Standardized Open Data for Impact Accounting Applications

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Introduction: a puzzle in reported versus physical changes in emissions

Climate TRACE is a free, open global emissions inventory jointly produced by a coalition of over a hundred nonprofits, universities, emissions data providers, and individual researchers. The coalition combines data from hundreds of satellites and tens of thousands of sensors and other publicly available data sources.

The Climate TRACE inventory provides detailed estimates of the monthly emissions of over 745 million emitting "assets" (power plants, ships, farms, mines, groups of cars, groups of buildings, etc). This list of assets is now so comprehensive that the sum of estimated emissions from assets Climate TRACE is monitoring closely matches total anthropogenic emissions as observed by space agencies such as NASA, JAXA, and ESA.

This allows a previously rarely possible kind of analysis: comparing, for any geography or sector, changes in *reported* emissions with changes in *physical* observed emissions.

Analyzing these data consistently yields a result that many find surprising. Specifically, evidence strongly suggests that very many actions which are reported to have reduced (or increased) emissions by some amount often appear to have caused a wildly different—often even completely opposite—effect on total physical emissions.

In some cases such discrepancies can be explained by mere errors in one or more datasets. But the effect is common even in the most unambiguous cases, with the highest-quality measurements compared to the most carefully audited reporting following leading carbon accounting standards such as the GHG Protocol, SBTi, the GPC, PCAF, and others.

This can be surprising to anyone who has always simply assumed that the best way to mitigate total physical emissions was for institutions to set and meet emissions reduction targets using today's leading standards.

But it should be stressed that this is not due to any *error* in the data or by any of these standards. Rather, it is due to a common confusion about what such standards are *for*.

These and numerous other leading carbon accounting standards are primarily based on the principle of **allocational accounting** (also often called attributional accounting). This is the practice of institutions designating an inventory boundary that is "theirs" and only measuring emissions, and changes in emissions, within their particular boundary. In most cases, allocational accounting mechanisms were never intended to, and do not claim to, accurately measure changes in emissions outside the boundary.

Thus, to the extent that actions which affect reported emissions *within* a boundary also cause a significant net increase or decrease in emissions *outside* the boundary, allocational accounting does not accurately measure effects on total real-world emissions. And Climate TRACE data show that this scenario is *very* common. Surprisingly often, this can even often lead to actions that are on net emissions-increasing being reported as emissions-reducing, or vice-versa.

Again, this is not a mistake, but rather a question of analytical objective. It is not the purpose of allocational accounting to provide guidance comparing how different decisions will affect total physical emissions.

But for those institutions who are interested in that objective, other carbon accounting frameworks do exist that were designed for that purpose. Since many use the shorthand of emissions “impact” to describe the effect of actions on total global physical emissions, these frameworks are sometimes called **impact accounting** (and in other contexts, consequential or avoided emissions accounting).

Today, dozens of carbon accounting standards and frameworks either have adopted or are actively exploring adopting some form of impact accounting. This includes the Paris Agreement; WBCSD’s Guidance on Avoided Emissions; California’s MIDAS and SGIP programs; ISO; GFANZ; the Task Force for Corporate Action Transparency (TCAT); the GHG Protocol’s Scope 2 Technical Working Group and AMI Working Group; Verra; Japan’s GX League; New York’s Local Law 97; and many others.

However, historically impact accounting has often faced a significant practical barrier: the lack of data. And while no dataset is perfect, Climate TRACE’s data has the useful properties of being globally comprehensive, free and open, heavily validated, and standardized. (Standardization being important to avoid the potential of gaming.) Due to these features, Climate TRACE has now received requests for data and technical support for impact accounting from dozens of such carbon accounting standards and frameworks all around the world.

The Climate TRACE coalition’s mission is to provide free emissions data to facilitate decarbonization, not to become carbon accounting experts. The coalition currently has no plans to weigh in on any particular carbon accounting methodology. However, we are happy to let anyone use our free open data for any kind of decarbonization purpose, including impact accounting. This document is an early step towards laying out how to do so in a standardized, consistent way.

