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Setting-up a greenhouse gas emissions inventory: Scope 1-3 Emissions

Information Session

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Instructor introduction

Kyle Aben

- Bachelor in Business Administration, Business and Regulatory Policy
- Master of Arts in International Studies, Global Environmental Policy
- Certificate in ISO 14064 (Quantification, Projects, Validation, and Verification)
- Certified as a Greenhouse Gas Inventory Quantifier (GHG-IQ)

- Pacific Institute for Climate Solutions
- David Suzuki Foundation
- West Fraser Timber
- Carbon Realities Consulting
- Carbon Accounting Instructor (University of Northern British Columbia, Quest University, and CIET)

Agenda

- CIET introduction
- Housekeeping items (acknowledgements, recording, chat, questions, etc.)
- Greenhouse gases. What are they and why are they important?
- Who measures their greenhouse gas emissions and why?
- Who developed the three-scope carbon accounting framework?
- Measuring greenhouse gas emissions: Scopes 1, 2, and 3 explained
- Conclusion, references, and questions

Objectives - through this information session, participants will learn:

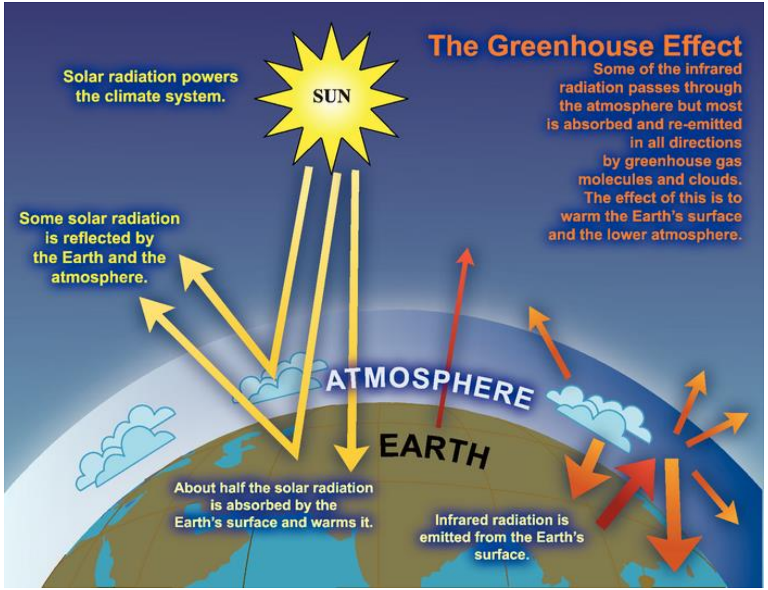
- Basic information about greenhouse gases, including types and impacts
- The definition of Scope 1, 2, and 3 greenhouse gas emissions
- Foundational elements of developing a greenhouse gas inventory using the Greenhouse Gas Protocol

Greenhouse gases

What are they and why they are important?

Greenhouse gases (GHGs) in the Earth's atmosphere trap heat from the sun, creating a greenhouse effect that warms the planet. While this natural process is essential for life on Earth, an excess of GHGs due to human activities is causing climate change. The impacts of climate change are considerable:

- Record breaking heatwaves
- Increased Canadian wildfires
- Melting glaciers and rising sea levels
- Stronger and more prevalent floods and hurricanes



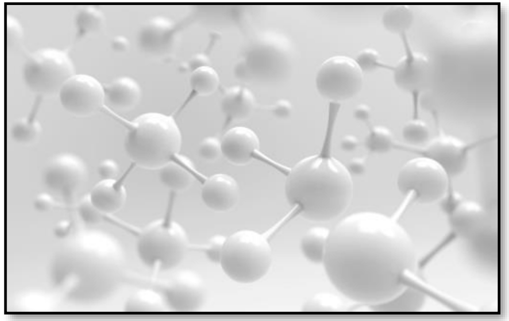
Source : Climate Change 2007: IPCC Working Group I: The Physical Science Basis

Greenhouse gases

There are seven main GHGs measured (the Kyoto gases)

Each GHG has different warming impacts on the climate over a 100-year period and that are conveyed as global warming potentials (GWPs) in the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5).

