.gov/egrid/summary-data
    2. Click on *Summary Tables* (either PDF or Excel) if the appropriate year is displayed.
    3. From Table 1, copy the value for NWPP's **Total output emission rates** (in lb/MWh) for CO_2e.
    4. For previous years, click **Download Detailed Data** on the left, and select *Download eGRID historical files (1996-20XX) (ZIP) (zip)* under **Other Historical Data**.

Printing a Climate Action Report

The print area is set to produce a Climate Action Dashboard Report. This Dashboard Report will show your agency's baseline emissions and CAP annual reduction (in MT CO_2e and percentage from baseline) by activity and scope, along with two report graphics showing the same data as well as goal tracking. Select File > Print.

1. Stationary Energy

Stationary energy GHG emissions are primarily from the combustion of natural gas and electricity use for lighting and heating facilities. There are five strategies in the Climate Action Dashboard that may be used in combination to achieve significant reductions:

- **Energy efficiency** to reduce consumption of natural gas and electricity for light and heat.
- **On-site renewable electricity** generation of solar power using roof or ground space.
- **Grid renewable electricity** to purchase renewable electricity through utilities.
- **Renewable natural gas** purchases through the natural gas utility or other supplier.
- **Building electrification** to phase out natural gas appliances.

Energy Efficiency

Within climate action planning, energy efficiency should always be the first consideration. By reducing the overall need for energy – we reduce the need for some of the most carbon intensive portions of our energy system. By constructing and renovating buildings with energy efficiency in mind, state agencies can significantly reduce long-term operating costs and redirect those savings to fund essential services. Reducing overall electricity use is also critical in that it will free up electric resources to serve our vehicles and additional buildings in the future. Efficiency provides a means to balance new needs without increasing overall consumption.

ODOE provides support to state agencies to plan for energy efficiency upgrades in new construction and renovations. State statute and ODOE rules require all state agency facilities newly constructed or substantially remodeled to perform better than the energy conservation provisions of the Oregon state building code by a minimum of 20%.[14] Since 2003, investments by state agencies in energy conservation guided by ODOE have saved almost double the cost of the initial investment. Historically, new construction projects completed since 2003 saved between 23–33%, while renovations saved between 11–24%.[15]

ODOE's State Energy and Efficient Design (SEED) report covers "New Construction and Remodels" and includes reported annual energy savings, improved performance, building size/class, cost, efficiency compared to code, and project highlights for state facilities. Projects include solar energy generation, high-performance features, heat pumps, low-flow plumbing, and energy star appliances. ODOE provided Table 2 to support energy efficiency decision making by sorting potential actions by cost and effectiveness.

[14] ORS 276.900-915; OAR 330-130
[15] ODOE 2020 Biennium SEED Report:
https://www.oregon.gov/energy/Data-and-Reports/Documents/2021-SEED-Report.pdf

ODOE 2020 Biennium SEED Report:
https://www.oregon.gov/energy/Data-and-Reports/Documents/2021-SEED-Report.pdf

Table 2: Energy efficiency measures by cost and impact

Energy Efficiency Measures*	
Low Cost, High Impact (>5% of building use)	**High Cost, High Impact (>5% of building use)**
Lighting – upgrade to LED	Boiler upgrade to condensing boiler
Controls – unoccupied temperature setbacks	Controls – upgrade to Direct Digital Control (DDC), including adding capabilities
Controls – retro-commissioning (when addressing a system failure)	HVAC – upgrade air conditioning chiller to high efficiency chiller
	Electrification of heating systems, replacement of boilers with heat pumps for space heating or domestic hot water***
Low Cost, Low Impact (<5% of building use)	**High Cost, Low Impact (<5% of building use)**
Boiler burner upgrade	HVAC – upgrade from constant air volume to variable air volume system
Motors – adding Variable Frequency Drives (VFDs) to pumps and fans	HVAC – add heat recovery system
Exterior lighting – upgrade to LED	HVAC – upgrade air conditioning chiller to high efficiency chiller
Lighting – occupancy sensors	Controls – add demand-controlled ventilation (DCV)
Controls – retro-commissioning	Domestic hot water – upgrade to high efficiency equipment
Building envelope – replace/install seals against infiltration **	Building envelope – replace or install roof insulation
HVAC – replace unit ventilators with heat pumps **	HVAC – replace units to add variable refrigerant flow (VRF) system
Plug loads – occupancy-based control, smart strips etc.	Cooling tower replacement
	HVAC, packaged units – replace with high-efficiency units
	Building envelope – window replacement
***General categorization of EE measures, items in bold primarily impact GHG emissions. Source: ODOE**	
****Cost can depend on number of units or cost to diagnose.**	
*****For larger buildings tends to be cost prohibitive and limited by available technology.**	

Using the G3C – Climate Action Dashboard

The Climate Action Dashboard calculates GHG emissions reductions for common energy efficiency measures agencies may find most applicable and effective:

- ***Building retro-commissioning*** (natural gas) projects that provide a "tune up" for building heating systems. This action typically saves 15% of total natural gas use.
- ***Heating system upgrade*** (natural gas) projects increase the energy efficiency of the system providing the same heating with less gas combustion. Upgrading from constant to variable air volume HVAC or upgrading packaged units to high efficiency units. These types of action typically provide a 5% increase in energy efficiency, but this input may be changed in the CAP Dashboard.
- **Plug load management** (electricity) projects, as reported on by DAS, have achieved measured savings of 10-15%. Modeling of reductions for this action in the CAP Dashboard assumed 10%.
- ***Lighting retrofits*** (electricity) projects such as converting existing fluorescent lighting to LED typically saves about 15% of total electricity use.

This module offers two methods for forecasting emissions reductions:

- ***Simple method:*** Allows the user to select the project for the agency's entire portfolio. The user needs to **select the project to include in the CAP by selecting "yes"** from the dropdown menu in the CAP Dashboard.
- ***Custom method:*** Allows the user to specify project-level data.
    - Retro-Commissioning: **Enter the amount of baseline natural gas use** (in therms) for a specific facility or group of facilities where the action will be taken.
    - Lighting Retrofits: **Enter the amount of baseline electricity use** (in kWh) for a specific facility or group of facilities where the action will be taken. Then, **select the electric utility** that serves the project location.

