CDP full GHG emissions dataset

Technical Annex IV: Scope 3 Overview and Modelling

Contents

1 Introduction

The Full GHG Emissions Dataset provides CDP's investor members and other stakeholders with the most up-to-date, accurate and comparable corporate GHG emissions and energy-use data. This is one of a series of documents outlining how the raw reported data is enhanced. All are available on CDP's website.

- CDP Full GHG Emissions Dataset: Summary 2023
- Technical Annex I: Data Cleaning Approach
- Technical Annex II: Physical Activity Modelling Primer
- Technical Annex III: Statistical Framework
- Technical Annex IV: Scope 3 Overview and Modelling

This document provides an introduction to reported Scope 3 emissions data, and an overview of the methods used to clean and model it. These methods build upon the statistical framework and cleaning approach developed by CDP's Data Analytics team. Refer to the documents listed above for more information.

As defined in the GHG Protocol, Scope 3 represents the indirect GHG emissions of a company from all sources excluding purchased energy, accounted for under Scope 2. For many companies, the indirect emissions caused by their business can far outweigh their direct emissions.

The GHG Protocol splits Scope 3 emissions into 15 different categories, grouped into Upstream and Downstream. The CDP Climate Change Questionnaire is based on this standard. The GHG Protocol provides guidance on how the emissions for each category may be calculated. While this guidance is widely used, it is less prescriptive than the Scope 1 & 2 guidance and companies may account for their Scope 3 emissions in several valid ways. Differences in interpretation of these guidelines can result in varied responses between similar companies.

In addition, companies involved in similar activities can have very different corporate structures, resulting in different emissions profiles. This presents a problem when trying to compare the emissions profiles across companies. While these difficulties exist in Scope 1 & 2 reporting, they are magnified for Scope 3 because of the greater variation in methodologies and the fact that Scope 3 emissions often dominate a company's total footprint.

Scope 3 emissions by definition occur outside of the reporting company's control boundary. It is often difficult for companies to collect sufficient primary data to be able to calculate their Scope 3 emissions to the same level of accuracy as scope 1 & 2. Simplifying assumptions can be made to overcome the lack of primary data, however this has implications for the comparability of different companies. Each Scope 3 category has its own limitations with data collection, behavioural assumptions and boundary settings, which are summarized in the Appendix.

Increasingly investors are recognizing the importance of Scope 3 emissions accounting and are exploring means to integrate this data into their corporate assessments. In order to support investors and other stakeholders in their work, CDP's Full GHG Emissions Dataset provides a comprehensive view of current reporting practises for Scope 3 emissions. By filling gaps in reported data with modelled estimates, this dataset overcomes one of the main hurdles that prevent investors using Scope 3 data in their analyses.

1.1 Scope 3 Data Reported to CDP

The CDP Climate Change Questionnaire provides companies with the opportunity to disclose data for all 15 categories plus two 'Other' categories for additional up- & downstream emissions. Alongside the emissions figures, there are additional data points that allow companies to explain the process by which their Scope 3 data is collected. This information is leveraged during the cleaning process to establish the extent to which the reported data is reliable and comparable to similar companies.

The CDP Questionnaire provides companies with the following table to complete:

(C6.5) Account for your organization's Scope 3 emissions, disclosing and explaining any exclusions.

Scope 3 emissions	Evaluation status	Metric tons CO_2e	Emissions calculation methodology	Percentage of emissions calculated using data obtained from suppliers or value chain partners	Explanation
Purchased goods and services					
Capital goods					
Fuel-and-energy-related activities (not included in Scope 1 or 2)					
Upstream transportation and distribution					
Waste generated in operations					
Business travel					
Employee commuting					
Upstream leased assets					
Downstream transportation and distribution					
Processing of sold products					
Use of sold products					
End of life treatment of sold products					
Downstream leased assets					
Franchises					
Investments					
Other (upstream)					
Other (downstream)					

In the 'Evaluation Status' column, companies are asked to declare whether they consider a Scope 3 category relevant to their business and whether they have carried out the calculation. Many companies perform a rough calculation to gain a sense of scale before deciding whether a category is relevant to their GHG inventory. If they decide the figure is irrelevant then they may choose to omit this data point from their inventory. Despite the extensive guidance in the GHG Protocol's Scope 3 Standard, companies within the same sector may not agree on which categories are relevant to them. CDP has assessed which categories are, in general, applicable to each CDP Activity. If a company has not reported data for a category that CDP has deemed applicable for that activity, then a modelled estimate is provided. CDP's assessment of the applicability of each Scope 3 category to each CDP Activity is made available in the dataset.