- **Carbon dioxide (CO_2) = GWP 1**
- **Methane (CH_4) = GWP 28**
- **Nitrous oxide (N_2O) = GWP 265**
- **Hydrofluorocarbons (HFCs) = GWP ranges from 4 to 12,400**
- **Perfluorocarbons (PFCs) = GWP ranges from 6,630 to 11,100**
- **Sulfur hexafluoride (SF_6) = GWP 23,500**
- **Nitrogen trifluoride (NF_3) = GWP 16,100**



These GWPs are used to convert all greenhouse gases into a carbon dioxide equivalent **(CO_2e)** - this enables a common emissions unit to be used during measurement.

Who measures their carbon footprint?

Organizations of all types conduct emissions inventories. An **emissions inventory** is a comprehensive accounting of all GHGs an organization directly and indirectly emits. GHGs are accounted for several important reasons:

- **Regulatory compliance.** Canada has agreed to international commitments to reduce GHG emissions and has adopted an Output-Based Pricing System as a federal backstop to provincial regulations. Facilities in Ontario that emit 10,000 tonnes or more of CO2e per year are required to report their emissions to the provincial government. This includes facilities in sectors such as manufacturing, electricity generation, mining, and waste management.
- **Investor and stakeholder pressure.** Environmental, social, and governance (ESG) criteria are becoming a central part of investment decisions. An emissions inventory is a key component of ESG reporting. Investors demand transparency about climate risks, compelling organizations to disclose their carbon footprints through frameworks like the CDP (formerly the Carbon Disclosure Project) and Task Force on Climate-related Financial Disclosures (TCFD).
- **Consumer demand.** Consumers are demanding more sustainable products, and companies face increasing pressure to assess and reduce their carbon footprints. Branding products as carbon neutral or low carbon is becoming a competitive advantage, driving companies to measure and reduce their emissions.
- **Risk management.** There are both financial and reputational risks that can be mitigated with managing emissions. Carbon pricing, operational cost increases, fines for non-compliance, and investor concerns are just a few of the risks being considered by managers. Disclosing an organization’s carbon footprint and reducing carbon emissions can enhance brand value while reducing risks.

Who measures their carbon footprint? (Cont')

Many of Ontario's largest companies – including RBC, Magna, Manulife Financial, Loblaws, Rogers, Barrick, Suncor Energy, and CN – measure their carbon emissions and report them publicly and voluntarily in addition to meeting regulatory requirements. Some smaller organizations also feel pressure to measure their carbon footprints due to supply chain requirements and to access sustainable financing sources.

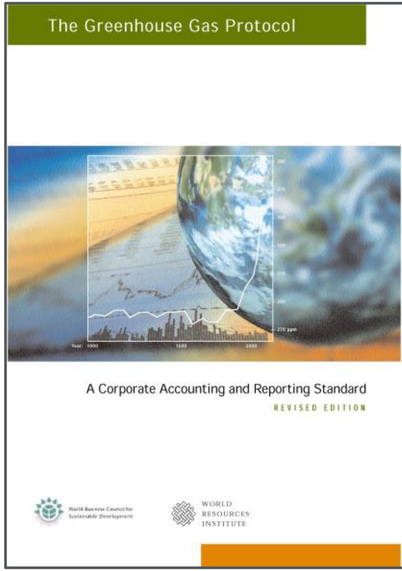
Who developed the three-scope carbon accounting framework?

GREENHOUSE GAS PROTOCOL

The three scopes were developed in the Greenhouse Gas Protocol.

The GHG Protocol:
A partnership between the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD). The GHG Protocol works with governments, industry associations, NGOs, businesses, and other organizations to address climate change. The GHG Protocol is the most widely used framework for GHG inventories globally.

GHG Protocol Corporate Standard:
The Protocol provides the accounting framework for almost every GHG reporting program in the world. It includes detailed guidelines, calculation tools, and examples.



Source: ghgprotocol.org

ISO-14064-1

The ISO and GHG Protocol standards are compatible and complementary.

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Measuring greenhouse gas emissions

The first step in measuring GHG emissions is to define an **organizational boundary**. Are you measuring an entire province, a large company with many ownership stakes, a municipality, a small company, or an event?

The GHG Protocol provides three options to set an organizational boundary:

1) **Equity Share.** This boundary means that a company accounts for GHG emissions based on its ownership stake in a particular operation or asset rather than based on direct operational control.