Note that these calculations are only meant for high-level planning purposes and are based on predicted savings from past energy evaluations and literature research. Realized savings made be different.

For stationary/building energy and technical support on energy efficiency contact:

Stephanie Kruse, Facilities Engineer, Dept. of Energy, Stephanie.KRUSE@energy.oregon.gov

On-site Renewable Electricity Generation

The operational and financial viability of developing onsite solar photovoltaic (PV) electricity generation can vary widely between agencies and specific project sites – on the roof or ground. It is recommended that agencies explore solar PV feasibility for their facilities and land if they have not yet done so. Energy Trust of Oregon offers incentives for conducting site-specific feasibility analyses and can defray much of the study cost.[16] DAS staff can provide initial data and GIS information for potentially viable areas within agency ownership.

[16] https://energytrust.org/incentives/solar-for-your-business/

Oregon passed legislation (HB2021: 100% Clean Energy Standard) in 2021 that requires Oregon utilities to supply zero-GHG electricity to the state by 2040, reaching 80% coverage by 2030. This transition will be challenging; Oregon utilities will need support and assistance from all willing participants, including the public sector.

G3C's Climate Action Dashboard provides a planning-level tool for assessing solar PV.

USING THE G3C – CLIMATE ACTION DASHBOARD

This module estimates a solar installation project based on the square footage of available flat surface area. The module assumes the project will be implemented on owned property and reduce owned facility emissions from electricity use.

- To use this module, first **enter a brief project description**. Then, **enter total square footage of available area** – roof or ground, suitable for installation. Finally, **select the appropriate utility** that serves the project location as well as whether the site is in western or eastern Oregon, as solar potential varies between the two regions.

Interested parties may also consult the following for project-level analysis:

U.S. Department of Energy, Solar Rooftop Potential Toolkit

https://www.energy.gov/eere/solar/solar-rooftop-potential

For individual rooftops, national laboratories and private companies have developed a number of tools to estimate the amount of solar that can be installed on a given rooftop. The tools were funded in part by the U.S. Department of Energy's Solar Energy Technologies Office (SETO) to help consumers start the process of choosing solar by determining the solar potential of their homes or businesses.

NREL's PVWatts® Calculator

https://pvwatts.nrel.gov

This calculator estimates the energy production and cost of energy of grid-connected PV energy systems throughout the world. It allows homeowners, small building owners, installers, and manufacturers to easily develop estimates of the performance of potential PV installations.

For land parcel and building footprint information, contact:

Paul Platosh, GIS Analyst, Oregon Dept. of Administrative Services**,** Paul.PLATOSH@oregon.gov

Grid Renewable Electricity (RECs or Green Power Purchases)

Once all cost-effective efficiency upgrades are addressed, agencies should consider procuring a clean supply of electricity. Oregon HB2021 "requires retail electricity providers to reduce GHG emissions associated with electricity sold to Oregon consumers to 80 percent below baseline emissions levels by 2030, 90 percent below baseline emissions levels by 2035 and 100 percent below baseline emissions levels by 2040."

As of this writing, Oregon HB2021 was just signed into law and it is difficult to offer definitive guidance on how best to approach participation in voluntarily purchase of additional renewable electricity.

Participation in utility sponsored renewables programs, however, offers a rapid action that agencies can take with significant climate benefit without required equipment investment. These programs offer the greatest benefits for investor-owned utilities in Oregon – specifically, Portland General Electric (PGE) and Pacific Power (PacifiCorp). For example, PGE's Green Future Impact and Enterprise Programs allow agencies to purchase electricity from renewable projects in Washington and Oregon.

USING THE G3C – CLIMATE ACTION DASHBOARD

There are two methods to estimate reduction benefits from renewable electricity purchases. Note that only one method will work at a time to avoid double counting benefits. Choose the method that applies – either the simple method for a blanket policy for all facilities (e.g. 100% REC purchases for all owned and/or leased facilities) or the custom method for specific facilities and/or utilities (e.g. isolating electricity purchases for PGE and PacifiCorp powered facilities).

1. ***Simple method:*** automatically shows the baseline electricity emissions and consumption (in kWh) for the chosen baseline year for both owned and leased facilities. **Simply enter a percentage of purchased renewables to calculate the benefit.** *This method is best used when a specific percentage of renewable energy purchases will be consistent for all owned and/or leased facilities.*
2. ***Custom Method:*** allows the user to specify ownership, electricity consumption (in kWh), and electric utility in order to isolate specific facilities for renewable electricity purchases. First, **select facility ownership in the activity dropdown**, either "Electricity (owned)" or "Leased Facilities". Then, **enter the baseline annual electricity consumption** (in kWh) and applicable electric utility. Finally, **enter a percentage of purchased renewables** to calculate the benefit.

For renewable electricity information, contact:

Portland General Electric (**https://portlandgeneral.com/energy-choices/renewable-power**) and Pacific Power (**https://www.pacificpower.net/savings-energy-choices/blue-sky-renewable-energy.html**)

Renewable Natural Gas

A renewable form of fossil methane gas (i.e., natural gas) is produced by landfills, wastewater treatment plants, dairy farms, etc. This gas – referred to as renewable natural gas, or RNG – may be cleaned and used as a substitute for fossil fuels. RNG offers a near-term, renewable substitute, but longer-term renewable hydrogen (produced from renewable electricity or other innovation) will also provide a substitute for fossil gas. As of this writing, RNG is not available for commercial purchase. Those currently utilizing RNG for energy are typically co-located with the production source and generating electricity with it. Others like the Eugene/Springfield wastewater plant and Portland Bureau of Environmental Services are using wastewater to produce RNG for use in vehicles. Northwest Natural Gas (NWN) plans to have a 4% RNG product offering available in 2022. Agencies will likely be able to procure this RNG for locations within NWN territory at that time.

USING THE G3C – CLIMATE ACTION DASHBOARD

There are two methods to estimate reduction benefits from RNG purchases. Note that only one method will work at a time to avoid double counting benefits. Choose the method that applies: either the simple

method for a blanket policy for all facilities (e.g. 100% natural gas purchases for all owned and/or leased facilities) or the custom method for isolating specific facilities.