In this article, we:

(1) Outline a conceptual framework to help clarify under what specific conditions physical and reported changes in emissions differ;
(2) Show a practical empirical method to estimate the impact of any intervention; and
(3) Provide examples of three ways to turn impact estimates into impact accounting.

1. A conceptual framework to help clarify under what specific conditions physical and reported changes in emissions differ

Background: physical emissions can only change via a few specific mechanisms.

By definition, mitigating total global physical emissions means reducing the sum of all physical emissions sources and sinks, in all locations.[1] A common way to conceptualize this is to break down each source using the equation:

$$\text{Total physical emissions} = \sum_S (A_S EF_S)$$

Where for each source s, A = the quantity of its activity, and EF = the emissions produced per unit of that activity. For example, a steel mill that produces 1 million tons of steel per year, at an emissions factor of 1.2 tons CO2/ton steel, emits 1.2 million tons CO_2 per year.

If one wishes, one can further analyze the activity of any source as its capacity, C, times its utilization

[1] For brevity, here we refer to both as “sources” where a sink is a source with negative emissions.

rate, U. For example, the above steel mill's activity may be based on a capacity to produce 2 million tons of steel per year, operating at 50% utilization.

While the breakdown above may not be *intuitive* for some sources—due to unknown variables, interdependencies, or alternative formulations—the above equation is mechanically *true* for every single emissions source, without exception. Climate TRACE has shown that this framework can be applied universally across all sources, and when aggregated, the resulting sum of emissions of any given region at any given time aligns with total emissions physically observed by groups such as NASA.[2]

And here's why this mental framework can be so clarifying. It highlights that mechanically, there are only two possible ways to mitigate emissions in the real physical world. Namely, effects that:

- Reduce or prevent increases in the **emissions factors** of physical emitting sources; or
- Reduce or prevent increases in the **activity** of emissions sources—by some combination of reducing or preventing increases in their capacity and/or utilization.

It's a useful mental model to remember that regardless of how reductions occur or how precisely we measure them, the real-world effect of any intervention on total emissions is defined strictly by whether it reduces (or prevents increases in) one or more of these factors. Ultimately, the total effect of any action on emissions is the sum of its influence on these factors across all sources and time periods.

In this article, we define the **impact** (denoted as ΔE_{imp}) as the actual real-world change in total physical emissions resulting from any intervention, whether or not this value is known. This may or may not match the **allocational emissions change** (denoted as ΔE_{alloc}), which refers specifically to the change in emissions allocated to the particular institution who took that intervention. Note that here we use ΔE_{alloc} to reflect only the intervening institution's reported emissions change—not the change in global total allocational emissions. As we will show, this subtle distinction is crucial.

In practice, impact usually cannot be perfectly measured. However, this framework allows us to ask under what conditions it is or is not likely to be systematically different from the allocational emissions change.

The three key cases when impact and allocational emissions change differ

Most allocational accounting systems correctly measure changes in emissions (whether through changes in capacity, utilization, and/or emissions factors) *inside* the inventory boundary. Thus, impact can be seen as the sum the allocational emissions change, plus changes outside the boundary:

$$\begin{aligned}\Delta E_{imp} &= \textstyle\sum_S(\Delta A_S EF_S)\\ &= \textstyle\sum_S(\Delta A_S \text{ inside boundary} * EF_S \text{ inside boundary}) + \sum_S(\Delta A_S \text{ outside} * EF_S \text{ outside})\\ &= \Delta E_{alloc} + \textstyle\sum_S(\Delta A_S \text{ outside} * EF_S \text{ outside})\end{aligned}$$

This is one reason many people intuitively assume allocational accounting measures impact. Because if interventions have no effect outside the inventory boundary, it does. The differences occur when this is untrue. This can occur in the following three ways:

(A) <u>**Boundary Exclusion**</u>: **When an intervention does change activity outside the boundary, but allocational accounting ignores this altogether.** Consider the effect of an intervention that changes activity outside the boundary. Again, the impact is:

$$\begin{aligned}\Delta E_{imp} &= \textstyle\sum_S(\Delta A_S EF_S)\\ &= \Delta E_{alloc} + \textstyle\sum_S(\Delta A_S \text{ outside} * EF_S \text{ outside})\end{aligned}$$

If this latter term is ignored, allocational emissions change does not equal impact.

