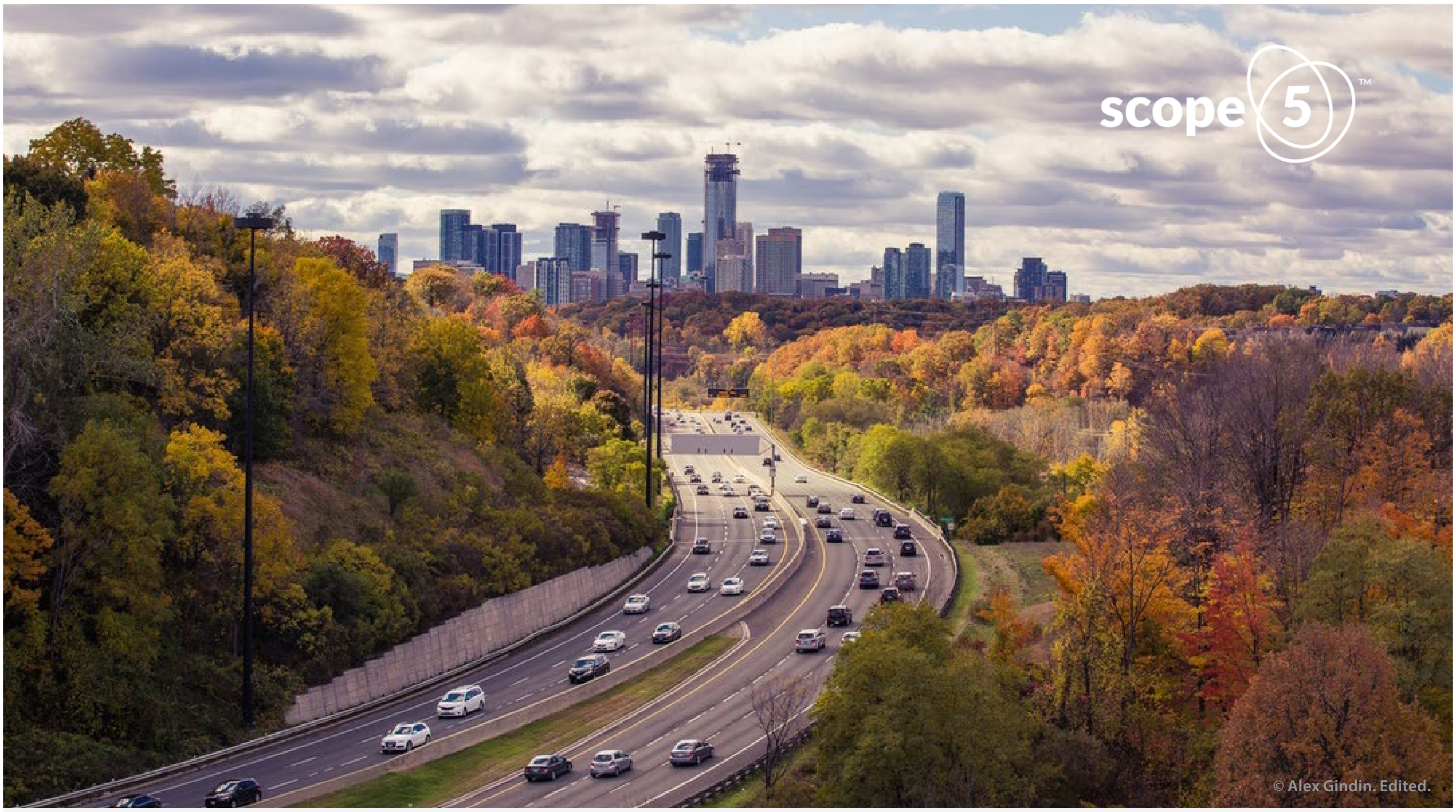


Tackling Mobile Combustion Emissions

Part I: Mobile Combustion Activity

We're often asked to help organizations devise a strategy for tracking their *Mobile Combustion* activity and calculating the resulting greenhouse gas emissions (GHGs). This effort can be complicated due to the large variety of underlying activities and the various methodologies for calculating resulting emissions.

