What a Full Carbon Footprint Looks Like — A Demo Manufacturing Company Worked Example

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OVERVIEW

In the earlier articles, we looked at the building blocks of carbon accounting — first the basics, then Scope 3 in more detail.

But in practice, a business does not manage emissions in separate compartments. It manages them as one overall footprint. That is why a full greenhouse gas inventory matters.

Under the GHG Protocol Corporate Standard, a company's emissions are organised into Scope 1, Scope 2 and Scope 3, giving management a more complete view of where emissions arise across operations and the wider value chain

This **article brings that together through a simple demo manufacturing company.**

The purpose is not to produce an assured emissions inventory, but to show how a business can begin thinking about all three scopes in one connected way. The GHG Protocol's Corporate Standard provides the accounting framework for Scope 1 and Scope 2, while the Corporate Value Chain Standard and Scope 3 Calculation Guidance provide the framework and methods for Scope 3 categories across the value chain

MEET THE DEMO COMPANY

Let us assume we are looking at DemoAir Manufacturing Sdn Bhd, a fictional Malaysian manufacturer of industrial ventilation fans used in factories and warehouse.

It operates:

- a small production plant,
- owns delivery vehicles,
- purchases electricity from the grid,
- buys steel and aluminium as key inputs,
- uses third-party freight providers,
- generates production waste, and
- sells products that consume electricity during use

For a company like this, a meaningful carbon footprint does not stop at the factory gate. It stretches from fuel use and electricity consumption to purchased materials, logistics, employee travel and the lifetime use of sold products. That is exactly the kind of full picture view the GHG Protocol is designed to support.

A good carbon footprint exercise starts by separating emissions into the three scopes

SCOPE 3 Categories

1. **These relate to activities after the product or service leaves the company:**
2. **Purchased goods and services**
3. **Capital goods**
4. **Fuel- and energy-related activities not included in Scope 1 or Scope 2**
5. **Upstream transportation and distribution**
6. **Waste generated in operations**
7. **Business travel**
8. **Employee commuting**
9. **Downstream transportation and distribution**
10. **Processing of sold products**
11. **Use of sold products**
12. **End-of-life treatment of products sold**
13. **Downstream leased assets**
14. **Franchises**
15. **Investment**

Scope 1 covers direct emissions from sources the company owns or controls, such as fuel used in company vehicles, on-site boilers or fugitive refrigerants

Scope 2 covers indirect emissions from purchased electricity, steam, heating or cooling consumed by the company

Scope 3 covers the wider value chain — upstream and downstream — including purchased goods, transport, waste, travel, commuting and the use of sold products.

This three-scope structure is the backbone of corporate greenhouse gas accounting under the GHG Protocol

THE 7 STEPS PROCESS

Step 1: Map the emissions sources for this demo	Step 2: Gather the activity data (use simple annual activity data for one financial year)	Step 3: Apply emission factors (For this article, the emission factors are illustrative assumptions)
Scope 1 includes diesel used in company-owned delivery lorries, LPG used in a small heating process in production, refrigerant top-up for air-conditioning systems	**Scope 1 activity data** Diesel used by company lorries: **40,000 litres** LPG used in production heating: **12,000 kg** Refrigerant top-up: **25 kg**	**Scope 1 Emission Factor** •Diesel: 0.00268 tCO2e per litre •LPG: 0.00300 tCO2e per kg •Refrigerant: 1.43 tCO2e per kg
Scope 2 — purchased electricity DemoAir buys electricity from the grid to run production lines, lighting, office equipment and cooling systems	**Scope 2 activity** data Purchased electricity: 1**,800,000 kWh**	**Scope 2** Grid electricity: 0.00070 tCO2e per kWh
Scope 3 — Most relevant value chain emissions •Category 1: purchased goods and services, •Category 4: upstream transportation and distribution, •Category 5: waste generated in operations, •Category 6: business travel, •Category 7: employee commuting, •Category 11: use of sold products	**Scope 3 activity data:** •Steel purchased: **800 tonnes** •Aluminum purchased: **120 tonnes** •Packaging purchased**: 150 tonnes** •Inbound freight: **900 tonnes moved over 250 km** •Waste to landfill: **25 tonnes** •Scrap sent for recycling: **140 tonnes** Domestic return flights: **18 trips** Hotel stays: **60 nights** Employees: **85** Average round-trip commute: **30 km/day** Working days: **240 days/year** Fans sold in the year: **1,000 units** Electricity consumption per fan: **0.75 kW** Average operating time: **8 hours/day × 300 days/year** Product life: **10 years** This data would come from fuel invoices, utility bills, procurement records, freight providers, waste contractors, travel claims, HR records, employee surveys and product specifications.	**Scope 3** •Steel: 2.10 tCO2e per tonne •Aluminium: 8.00 tCO2e per tonne •Packaging: 1.20 tCO2e per tonne •Freight: 0.00009 tCO2e per tonne-km •Landfill waste: 0.45 tCO2e per tonne •Recycled scrap: 0.02 tCO2e per tonne •Domestic return flight: 0.25 tCO2e per trip •Hotel stay: 0.02 tCO2e per night •Employee commuting: 0.00012 tCO2e per passenger-km •Electricity used by sold products: 0.00070 tCO2e per kWh