1.2 Issues of comparability with reported Scope 3 data

There are several common issues that arise when comparing the GHG inventories of different companies. The most significant are outlined in this section with an accompanying table in the Appendix.

- *Incomplete data*

The main limitation with Scope 3 data is that it is sparsely reported. This means that there is a lower sample size for making comparisons across companies. The disclosure rate across Scope 3 categories varies significantly. Categories with a more straightforward means of calculation, for example Business Travel, are more commonly reported. For many other categories, primary data can be difficult for companies to collect.

- *Different business models*

On the surface, many would assume that Apple Inc. and Samsung Electronics have similar emissions profiles because of the similarity of their products. In fact, Samsung has much higher Scope 1 & 2 emissions than Apple. This is because it manufactures components whereas Apple has outsourced its manufacturing to other companies (including Samsung), so these emissions are accounted for in its Scope 3 'Purchased Goods and Services'.

- *Differences in calculation methodologies*

Two common approaches for calculating emissions in the 'Purchased Goods and Services' category are (1) to ask suppliers to disclose the emissions associated with the goods/services they supply, and (2) to use an environmentally-extended economic input output model, which estimates emissions from the production and upstream supply chain activities of different sectors and products in an economy. An advantage of the first method is that it involves primary data collection, however the second method is often favoured by companies with a large number of suppliers.

While both methods are valid under the GHG Protocol, they have been known to give very different Scope 3 totals. Since, input-output models consider the full cradle-to-gate emissions of all products purchased, they often yield much higher results. This poses a challenge to any comparative analysis of the 'Purchased Goods and Services' emissions for these companies.

- *Interpretation of reporting guidelines*

The varied interpretation of category definitions can result is large differences in reported emissions between similar companies. For example, companies making the same product may disagree on the meaning of 'Use of Sold Products'.

- *Different reporting boundaries*

For companies with complex corporate structures, their reported emissions may be inconsistent with other similar companies. This can be due to whether or not a parent company reports on behalf of subsidiaries, for example.

1.3 Cleaning Scope 3 data

Despite the nuances of Scope 3 accounting, CDP has reviewed the reported methodologies employed by companies and flagged values that are either incomplete or at odds with other companies in the sector. Data points may have been flagged if:

- The company has indicated it omitted key parts of its business, activities or products
- The calculation methodology appears suspect
- CDP's analysts suspect that the data has been entered incorrectly
- The value is an outlier and the methodology used to derive the emissions is not clear
- The emissions figure has been entered in the wrong category
- There has been a large change in the reported value compared to the previous year, with no clear explanation

More comprehensive data cleaning is carried out for the most commonly reported Scope 3 categories, where more reliable comparisons across companies can be made.

2 Statistical Models and Application to Scope 3

2.1 Statistical Models

Technical Annex III: Statistical Framework provides an overview of the statistical framework used for modelling the Scope 1 & 2 emissions for the CDP Full GHG Emissions Dataset. The Scope 3 data reported to CDP is treated in a similar manner, applying the same multi-variable Gamma family Generalised Linear Model (Gamma GLM) using revenue and activity information.

The Scope 3 data reported to CDP is considerably less consistent and the samples for each category are much smaller than with Scopes 1 & 2. Despite this, the data is still positive and heteroskedastic much in the same way as the Scope 1 data. For these reasons, the Gamma GLM model is still appropriate.

In the simplest terms the model coefficients (also called predictors or estimators) can be thought of average revenue intensities based on the data reported to CDP. For more detail on these basic assumptions, please review *Technical Annex III: Statistical Framework*.

2.2 Model assumptions

Each of the 15 Scope 3 categories has their own independent multi-variable regression model. In developing these models, assumptions are made to generalise the problem. These assumptions are similar to those made for the Scope 1 and 2 models and are summarised below.