1. ***Simple method:*** automatically shows the baseline natural gas consumption for the chosen baseline year for both owned and leased facilities (make sure this activity data is entered as therms in the *G3C-Ops>Buildings* worksheet). **Enter a percentage of purchased renewables to calculate the benefit.** *This method is best used when a specific percentage of renewable energy purchases will be consistent for all owned and/or leased facilities.*
2. ***Custom Method:*** allows the user to enter a specific therm consumption quantity in order to isolate specific facilities for renewable natural gas purchases. **Enter the appropriate number of therms consumed** for "Natural Gas (owned)" or "Leased Facilities". Then, **enter a percentage of purchased renewables** to calculate the benefit.

For renewable natural gas information, contact:

Northwest Natural's SmartEnergy Program (https://www.nwnatural.com/about-us/carbon-offset-program/about-smart-energy)

Building Electrification (from natural gas heating)

Electricity offers the promise of zero emissions on a much more rapid timeline compared to natural gas. Natural gas utilities in Oregon have voluntarily committed to a goal of only 30% renewables by 2050.

Electricity offers a compelling substitute for natural gas but does not provide a similar "drop-in" substitute for heating systems that currently use natural gas. Buildings currently served by natural gas will require an equipment change to heat pumps for air and water heating. Electric heat pump technology is still evolving with commercial feasibility limited to 10-ton systems that can serve a total area of about 5,000 square feet.

The American Council for an Energy Efficiency Economy's report, *Electrifying Space Heating in Commercial Buildings: Opportunities and Challenges (https://www.aceee.org/research-report/b2004)*, details the cost-effective opportunities for commercial sector electrification. Note that the report found low-cost, high-return investment for office space in the Pacific Northwest. Interested readers should consult this report.

Using the G3C – Climate Action Dashboard

1. **Select facility ownership in the activity dropdown**, either "Natural Gas (owned)" or "Leased Facilities"
2. **Enter annual natural gas consumption** (in therms)
3. Select the appropriate electric utility in the dropdown to calculate the net benefit.

2. Fleet

Transportation emissions are primarily from the combustion of gasoline and diesel fossil fuels by vehicles. Strategies that may be used in combination to achieve significant reductions include:

- Reduce vehicle trips and vehicle miles traveled (VMT).

- Right-size to the most efficient and cost-effective vehicles that meets the service need.
- Fuel switch from fossil fuels to electricity, renewable fuels, or biofuels.

Oregon Accounting Manual Travel Policy supports these actions:

> *"Transportation Methods 122. Selection of Modes of Transport. Each agency must select the method of transportation most advantageous to state government, when cost and other factors are considered. The travel should be by the most expeditious means of transportation practicable and commensurate with the nature and purpose of the employee's duties. In addition, agencies should consider energy conservation, total cost to state government (including costs of per diem, overtime, lost work time, and actual transportation costs), total distance traveled, number of points visited, and number of travelers."*

Agencies should also refer to DAS policy 107-011-040[17], which requires agencies to select an electric or most fuel-efficient vehicle **for purchase and use** before any and all other vehicles. While EVs are not currently available in all vehicle classes or fit all operational needs, agencies are directed to maximize efficiency, and agency fleet strategies for addressing GHG emissions will be necessary to align with Oregon's climate goals.

Figure 7: Average fuel efficiency by vehicle

Vehicle Type	Fuel Economy (MPG)	Fuel Cost per Mile
Battery Electric Sedan	110	$0.01
Plug-in Hybrid Electric Sedan	110 (electric) 42 (hybrid)	$0.06
Hybrid Electric Sedan	40	$0.07
Sedans	22	$0.12
SUV	20	$0.13
Other	17	$0.15
Station Wagon	18	$0.15
Passenger Van	15	$0.17
Pickup (<1 ton)	13	$0.19
Cargo Van	14	$0.19
Cab-Chassis	11	$0.24

Figure 7 compares average fuel economies and per mile fuel costs for DAS vehicle classes. Battery electric vehicles offer five times the fuel economy compared to a gasoline hybrid vehicle and over 8 times the fuel economy of a pickup truck.

As can be seen in Figure 8, other fuel types also offer climate benefits, but renewable diesel and electricity offer the greatest near-term potential with the lowest costs and fewest equipment upgrades as replacements for diesel and gasoline. Renewable propane and renewable natural gas can also offer an immediate drop-in solution (provided existing equipment uses fossil versions of those fuels). Other zero emissions fuels on the horizon, like green hydrogen, may offer a similar benefit, but hydrogen electric fuel cell technology and supporting infrastructure will require significant development to make the technology a viable option.

[17] https://www.oregon.gov/das/Policies/107-011-040.pdf

Figure 8: Climate benefit scores for various vehicle fuels

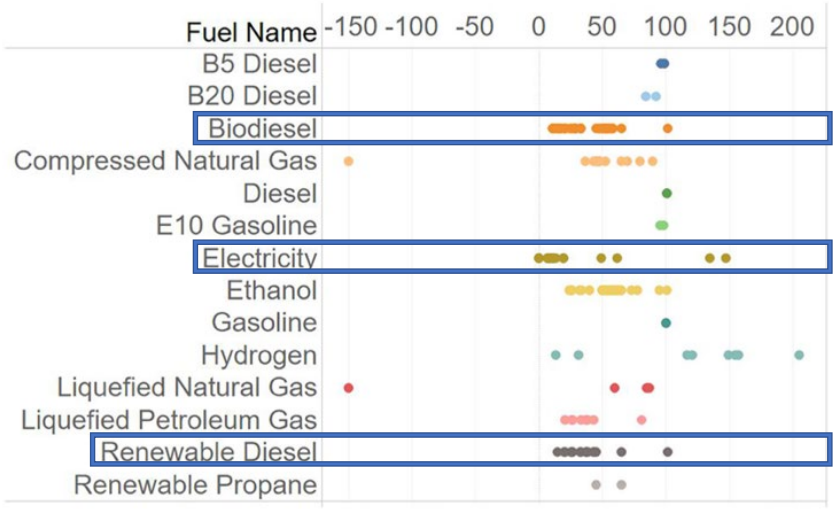


Image Note: The carbon intensity values for the program are expressed in grams of carbon dioxide equivalent per megajoule of energy (g CO_2e / MJ). B5 diesel and E10 gasoline are the minimum standards required in Oregon.
Image Source: https://www.oregon.gov/deq/ghgp/Documents/cfpCarbonIntensityValues.pdf

Electric Vehicles, Rightsizing and Efficiency

For necessary trips, an electric vehicle (EV also referred to as Battery EV or BEV) offers the most climate friendly option currently available. Paired with renewable electricity like wind and solar, the climate impacts for EV use drops to near zero. Electric vehicles are the only currently available and scalable technology alternative for fossil gasoline that can make such a claim.