In general, we recommend that organizations seek a method that balances complexity and benefit. In this context, *complexity* refers to the number and granularity of different data points tracked and benefit refers to the potential to identify opportunities for meaningful change coupled with meeting the obligation to report significant emissions.

In this two-part whitepaper, we'll take a look at the factors impacting mobile combustion emissions (referred to from here on as MCEs) with the goal of helping the reader decide how to tackle them[1]. This decision is important because MCEs can be a material source of GHGs. Deciding how to track and process the information amounts to trading off the cost of processing finer grain data with the benefits of doing so. The benefits can be well worth the costs in certain situations but not in others.

1.1 General Approach

In deciding how to tackle an organization's MCEs, we recommend the following general steps:

1. Identifying relevant mobile combustion activities.
2. Deciding which of them are *material* and to what degree.
3. Choosing whether to include Scope 3 emissions.
4. Identifying the activity data that would need to be tracked.
5. Choosing methods to convert activity data to emissions.

*[1] So far, we've discussed **tracking** mobile combustion activity as distinct from **calculating** the resulting emissions. While this distinction is important, for the sake of brevity we'll often use the term **calculating** or **tackling** MCEs to refer to both the tracking of underlying activity as well as the calculation of resulting emissions.*

2. FACTORS IMPACTING MOBILE COMBUSTION EMISSIONS

In the previous section, we identified a sequence of steps to be used in devising a strategy for tackling an organization's MCEs. In the first part of this paper, we'll look at Steps 1-4 and related considerations. In the second part, we'll delve into Step 5. The steps are not completely independent of each other—stepping through them in sequence is appropriate but some degree of iteration may be required.

2.1 Categories of Mobile Combustion Activities

To begin with, let's take a look at the different categories of activities that contribute to MCEs. MCEs are the emissions that result from burning fuel in all types of vehicles[2].

Activities to consider when tackling MCEs include:

- Operation of vehicle fleets by or on behalf of the organization
- Operation of other mobile equipment by or on behalf of the organization (agricultural equipment, earth moving equipment, etc.)
- Business travel (air travel, taxis, rental cars, trains, etc.)
- Employee commuting (private or public transport)

2.2 Materiality

The emissions related to each of these activities may or may not be *material* to any specific organization. In general, they're material to a certain organization if they make up a substantial percentage of that organization's total emissions. The more substantial they are, the more material they are and the more effort should be put into tracking activity data and calculating resulting MCEs accurately and precisely.

2.3 Scope-3

In greenhouse gas accounting, an organization's emissions are categorized into one of three Scopes. Briefly:

- **Scope 1** emissions are those resulting from fuel burned in the organization's equipment or facilities.
- **Scope 2** emissions are those resulting from fuel that is burned for the organization's direct benefit but by a third party. The most common of these is electricity that is used by the organization and less commonly, steam heat. Scope 2 does not generally apply to mobile combustion emissions.
- **Scope 3** emissions are all other emissions for which the organization can be considered indirectly responsible.

Looking back at the categories of activities that result in MCEs—vehicles operated by the organization result in Scope 1 emissions. All other MCEs are Scope 3 emissions[3].

These Scopes are important because for many organizations, Scope 1 MCEs are immaterial and are quite simple to calculate. Scope 3 MCEs on the other hand can be material and can be complex to calculate. In this case, it can be tempting to neglect Scope 3 MCEs (especially since most reporting protocols do not mandate calculating Scope 3 emissions). We recommend calculating Scope 3 MCEs if they would comprise a significant percent of an organization's overall emissions and especially if it is possible to effect changes that would reduce them.