[2] See. e.g. https://climatetrace.org/data.

Example 1: A company opens a low-emissions cement kiln (dry-process with preheating and precalcination) in a cement market where all incumbent cement kilns are higher-emitting (wet-process). Thus, the company's allocational emissions change is to increase emissions. But because the total demand for cement doesn't change, the plant opening displaces activity from competing cement plants, reducing their emissions. Thus, the impact is to decrease emissions.

Example 2: A city covers its landfill, which reduces emissions from all trash in the landfill, no matter where it came from. But under the current GHG Protocol for Cities, the city's inventory boundary only includes the emissions from the 25% of the trash in this landfill that was generated by its own residents. In this case, the impact is four times larger than the change in reported allocational emissions.

Both types of examples are common in practice, highlighting how significantly boundary exclusions cause allocational emissions changes to diverge from impact.

(B) **Marginality issues: When allocational accounting uses the emissions factors from the intervening company's suppliers, but these are systematically different from the emissions factors of the sources actually affected by the intervention (the "marginal" sources).**[3] Issues also arise when an intervention changes activity at one group of sources (with emissions factors EF_S) but the allocational emissions change is based on the emissions factor of a different group of sources with a significantly different emissions factor (EF_D). This can be seen as:

$$\begin{aligned}\Delta E_{imp} &= \sum_S(\Delta A_S EF_S)\\ &= \sum_S(\Delta A_S EF_D) + \sum_S(\Delta A_S (EF_S - EF_D))\\ &= \Delta E_{alloc} + \sum_S(\Delta A_S (EF_S - EF_D))\end{aligned}$$

Example 1: A grid-scale battery in California consumes 100 megawatt-hours of electricity at 2pm, during which time its utility has an average emissions factor of 400 lbs CO2 per megawatt-hour. Thus, this intervention increases the company's allocational emissions by 100 x 400 = 40,000 lbs. However, at 2pm the local grid operator was curtailing excess solar production. The battery charging simply causes less solar to be wasted, increasing activity of assets that have an emissions factor of 0. Thus, this intervention causes an impact of 100 x 0 lbs.

Example 2: A publisher procures 1000 tons of paper from a pulp and paper mill with an emissions factor of .9 tons CO2 per tons of paper, increasing allocational emissions by 900 tons. However, the facility it purchased from has no capacity to increase production, so it now sells less to others. As a result, the only pulp and paper mill in the region with excess capacity, which has an emissions factor of 1.1, increases its production. Thus, the intervention increases total physical emissions by 1,100 tons.

In other words, when an intervention affects emissions by changing activity of emitting assets outside the inventory boundary–as most interventions that affect Scope 2 and/or Scope 3 do–the impact is based on the emissions factor of the sources whose activity is *actually affected*. If these sources can have different emissions factors than those in the institutions' inventory boundary, impact and allocational emissions change are different.

(C) **Additionality issues: When procurement of a credit doesn't change activity outside the boundary, but allocational accounting assumes that it does.** In most allocational accounting systems, institutions use the emissions factors from goods and services they procure. But what if this procurement isn't additional, i.e. it does not cause activity to change but rather *transfers* ownership of it? Then the change outside the boundary is equal and opposite to change inside:

$$\Delta E_{imp} = \sum_S(\Delta A_S EF_S)$$

[3] Note that in this context "marginal" does not mean small, it means the amount affected by the intervention. That might be small, fairly large, or even enormous, depending on the intervention.