Electric vehicles already provide a cost-effective substitute for gasoline passenger sedans with ranges over 250 miles (such as the Hyundai Kona and Chevy Bolt). Within the next five years it is widely anticipated that many cost-effective EV pickups and SUVs will be commercially available. Table 3 summarizes known products with cost and range as of 2021-2022 (note that not all of the following are available for purchase by State of Oregon agencies).

Table 3: Price and range for EVs

Name	Price	Range	Availability
Trucks			
Ford F-150 Lightning[i]	$40,000	230-300 Miles	2022
Rivian R1T[ii]	$67,500	300-400 miles	2022
Chevy Silverado EV[iii]	$50,000+	400+ Miles	2024
GMC Hummer EV[iv]	$80,000-$112,595	350 Miles	2024
SUVs[v]			
Chevy Bolt EUV[vi]	$37,500	247+ miles	Currently available
Kia Niro EV[vii]	$40,000	239 Miles	Currently available
Volvo Recharge[viii]	$55,300	223 Miles	Currently Available
Rivian R1S[ix]	$75,000	316 Miles	2022
GMC Hummer EUV[x]	$80,000-$112,595	350 Miles	2024

[i] https://www.cnet.com/roadshow/news/2022-ford-f-150-lightning-electric-pickup-truck-specs-pricing/
[ii] https://rivian.com/r1t
[iii] https://www.chevrolet.com/electric/upcoming-all-electric-silverado
[iv] https://gmauthority.com/blog/gm/gmc/gmc-hummer-ev/
[v] https://insideevs.com/car-lists/electric-suvs/
[vi] https://www.chevrolet.com/electric/bolt-euv
[vii] https://www.kia.com/us/en/niro-ev
[viii] https://www.volvocars.com/us/v/cars/xc40-electric
[ix] https://rivian.com/r1s

Using the G3C – Climate Action Dashboard

DAS Fleet and Parking Services prepares a biannual report on each agency's mileage driven, fuel use, and GHGs for state fleet vehicles. Specifically, the report provides the VMT by state agency and by vehicle type. This report provides the data and means for agencies to evaluate staff vehicle usage and specifically the usage rates of vehicles by type and fuel economy. This data can be used to better understand current vehicle use and plan to transition as many VMTs as possible to battery EVs or hybrids as soon as possible towards reaching climate goals.

For data on agency vehicle and fuel use contact:

Brian King, DAS Fleet and Parking Services Manager, Brian.King@das.oregon.gov

1. **Enter baseline annual distance (VMT) data (from Fleet Report)**
2. **Enter a lower-impact Climate Action Scenario,** by VMT change, toward reducing VMT and/or shifting trips to lower impact vehicles.

3. When including EVs, make sure to **select the applicable electric utility in the dropdown**. Note that one drop-down options include all Oregon utilities, 100% renewable electricity, and an Oregon average, and Other (requires manual entry).

Renewable Diesel Fuel

Electricity offers a compelling substitute for gasoline but does not provide a similar substitute for medium and heavy-duty diesel engines. Renewable diesel is a commercially viable product being used by state agencies and a wide variety of public agencies across Oregon. Renewable diesel is known as a "drop-in" fuel, meaning it can act as a 1:1 substitute for conventional diesel fuels without any new equipment needs, additional maintenance, or operational change.

Renewable diesel fuels certified under Oregon's Clean Fuels Program almost eliminate fossil tailpipe emissions and reduce lifecycle fuel emissions by between 50–70%. DAS Procurement Services has developed a statewide price agreement from which agencies can purchase renewable fuels or fuel blends.[18] Biodiesel, renewable natural gas, and renewable propane also offer low-impact fuel alternatives, but may require equipment retrofits or upgrades.

Renewable diesel is the focus of this section and the Climate Dashboard based on the success state fleets have had with its implementation as a drop in fuel. There are a variety of other low-impact fuel choices available in Oregon including biodiesel, RNG, renewable propane, biodiesel, and others. See Figure 8 for a complete list. These other fuels should be considered by Oregon fleets, particularly for those fleets that already use fossil version of the fuels – such as compressed natural gas or propane. For fleets that do not currently utilize these fuels – agencies should consider the capital and equipment upgrades required to support the fuel switch.

Using the G3C – Climate Action Dashboard

This module calculates the benefit of switching from fossil to renewable diesel for fleet and equipment uses for *tailpipe* emissions only. The tool automatically pulls in the selected baseline year fuel use data for fleet fuels and other stationary uses (make sure this activity data is entered as gallons in the Transportation worksheet).

1. **Enter the percentage of planned purchased renewable diesel fuel** (e.g. 99% for R99 blend, 50% for R50 blend, etc.).
2. **For contracted fuel use, first manually enter the annual gallons** per year consumed.
3. **Update the clean fuels lifecycle emissions factors** to use the tool in future years. Updates will be provided by Oregon DEQ's Clean Fuels Program.

For more transportation fuel lifecycle emissions factors, contact:

Cory-Ann Wind, Oregon Clean Fuels Program Manager, Department of Environmental Quality, Cory.Ann.Wind@deq.state.or.us.

[18] For details visit https://www.oregon.gov/das/Procurement/Guiddoc/BulkFuelBuyersGuide.pdf.

3. Air Travel

Air travel is a significant source of climate pollution. Airplanes require large quantities of fuel to transport goods and people across the country in a matter of hours. Avoiding air travel when possible is the simplest solution. This option has become simple and effective given the rise of video communications. When air travel is unavoidable, emissions offsets can often be purchased through a travel agency, the airline, or a third-party vendor (e.g., The Climate Trust, Bonneville Environmental Foundation, etc.).