- *Activity-revenue as the independent variable*

  The revenue earned by activity segment is used as the basis of the regression model. This approach assumes that revenue is directly proportional to production and therefore proportional to emissions. For more detail on these basic assumptions, please review *Technical Annex III: Statistical Framework*.

  The emissions associated with 'Employee Commuting' are estimated using the number of full time-equivalent employees (FTE) and the emissions associated with 'Capital Goods' were estimated using capital expenditure (CapEx). These models are built using a single sector classification of each company, as FTE and CapEx data is not available at the same granularity

as revenue. The use of these predictor variables gives rise to the following additional assumptions.

- *Constant earnings per employee*

The earnings per employee is used by analysts to compare personnel productivity. This ratio varies drastically across industries but here it is assumed to be reasonably consistent for companies engaged in similar activities.

There is an assumption made in the statistical modelling framework that companies undertaking the same activity do so in a similar manner using similar processes. This can be extended to apply to the number of employees as well; if this assumption is true then companies should employ a similar number of people per unit of production/revenue. This means that the earnings per employee could be assumed to be reasonably consistent within any given activity group.

- *Constant capital expenditure ratio*

Companies engaged in any given activity could be assumed to have made similar capital expenditures per unit of production assuming they use the same equipment for production.

- *Companies use similar calculation methodologies*

This assumption was made about the Scope 1 & 2 data reported to CDP in the Statistical Framework. It is not reasonable to use this assumption in Scope 3 modelling due to the different interpretations and estimation approaches of the Scope 3 categories introduced previously.

- *Estimates reflect a mixture of calculation methodologies*

In any given sector, the model estimates will reflect a mixture of the calculation methodologies of the reporting companies. In many cases these differing methodologies and assumptions will yield roughly similar results but in some cases the difference between approaches can be significant.

The regression models calculate an average revenue intensity of the companies' data, which represents a mixture of these methodologies. This means that the estimates could be thought of as a weighted average of the various methodologies employed by companies.

This also means that CDP does not choose an approach for the predictions. To use a previous example, if the reported Scope 3 'Purchased Goods and Services' data were split into two sets, with one model constructed using the reported data calculated through the input-output models, and another using the reported data that only included first tier suppliers, then a choice would have to be made as to which model to employ for predicting for non-disclosers.

This is the most significant source of uncertainty in these Scope 3 models and is difficult to address without more harmonised reporting between peer companies.

2.3 CDP Activity Classification System

The models for Scopes 1 and 2 used company classifications at the activity level – the most granular available. For Scope 3, the modelling process makes use of all three levels of the CDP Activity Classification System. This is to maximise sample size in the models, so that the resulting estimates are as robust as possible.

2.3.1 Classification Hierarchy

These revenue-based statistical models are dependent upon how companies are grouped together. The CDP Activity Classification System (CDP-ACS) has been developed to provide a framework for quantifying a company's environmental impacts connected to its activities; impacts across the Forests, Water and Climate Change programs have been considered. The classification hierarchy has three levels:

- *Activity:* A company's environmental impacts are the result of their activities and so the most granular level of the CDP hierarchy is the Activity, companies may have many different activities. There are 208 different Activities in the CDP-ACS.
- *Activity Group:* CDP grouped the 208 activities into 60 Activity Groups**.**
- *Industry:* Multiple Activity Groups make up an Industry, which is the highest or the least granular level of the hierarchy. There are 13 Industries.

Each grouping has been created to try to ensure that the environmental impacts across Climate, Water and Forests are as consistent as possible.

2.3.2 Climate Change Hybrid classification system

In CDP-ACS, some of the Activity groupings have been combined where the main distinction between them relates to their Forests or Water Impacts. The Climate Change Hybrid classification instead focusses on climate change (i.e. emissions) impacts alone. This permits more reliable regression analysis, where activity is used as a predictor variable.

For example, hydro power has significantly different impacts on both local water systems and forests, so a distinction made between hydro power and other renewable electricity sources. In the climate change hybrid, this distinction is ignored because all types of renewable energy have similarly small emissions intensities.