$= \Delta E_{alloc}$ (ΔA_S inside boundary * EF_S inside) + $\sum_S$(ΔA_S outside boundary * EF_S outside boundary)
$= \Delta E_{alloc}$ (ΔA_S inside boundary * EF_S inside) + $\sum_S$($-\Delta A_S$ inside boundary * EF_S inside)
$= \Delta E_{alloc} - \Delta E_{alloc}$
$= 0$

Example 1: A company procures 10,000 megawatt-hours of local, hourly matched zero-emissions hydropower in a grid with an emissions factor of 500 lbs CO2 per megawatt-hour. This reduces its allocational emissions by 10,000 x 500 = 5,000,000 lbs. However, the hydro dram was built in 1930 and no physical real-world activity changes. Thus, it also increases the allocational emissions of other companies by the same amount. The total impact is zero.

Example 2: A large brewery switches from coal fuel to biomass fuel sourced from regional crop residues. However, all available crop residues in the region are already being used to create biomass. As a result, the purchase enables that brewery to lower its coal consumption and allocational emissions. But now there is no longer enough crop residue available to generate biomass to supply its rival brewery down the road, who then must increase coal consumption as a result. In this situation, impact is zero

The solution is that perfect impact accounting would measure the effect of procurement on source *activity*, not on the number of certificates *procured.* Impact accounting can do the same.

In each of these situations, the allocational emissions change can diverge significantly from impact, i.e. the actual impact on total physical emissions. And you can't manage what you can't measure. To make choices that meaningfully drive real-world climate impact, institutions would have to define targets such that achieving progress towards these targets aligns reasonably closely with mitigating real-world total emissions. Unfortunately, today's allocational carbon accounting often fails to provide this alignment.

2. A practical empirical method to estimate the impact of any intervention

As the above examples show, the essence of perfectly calculating the impact of any intervention would be to perfectly calculate the sum of changes in emissions inside the boundary (which is measured by allocational accounting), plus changes in emissions outside the boundary:

ΔE_{imp} $= \Delta E_{alloc}$ (ΔA_S inside boundary * EF_S inside) + $\sum_S$(ΔA_S outside boundary * EF_S outside boundary)

The first three terms are generally straightforward to obtain. Since most institutions already perform allocational accounting, they usually already know ΔA_S and EF_S inside the boundary.

The change in activity outside the boundary is often also easy to estimate as it often either equals the total activity, or the total activity times minus one. For example, an intervention to increase manufacturing of low-carbon cement by 100 tons likely won't change the total demand for cement; rather it will reduce manufacturing of 100 tons of other cement production outside the boundary.

But how to calculate this last term, EF_S outside the boundary? Here we show a standardized empirical approach.

Combined marginal emissions rates: applying the Greenhouse Gas Project Protocol's existing method

The Greenhouse Gas Protocol's Project Protocol *Guidelines for Grid-Connected Electricity Projects* provides a simple, practical way for how to calculate this, which it calls the **combined marginal emissions rate, CMER**. (Also sometimes called a long-run marginal emission rate.)

The CMER is defined as the weighted average of two elements, the build margin and the operating margin. Its formula is:

$$EF_S = CMER = (w)\ (\text{build margin}) + (1\text{-}w)\ (\text{operating margin})$$

What are build margin, and operating margin, and w? Recall that from section 1 above, mechanically any intervention that changes the activity of emitting sources must do some by changing either their capacity, their utilization, or more commonly a weighted combination of the two.

- Here, the build margin is the activity-weighted average emissions factor of any generation from plants built in response to the intervention.
- The operating margin is the activity-weighted average emissions factor of any generation from existing plants who increase their utilization in response to the intervention.
- And the build margin weight, w, measures the fraction of any change in activity that comes from changing capacity (as opposed to changing utilization).

For example, a build margin weight of 50% would imply that increasing demand for electricity by 100 megawatts would cause the market to supply 50 additional megawatts from plants specifically built in response to the intervention, and 50 additional megawatts from increasing production at existing power plants. The CMER estimates the weighted average emissions factor of all those 100 megawatts.

