

newtral

The Complete Handbook on Product Carbon Footprint (PCF)

Learn how to measure, reduce, and report Product Carbon Footprint (PCF) using best practices, GHG Protocol, and industry-leading methodologies.



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Introduction

Introduction to Product Carbon Footprint

Learn what Product Carbon Footprint (PCF) is, why it matters, and how it helps businesses meet sustainability goals and regulations like ISO 14067 & GHG Protocol.

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What is Product Carbon Footprint (PCF)?

Imagine you're holding a product—maybe a smartphone, a piece of clothing, or even a cup of coffee. Have you ever thought about the invisible emissions tied to that product's journey? From raw material extraction to manufacturing, shipping, usage, and disposal—each stage contributes to greenhouse gas (GHG) emissions.

That's where Product Carbon Footprint (PCF) comes in. PCF measures the total amount of GHG emissions generated across a product's entire lifecycle, usually expressed in kilograms of CO₂ equivalent (kg CO₂e). It helps businesses understand their impact and find ways to reduce it.

How is PCF Different from Corporate Carbon Footprint?

You might have heard of Corporate Carbon Footprint (CCF)—that's the total emissions of a company as a whole. PCF, on the other hand, zooms in on a single product. It tells us which part of a product's journey emits the most carbon and where businesses can make meaningful reductions.

PCF vs. Life Cycle Assessment (LCA)

People often confuse PCF with Life Cycle Assessment (LCA). Here's the key difference:

- PCF focuses only on greenhouse gas emissions (CO₂, methane, etc.).
- LCA looks at a broader picture, including factors like water consumption, land use, toxicity, and pollution.

- **PCF follows ISO 14067** (a globally recognized standard), while LCA follows **ISO 14040 & 14044**.

Businesses typically use both: LCA for a complete sustainability analysis and PCF to cut carbon emissions.

Why Should Businesses Care About PCF?

You might wonder, "Why should I care about PCF?" Well, if you're a business looking to stay competitive, compliant, and sustainable, PCF matters now more than ever.

1. Regulations & Compliance: Avoid Future Risks

Governments worldwide are tightening their grip on carbon emissions. Some key regulations include:

- **EU CBAM** (Carbon Border Adjustment Mechanism) – If your product is exported to Europe, you'll soon need to report its PCF or face additional carbon tariffs.
- **SEC Climate Disclosure Rules** – In the U.S., companies must now disclose climate-related financial risks, including Scope 3 emissions (which include PCF).
- **India's BRSR (Business Responsibility and Sustainability Reporting)** – Large companies in India must report their sustainability performance, and PCF is becoming a key metric.

Ignoring PCF today could mean **higher costs, legal risks, and lost opportunities** tomorrow.





2. Business Growth: Stand Out in the Market

Consumers, investors, and business partners are all looking for low-carbon, sustainable products. If your product has a lower PCF, it becomes more attractive to:

- Eco-conscious customers who prefer sustainable brands.
- Investors who prioritize ESG (Environmental, Social, and Governance) factors.
- Suppliers & retailers who need to meet sustainability goals.

3. Cost Savings & Operational Efficiency

Reducing PCF isn't just about compliance—it's good for business too. When companies measure their product's carbon footprint, they often discover ways to:

- Use energy more efficiently (lowering electricity & fuel costs).
- Optimize raw material sourcing (cutting waste & expenses).
- Improve supply chain logistics (reducing transportation emissions & costs).

How Do Businesses Measure PCF?

To ensure accurate and comparable PCF data, businesses follow recognized global standards:

1. ISO 14067 – The Gold Standard for PCF Calculation

ISO 14067 is the most widely accepted international standard for measuring and reporting PCF. It defines:

- What emissions should be counted.
- How data should be collected.
- How to ensure transparency and comparability.