As a result, there are less unique Activities in the Climate Change Hybrid classification (91), as opposed to CDPACS (208).

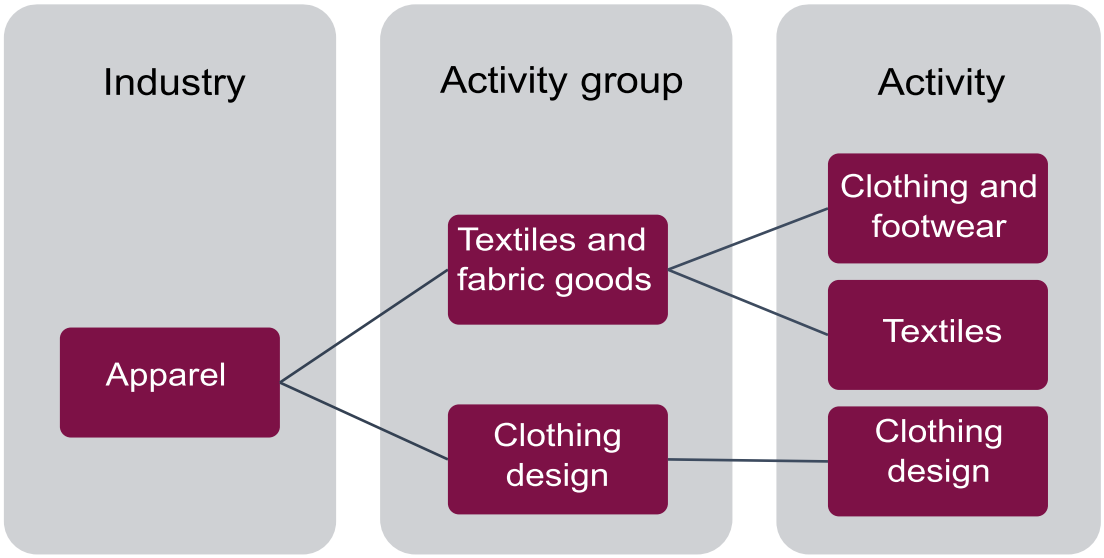
2.4 Three Levels of Model Granularity

Each of the statistical models used for the Scope 1 and Scope 2 estimates used the revenue broken down into the activity groups, resulting in a multi-variable regression model with 91 different independent variables and, therefore, 91 model coefficients representing the average revenue intensity for each Activity. The model sample used to fit these coefficients needs to contain enough data points for each Activity to be able to find a good fit. This is not simply an issue of how many data points are in the sample but also the consistency of the reported data.

There is enough Scope 1 & 2 GHG data available to be able to build regression models using the Activity revenue. For many of the Scope 3 categories, the disclosure rate is much lower. This means that for some Activities, where the data is either too sparsely reported or too inconsistent for the model to find a good fit, a different level of aggregation is necessitated. Using the revenue broken down by Activity Group as opposed to Activity results in 44 variables instead of 91. This means that the model is more likely to be able to find a good fit, but that the coefficients of the model will be the Activity Group average revenue intensities.

If there is insufficient data in the sample to fit a model using the revenue breakdown by Activity Group, then the Industry level is selected. This aggregation results in estimates that are less precise but more robust. In the final dataset, the level of aggregation used for each Scope 3 model is recorded in the *Scope 3 Model Appendix* worksheet.

To illustrate this, the figure below shows a portion of the CDP classification tree which can be 'pruned' to improve the robustness of the estimates if there is insufficient data.



Based on the above diagram, if there were not enough companies involved in the 'Textiles' or 'Clothing and Footwear' Activities, it would be necessary to group them into the 'Textiles and Fabric Goods' Activity Group to produce more reliable model estimates.

2.5 Model Selection

2.5.1 Stepwise criterion-based model selection

Models are produced at all three levels of the classification hierarchy, and the Akaike Information Criterion (AIC), a measure of relative model quality, is used to choose the most appropriate for each Scope 3 category. For well reported categories like 'Business Travel' the Activity model can often be used, but for poorly reported categories like 'Franchises', the more general Industry model may be more appropriate.

