

Carbon Management Guidelines for

Carbon Neutrality and Sustainable Development Targets

of Hong Kong and Mainland China

Strategic Toolkits for Hong Kong-invested Manufacturing Enterprises with Asia-Pacific Operations

August 2025 Edition

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Forewords

At this pivotal moment in the global industrial restructuring, carbon management has transformed from an optional choice to a mandatory requirement for businesses. The emergence of carbon trading markets across the Asia-Pacific, alongside international green investment trends, is profoundly reshaping the competitive landscape for manufacturing. With decades industrial development and innovation capabilities across the Asia-Pacific, Hong Kong manufacturers are positioned to lead this transformative wave.

The Federation of Hong Kong Industries (FHKI) has played a leading role in enabling SMEs to navigate environmental challenges. Since 2015, we have organised the annual BOCHK Corporate Low-Carbon Environmental Leadership Awards, recognising enterprises with outstanding sustainability performance. The program's steadily growing participation underscores the rising priority that industry now places on environmental issues and sustainable growth. In 2021, we established the Environmental, Social and Governance (ESG) Committee to further consolidate resources and strengthen industry engagement through seminars, workshops, and industry surveys, enhancing members' understanding of carbon mitigation policies and strategies. Last year, through the Hong Kong Q-Mark Council, we launched the Hong Kong Q-Carbon Certification Scheme and Hong Kong Q-ESG Certification Scheme, providing professional accreditation services to assist SMEs in establishing robust carbon and ESG management systems.

Hong Kong's manufacturers have built a comprehensive supply chain centred on Mainland China and extending across ASEAN. In this context, carbon management serves as a strategic opportunity to enhance corporate competitiveness in global markets. As a leading international financial and professional services centre, Hong Kong possesses a distinctive advantage in connecting global capital markets with green finance, providing comprehensive support for the green transformation of manufacturing. Through the synergy of finance, technology, and manufacturing, Hong Kong is poised to become a regional hub for green economic development, driving carbon neutrality across the Asia-Pacific.

We recognise that SMEs often face difficulties in understanding and complying with complex carbon regulations, particularly when engaging with diverse international markets and rules. The two volumes of *Carbon Management Guidelines* seek to bridge that gap. By integrating international standards, CBAM regulations of EU, and the practical needs of Hong Kong manufacturers, these guides unpack complex requirements into clear, actionable steps,

supplemented with case studies and industry insights. The guidelines provide SMEs with the knowledge and tools required to transition seamlessly to low-carbon operations, while maintaining operational efficiency and market competitiveness. We firmly believe that, in the context of the regional green transformation, establishing scientific and systematic carbon management practices early will gain a strategic advantage, reinforcing Hong Kong manufacturing's position in the global value chains.

FHKI remains steadfast in our commitment to walk alongside with industry, guiding manufacturers to navigate the challenges and capitalise on the opportunities of green transformation. Through these two *Carbon Management Guidelines*, we deliver decisive, actionable roadmap to Hong Kong manufacturers to not merely adapt, but thrive in the carbon-neutral era—powering forward our national carbon peaking and carbon neutrality ambitions, and driving transformative progress in global sustainable development.

Anthony Lam
FHKI Chairman

August 2025

In the face of escalating climatic challenges, Environmental, Social and Governance (ESG) issues are garnering unprecedented attention. Regulatory pressure on ESG is accelerating worldwide, particularly with the European Union's (EU) recent implementation of the Carbon Border Adjustment Mechanism (CBAM) and the imposition of carbon tariffs. As a highly open and export-oriented economy, Hong Kong manufacturers will inevitably face carbon regulatory challenges, implying that carbon management must become an integral part of corporate decision-making and daily operations for SMEs.

The Federation of Hong Kong Industries (FHKI) established the ESG Committee in 2021, dedicated to promoting industrial participation in achieving Hong Kong's goal of carbon neutrality by 2050. Through capacity building, knowledge exchange and ESG talent development, the Committee supports the industry sector in implementing effective ESG management. To strengthen the carbon management capabilities across the industry, and with the funding support from the Trade and Industry Department's Trade and Industrial Organisation Support Fund (TSF), we commissioned the Institute of Climate and Carbon Neutrality at the University of Hong Kong to launch the Project, "Facilitating ESG compliance in supply chain management for Hong Kong-invested manufacturing enterprises (HKMEs)". The Project includes hosting the APAC ESG Summit for SMEs, compiling two *Carbon Management Guidelines*, and developing an online carbon management platform to help businesses take practical actions in response to increasingly stringent regulatory requirements.

The two *Carbon Management Guidelines* are designed specifically for Hong Kong-funded manufacturing enterprises with production lines and supply chains operating across the Asia-Pacific region. Targeting the decision-makers, operational departments and green professionals, the *Guidelines* emphasise operability and practical application, providing the industry with step-by-step guidance. The *Carbon Management Guidelines for Carbon Neutrality and Sustainable Development Targets of Hong Kong and Mainland China* ("General Carbon Management Guidebook") focus on internal corporate management, introducing international standards and systems, and detailing how to establish and optimise carbon management systems, accurately capture carbon data, and implement emission reduction actions. The *Carbon Management Guidelines for EU Carbon Border Adjustment Mechanism (CBAM) Compliance* ("EU CBAM Guidebook"), on the other hand, focuses on analysing compliance and practices for the two major CBAM in-scope industries, iron and steel, and aluminium, addressing emissions calculation, data collection, reporting, and verification processes, illustrated with case studies. These complementary guides—the former emphasising internal capacity building and long-term transformation, the latter providing specialised analysis and strategies for CBAM—offer a systematic blueprint and action plan for the Hong Kong

manufacturers to establish comprehensive ESG management systems under the increasingly stringent international environmental requirements.