2. GHG Protocol Product Standard

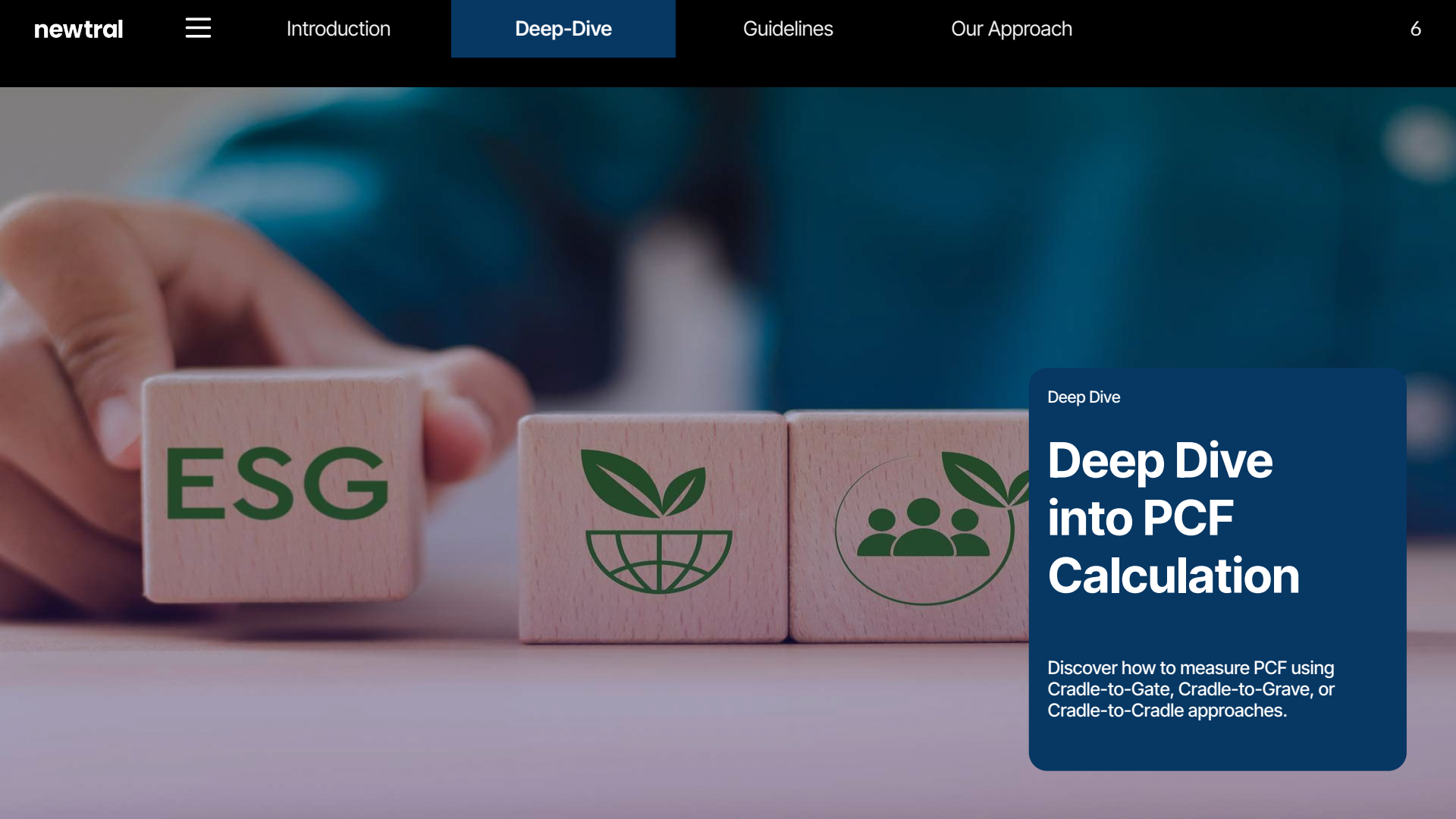
Developed by the World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD), this framework aligns with ISO 14067 but provides additional guidance for corporate emissions reporting.