However, this one-size-fits-all approach for each Scope 3 category ignores the fact that there are some categories that are more relevant to different Activities than others. A stepwise model selection method is therefore used to return the most appropriate model for each combination of Activity and Scope 3 category.

An iterative process is used to generate a subset of possible models based on different groupings of variables. The AIC is used at each iteration to compare the test model with the current best known model (the one with the lowest AIC). The algorithm starts with the full classification tree and 'prunes' branches by grouping the Activity variables into the respective Activity Groups and Industries. This method can be thought of as a Backwards Elimination approach.

2.5.2 Applicable Scope 3 Categories

There are many combinations of Activity and Scope 3 category where it is not clear what the source of emissions would mean. For example, there are no emissions from the 'Use of Sold Products' for clothing manufacturers. Similarly, a health care provider would have no 'Processing of Sold Products' emissions. In order to capture this logic, CDP has defined an applicability categorisation.

For each activity/category combination, CDP has decided whether it is either Applicable / Not Applicable. Estimates will not be shown for Activity/category combinations that were deemed Not Applicable. These definitions are largely based on work carried out by Nils Niehues in "*An Agency Perspective on Voluntary CO2 Disclosure: A Mixed-method Study*", in collaboration with CDP. A number of rules are used, based on reported data, to define whether a category is applicable.

2.6 Physical activity modelling

Physical activity modelled estimation is based on the combining of physical activity indicators (tonnes, barrels, kilometres, etc.) and their associated emission factors. Because such indicators relate directly to the emitting activity, the bottom-up estimates are expected to have a narrower margin of error than the statistical estimates. Activities and products are accounted for individually, so the method is limited to homogenous sectors. Homogenous sectors are so-called because they are structured around one, or a low number of, processes and products. Such structures are most common in the upstream extraction, production and conversion industries, which is why the method accounts for the most energy- and emissions-intensive sectors.

Three homogenous sectors are physical activity modelled for Scope 3 emissions: coal mining, oil and gas extraction, and petroleum refining. Note that estimates are only provided for category 11: 'Use of Sold Products', which often dominates the emissions profile for these sectors.

Appendix 1 - Scope 3 Comparability Issues

Scope 3 Category:	Common issues with data reported to CDP
Business travel	Best responded category, calculations are very sensitive to different emissions factors and assumptions.
Capital goods	Companies' capital investments are not necessarily consistent year on year.
Downstream transportation and distribution	Calculations are very sensitive to the assumptions about mode of transport and so similar calculation methodologies may result in different values.
Downstream leased assets	The decision to lease or purchase assets often depends on the company's business strategy more than on size or activity.
Employee commuting	Different assumptions about employee behaviour and emissions factors from public transport can lead to different results.
End of life treatment of sold products	Calculations depend on assumptions about behaviour of users or clients which can affect the calculations.
Franchises	Depends on the company's reporting boundary and business model.
Fuel-and-energy related activities	This Scope 3 category often confusion amongst companies and the calculation methodologies vary considerably.
Investments	Dependant on Scope 1 & 2 reporting boundary, if a company excludes Scope 1 & 2 emissions from assets that it does not operate because it is reporting on an Operational Control Boundary then the emissions from these assets should be included in their Scope 3 Investments. The emissions from these assets would be included in Scope 1 & 2 if the company reports on an Equity Share basis.
Processing of sold products	Companies often differ on which parts of their value chain constitutes 'Processing' and which parts constitute 'Use'.

Purchased goods and services	Companies either use Life Cycle Analysis which considers the emissions of the emissions from the full value chain whereas other companies only consider the emissions of their direct suppliers, ignoring the rest of the value chain. Companies may not include all raw materials, goods, or services they purchase, many only account for paper or water purchases.
Upstream leased assets	The decision to lease or purchase assets depends on the company's business strategy more than on size or activity.
Upstream Calculations are very sensitive to the assumptions about mode of transportation/distribution transport and so similar calculation methodologies may result in different values.	
Use of sold products	Calculations are sensitive to behavioural assumptions made about end users.
Waste generated in operations	Calculations methodologies vary, emissions from waste depend on method of disposal which may have a much stronger regional variation due to differences in regulations.