2.4 Examples in which Scope-3 MCEs are Important

Consider for example, a consulting enterprise that employs thousands of consultants that fly around the world. Such an organization likely has pretty low Scope 1 and Scope 2 emissions (it doesn't take much electricity and fuel to keep the lights on and to heat offices). On the other hand, air travel is very emissions intensive (especially when flying business or first class)—and—consultants or travel agents can effect changes by flying direct when possible, flying during the day instead of at night[4], avoiding flying in favor of teleconferencing, choosing airlines with more efficient fleets, etc. So, even though this enterprise may not be obligated to report Scope 3 emissions, these may be far more material than their Scope 1 and Scope 2 emissions.

Similar considerations might apply in the case of an organization such as a department store chain that doesn't burn much fuel in their own vehicles but that affects large freight related emissions through the fleets that supply their stores.

These are just two of many examples in which Scope 3 MCEs are worth scrutiny.

*[2] Keep in mind that moving vehicles include those traveling by road, rail, sea or air. [3] This is a bit of a simplification—to some degree, the classification of emissions depends on whether an organization is reporting under **financial control** or **operational control**.*

3. ACTIVITY DATA

As with any type of GHG emissions, MCEs are calculated by multiplying certain activity data parameters by *emissions factors*. The most important activity data points for MCEs are *volume of fuel burned* and *distance traveled*. Data points of secondary importance include *engine size and type* as well as activity-specific parameters such as class of travel (for air travel).

3.1 Volume of Fuel Burned

For the most part, simple stoichiometry links volume of fuel burned and related MCEs. For example, the clean combustion of one gallon of gasoline emits about 19.5 lbs. of CO_2.

However, mobile combustion fuels are rarely 'cleanly' combusted—they are combusted in engines of various types and sizes. In addition to emitting CO_2, these engines emit other greenhouse gases, namely N_2O and CH_4. The amounts of these other gases that are emitted depend on the size and type of engine in which the fuel is combusted, the distance traveled, the *drive cycle*[5], the type and age of catalytic converter and other factors. While the global warming potential of these other gases can be quite large relative to CO_2, the amounts emitted are generally small enough that their marginal global warming impact is negligible[6].

3.2 Distance Traveled and Vehicle Type

As an example, looking at the WRI's emission factors for modern gasoline passenger cars, we see that the marginal global warming impact of CH_4 and N_2O is on the order of 0.7% of total MCEs. For certain classes of vehicles and operating conditions (generally older vehicles and vehicle operation that correlates with low fuel efficiency), N_2O and CH_4 may contribute as much as 6% or more of total MCEs.

We review these numbers here because they inform us regarding the types of activity data that need to be collected and tracked. Volume of fuel burned is sufficient to calculate most of an organizations' on-road MCEs with reasonable accuracy. The amount of CH_4 and N_2O emitted cannot be accurately calculated from volume of fuel burned alone but it can be reasonably approximated by assuming some average fuel efficiency.

Because the contribution of CH_4 and N_2O to MCEs are relatively minor for most organizations, it is generally not necessary to collect distance traveled activity data, or to categorize activity data by engine type. Of course, if MCEs are a material component of a certain organization's total emissions and those emissions arise from heavy vehicles or older fleets, it may be necessary to collect and track data regarding distance traveled in different engine types in addition to volume of fuel burned.

For certain types of mobile combustion activity, distance traveled may be the only data available. This is typically the case for air travel for example. We'll look at the availability of different types of data in Section 3.4.

3.3 Freight

A special type of activity data is relevant when considering the movement of freight. In this case, the relevant activity units are expressed in the product of distance traveled multiplied by payload weight or volume (ton-miles or TEU-miles). Of course, the type of shipping vehicle must also be considered.

[4]Aircraft GHG emissions contribute more to global warming when emitted at night than during the day. [5]Relative proportion of speeds a vehicle is driven at (e.g. highway vs. city driving for on-road transport). [6]The estimation of the contributions of CH_4 and N_2O to MCEs is complex and depends on many factors.