3. Science-Based Targets Initiative (SBTi)

SBTi helps businesses set PCF-aligned reduction goals based on climate science. Companies that commit to SBTi are seen as leaders in sustainability.

4. Regulatory & Market Expectations

With carbon reporting becoming mandatory, companies need to track PCF not just to be sustainable—but to stay in business.



ESG



Deep Dive

Deep Dive into PCF Calculation

Discover how to measure PCF using Cradle-to-Gate, Cradle-to-Grave, or Cradle-to-Cradle approaches.

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Understanding and reducing a product's carbon footprint starts with accurate measurement. A well-calculated Product Carbon Footprint (PCF) helps businesses identify emission hotspots, improve supply chain efficiency, and meet regulatory requirements. However, calculating PCF isn't as simple as adding up emissions—it requires setting boundaries, understanding emission sources, collecting reliable data, and using accurate methodologies.

This section provides a step-by-step guide to measuring PCF, including:

- Defining system boundaries and selecting a calculation approach.
- Identifying key emission sources.
- Understanding activity data and emission factors.
- Using industry-recognized tools for accurate calculations.

2.1 Defining System Boundaries and Life Cycle Stages

Before measuring a product's emissions, a company must define its system boundaries—which determines how much of the product's life cycle is included in the calculation.

There are three commonly used approaches:

1. Cradle-to-Gate

- Covers emissions from raw material extraction to the point where the product leaves the factory.
- Excludes emissions from transportation, product use, and end-of-life disposal.
- Commonly used for internal emissions tracking and supplier reporting.

💡 Example: A steel manufacturer calculating PCF only up to the factory gate to report emissions to automotive customers.

2. Cradle-to-Grave

- Covers the entire product life cycle—from raw material extraction to disposal.
- Includes transportation, product usage, and end-of-life impact.
- Best for companies committed to full life cycle emissions transparency.

💡 Example: A refrigerator manufacturer assessing PCF from material sourcing, manufacturing, customer use, and final disposal.

3. Cradle-to-Cradle

- Extends Cradle-to-Grave by assuming a circular economy model—where materials are recycled or reused instead of being discarded.
- Best for businesses focusing on sustainable product design and zero-waste models.

💡 Example: A shoe brand using fully recyclable materials measures its PCF with the assumption that old shoes will be returned, recycled, and remanufactured.

How to Choose the Right Approach?

- If you only need factory-level emissions, use Cradle-to-Gate.
- If your product's biggest emissions come from customer use, go with Cradle-to-Grave.
- If your company designs for recycling, Cradle-to-Cradle is the best fit.



2.2 Identifying Key Emission Sources in PCF

A product's carbon footprint is shaped by emissions at different stages of its life cycle. These emissions are categorized into:

1. Raw Material Extraction & Processing

- Emissions from mining, farming, or manufacturing raw materials.
- Material type matters—metals and plastics often have higher footprints than bio-based materials.

💡 Example: Aluminum production is highly carbon-intensive due to the electricity required in smelting, whereas recycled aluminum has a 95% lower footprint.

2. Manufacturing & Production

- Energy use in factories (electricity, fuel, heat).
- Chemical reactions in production that generate emissions (e.g., cement and steel manufacturing).
- Waste generated in production that leads to emissions.

💡 Example: Cement production releases CO₂ as a direct byproduct of its chemical reaction, making it a major industrial emissions source.

3. Transportation & Logistics

- Emissions from shipping raw materials to factories and transporting finished goods to customers.
- Transport mode matters—air freight has a much higher footprint than sea or rail transport.

💡 Example: A global fashion brand reducing its PCF by shifting from air freight to sea shipping, cutting transport-related emissions by 40%.

4. Product Usage Phase

- Some products continue to emit CO₂ when they are being used (e.g., appliances, electronics, vehicles).
- Design improvements can lower emissions during usage.

💡 Example: A washing machine with energy-efficient motors reduces electricity consumption, leading to a lower lifetime PCF.