Step 4: Calculate Scope 1	Step 5: Calculate Scope 2	Step 6: Calculate Scope 3
Emissions = activity data × emission factor		
Diesel for company lorries 40,000 litres × 0.00268 = 107.20 tCO2e LPG used in production 12,000 kg × 0.00300 = 36.00 tCO2e Refrigerant leakage / top-up 25 kg × 1.43 = 35.75 tCO2e Total Scope 1 178.95 tCO2e	Purchased electricity 1,800,000 kWh × 0.00070 = 1,260.00 tCO2e Total Scope 2 1,260.00 tCO2e	Category 1: Purchased goods and services •Steel: 800 × 2.10 = 1,680.00 tCO2e •Aluminium: 120 × 8.00 = 960.00 tCO2e •Packaging: 150 × 1.20 = 180.00 tCO2e Category 1 total = 2,820.00 tCO2e The Scope 3 Calculation Guidance recognises several methods for purchased goods and services, including supplier-specific, hybrid, average-data and spend-based methods. Quantity-based estimates like this are often a practical starting point when basic material data is available
This is a useful reminder that Scope 1 is not only about one source. Even in a medium-sized manufacturing example, emissions may arise from mobile fuel, stationary fuel and fugitive emissions	For many manufacturers, Scope 2 is immediately material because electricity powers core operations.	Category 4: Upstream transportation and distribution 900 tonnes × 250 km × 0.00009 = 20.25 tCO2e This category captures third-party freight bringing materials into the business. Tonne-kilometer style methods are a common way to estimate transport-related value-chain emissions
		Category 5: Waste generated in operations • Landfill: 25 × 0.45 = 11.25 tCO2e • Recycling: 140 × 0.02 = 2.80 tCO2e Category 5 total = 14.05 tCO2e Waste emissions depend not only on the amount of waste, but also on the disposal route. That is why separating landfill and recycling matters
		Category 6: Business travel • Flights: 18 × 0.25 = 4.50 tCO2e • Hotel stays: 60 × 0.02 = 1.20 tCO2e Category 6 total = 5.70 tCO2e
		Category 7: Employee commuting 85 × 30 km × 240 days × 0.00012 = 73.44 tCO2e
		Category 11: Use of sold products First calculate lifetime electricity use per fan: 0.75 kW × 8 hours/day × 300 days/year × 10 years = 18,000 kWh per fan Then apply the electricity factor: 18,000 × 0.00070 = 12.60 tCO2e per fan Then multiply by units sold: 1,000 × 12.60 = 12,600.00 tCO2e Category 11 total = 12,600.00 tCO2e

		This is often where the picture changes dramatically for manufacturers of energy-using products. The GHG Protocol's Scope 3 Standard and technical guidance explicitly include downstream use of sold products as a category because it can be one of the largest sources of value-chain emissions
		Total Scope 3 **2,820.00 + 20.25 + 14.05 + 5.70 + 73.44 + 12,600.00** **= 15,533.44 tCO2e**

Step 7: See the full carbon footprint together

Scope	**Emissions (tCO2e)**
Scope 1	178.95
Scope 2	1,260.00
Scope 3	15,533.44
Total carbon footprint	**16,972.39**

Just a note for readers on Category 12

Category 12: End-of-life treatment of sold products can also be calculated to see whether it is a relevant disclosures for DemoAir.

Category 12 emissions = sum of each material mass × disposal route % × treatment factor

GHG Protocol's technical guidance summarises Category 12: Companies need the total mass of sold products at end of life, the proportion treated by different waste methods, and the corresponding waste-treatment emission factors

For DemoAir, Category 12 would be calculated by estimating the weight of steel, aluminium, plastic, copper and packaging in each fan, multiplying by the number of units sold, and then applying assumptions on end-of-life treatment routes such as recycling, landfill and incineration. The relevant waste-treatment emission factors would then be applied to each material and disposal route. This gives an estimate of emissions associated with the disposal of sold products after their useful life.

One caution is worth adding: if you include Category 12, keep the factors clearly labeled as illustrative assumptions, because GHG Protocol expects companies to disclose the methodology and assumptions used for end-of-life treatment.