This can provide a standardized impact estimate of the effect of any electricity sector intervention on emissions outside the boundary, from signing a solar Power Purchase Agreement to discharging a battery.

Estimating CMERs for other sectors

What is less well known is that the exact same methods also work beyond the electricity market. One can simply apply the same method to any arbitrary market M, as follows:

$$EF_S = CMER_M = (w_M)\ (\text{build margin}_M) + (1\text{-}w_M)\ (\text{operating margin}_M)$$

To estimate these effects, one just needs the weight w, the build margin, and the operating margin for each market. For example, if an intervention cuts electricity use by 5,000 MWh but also increases steel demand by 1,000 tons, it changes activity in both markets, and the change in emissions is the sum of both types of activity, times the relevant marginal emissions rates.

For example, every time steel demand rises in a given region, we can observe empirically that certain groups of plants (mostly lower-emissions DRI-EAF plants) tend to change their utilization rate in response, while others (mostly higher-emissions blast furnaces plants) do not–which is captured by the operating margin. Longer term, we can also observe that over time, changing demand patterns can lead to the construction of both new DRI-EAF or blast furnace steel capacity–which is captured in the build margin. The combined marginal emissions rate calculates the weighted sum of both, providing a surprisingly accurate consistent estimate of impact.

The GHG Protocol has some suggested default values for the weighting factor w, operating margin, and build margin, which Climate TRACE has adopted for the purpose of generating standardized data. An impact accounting standard could either adopt the same values, or refine them through empirical investigation. A standard giving users a single set of values, rather than allowing each institution to decide for themselves, would provide consistently produced emissions factors for any intervention that could be compared across markets and geographies without room for gaming.

Emissions factors calculated using this standardized, empirical CMER approach can be used to calculate the impact of any action that increases or deceases activity of an unknown group of assets. It is particularly suitable for any kind of activity that is somewhat interchangeable (sometimes called “activity pools”). Common are electricity but also cement, steel, coal, gas, oil, beef, rice, timber, glass, wastewater, solid waste, even miles traveled by rail, ship, or air, etc: nearly all the highest-emitting markets globally.

The data already exist and the method is scalable

The CMER methodology is scientifically robust and it can be implemented today. All the data required to calculate CMERs today either already exist or are being developed right now, namely:

- Market M: Critical to this method is a means to define what exactly each market is. This requires both defining a product class (e.g. is it “steel” or “hot rolled steel”?) and a geographic boundary. We suggest using standard product classes from an existing major regulation (e.g. Europe’s CBAM) and standard geographic boundaries from the antitrust literature (e.g. for markets with a central operator, their actual area; else the Elzinga-Hogarty Little In, Little Out test).
- Build margin of market M: use the build margin algorithm from *Guidelines*, which estimates the long-run effect of an action using the standardized proxy of the last 20% of (utilization-weighted) capacity built.[4] There are many sources for this data, e.g. governments of EU, US, India, China, Global Energy Monitor, Platts, Bloomberg, Climate TRACE, etc.
- Operating margin of market M: use the operating margin algorithm from the academic literature, i.e. the actual historic values of dE/dA for that actual market under similar circumstances, using (actual) past swings in activity. Since most markets don’t balance supply and demand hourly like electricity does, hourly data isn’t needed. Many sources track the necessary inputs and Climate TRACE or others could easily calculate this.
- Weight: given enough time, this could be precisely measured in any market. A very practical and reasonably accurate performance standard might be to start with the *Guidelines’* default of 50% unless proven otherwise.

While not perfect, the default methods in the Project Protocol’s Guidelines offer a practical, scalable way to estimate impact across sectors. The Climate TRACE coalition is already estimating these parameters for across sectors covering 70% of global emissions including steel, cement, aluminum, lime, chemicals, road transport, aviation, shipping, coal, oil and gas, mining, beef, rice, other crops, construction, forestry, solid waste, wastewater, and others.