5. End-of-Life Disposal

- Emissions from waste processing, incineration, landfill degradation, or recycling.
- Products designed for recyclability tend to have a lower PCF over multiple life cycles.

💡 Example: A plastic bottle made from biodegradable materials has a lower end-of-life impact compared to one that ends up in a landfill.

📌 Key Takeaway:
Every product has different high-impact areas—for electronics, it's the use phase; for packaging, it's material sourcing and disposal.

2.3 PCF Calculation Methodology

To calculate PCF, businesses need two main types of data:

1. Activity Data – "How much?"

- Real-world measurements like energy consumed, distance transported, or material used.

💡 Example: A factory consumes 10,000 kWh of electricity per month—this is activity data.

2. Emission Factors – "How polluting?"

- Standardized values that show how much CO₂ is emitted per unit of activity.
- Example: Electricity from coal has a much higher emission factor than electricity from wind power.

📌 Basic PCF Calculation Formula:

$$\text{PCF} = \sum (\text{Activity Data} \times \text{Emission Factor})$$

💡 Example Calculation:
A company produces 1 kg of plastic packaging.

- Raw Material Emissions: 5 kg CO₂e
- Manufacturing Emissions: 2 kg CO₂e
- Transport Emissions: 1 kg CO₂e
- End-of-Life Emissions: 2 kg CO₂e

Total PCF = 5 + 2 + 1 + 2 = 10 kg CO₂e per kg of product

📌 Key Considerations:

- Primary data is preferred (actual company data) over secondary data (industry averages).
- Region-specific emission factors improve accuracy.

Key Takeaways from PCF Calculation

1. Setting clear system boundaries is crucial—Cradle-to-Gate, Cradle-to-Grave, or Cradle-to-Cradle.
2. PCF comes from multiple sources, with raw materials, manufacturing, and transport often being the biggest contributors.
3. Reliable activity data and accurate emission factors are key to a trustworthy PCF calculation.



Guidelines

Guidelines for Effective PCF Management

Reduce PCF with sustainable materials, energy efficiency, green supply chains, and circular economy models.

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Once a company calculates the Product Carbon Footprint (PCF) of its products, the next step is taking action to reduce emissions. Managing PCF effectively requires looking at the entire product life cycle, from raw material sourcing to production, transportation, product use, and disposal.

This section provides a detailed roadmap for reducing emissions and creating low-carbon, sustainable products that benefit both businesses and the environment.

3.1 Strategies to Reduce PCF Across the Product Life Cycle

Every product has a life cycle, and each stage presents different opportunities to cut emissions. By making strategic choices at each step, businesses can significantly lower their carbon footprint without sacrificing quality or profitability.

1. Choosing Sustainable Raw Materials

The type of materials used in a product has a huge impact on its carbon footprint. Extracting and processing raw materials often accounts for a large portion of total emissions.

How to Reduce Emissions from Raw Materials

Use Recycled or Bio-Based Materials

- Recycled materials require less energy to process than virgin materials.
- Bio-based materials (such as plant-based plastics) store carbon rather than emit it.

Source Materials Locally

- Transporting materials over long distances adds significant carbon emissions.
- Switching to local suppliers reduces emissions while improving supply chain reliability.

Engage with Sustainable Suppliers

- Work with suppliers that use renewable energy and have their own carbon reduction strategies.

Design for Material Efficiency

- Reducing material waste during manufacturing lowers emissions and costs.

2. Improving Energy Efficiency in Manufacturing

Factories and production facilities consume large amounts of energy, and much of this comes from fossil fuels. Transitioning to cleaner energy sources and improving efficiency can dramatically cut emissions.

How to Lower Manufacturing Emissions:

- **Switch to Renewable Energy**
 - Installing solar panels, wind turbines, or hydroelectric power can drastically reduce emissions.