Using the G3C – Climate Action Dashboard

DAS Shared Financial Services maintains records of annual agency air travel and associated GHG emissions. Data can be requested through the DAS Office of Sustainability.

This module allows for three separate methods to estimate reduction benefits – **choose only one method based on the activity data available** to avoid double counting.

1. **Emissions Method 1** allows the user to **enter previously calculated annual air travel emissions in MT CO_2e**, such as emissions calculated by the state's air travel vendor, and **then specifying a reduction in emissions using a percentage**.

If emissions data for Method 1 is not available, two other methods can be used:

2. **Miles Method 2** allows the user to enter activity data in **annual passenger miles of air travel**, **then specifying a reduction in emissions using a percentage**.
3. **Cost Method 3** allows the user to enter activity data in **annual dollars spent on air travel**, **then specifying a reduction in emissions using a percentage**.

For state agency travel data (cost, passenger miles, and GHGs) contact:

Steve Markham, DAS Office of Sustainability, Steve.Markham@das.oregon.gov.

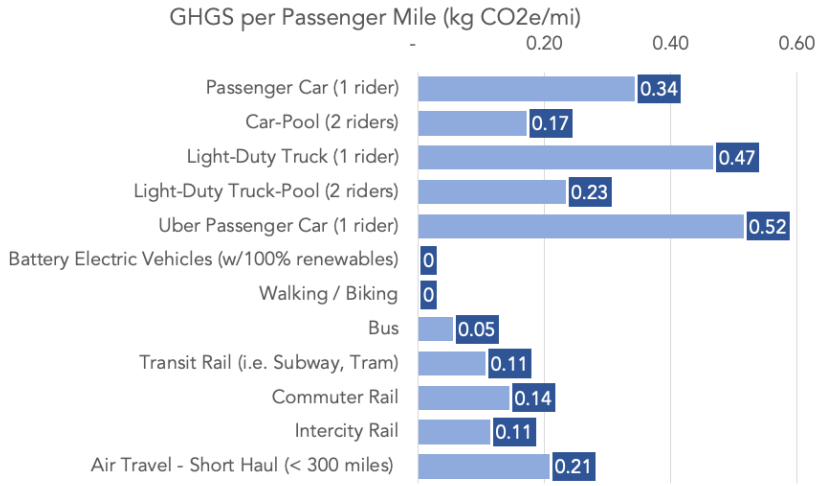
4. Employee Commute

Employees traveling to and from work sites represent a significant source of VMT and gallons of gasoline combusted every year in Oregon. These trips, because they are regular and recurring, are often the focus of travel reduction programs.

DAS has calculated employee commute Impacts for agencies using home zip code and primary office locations, employee time coding, and census data on travel modes by county. This will provide agencies with employee counts, average miles traveled, and mode splits.

Alternatively, an agency may wish to a conduct commute survey to better understand current conditions, and to consider how it might support employee transitions to a lower impact means of travel – be it telecommute with use of video conference technology, use of active transportation including public transit, or even encouraging the use of EVs by providing charging locations. The best solutions for any organization will vary depending on a variety of factors. Once these factors are understood, tailored solutions may be developed.

Figure 9: GHGs by passenger mile for modes of travel



USING THE G3C – CLIMATE ACTION DASHBOARD

To calculate an emissions benefit for a climate action scenario module:

1. **Enter activity data for an alternative "Climate Action Scenario" (see row 173)**:
    a. Update Annual Workdays (cell F173): To correspond with number of annual workdays, including telecommute days.
    b. Update modal split away from single occupancy vehicles (SOV) (cell J-N 173) to correspond with uptake and use of employee incentives such as transit passes, bicycle facilities, and OTHERS HERE. *Make sure all fields are filled in and the five commute modes add up to 100%.*

For more information on available commuting data for agencies, contact:

Paul Platosh, DAS CAD/GIS Information Systems Specialist, Paul.Platosh@oregon.gov

Also visit the DAS Fleet and Parking Services **Smart Commuter Program** web page:

https://www.oregon.gov/das/FleetPark/Pages/commute.aspx

5. Purchased Goods

DAS Procurement Services can provide agencies with annual spend data for IT hardware and paper. Data for other product categories may also be available if an agency wishes to use the Other Innovation section of the Climate Action Dashboard, below.

The Climate Action Planning Dashboard does not include a specific section for Purchased Goods. If an agency wishes to estimate reductions associated with purchases, they can simply enter reduced spending data in the Supply Chain tab of the GC3 tool to generate an estimate.

For more information, contact:

Adam Helvey, ORCPP and Sustainability Program Manager, Oregon Buys, Adam.L.HELVEY@oregon.gov

6. Other Innovation

There are a variety of other actions that may be taken to address climate change. Those highlighted in this guidebook are the most common and commercially viable alternatives that agencies have the potential to scale quickly. That said – the urgency of climate change and the scale of action required cannot be overstated. It is truly an all-hands-on-deck moment. While we have the technologies and solutions at our disposal to act right now, future innovation and new solutions will be needed. This section of the Climate Action Dashboard offers agencies the ability to enter custom strategies and see how they contribute to overall agency GHG reduction goals.

Example 1 – Carbon Offsets

Purchasing carbon offsets from a broker (e.g. The Climate Trust or Bonneville Environmental Foundation) or on-bill from Northwest Natural's SmartEnergy program. Carbon offsets may be purchased in any quantity and that quantity may be recorded in the Other Innovation's worksheet. See the USING THE G3C section below. In the Other Innovations module, carbon offsets may be applied toward any emissions source, but the most common are natural gas and air travel.

Example 2 – Planting Trees

Planting trees is a symbol of climate action. Trees provide communities with a variety of benefits, keeping our communities cool and reducing the need for air conditioning. According to EPA's GHG equivalency calculator, one (1) MT of CO_2e is offset by planting 16 tree seedlings and letting them grow for 10 years. Another way to think about it is one (1) MT CO_2e is equal to one year's carbon storage by 1.2 acres (about half the area of a city block) of average U.S. Forest. USDA provides a suite of tools for assessing the climate and co-benefits of trees (https://www.itreetools.org).