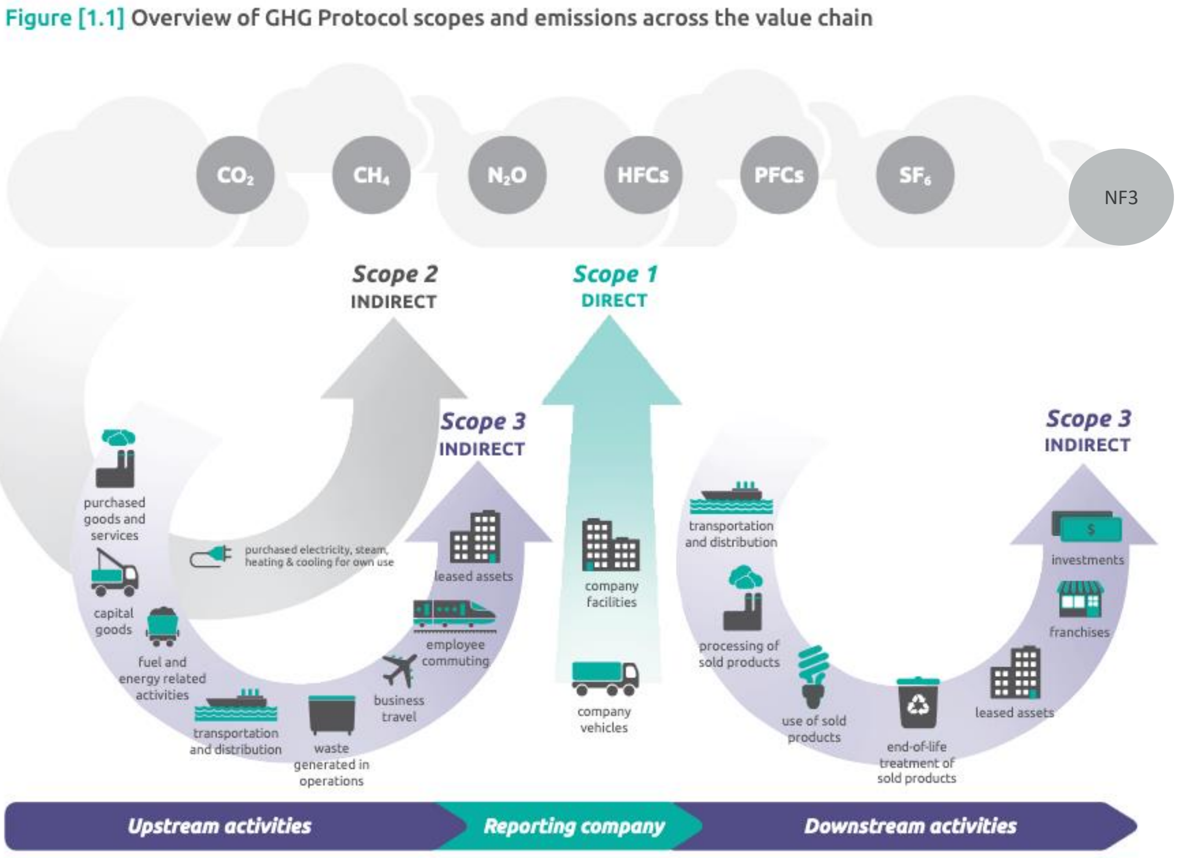
2) **Financial Control.** Measured emissions are based on financial control of ownership stakes. If financial control exists, then emissions are accounted for. If financial control does not exist, emissions are not accounted for.

3) **Operational Control.** Measured emissions are based on the operational control of ownership stakes. If operational control exists, then emissions are accounted for. If operational control does not exist, emissions are not accounted for.

Measuring greenhouse gas emissions (Cont')

Once the organizational boundary is determined, the second step in measuring GHG emissions is to define an **operational boundary**. An operational boundary refers to the scope of activities and emission sources that a company includes in its GHG inventory. It defines which emissions a company is responsible for tracking and reporting based on the level of control or influence it has over those emissions. This step requires grouping emissions into categories named Scope 1, Scope 2, and Scope 3 emissions. These are defined on the next slides.