- **Upgrade to Energy-Efficient Machinery**
 - Investing in modern, high-efficiency equipment reduces electricity consumption..
- **Optimize Production Processes**
 - Implementing lean manufacturing reduces waste and energy consumption.
- **Use Smart Energy Management Systems**
 - AI-driven energy tracking systems can identify inefficiencies and suggest optimizations.

3. Optimizing Supply Chain and Transportation

Transportation is one of the biggest contributors to Scope 3 emissions in a product's carbon footprint. Companies can cut emissions by reworking their logistics strategy.

Ways to Reduce Transportation Emissions:

- **Shift from Air Freight to Sea or Rail Transport**
 - Air freight has a much higher carbon footprint compared to sea or rail transport.
- **Optimize Supply Chain Routes**
 - Redesigning delivery routes minimizes fuel consumption and carbon impact.
- **Invest in Low-Carbon Vehicles**
 - Switching to electric or hydrogen-powered trucks reduces transport emissions.

- **Consolidate Shipments**
 - Combining shipments into full truckloads or cargo loads avoids empty space and wasted fuel.

4. Reducing Carbon Footprint in Product Use Phase

For some products, most emissions occur during use—for example, electronics, home appliances, and vehicles consume energy throughout their lifetime.

How to Lower Product Use Emissions:

- **Improve Energy Efficiency in Design**
 - Products that consume less electricity, fuel, or resources during use have a smaller carbon footprint.
- **Encourage Sustainable Usage**
 - Educating customers on how to use products more efficiently can help.



5. Designing for Circular Economy & End-of-Life Management

What happens when a product reaches the end of its life? Sustainable design can extend product lifespans and reduce waste.

How to Design for Sustainability:

- **Use Easily Recyclable Materials**
 - Products should be easy to disassemble so materials can be recovered and reused.
- **Offer Take-Back and Recycling Programs**
 - Companies can encourage customers to return old products for recycling rather than sending them to landfills.
- **Reduce Packaging Waste**
 - Avoid excess packaging and switch to compostable or recycled materials.

3.2 Industry Best Practices and Case Studies

Companies across industries are making major progress in **PCF reduction**:

- **Steel Industry:** ArcelorMittal is using **hydrogen-powered steel production** to replace coal.
- **Tech Industry:** Microsoft has committed to **being carbon negative by 2030**, removing more carbon than it emits.
- **Retail Industry:** H&M is designing **clothes for circular fashion**, allowing customers to recycle old garments.

3.3 Regulatory and Market Expectations

Governments and investors are increasingly pushing for **carbon transparency and reduction**.

- The **EU Carbon Border Adjustment Mechanism (CBAM)** requires companies exporting to Europe to report product carbon footprints.
- The **SEC Climate Regulations** in the U.S. now mandate carbon disclosures, including Scope 3 emissions.
- India's **BRSR framework** is encouraging businesses to measure and report their PCF.

Beyond regulations, **investors and consumers are rewarding companies that take carbon reduction seriously**.

Key Takeaways from PCF Management

- Every stage of the product life cycle offers opportunities to reduce carbon emissions.
- Companies that implement sustainable materials, energy efficiency, low-carbon transport, and circular economy strategies can significantly lower their PCF.
- Regulatory pressure is increasing, making PCF reduction a business necessity.
- Businesses that prioritize carbon reduction gain a market advantage, reduce costs, and future-proof their operations.



4. Conclusion and Call to Action

Sustainability is no longer just a buzzword—it's a business imperative. The Product Carbon Footprint (PCF) plays a crucial role in helping businesses understand their environmental impact, comply with evolving regulations, and build a competitive edge in a carbon-conscious market.

This handbook has walked through what PCF is, how to calculate it, and how to reduce it effectively. Now, let's look at the future of PCF management, key takeaways, and the immediate steps businesses can take today.

4.1 The Future of PCF and Sustainability Trends

The push for **carbon reduction and transparency** is only going to accelerate in the coming years. Businesses that **act now** will be in a stronger position as global regulations tighten and sustainability expectations rise.

