# The Lab

Technical Briefing Note

## Scope 3 Spend Factors

CarbonSAVER®

# Technical Advisory: Understanding Volatility in Spend-Based Emission Factors

## Executive Summary

Organizations utilizing spend-based emission factors (Environmentally Extended Input-Output or EEIO) for Scope 3 carbon accounting often encounter significant volatility in their emissions figures. This volatility does not necessarily reflect actual changes in environmental performance, which can complicate year-on-year comparisons and progress tracking.

This report outlines the three primary categories of volatility—economic factors, methodological factors, and supply chain structural factors—and explains why historical factors are often recalculated in annual updates.

## 1. Economic Factors: The "Price" Drivers

Spend-based emission factors are expressed as emissions per unit of currency (e.g., kg$CO_2$e per £ or $). Because they are tied to financial value, any fluctuation in the value of money directly affects the calculated emissions, even when physical emissions remain unchanged.

## 1.1 Inflation (The 'Vintage' Mismatch)

Most emission factor databases are anchored to a specific "base year" of currency values. This creates two specific volatility effects:

- **Inflationary Overstatement:** If a factor calibrated to a past base year (e.g., 2018) is applied to current spending without adjustment, emissions will be systematically overstated. This occurs because a unit of currency today purchases less physical product than it did in the base year due to cumulative inflation, yet the unadjusted factor treats the spend as equivalent.
- **The "Drop" Upon Update:** When database providers update their base year (e.g., moving from 2018 to 2022), emission factors often appear to drop across the board. This reduction typically reflects the lower purchasing power of the new base year currency rather than genuine decarbonization in the supply chain.

## 1.2 Currency Exchange Rates

Global supply chains involve expenditure in multiple currencies, whereas emission factor databases are typically denominated in a single currency (often USD or Euros). Converting spend data to match the database currency introduces sensitivity to exchange rate movements.

- **The Volatility Effect:** Exchange rate movements can create apparent changes in carbon footprints that have no relationship to actual emissions. For example, if Sterling strengthens against the US Dollar, USD-denominated spend figures decrease when converted, making the carbon footprint appear smaller purely due to foreign exchange markets.

### 1.3 Pricing Strategy and Profit Margins

Spend-based models assume a linear relationship where higher prices correlate with higher embedded emissions. This assumption breaks down when price changes are driven by commercial factors rather than production.

- **Artificial Volatility:** If a supplier increases prices to expand profit margins, calculated emissions will increase proportionally, even if the product is unchanged. Conversely, negotiating a volume discount will reduce calculated emissions, despite the physical product remaining identical.

## 2. Methodological Factors: Why Factors Change

EEIO factors are outputs of complex economic models rather than direct measurements. Updates to these models or their underlying data sources can cause significant shifts.

### 2.1 Data Vintage and Lag

The economic data underpinning these models takes years to compile. A "2024" emission factor set may rely on economic input-output tables from 2019 or 2020.

- **The "Catch-Up" Effect:** When modelers update the underlying economic data (e.g., jumping from 2019 to 2022 source data), factors can shift suddenly. This causes the model to absorb several years of economic structural changes—such as post-COVID supply chain reconfigurations—simultaneously.

## 2.2 Sector Re-aggregation

Database developers periodically redefine industry categories to improve granularity. For example, a broad "IT Hardware" category might be split into specific categories like "Semiconductors" and "Peripheral Equipment".

- **The Re-mapping Impact:** If an expenditure code is remapped to a new, more specific category, the associated emission factor can change dramatically (potentially doubling or halving) because the new category has a distinct carbon intensity profile.

## 2.3 Grid Decarbonization

EEIO models incorporate the carbon intensity of electricity grids used by manufacturers.

- **Step-Change Reductions:** Grid improvements are often incorporated as discrete step-changes rather than gradual curves. A new database release might reflect multiple years of renewable energy growth at once, causing sharp reductions in factors for electricity-intensive sectors like data centers or aluminum production.

# 3. Supply Chain Structure Factors

EEIO models rely on assumptions about "average" global trade flows (e.g., assuming a specific percentage of imports comes from a specific region).

- **Value Chain Shocks:** Major geopolitical or economic events (such as trade tariffs or conflicts) can substantially shift global trade patterns. When model updates capture these shifts—such as sourcing moving to regions with different carbon intensities—the average emission factor for that commodity can swing significantly.