A simple DemoAir illustration		
Let us assume each fan contains: 20 kg steel 5 kg aluminium 3 kg plastic 2 kg copper 5 kg cardboard packaging	DemoAir sold 1,000 fans .That gives total sold material at end of life of: Steel: 20,000 kg Aluminium: 5,000 kg Plastic: 3,000 kg Copper: 2,000 kg Cardboard: 5,000 kg	Now assume the end-of-life treatment mix is: 80% recycled 15% landfilled 5% incinerated For each material : apply the following formula material mass × route % × route-specific factor Example for steel: If factors were: recycling = 0.02 kgCO2e/kg landfill = 0.01 kgCO2e/kg incineration = 0.03 kgCO2e/kg
		Then steel Category 12 emissions would be: 20,000 × 80% × 0.02 = 320 kgCO2e 20,000 × 15% × 0.01 = 30 kgCO2e 20,000 × 5% × 0.03 = 30 kgCO2e Steel total = 380 kgCO2e = 0.38 tCO2e You would repeat that for aluminum, plastic, copper and packaging, then add them together.
For this demo company, Category 11: Use of sold products is likely to be much larger than Category 12, because the fan consumes electricity over many years. That is common for products that use energy in operation. Category 12 still matters, but usually as a smaller downstream category compared with use-phase emissions.		

GHG Protocol treats Category 11 and Category 12 separately for exactly this reason: one captures emissions during use, the other captures emissions at disposal

This kind of summary is where carbon accounting starts becoming useful for management. The company can now see not just what it emits directly, but where the biggest emissions hotspots really sit across the wider business model. Under the GHG Protocol, the Scope 2 sits separately from direct fuel use, which helps management see whether operational emissions are driven more by owned combustion sources or by purchased energy The GHG Protocol's value-chain framework is intended to help companies assess these impacts and identify where to focus reduction activities

WHAT DOES THIS TELL MANAGEMENT?

Three important messages come through immediately.

- **First, Scope 3 dominates the footprint**.

In this example, most emissions do not come from the company's own vehicles or electricity use. They sit in purchased materials and especially in the use of sold products. That is a very important management insight because it shifts attention beyond the factory gate.

The Scope 3 Standard was developed for exactly this reason: to help companies assess emissions impacts across their value chains and identify reduction priorities.

- **Second, Scope 2 still matters materially**.

Purchased electricity is the second largest part of the footprint in this demo, which means energy efficiency, process optimisation and cleaner electricity choices could make a meaningful difference.

The GHG Protocol's Scope 2 Guidance exists because purchased electricity is often a significant emissions source for companies.

- **Third, Scope 1** is smaller, but still operationally important. Company fuel use, heating fuel and refrigerants are still part of the business' direct emissions profile and may be easier to influence directly through operational controls, equipment changes and maintenance practices.

SO, WHERE WOULD THE COMPANY ACT FIRST?

The first priority would likely be product efficiency, because Category 11 is the largest emissions hotspot.

The second would be procurement and supplier engagement, especially for steel and aluminum.

The third would be electricity management inside the factory, because Scope 2 is material.

After that, the company could look at fleet efficiency, refrigerant controls, waste management, freight optimisation and travel practices.

This is exactly how a full GHG inventory should be used — not just for disclosure, but for decision-making.
The GHG Protocol's Scope 3 framework is explicitly intended to help companies identify where to focus reduction activities. Which categories are likely to be the largest?

HOW THIS LINKS TO REPORTING FRAMEWORKS

It is also worth noting that these calculations do not sit in isolation.
A greenhouse gas inventory built using the GHG Protocol can support a range of sustainability reporting approaches, including ASEDG, EU's ESRS framework and IFRS S2.

IFRS S2 requires entities to measure greenhouse gas emissions in accordance with the GHG Protocol Corporate Standard unless a jurisdiction or exchange requires a different method.

That said, the GHG Protocol is best seen as the measurement foundation, not the full reporting framework. A company still needs to address the broader disclosure requirements of whichever framework it uses, including governance, strategy, risks, metrics and presentation.

IFRS's 2025 educational material makes this point clearly by noting that IFRS S2 refers to the GHG Protocol for measurement but does not simply import all of the GHG Protocol's broader requirements beyond measurement.

FINAL THOUGHT

A full carbon footprint is far more useful than looking at one scope in isolation. It shows management the complete picture: what the business emits directly, what it buys in energy, and what happens across the wider value chain.

For many manufacturers, that complete picture can be surprising.

The biggest emissions may not come from inside the plant at all. They may sit in raw materials, purchased electricity, and especially in how products are used after sale.

That is why a full greenhouse gas inventory matters. It gives the business a clearer environmental baseline, sharper priorities and a stronger foundation for future reporting.

In the next articles, we will move from carbon measurement into the reporting landscape itself — looking at how disclosures can be approached through ASEDG, IFRS Sustainability and ESRS.

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