Emerging Innovations in PCF Management

1. AI and Digital Tools for Carbon Accounting

- More companies are using **AI-powered platforms** to track emissions in real-time, automate calculations, and find reduction opportunities.

2. Low-Carbon and Circular Economy Models

- Businesses are **rethinking product design** by using recycled materials, reducing waste, and shifting to circular economy models.

3. Carbon Capture and Offsetting Solutions

- While reduction remains the priority, **carbon capture technologies** and **verified offset programs** are becoming mainstream.

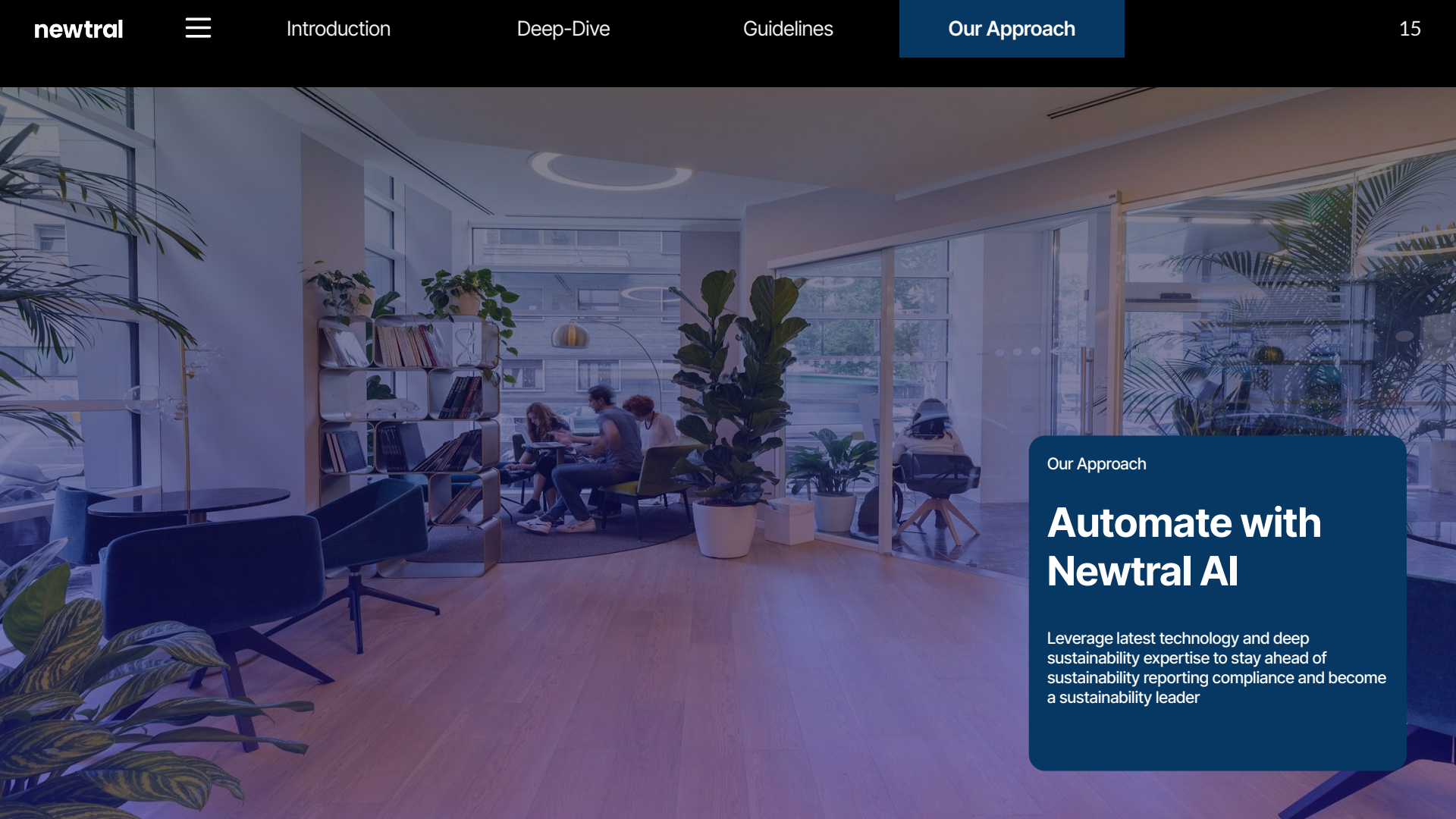
4. Stricter Regulations and Mandatory PCF Reporting