By setting clear operational boundaries, organizations can consistently track, manage, and report their carbon footprints, allowing for better comparisons and accountability in sustainability efforts.



Source: http://efaidnbmnnnibpcajpcglclefindmkaj/https://ghgprotocol.org/sites/default/files/standards/CorporateValue-Chain-Accounting-Reporing-Standard_041613_2.pdf

Understanding the three scopes of emissions

Scope 1: Direct emissions generated from owned and controlled facilities (fuel for heating and production and mobile fuel).

Scope 2: Indirect emissions generated from purchased energy (electricity, heat, steam, cooling).

Scope 3: Indirect emissions generated from supply chain partners and activities.

Scope 1: Direct GHG emissions

Scope 1 emissions are direct GHG emissions from sources that an organization owns or controls. These include emissions from:

- **Onsite fuel combustion,** e.g. natural gas for heating, hot water, and other processes (Biomass fuels in Scope 1 include any CH_4 or N_2O only, CO2 is reported separately outside the boundary)
- **Company-owned vehicles,** e.g. fuel burned in equipment, trucks, cars, or forklifts
- **Fugitive emissions,** e.g. refrigerant leaks, chemical processes

Scope 1 emissions are usually the easiest to quantify for an organization because they involve emissions from its own operations. They are calculated by collecting data on fuel consumption, chemical use, or fugitive emissions released and applying the relevant emissions factors.

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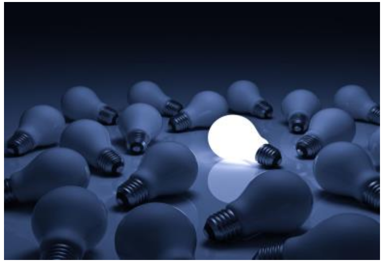
Scope 2: Indirect GHG emissions from energy

Scope 2 emissions are indirect GHG emissions from external sources that produce energy for consumption by others. These include emissions from:

- **Purchased electricity**
- **Purchased steam, heat, or cooling**

Emissions occur at power plants generating energy. Organizations using that energy account for these emissions under Scope 2. Therefore, quantifying Scope 2 emissions involves tracking energy use (in kWh or GWh) and multiplying use by the emissions factors associated with the energy producers (two ways to do this!).



Canada's Provincial and Territorial Grid Emissions Factors:

British Columbia	15 grams CO_2e/kWh
Alberta	540 grams CO_2e/kWh
Saskatchewan	730 grams CO_2e/kWh
Manitoba	2 grams CO_2e/kW
Ontario	30 grams CO_2e/kWh
Quebec	1.7 grams CO_2e/kWh
New Brunswick	300 grams CO_2e/kWh
Nova Scotia	690 grams CO_2e/kWh
Prince Edward Island	300 grams CO_2e/kWh
Newfoundland and Labrador	2.0 grams CO_2e/kWh
Yukon	80 grams CO_2e/kWh
Northwest Territories	170 grams CO_2e/kWh
Nunavut	840 grams CO_2e/kWh

Government of Canada, Emissions Factors and Reference Values, Version 2.0 May 2024, Table 5.1 Electricity Consumption Intensity Values (g CO_2e/kWh electricity consumed) for 2023 and 2024

Source: https://www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work/output-based-pricing-system/federal-greenhouse-gas-offset-system/emission-factors-reference-values.html#toc5

Scope 2: Location-based or market-based factors

1. **Location-Based Accounting.** Reflects the average emissions intensity of the electricity grid where energy consumption occurs.

   Key Aspect: Based on **grid average emissions factors** (e.g. regional/national grid mix)

   Example: If a company operates in a region with high coal usage, its Scope 2 emissions will be higher even if the company purchases renewable energy certificates (RECs).

2. Market-Based Accounting. Reflects emissions from electricity a company has chosen through specific purchases.

Key Aspect: Based on **contractual instruments** (e.g. power purchase agreements, RECs)

Example: A company buying 100% renewable electricity via RECs can report zero or low emissions using this method even if the local grid is carbon intensive.