USING THE G3C – CLIMATE ACTION DASHBOARD

This module allows for other calculated innovation projects beyond the listed Climate Action modules to be included in the benefits estimates.

1. Select the applicable activity area in the left dropdown.
2. Enter the pre-calculated GHG benefit value in MT CO_2e into the GHG Benefit field *as a negative number*.
3. Finish with a **brief description of the project.**

Appendices

Appendix A: Methodology Details

Stationary Energy

- Electricity: Consumption multiplied by category-specific emission factors. Greenhouse Gas Protocol's Scope 2 Guidance suggests using two methods for calculation of electricity emissions. Location-based accounting shows the impacts of the regional grid, while market-based accounting shows the impacts of an agency's contracts.
    - Location-based emissions: Calculates emissions using EPA eGRID factors for reginal electricity grids. User sets this region on the Operations Info worksheet.
    - Market-based emissions: This is electricity contracted for purchased from a local utility or other provider. Market-based emissions are calculated from user entries on the Operations Info worksheet. Contact your energy provider for the factor.
- Natural Gas: Consumption multiplied by combustion emissions factor to calculate Scope 1 emissions (or Scope 3 for leased facility emissions). Also calculates Scope 3 fuel production by subtracting Scope 1 emissions from calculated lifecycle emissions.
- Diesel: Consumption multiplied by combustion emissions factor to calculate Scope 1 emissions (or Scope 3 for leased facility emissions). Also calculates Scope 3 fuel production by subtracting combustion emissions from calculated lifecycle emissions.
- Propane: Consumption multiplied by combustion emissions factor to calculate Scope 1 emissions (or Scope 3 for leased facility emissions). Also calculates Scope 3 fuel production by subtracting combustion emissions from calculated lifecycle emissions.
- Steam: Consumption multiplied by steam provider emissions factor and/or fuel factors.

Transportation

- Owned fleet: Consumption multiplied by EPA emission factors to calculate Scope 1 emissions. Consumption multiplied by eGRID location-based or entered market-based electricity emissions factors for Scope 2 electric vehicle emissions. Also calculates Scope 3 fuel production by subtracting combustion/electricity emissions from calculated lifecycle emissions. Lifecycle emissions factors for fuels will need to be aligned with the appropriate inventory year and updated for future years. See Emissions Factors > Transportation and Commute (row 210) > Gasoline (column E); Ethanol (column I); Diesel (column N); Biodiesel (column U); Renewable Diesel (column AB); CNG (column AI); LNG (column AP); Propane (column AU).
- Contracted freight: Ton-miles or gallons multiplied by default EPA emissions factors. Users are able encouraged to customize per ton-mile emissions factors as needed as EPA's factors are general and may not be appropriate for all circumstances.
- Business Travel
- Rental Vehicles: Distance multiplied by EPA emissions factor
- Employee-owned Vehicles: Distance multiplied by EPA emissions factor

- Air Travel: Passenger miles multiplied by EPA emissions factor. Financial activity data uses a conversion factor ($ / passenger miles) from Massachusetts Institute of Technology's Global Airline Industry Program – Airline Data Project to estimate miles if needed. If entering as financial data, make sure this factor is up-to-date in the Inventory Constants worksheet.
- Bus Travel: Passenger miles multiplied by EPA emissions factor
- Commuter Rail: Passenger miles multiplied by EPA emissions factor
- Transit Rail: Passenger miles multiplied by EPA emissions factor

Refrigerants

- Refrigerants: Fugitive refrigerant weights are multiplied by the global warming potentials reported in the Intergovernmental Panel on Climate Change (IPCC) Assessment Report 5
- Process emissions are calculated by the user outside of G3C and the summary is entered into G3C-Ops.

Waste

- Solid waste weight is multiplied by mixed solid waste emissions factor from EPA's Waste Reduction Model (WARM). Solid waste volumes are multiplied solid waste densities from CalRecycle Waste Characterization Study to convert volume to weight first; followed by a calculation of emissions using EPA WARM emissions factors for specific methane management practices. If landfilled waste weight is unknown, an estimate is calculated using CalRecycle factors based on facility square footage and primary building activity type as selected in Operations Info.

Employee Commute

- Miles traveled are calculated by mode and multiplied by EPA commute emissions factors.
- Sample commute survey questions:
    - How many days per year do you work? (5 days per week x 52 weeks per year = 260 days per year. Make sure to factor in vacations and other non-workdays into your response. Telecommute days are considered workdays.
    - How many one-way travel miles from your home to work? *It may be helpful to suggest calculating the distance from home to work using Google maps at www.google.com/maps.*
    - *Optional:* What is the fuel efficiency (miles per gallon) of your commute vehicle? Leave blank if you do not drive a diesel or gasoline vehicle for your commute. (Note: You may also use average fuel economy values based on fueleconomy.gov).
    - What percentage of travel do you commute using each of the following? Please use as many modes below as apply to your commute. If using more than one mode, all answers should add up to 100%. (Example 1: If you exclusively commute to work by a gasoline powered car, fill in "Drove alone: Gasoline passenger vehicle" with 100). Example 2: If you travel to work by bus 90% of the time and carpool 10% of the time. Fill in bus with 90 and "carpool or vanpool" 10).
        - Walk, bike, or other active transportation
        - Telecommute

        - Carpool or vanpool
        - Bus
        - Light rail (if applicable to region)
        - Drive alone
    - If you carpool or vanpool, what is the average number of passengers?
    - Optional: what commute modes and incentives are you interested in learning more about? (*Response options should be tailored to specific areas and/or offices*)

Glossary of Terms

CO_2e

Carbon dioxide equivalent – a unit of measure. Most greenhouse gases are more potent in warming the atmosphere than carbon dioxide. In order to calculate and compare emissions easily, all gases are calculated and combined into a carbon dioxide equivalent, typically measured in metric tons (MT CO_2e).

Emissions Factor

The volume of greenhouse gasses, (MT CO_2e) emitted per unit of activity. The emissions factor for electricity might be given in units of MT CO_2e per KWh; for diesel emissions it might be given in MT CO_2e per gallon of diesel; and for supply chain emissions it might be expressed in MT CO_2e per dollar.