- Many countries are making **PCF disclosure mandatory** in sustainability reports.

These trends indicate that **businesses that integrate PCF tracking and reduction into their strategy today will be ahead of the curve** in the coming years.

4.2 Key Takeaways from This Handbook

- Understanding PCF:** A product's carbon footprint includes emissions from raw materials, production, transportation, usage, and disposal.
- PCF Calculation:** Accurate calculations require defining system boundaries, collecting reliable activity data, and using standardized emission factors.
- Reduction Strategies:** Businesses can lower PCF by choosing sustainable materials, improving energy efficiency, optimizing supply chains, and adopting circular economy principles.
- Industry Best Practices:** Leading companies across manufacturing, retail, tech, and logistics are already implementing low-carbon innovations.
- Regulations and Market Expectations:** Stronger regulatory frameworks, investor scrutiny, and consumer demand are making PCF management a business necessity.

A wide-angle photograph of a modern, bright office space. The room features large windows on the right side, letting in natural light. The floor is made of light-colored wood. In the center, there is a circular area with a rug where three people are sitting and working on laptops. To the left, there is a bookshelf filled with books and plants. In the foreground, there are several large potted plants, including a peace lily and a fiddle leaf fig. The overall atmosphere is clean, professional, and collaborative.

Our Approach

Automate with Newtral AI

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At Newtral, we understand the challenges businesses face in navigating the complex landscape of sustainability reporting and ESG integration. That's why we've developed a cutting-edge, AI-powered sustainability platform that streamlines your entire sustainability workflow, ensuring compliance, transparency, and value creation for all stakeholders.

Key Features and Benefits:

Automated Sustainability Workflow:

- Our AI-driven platform automates data collection, analysis, and reporting, saving time and resources
- Seamless integration with existing systems for efficient data management
- Ensures accuracy and consistency in sustainability reporting

Comprehensive Concierge Services:

- Dedicated sustainability experts to guide you through every step of your sustainability journey
- Tailored strategies and actionable insights based on your unique business needs
- Continuous support and expertise to help you achieve your sustainability goals

ESG Supply Chain Innovation:

- Advanced tools to assess and manage ESG risks and opportunities within your supply chain
- Collaborate with suppliers to improve sustainability performance and transparency
- Gain a competitive edge by demonstrating responsible supply chain practices

Scope 3 Emissions Management:

- Accurately measure and report your Scope 3 emissions with our AI-powered platform
- Identify hotspots and implement targeted reduction strategies
- Demonstrate leadership in addressing indirect emissions and climate change

Regulatory Compliance and Transparency:

- Stay ahead of evolving sustainability regulations and disclosure requirements
- Communicate your sustainability performance effectively to investors, customers, and other stakeholders
- Build trust and credibility through transparent and reliable sustainability reporting

Take the first step towards a more sustainable future with Newtral. Our AI-powered platform and expert concierge services provide the tools and guidance you need to integrate sustainability seamlessly into your business operations. Contact us today to schedule a demo and discover how Newtral can help you create lasting value for your stakeholders while contributing to a greener, more resilient world.



Newtral AI Platform- Enterprise ESG Platform for Corporates and Supply Chain

We help organizations automate their ESG metric measurements, tracking and reporting across company as well as their supply chain. Our platform solves for all corporate sustainability reporting and carbon accounting needs, visit [newtral.io](https://www.newtral.io) for more information.

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