# 4. Why Historical Factors Are Recalculated

It is common for government bodies or database providers to recalculate historical factors in annual publications. This is done to ensure comparability and allow for like-for-like comparison.

- **Consistency Principle:** Applying improved methodologies (e.g., better data sources or updated Global Warming Potential values) only to the current year would create a false comparison with previous years.
- **Methodological Artifacts:** Without recalculation, a database update could show an "apparent reduction" in emissions even if spend and physical emissions remained unchanged.

# Summary of Volatility Scenarios

The table below illustrates how spend-based calculations can generate misleading signals compared to physical reality:

| Scenario | Physical Reality | Financial Reality | Scope 3 Calculation Result |
|---|---|---|---|
| **Supplier doubles price** | Emissions unchanged | Spend doubles | **Emissions double** (False Positive) |
| **Supplier efficiency improves 50%** | Emissions halve | Price unchanged | **No change detected** (Missed Reduction) |
| **5% Annual Inflation** | Emissions unchanged | Spend increases 5% | **Emissions +5%** (False Increase) |
| **Database Base Year Update** | Emissions unchanged | Spend unchanged | **Apparent reduction** (Methodological Artifact) |

# UK Footprint (DEFRA)

The total UK consumption-based carbon footprint data, published by DEFRA, is subject to significant volatility. These figures are released three years in arrears (e.g., the 2022 footprint is published in 2025), and crucially, historical figures are often materially updated with each new publication.

For instance, the reported 2020 footprint published in 2025 was 74 million tCO2e greater than the figure published in 2023—a substantial 12.8% increase. This volatility is a major drawback of using spend-based emission factors for routine annual footprint reporting, as material changes necessitate costly and time-consuming historical recalculations to ensure compliance with reporting standards.

Given these limitations, we strongly advise using spend-based factors primarily as a high-level diagnostic tool, or for initial scoping and estimating. For tracking emissions reduction over time and for formal annual Carbon Footprint Reports, the use of supplier-specific factors is essential.

| GHG emissions ktCO2e | 2023 release (UK footprint for 2020) | 2024 release (UK footprint for 2021) | 2025 release (UK footprint for 2022) |
|---|---|---|---|
| 1990 | 911,615 | 921,968 | 921,266 |
| 1991 | 923,611 | 934,073 | 933,227 |
| 1992 | 879,868 | 890,372 | 889,502 |
| 1993 | 853,913 | 864,487 | 863,786 |
| 1994 | 841,974 | 851,273 | 850,674 |
| 1995 | 804,058 | 813,119 | 812,695 |
| 1996 | 819,121 | 828,109 | 825,684 |
| 1997 | 828,429 | 837,284 | 833,234 |
| 1998 | 877,516 | 885,169 | 880,985 |
| 1999 | 863,559 | 870,337 | 869,710 |
| 2000 | 859,806 | 866,309 | 864,784 |
| 2001 | 849,314 | 856,086 | 858,501 |
| 2002 | 893,230 | 898,725 | 903,235 |
| 2003 | 891,953 | 896,709 | 913,336 |

| | | | |
|---|---|---|---|
| 2004 | 952,298 | 957,176 | 964,295 |
| 2005 | 942,176 | 946,556 | 953,024 |
| 2006 | 944,480 | 949,009 | 954,741 |
| 2007 | 958,767 | 963,061 | 977,406 |
| 2008 | 890,032 | 894,766 | 908,048 |
| 2009 | 799,983 | 800,896 | 813,263 |
| 2010 | 804,504 | 803,712 | 818,724 |
| 2011 | 776,589 | 777,652 | 792,719 |
| 2012 | 809,988 | 811,342 | 823,904 |
| 2013 | 800,601 | 800,863 | 812,825 |
| 2014 | 783,586 | 784,159 | 798,280 |
| 2015 | 775,742 | 776,708 | 797,699 |
| 2016 | 694,681 | 698,261 | 792,229 |
| 2017 | 671,761 | 673,407 | 742,811 |
| 2018 | 689,884 | 699,145 | 779,141 |
| 2019 | 670,475 | 684,760 | 761,856 |
| 2020 | 582,005 | 612,508 | 656,222 |
| 2021 | | 704,549 | 719,302 |
| 2022 | | | 739,519 |

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