3.4 Available Data

So far, we've looked at the different types of MCE related activity data in terms of their *importance* to calculating total emissions. But in the interest of pragmatism, the decision to track different types of activity data must be weighted by the *availability* of that data.

The sub-categories of MCE activity data and the granularity at which they are relevant are:

- Volume of fuel burned
  - by fuel-type
- Distance traveled
  - by vehicle type
  - by engine size and type

In rare cases both categories of activity data may be directly and readily available at the granularity suggested for all relevant MCEs. However, in most cases, one or both of these categories of data may be available only indirectly and only at sub-optimal granularity. Furthermore, it might be prohibitively costly to track both. In these cases, a sound methodology for calculating MCEs would start by defining types of activity data that can be tracked directly and that would enable the derivation of fuel burned and/or distance traveled.

3.5 Activity Data by Activity Category

Let's take a look at specific MCE related activities and the data that might be available for each.

Vehicle Fleets and Vehicles Operated by the Organization

Different organizations operate different types of vehicle fleets for which different data may be available. Many track both distance traveled by fleet vehicles as well as total fuel purchased and consumed. Some track only one or the other. Organizations may track either type of activity data at a per-vehicle granularity or in aggregate.

If fleet operation is material to an organization's MCEs then thought should be given to sources of related activity data and how best to collect it. Since fleet operation is a material activity, it's likely that the organization has mechanisms in place to maintain the fleet and to track fleet operating parameters.

DISTANCE TRAVELED

Consider the following sources of distance-traveled data:

- Per vehicle odometer readings from service records.
- Driver maintained logs that include odometer readings.
- Known frequency of trips over known distances (for example, a certain vehicle may traverse the same delivery route 3 times per week).
- Specific information systems that are designed and used for fleet management.

FUEL BURNED

Consider the following sources of fuel consumed:

- Driver maintained logs that include fuel purchased by volume and/or dollars spent.
- Credit cards or expense accounts issued to fleet drivers specifically for fuel purchases often include volume data.
- Finance accounting systems often centrally track fuel purchased at various granularities.
- Dollars spent on fuel can be translated to volume of fuel burned using national or regional average fuel price tables.

FREIGHT

Often some or all of an organization's fleet related activity is for the movement of freight. In this case, ton-mile (or equivalent) data by mode of travel is commonly maintained. This data is likely to be readily available if the organization contracts with a third party shipper or logistics company. Fleet activity should generally be treated as freight activity when the fleet is used to move significant weight or volume of goods. So, for example, a fleet of passenger cars used to transport service personnel should not be considered freight. On the other hand, a fleet of trucks used to deliver tangible goods, should be considered freight.

Business Travel

Business travel falls into two general sub-categories: public transport and personal vehicle. Let's take a look at each category and the relevant activity data.

PUBLIC TRANSPORT

The following modes of transport are generally categories of public transportation:

- Air
- Rail
- Ferry
- Coach/bus

For these, the quantity of fuel burned is generally not readily available. Activity data in the form of distance traveled is usually readily available.

AIR

Most airlines or travel agents provide distance-traveled information for flights flown. For optimal accuracy, distance traveled should be tracked separately for each leg traveled. This is because landing and takeoffs contribute disproportionately to flight emissions and as a result, different emissions factors are applied to different flight lengths. In many cases, airlines or travel agents may actually provide per-passenger emissions for each flight.

In addition to tracking distance traveled for each flight, it's important to track the class of travel. First class seats may occupy as much as three times the volume of coach class seats, resulting in far higher emissions.