GHG

Short for greenhouse gas. Emissions of greenhouse gases are the cause of current climate change. An inventory of GHGs measures gases in units of CO_2e. A GHG inventory is also known as a carbon footprint.

GWP

Short for global warming potential. This refers to the potency of emissions to trap heat in the atmosphere. Carbon dioxide has a GWP of 1, and other GHG gases are more potent and expressed as a multiple of carbon dioxide. For example, methane has a GWP of 28, meaning one molecule has 28 times the effect of one molecule of carbon dioxide (IPCC AR5 values).

KWh

Short for kilowatt hour. Kilowatt hours are a standard unit for electricity consumption, and a measure of electrical energy equivalent to a power consumption of 1,000 watts for 1 hour.

MT

Short for Metric Ton (~2,200 lbs.). This is a common unit by international standards.

Scope (as in Scope 1, Scope 2, Scope 3)

Scopes are one method to define the source of emissions. Scope categories distinguish between emissions that occur within a geographic boundary (Scope 1), from electricity generation serving the community (Scope 2), and emissions that occur outside the boundary, but that are driven by activity within the boundary (Scope 3).

Therm

Common reporting unit of natural gas that represents 100,000 British thermal units. A therm is roughly equivalent to 100 cubic feet of natural gas.

Electricity Emissions Factors

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Market-Based Utility	$MTCO_2e$ / MWh	$MTCO_2e$ / MWh	$MTCO_2e$ / MWh	$MTCO_2e$ / MWh	$MTCO_2e$ / MWh	$MTCO_2e$ / MWh	$MTCO_2e$ / MWh	$MTCO_2e$ / MWh	$MTCO_2e$ / MWh	$MTCO_2e$ / MWh
Idaho Power Company	0.4513	0.2824	0.3445	0.4384	0.3884	0.3726	0.3262	0.2363	0.2425	0.2473
Pacific Power (PacifiCorp)	0.7130	0.6690	0.7010	0.7210	0.7250	0.7395	0.6529	0.6519	0.6741	0.6894
Portland General Electric (PGE)	0.5053	0.4110	0.3653	0.3614	0.3825	0.4113	0.3761	0.3522	0.3727	0.4180
Ashland Electric Department	0.0580	0.0190	0.0146	0.0173	0.0170	0.0146	0.0116	0.0089	0.0117	0.0204
Bandon	0.0580	0.0190	0.0146	0.0173	0.0170	0.0146	0.0116	0.0089	0.0117	0.0204
Blachly-Lane Electric Cooperative	0.0330	0.0119	0.0142	0.0158	0.0160	0.0139	0.0110	0.0084	0.0111	0.0370
Canby Utility Board	0.0580	0.0190	0.0146	0.0173	0.0170	0.0146	0.0116	0.0089	0.0117	0.0204
Cascade Locks	0.0580	0.0190	0.0146	0.0173	0.0170	0.0146	0.0116	0.0089	0.0117	0.0204
Central Electric Cooperative, Inc.	0.0262	0.0112	0.0146	0.0172	0.0170	0.0146	0.0115	0.0089	0.0116	0.0257
Central Lincoln PUD	0.0580	0.0190	0.0146	0.0173	0.0170	0.0146	0.0116	0.0089	0.0117	0.0204
Clatskanie PUD	0.0590	0.0653	0.0725	0.0859	0.0637	0.0728	0.0302	0.0330	0.0357	0.0534
Clearwater Power Company	0.0305	0.0185	0.0146	0.0172	0.0170	0.0146	0.0116	0.0089	0.0117	0.0209
Columbia Basin Cooperative	0.0580	0.0190	0.0146	0.0173	0.0170	0.0146	0.0116	0.0089	0.0117	0.0204
Columbia Power Cooperative	0.0580	0.0190	0.0146	0.0173	0.0170	0.0146	0.0116	0.0089	0.0117	0.0204
Columbia River PUD	0.0580	0.0190	0.0146	0.0173	0.0170	0.0146	0.0116	0.0089	0.0117	0.0204
Columbia Rural Electric (Columbia REA)	0.0580	0.0190	0.0146	0.0173	0.0196	0.0146	0.0116	0.0089	0.0117	0.0204
Consumers Power, Inc.	0.0295	0.0120	0.0144	0.0164	0.0160	0.0138	0.0110	0.0085	0.0110	0.0283
Coos-Curry Electric Cooperative, Inc.	0.0302	0.0124	0.0146	0.0173	0.0169	0.0146	0.0116	0.0089	0.0117	0.0204
Douglas Electric Cooperative	0.0293	0.0121	0.0146	0.0173	0.0170	0.0146	0.0116	0.0089	0.0117	0.0204
Drain	0.0580	0.0190	0.0146	0.0173	0.0170	0.0146	0.0116	0.0089	0.0117	0.0204
Emerald PUD	0.0558	0.0303	0.0144	0.0174	0.1218	0.1406	0.1083	0.0954	0.1195	0.1446
Eugene Water & Electric Board (EWEB)	0.0294	0.0143	0.0127	0.0201	0.0142	0.0127	0.0098	0.0167	0.0147	0.0548
Forest Grove Light & Power	0.0518	0.0170	0.0131	0.0157	0.0153	0.0131	0.0104	0.0080	0.0106	0.0184
Harney Electric Cooperative	0.0580	0.0190	0.0146	0.0173	0.0170	0.0146	0.0116	0.0089	0.0117	0.0204
Hermiston Energy Services	0.0580	0.0190	0.0146	0.0173	0.0170	0.0146	0.0116	0.0089	0.0117	0.0204
Hood River Electric Cooperative	0.0580	0.0190	0.0146	0.0173	0.0170	0.0146	0.0116	0.0089	0.0117	0.0204
Lane Electric Cooperative, Inc.	0.0282	0.0118	0.0146	0.0172	0.0168	0.0145	0.0116	0.0089	0.0117	0.0203