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Scope 3: Other indirect GHG emissions (supply chain)

Scope 3 emissions are all other indirect GHG emissions that occur in the value chain. These emissions are not directly controlled by the organization but are a consequence of its operations. These emissions are grouped into **upstream** and **downstream** within 15 categories:

Upstream emissions:

- Purchased goods and services
- Capital goods
- Fuel and energy related emissions
- Transportation
- Waste management
- Business travel
- Employee commuting
- Leased assets

Downstream emissions:

- Transportation
- Processing of sold products
- Use of sold products
- End-of-life treatment of sold products
- Leased assets
- Franchises
- Investments

Scope 3 is the broadest and quite often the largest category, making it more complex to quantify. Estimation methods vary depending on the type of activity.

Activity data can vary in quality and accuracy!

Examples of converting mobile fuel use data to calculate Scope 1 emissions:

- Identify amount spent on fuel. Then convert average price/litre to litres used. **(Poor)**
- Estimate based on distance travelled and type of vehicle used. Then convert average vehicle efficiency/distance into litres used. **(Fair)**
- Actual litres of fuel used and type of vehicle used. **(Good)**
- Tailpipe measurement of actual emissions. **(Best** *but not realistic)*

Activity data can vary in quality and accuracy (continued)

Example of converting purchased tire data (for an auto manufacturer) into Scope 3 emissions:

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- Identify amount spent on tires. Then convert average cost/tire and use industry estimate for emissions from manufacturing. **(Poor)**
- Identify average number of tires purchased in past five years. Then use industry average for emissions from manufacturing. **(Fair)**
- Identify the precise number and type of tires purchased. Then use industry wide estimate for emissions for each tire used. **(Good)**
- Identify the precise number and type of tires purchased and supplier-provided emissions data. Then convert into emissions. **(Best)**

When researching emissions factors, it is essential to know your activity data to ensure an accurate calculation can be made. There may be a need to convert the data before using a certain emissions factor: GJ to M^3 of natural gas, kWh to GWh of electricity, kilograms to tonnes of materials or waste, $CAN to $US of currency used, etc.

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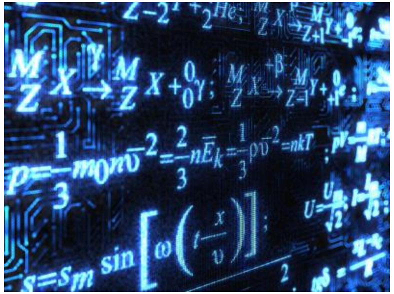
Calculation examples – Scopes 1, 2, and 3



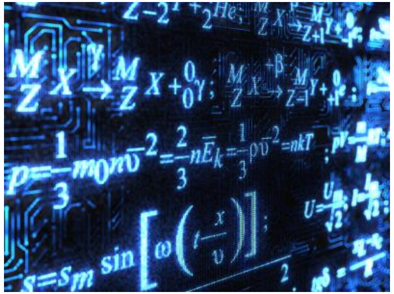
Scope 1 example: Natural gas use

Emissions factors:
(Unit conversion factor = 0.03885 GJ/M^3)

- CO2 = 49.58 kg/GJ
- CH4 = 0.0010 kg/GJ
- N2O = 0.0009 kg/GJ

If 88 GJ of natural gas is used, emissions =
(88 GJ*49.58 kg/GJ)+(88 GJ *0.0010 kg/GJ *28 *(GWP for CH_4))*+(88 GJ*0.0009 kg/GJ *265 *(GWP for N_2O))*
= **4,386.5 kg CO_2e**
OR
CO_2e = 49.85 kg CO_2e/GJ
Therefore, if 88 GJ of natural gas is used = 88 GJ*49.85 kg CO_2e/GJ = **4,386.8 kg CO_2e**

1-Calculation examples – Scopes 1, 2, and 3



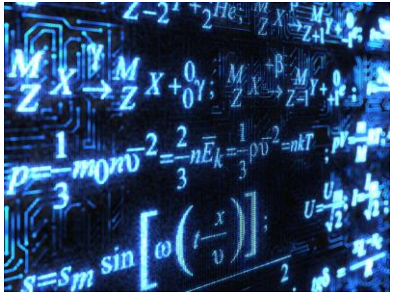
Scope 2 example: Electricity use

Emissions factor in grams/kWh:
Ontario = 30 grams CO_2e/kWh

Therefore, if 8,888 kWh of electricity is used = 8,888 kWh*30 g CO_2e/kWh = 266,640 g of CO_2e or **266.64 kg of CO_2e**