From time to time, we hear passengers assert that their flight would have flown whether they were on board or not and question why they should be responsible for the emissions. In response, we explain that when sufficient numbers of passengers change their travel behavior over time, airlines respond by changing theirs. They may reduce the number of flights flown, change routes, change the distribution of seats across different classes of travel and so forth. The truth is that although any particular flight's emissions are not attributable to any individual passenger, they are attributable to the passengers in aggregate and each passenger must take responsibility for their share of the emissions. Tracking such activity and taking ownership of associated emissions can lead to behavior changes that significantly impact aggregate emissions.

RAIL, FERRY, COACH AND BUS

These modes of transport are generally not as emissions intensive as air-travel. As a result the transport providers are less likely to make travel details such as distance traveled readily available to passengers and are even less likely to calculate emissions. However, providers are starting to do so and organizations tracking MCEs can easily obtain distances between origin and destination from various sources.

Whatever the mode of transport, the most appropriate activity data to track for public transport tends to be *passenger-mile*—the distance traveled by each passenger. The total emissions for a vehicle are divided by the number of passengers to come up with an emissions per passenger-mile emissions factor.

PERSONAL VEHICLE

The following are sub-categories of business travel by personal vehicle:

- Employee-owned vehicle
- Rental car
- Taxi
- Personal air-travel

For these forms of transport, fuel burned and/or distance traveled data may be available. Unlike public transport, in the case that personal vehicles are used, the entire emissions are attributable to the traveling passenger.

Employee Commute

The relevant activity data for employee commuting is similar to the data for business travel in the sense that both public transport and personal vehicle are considered. There are two ways in which activity data for employee commute differs from business travel; one is in the availability of employee commuting surveys, the other is in the way activity data is apportioned to individual employees.

In general, employee commute data must be collected for a large group of individuals across a broad range of activity types. Usually it is too cumbersome to collect detailed data for each and every employee. This is especially the case if there are sufficient numbers of employees to render their commute data material. In this case some statistical sampling may be appropriate.

PUBLIC TRANSPORT VS. PERSONAL VEHICLE

One subset of an organization's employees may commute via public transport, another via personal vehicle. For those commuting via public transport, activity data is much the same as when public transport is used for business travel except that the more common modes of transport are likely to differ (most employees do not commute via air travel). On the other hand, for those employees that commute via personal vehicle, activity data must be apportioned correctly.

APPORTIONING EMPLOYEE COMMUTE DATA—CARPOOLING

Activity data for employee commute via personal vehicle is sort of a hybrid between the activity data we looked at for business travel via public transport and business travel via personal vehicle. When employees use their own vehicles to commute *alone*, the relevant activity data is fairly straightforward, similar to when employees use their own vehicles for the occasional business travel. The more complicated case is that of employees *carpooling*. In these cases, it's important to consider the manner in which activity data should be apportioned among each group of carpoolers.

Often, many of the employees commuting via personal vehicle are doing by carpooling with a group of peers. They may be using one or more of the group members' personal vehicles, possibly in some sort of rotation, or in some cases, they may be using a vehicle owned by a third party, made available specifically for the purpose of carpooling.

When a third-party vehicle is used specifically for carpooling, it can be relatively straightforward to track the relevant activity data. Since the vehicle is dedicated to carpooling, *all* of the fuel used or distance traveled by the vehicle can be apportioned to the carpooling group's members and, if they are all employees of the same organization, then the entire vehicle's activity is attributable to that organization's Scope 3 emissions.

CARPOOLING IN PERSONAL VEHICLES

When members of the carpooling group use their personal vehicles for their commute, two problems must be considered. The first is in how the vehicle's activity is apportioned, the second is in how that activity is then apportioned among the members of the group.

Recall our discussion regarding the use of personal vehicles in business travel—it is usually inappropriate to track activity data in the form of fuel burned. The problem is that volume of fuel burned is tracked by measuring the amount of fuel put into the vehicle's tank but that fuel is used for *all* of the vehicle owner's activity, not just commuting to and from work. In this case, as discussed previously, distance traveled is a much more appropriate form of activity data.