Combined marginal emissions rate (CMER) data already exist, or can be rapidly generated, and in many sectors differ substantially from average emissions rates. A sensible implementation pathway is to use a data hierarchy: apply CMER where it has been explicitly calculated, and use average emissions rates as the best available proxy in sectors where CMER is not yet developed, updating to standardized CMER data as they become available.

Some institutions (e.g. HASI, Apple, Amazon, the World Bank, UNEP, and UNFCCC) already use such Climate TRACE data such as in this method.

Like all data from Climate TRACE, CMER data are free, open source, and cover all countries worldwide. However, like average emissions, because the method is standardized, the same data can also be calculated from any other institution’s database without changing the answer. It is also easily compatible with a data hierarchy. For example, the EU ETS, EPA FLIGHT, and China’s carbon market all also contain data that could be used to calculate the same CMER values. It would be easy to adopt a rule that, for example, perhaps where authoritative government CMER data exist they should be preferred.

3. Examples of three ways to turn impact estimates into impact accounting

Impact accounting could therefore be used to estimate the impact of any intervention using any consistent standardized approach, such as the CMER approach as currently implemented by Climate TRACE, calculated the same way for all types of emissions in all places and times.

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[4] Studies to date shown this method suggest that, for this use case of retrospective accounting, this method is likely even more accurate than leading capacity expansion models, and dramatically more standardized and widely available. See e.g. Christian et al (forthcoming). Preview available here.

In this section we outline how to generate an entire emissions inventory out of this intervention-level approach. There are at least three different levels of stringency at which different standards are currently either doing so or exploring doing so. Climate TRACE data can be used to calculate any or all of them. At the end of this section, we have a case study example to walk through how to implement each of these three versions of impact accounting.

In economics, it is common to evaluate the causal effect of interventions as the total physical amount of some variable (in this case emissions) in a scenario that occurs, relative to a hypothetical baseline world without the intervention.

One can thus think about the three different impact accounting approaches as asking, what interventions should be reported? And therefore, what is the baseline?

The three proposed answers are:

1. **Project-level.** One method, currently the status quo in the GHG Protocol, is that every institution is completely free to define for themselves what interventions to optionally report the impact of. The baseline for each is a world where that intervention suddenly vanished. These statements are outside of Scope 1, 2, and 3 reporting.
2. **A "mitigation statement".** A new proposal would partially standardize institutions' reporting. Institutions would be encouraged to estimate the impact of all major interventions that meaningfully *mitigate* emissions *outside* their inventory boundary, and do so in some standardized way, such as the methods in this paper. But, not to apply impact accounting to interventions that increase emissions, or that mitigate emissions within their boundary. The baseline is a world where the companies' actions to mitigate emissions outside the boundary suddenly vanished.
3. **"Impact-based" Scope 1, 2, and 3.** A third proposal would fully standardize impact reporting. Institutions would be required to estimate the impact of *all* activities they currently report under Scope 1, 2, and 3. Institutions would provide a second, impact accounting-based, version of Scope 1, 2, and 3 to sit alongside the allocational accounting-based version. The baseline is a world where the entire institution suddenly vanished.

A full analysis of the advantages and disadvantages of each method are beyond the scope of this paper. But in general the first method has the advantage that it is simple and flexible.

The second method has the advantage that enables standardized comparison of actions companies take to mitigate emissions beyond their inventory. This would create an incentive for companies to take mitigation actions that reduce total physical emissions. (For example, power purchasing agreements that are additional and high-impact, or selling high-efficiency products.) It would also keep pressure on companies to lower their in-boundary emissions, but would not give them an incentive to avoid increasing emissions outside their inventory boundary.

The third method has the advantage that it is the most comprehensive and comparable, ensuring one consistent decarbonization signal across complex solutions like energy storage and electrification that involve tradeoffs between emissions inside and outside the boundary. It would strongly pressure companies to avoid increasing emissions, but would not give them an incentive to prioritize emissions reductions within their own boundaries.

Example: applying impact accounting to an institution

Here is a concrete example of the three main ways the above methods to estimate impact could be used to produce an impact accounting inventory.