Large users may also see emissions factors listed in tCO_2e/GWh

2-Calculation examples – Scopes 1, 2, and 3



Scope 3 example: Purchased tires

Emissions factor in kg CO_2e for a Michelin Primacy 225/45 R17 91V tire (supplier provided data!) =

9.66 kg CO_2e/tire (cradle to grave – embodied carbon)

Therefore, if 88,888 tires are purchased and used in production = 88,888 tires * 9.66 kg CO_2e/tire = 858,658.08 kg CO_2e or **858.66 tonnes CO_2e**

Emissions Factors:	Raw materials	= 0.4050 kgCO_2e/tire
	Transport	= 0.0348 kgCO_2e/tire
	Manufacturing	= 0.0255 kgCO_2e/tire
	Distribution	= 0.0257 kgCO_2e/tire
	Tire use	= 9.17 kgCO_2e/tire
	Transport end-life	= .0000734 kgCO_2e/tire
	End-of-life	= .0000609 kgCO_2e/tire
	Total	**= 9.66 kgCO_2e/tire**

Cradle to Grave: This refers to the carbon emissions produced throughout a products entire life cycle, from raw material extraction (cradle) to disposal (grave). It includes all stages where emissions can occur: production, use, and end-of-life.
Gradle to Gate: This refers to the carbon emissions produced from raw material extraction to the point where the product leaves the production facility (the factory gate). It excludes the outgoing transportation, use, and end-of-life phases.

Use stage: Includes the activities covering the period from the handover of the tire until it reaches its end of life, including fuel/energy consumption and related emissions attributable to the tire and particle emissions related to tire and road abrasion.

Source: Michelin Primacy EPD: S-P-02119 September 29, 2021. The International EPD System library. Found here: https://www.environdec.com/library/epd2119

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3-Calculation examples – Scopes 1, 2, and 3

Scope 3 example: Employee commuting

Emissions factor in kg CO_2e/litre for fuel consumed for commuting.

Request employees voluntarily respond to a survey on commuting. In the survey, ask:

- How far do you live from your workplace? *(Google Maps can help provide this)*
- What type of vehicle do you primarily use to commute to work? *(provide model and year)*
- How many days per year do you drive to work? *(240 workdays means every day of the work week minus 4 weeks off)*
- How many days per year do you take bus transit to work?
- How many days per year do you carpool to work?
  If so, how many people do you usually travel with? What is the make of the vehicle used to commute?
- How many days per year do you walk or bike to work?

The employee response rate is typically around 50%! The average motorcycle, car, truck, carpool, active transit, and bus estimates are combined with fuel efficiency ratings for each mode of travel and distances traveled to estimate litres of fuel used and emissions produced. If each commuting employee produces 3.5 tonnes CO_2, **then 888 employees produce Scope 3 emissions for category 7 (employee commuting) = 3,108 tonnes of CO_2 annually.**

Three scopes in a complete carbon footprint

Scope 1 and 2 emissions are the main focus of regulatory reporting and are the most commonly measured. An organization has far more control over these scopes than it does over Scope 3 emissions. An organization may track flights for employees in Scope 3 (business travel), but those same emissions are calculated as Scope 1 for an airline.

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Scope 3 emissions are measured by companies and organizations looking to improve their ESG standings, create a product carbon footprint or lifecycle analysis, or meet the requirements of other supply chain partners that now measure these emissions.

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Tracking all three scopes gives organizations a complete view of their carbon footprint, supporting more effective strategies for GHG reductions.

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Stay connected with tools and resources

- Virtual one-on-one coaching: Post-webinar support intake form for tailored support for organizations to manage energy resources effectively
- Monthly bulletin: Sign up to receive monthly training updates on all Save on Energy training and new support tools and resources
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References

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- GHG Protocol Scope 2 Guidance: https://ghgprotocol.org/scope-2-guidance
- GHG Protocol Scope 3 Standard: https://ghgprotocol.org/corporate-value-chain-scope-3-standard
- Canada’s National Greenhouse Gas Inventory: https://www.canada.ca/en/environment-climate-change/services/climate-change/greenhouse-gas-emissions/inventory.html