Once the activity data is determined, it's necessary to allocate it among group members. If all members of the group work for the same organization, at the same location, this is less important and the vehicle can be considered in its entirety, to be a source of the organization's Scope 3 activity (for the commute distance). The situation is more complicated when the commuting group's members do not all work for the same organization and do not all work in the same location. In this case, some fraction of the distance traveled activity data must be apportioned to each of the group's members (both because each member is responsible for their fraction of the vehicle's occupancy and because each member may be responsible for a different portion of the distance traveled. Activity data is further complicated when the carpooling group varies in size and membership.

In the case of the kind of ad-hoc carpooling described, the best tradeoff between complexity of data and benefit, may point to simply attributing to each employee the amount of emissions that would arise from traveling *their* commute distance in an 'average' passenger vehicle, divided by the average number of occupants in the group.

EMPLOYEE COMMUTE SURVEYS

We see that tracking employee commuting activity on an employee-by-employee basis can be quite burdensome. A common methodology for tracking employee commuting activity is the use of employee commuting surveys. Such surveys take a variety of forms. In all cases, they aggregate activity data across a population of employees, in so reducing it in complexity.

Some surveys are intended to be used on an ongoing basis—each employee might complete a survey form each month to describe their commute activity for the month. In other cases, a subset of employees might be asked to fill out a more general survey summarizing their annual commuting behavior. Surveys can be arbitrarily complex and fine grain, asking each employee to describe their commute in great detail, describing the vehicle used, the distance traveled, the number of people in the vehicle, etc. for each day of their commute.

Again, the tradeoff between complexity and benefit must be considered in deciding how to administer employee commute surveys and how to use the activity data collected. One thing to bear in mind when considering the use of employee commute surveys is that employee commute activity can be quite material—it can contribute significantly to an organization's Scope 3 emissions and there is often significant opportunity to effect change in employee commute behavior.

With regard to the latter point in particular, consider that a strong employee commuting program, with regular surveys, can encourage employees to share resources, whether by driving them towards the use of public transport, carpooling, biking or walking or other behavior changes. When employees are encouraged towards changing their commuting behaviors, benefits may accrue beyond commuting, such as an openness to considering various alternatives to single-occupancy personal vehicle use for other transport needs.

An in-depth discussion of the tracking and use of employee commuting activity is beyond the scope of this paper. Suffice it to say here that in most cases, employee commute activity data is probably best captured through some sort of periodic survey. The survey should yield an average weekly commuting distance per employee and the relevant class of vehicle (such as *municipal bus* or *mid-size passenger vehicle*). In the case that the vehicle is a personal vehicle (as opposed to public transport), the survey should also yield the average number of commuters sharing the vehicle's commute. Publishing survey results by department or even offering tangible rewards for lowering commute impact can be powerful motivators towards behavior change and ultimately, emissions reduction.

CONCLUSION

In the first part of this paper, we've taken a look at the high level factors organizations should consider in tackling their mobile combustion emissions. We focused primarily on the types and sources of relevant activity data that should be tracked. In Part II, we'll take a deeper look at how that activity data should be categorized and how it is converted to emissions numbers.

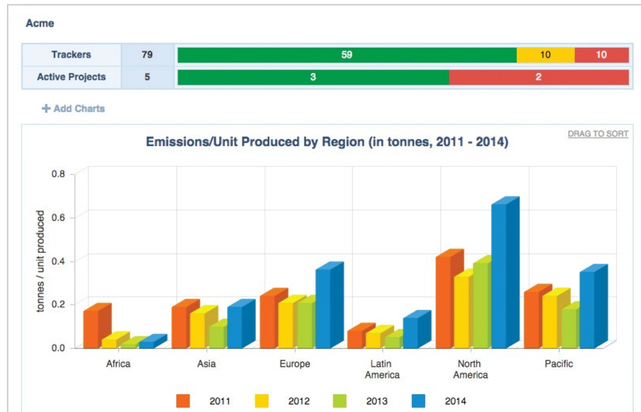
SCOPE 5

Scope 5 is a cloud-based software service that helps organizations of all types collect, structure, track, analyze and communicate their sustainability data, benefiting their top and bottom lines. In addition to using the service to produce GHG reports, many of our customers use ***Scope 5*** to go beyond reporting to identify opportunities and to communicate their progress to a variety of stakeholders.