McMinnville Water & Light	0.0562	0.0187	0.0149	0.0178	0.0175	0.0163	0.0116	0.0089	0.0117	0.0204
Midstate Electric Cooperative	0.0580	0.0190	0.0146	0.0173	0.0170	0.0146	0.0116	0.0089	0.0117	0.0204
Milton-Freewater City Light & Power	0.0442	0.0146	0.0111	0.0173	0.0130	0.0118	0.0093	0.0073	0.0094	0.0155
Monmouth	0.0580	0.0190	0.0146	0.0173	0.0170	0.0146	0.0116	0.0089	0.0117	0.0204
Northern Wasco PUD	0.0580	0.0190	0.0136	0.0161	0.0159	0.0132	0.0086	0.0062	0.0087	0.0292
Oregon Trail Electric Cooperative	0.0580	0.0190	0.0146	0.0173	0.0170	0.0146	0.0116	0.0089	0.0117	0.0204
Springfield Utility Board	0.0580	0.0190	0.0146	0.0173	0.0170	0.0146	0.0116	0.0089	0.0117	0.0204
Surprise Valley Electrification Corporation	0.0580	0.0190	0.0146	0.0173	0.0170	0.0140	0.0111	0.0086	0.0117	0.0204
Tillamook PUD	0.0579	0.0190	0.0145	0.0172	0.0168	0.0145	0.0116	0.0089	0.0117	0.0202
Umatilla Electric Cooperative	0.0277	0.0110	0.0144	0.0167	0.0188	0.0100	0.0132	0.0182	0.1009	0.1830
Umpqua Indian Utility Co-op	0.0580	0.0190	0.0146	0.0173	0.0170	0.0146	0.0116	0.0089	0.0117	0.0204
USDOE ARC	0.0000	0.0000	0.0000	0.0000	0.0170	0.0146	0.0116	0.0089	0.0117	0.0204
Wasco Electric Cooperative	0.0580	0.0190	0.0146	0.0173	0.0170	0.0146	0.0116	0.0089	0.0117	0.0204
West Oregon Electric Cooperative, Inc.	0.0326	0.0129	0.0146	0.0173	0.0170	0.0146	0.0116	0.0089	0.0117	0.0204
3 Phases Renewables	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Avangrid Renewables	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0263	0.0366	0.0112
Calpine Energy Solutions	0.5241	0.3990	0.4090	0.5140	0.4640	0.4871	0.4059	0.3464	0.4280	0.4280
Constellation New Energy	0.5340	0.3990	0.4090	0.0000	0.0000	0.4871	0.4059	0.3464	0.4280	0.4280
Shell Energy North America	0.0000	0.0000	0.0000	0.0000	0.0000	0.2757	0.1910	0.2131	0.2477	0.3030

Location-Based Emissions (NWPP)	lb/MWh MWh	lb/MWh MWh	lb/MWh MWh	lb/MWh MWh	lb/MWh MWh	lb/MWh MWh
CO2	842.5800	665.7500	906.9590	651.1990	639.0370	715.2410
CH4	0.0161	0.0126	0.0978	0.0610	0.0640	0.0680
N2O	0.0131	0.0104	0.0142	0.0090	0.0090	0.0100
Total CO2e	846.97	669.23	913.42	655.41	643.36	719.87

Appendix B: Cost Estimates for Climate Actions

Measure	Cost Ranges	Other Notes
Retro-commissioning	Typical costs for retro-commissioning can range from as low as $0.13 per square foot up to $2 per square foot. Payback ranges from 0.2 to 2.1 years. [19]	Some energy utilities offer free or subsidized retro-commissioning studies.
Lighting upgrades	Upgrading 100 lighting fixtures to LED can range from $7,500-20,000. Payback period of LED lighting retrofits is less than 3 years.	Utilities offer incentives and rebates for lighting upgrades that further reduce costs and shorten payback times.
HVAC efficiency upgrades	Upgrading HVAC for higher efficiency typically has a payback of 3-6 years[20].	Utilities offer incentives and rebates for HVAC upgrades that further reduce costs and shorten payback times.
Plug load management	Managing plug loads has minimal to no costs. Costs mainly associated with advanced plug strips and timers where used.	Use of computer power management and enforcing state policy on appliance use can reduce energy costs with no additional capital investment.
Onsite solar	According to the latest annual data from the National Renewable Energy Laboratory, a commercial rooftop PV system has a typical installed cost of $1.72 per watt[21].	Utility incentives and tax credits help offset the costs of solar.
Grid Renewable Energy	Varies by energy utility. 2022 costs to participate in Pacific Power's Blue Sky program are an additional $0.0071 – 0.0075 per kWh over baseline electricity rates.	Customers can pay an on-bill premium to have the utility obtain renewable energy credits (RECs) on the customer's behalf. There is flexibility in the scale and duration of participation. Other options include PGE's Green Future Impact and Pacific Power's Blue Sky, which may be more available.
Renewable natural gas	The cost of this renewable gas is more expensive than conventional fossil gas, but it is too early to tell the incremental increase for customers. Costs vary by subscription.	NW Natural Gas planning to offer 4% RNG product option for stationary applications in 2022. NWN's Smarty Energy program offers enrollment to offset gas use, similar to renewable energy credits.
Building electrification	Commercial heat pump costs vary widely by size and efficiency. Payback is about 15 years[22].	Heat pump applications for state buildings are limited generally to buildings 10,000 square feet or smaller.

[19] https://buildingefficiencyinitiative.org/articles/retro-commissioning-significant-savings-minimal-cost
[20] Cut carbon emissions by retrofitting real estate | JLL
[21] latest annual data from the NREL
[22] ACEEE Report

Measure	Cost Ranges	Other Notes
Electric vehicles	Cost per egallon of electricity is 99 cents, compared to over $3 for gas[23].	Up-front costs for EV purchases are included in the Guidebook.
Renewable Diesel	In FY21, the average R99 price per gallon ODOT paid was $1.95, versus $2.16 for B5 (a $0.21 savings per gallon for R99). Note: fuel costs include a markup for delivery; R99 delivery costs can be greater than for B5 due to delivery distances from Portland.	Performance of renewable diesel is as good as, if not better than conventional diesel.
Air travel	Savings from reducing flying to meetings. Carbon offsets for flight can be purchased for $15-20 for a flight up to 5,000 miles[24].	Most airlines offer option to purchase offsets.

[23] https://www.energy.gov/maps/egallon

[24]