A company in Virginia has two sources of emissions: consuming electricity and business travel (flying). Let's break down this company's actions into five interventions, from A to E.

Electricity:

A. The company consumes 100 MWh of electricity in Virginia, where the $CMER_{electricity}$ is 1 ton CO_2/MWh. The impact of this is 100*1 = 100 tons.
B. It then signs a long-term fully additional PPA to procure 50 MWh of renewable energy in California, where the $CMER_{electricity}$ is .5 tons CO_2/MWh. The impact of this is -50*.5 = -25 tons.
C. And it adds solar panels and batteries that generate 50 MWh in Virginia. The $CMER_{electricity}$ is the same. The impact of this is -50*1 = -50 tons.

Aviation:

D. The company's employees also fly 100,000 miles on routes with a $CMER_{aviation}$ of 0.0003 tons/mile, for impact of 100,000*0.0003 = 30 tons.
E. The company also procures sustainable aviation fuel sufficient for half that many flights. This fuel is made in India, where the $CMER_{aviation}$, for emissions also happens to be 0.0003 tons/mile. Burning it has a carbon footprint of 0.0001 tons/mile. Thus, the impact of this is -50,000*(0.0003-0.0001) = -10 tons.

Under the different forms of impact accounting:

- Under project-level accounting, the company would be free to choose any of A, B, C, D, and/or E. The total impact they report would therefore be largely up to them.
- Under a "mitigation statement", the company would report all interventions which are mitigations outside of their boundary, i.e. B + E. The total impact they report would therefore be -25 tons for electricity and -10 tons for aviation.
- Under "impact-based" Scope 1, 2, and 3, the company would report all interventions, i.e. A + B + C (100 - 25 - 50 - 25 tons) for scope 2 and D + E (30 - 10 = 20 tons) for scope 3.

Appendix: additional impact accounting examples

(A) Transportation and Distribution (Scope 3.9). An investment in China puts 1,000 tons of products on a container ship to Benin with an emissions factor of 20g CO2/ton-mile, where it is then distributed by the local postal service which does not report its emissions factors. The estimated impact of this intervention is:

∆Emissions within the boundary (zero)
+ ∆Indirect activity at known assets with known emissions factors (1,000*20*12,000 miles)
+ ∆Indirect activity at other assets (1,000 tons) × CMER for road transport in Benin

(B) Waste generated in operations (Scope 3, Category 5). A company in Japan adopts a composting program, which diverts 500 tons of organic matter from going to the landfill. The company does not know the emissions factor of this waste. This intervention changes impact by:

∆Emissions within the boundary (zero)
+ ∆Emisson at known assets with known emissions factors (zero)
+ ∆Indirect activity at other assets (500 tons) * CMER for organic waste in Japan (.8 tons CH4/ton waste)

Note that in this example, there is no evidence to suggest that the marginal emissions rate of organic waste in Japan is different from the average value. Thus, this calculation would produce the same results as it would under allocational accounting.

(C) Employee commuting (Scope 2, Category 7). A company in the UK adopts a carpooling program, which reduces miles traveled by employees outside of working hours by 10,000/year. The company does not know the emissions factor of the cars. This changes Impact-Based Method emissions by:

∆Emissions within the boundary (zero)
+ ∆Indirect activity at known assets with known emissions factors (zero)
+ ∆Indirect activity at unknown vehicles (10,000 miles) * CMER for cars in the UK

(D) Solar Procurement (Scope 2). A company in California purchases solar power through a contract, but the project is not additional—it would have been built anyway. The specific fossil plants displaced are unknown. This changes Impact-Based Method emissions by:

∆Emissions within the boundary (zero)
+ ∆Indirect activity at known assets with known emissions factors (zero)
+ ∆Indirect activity at other assets (zero), because the procurement does not alter overall grid supply or demand

Note that because the solar project isn't additional, the purchase doesn't displace fossil fuel use. Allocational accounting still lowers Scope 2 emissions, but the performance standard correctly shows zero impact—reflecting real-world change, not paper claims.