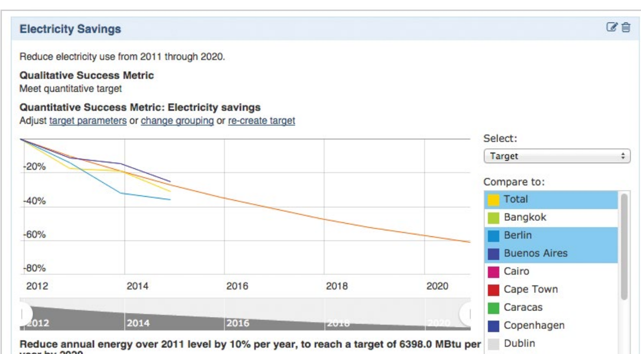
Scope 5 includes resource libraries that put up-to-date emission factors from recognized authorities at your fingertips to make it easier for you to calculate your GHG emissions and to assure that your results are reliable and meaningful. ***Scope 5*** is intuitively and flexibly designed to be managed independently by your workforce talent or in conjunction with ours. We'd love the chacge to help make your data easy-to-use, convenient and work for you!

1 Capture and manage any activity data, whether environmental, social or governance.

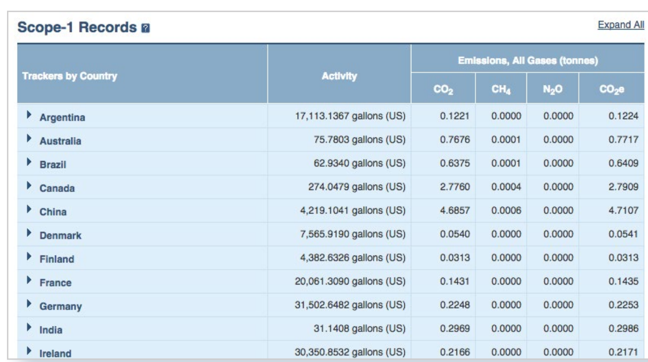
2 Calculate impacts of your activities such as greenhouse gas emissions, cost and other custom impacts.



3 Analyze your data to gain transparency and to identify opportunities to improve performance and save costs—demonstrate success!



4 Make reporting to the Carbon Disclosure Project, Global Reporting Initiative, B Corporation, and other reporting platforms easier.



Scope-1 Records Expand All

Trackers by Country	Activity	Emissions, All Gases (tonnes)			
		CO_2	CH_4	N_2O	CO_2e
Argentina	17,113.1367 gallons (US)	0.1221	0.0000	0.0000	0.1224
Australia	75.7803 gallons (US)	0.7676	0.0001	0.0000	0.7717
Brazil	62.9340 gallons (US)	0.6375	0.0001	0.0000	0.6409
Canada	274.0479 gallons (US)	2.7760	0.0004	0.0000	2.7909
China	4,219.1041 gallons (US)	4.6857	0.0006	0.0000	4.7107
Denmark	7,565.9190 gallons (US)	0.0540	0.0000	0.0000	0.0541
Finland	4,382.6326 gallons (US)	0.0313	0.0000	0.0000	0.0313
France	20,061.3090 gallons (US)	0.1431	0.0000	0.0000	0.1435
Germany	31,502.6482 gallons (US)	0.2248	0.0000	0.0000	0.2253
India	31.1408 gallons (US)	0.2969	0.0000	0.0000	0.2986
Ireland	30,350.8532 gallons (US)	0.2166	0.0000	0.0000	0.2171