While tightening international carbon management trends present significant challenges for the manufacturing industry, early preparation for relevant regulations can transform these challenges into a competitive advantage. With these two *Carbon Management Guidelines*, FHKI aims to heighten industry vigilance toward international carbon regulations, empower enterprises to build robust carbon management systems ahead of competitors, transform regulatory challenges into strategic advantages and forge greener, more resilient supply chains—ultimately reinforcing Hong Kong manufacturing’s competitive edge in global markets.

Clara Chan

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August 2025

Chapter 1: Introduction

1.1. Purposes of this Guidebook: Providing a Practical and Actionable Roadmap

As the world transitions towards a low-carbon economy, carbon management has become a critical business imperative. Hong Kong Manufacturing Enterprises, especially SMEs which form the backbone of Hong Kong's manufacturing sector, must equip themselves with the knowledge and tools to navigate evolving regulations, enhance competitiveness, and drive sustainable growth. This guidebook is designed to serve as a practical and actionable roadmap for SMEs embarking on their carbon management journey to achieve the following objectives:

- **Support HKMEs in Carbon Management:** This guidebook provides actionable insights and practical steps to help HKMEs establish or enhance their carbon management systems. It assists companies in quantifying, monitoring, and reducing their carbon emissions, thereby aligning with global sustainability expectations and gaining a competitive advantage through eco-friendly operations.
- **Enhance Compliance with Existing and Future Carbon Regulations:** While focusing on carbon management, this guidebook also prepares HKMEs for existing and potential future regulations, such as the EU Carbon Border Adjustment Mechanism (CBAM). It offers strategies to manage and report carbon emissions accurately, ensuring that HKMEs are ready for any forthcoming compliance requirements.
- **Promote Carbon Neutrality and Sustainable Development:** By adopting the practices outlined here, HKMEs can play a role in achieving carbon neutrality targets not only in Hong Kong but also in Mainland China and the broader Asia-Pacific region. This contributes to global climate commitments, including the Paris Agreement, and positions HKMEs as leaders in sustainable manufacturing.

1.2. How this Guidebook was Compiled

This guidebook was developed through a comprehensive approach that combined literature reviews of global carbon measurement and reporting standards with deep-dive interviews and site visits to representative HKMEs. These activities helped us understand their baseline capabilities and identify technical gaps. We gathered additional feedback through meetings with diverse

manufacturing companies and stakeholders from industry associations and academia.

The case studies in this guidebook present fictional names but incorporate real examples from our interviews, accurately reflecting the challenges and opportunities facing HKMEs.

1.3. Target Audience of this Guidebook

The primary audience for this guidebook includes:

- **Companies in All Manufacturing Sectors:** This guidebook is relevant to all HKMEs, regardless of whether their sector is currently or soon to be regulated under carbon-related mechanisms. Manufacturers seeking to reduce their carbon emissions, improve sustainability, and prepare for future regulations will find this guide invaluable.
- **Supply Chain Partners and Stakeholders:** Beyond manufacturers, this guidebook is useful for suppliers, industry associations, and stakeholders who are interested in understanding the carbon implications on manufacturing processes and the broader impact on global trade.

This guidebook aims to empower all levels of HKMEs to take proactive steps towards carbon management, ensuring they remain competitive and sustainable in an ever-evolving global market.

1.4. How You Should Read this Guidebook

This comprehensive guidebook is structured to provide actionable insights and detailed guidance across its chapters. Below is an outline of its contents against the targeted audiences:

	Strategy: Top Management	Operation: Production, Supply Chain, R&D, IT	Expertise: Carbon / Energy / EHS / ESG Specialist(s)
Chapter 2: Mysteries and Key Questions about Carbon Management: Explains core concepts like "carbon footprint," CMS, verification, and global trends.	Read at least Sections 2.1, 2.2, and 2.4 to grasp the core concepts and megatrends.	Skimming is suggested to understand the basics.	Read all and be the champion within your organisation.
Chapter 3: Strategic Recommendations for Top Management: Provides guidance on strategy, decision-making biases, and criteria for carbon management.	Read all. This chapter is designed for you.	Skimming is suggested to understand the strategic thinking.	Read all to understand how to align technical proposals with management's decision-making process.
Chapter 4: Organisation Level Carbon Monitoring, Reporting and Verification: A step-by-step guide to setting up an organisational GHG inventory based on ISO 14064-1.	Skimming is suggested to understand the process.	Production, Supply Chain, and IT teams should read this chapter as they are key data providers and implementers.	Read all. This is your core technical guide.
Chapter 5: Strategy and Operation for Carbon Emissions Reduction: Covers practical reduction strategies using frameworks like ISO 14001, ISO 50001, and eco-design.	Skimming is suggested to understand the available reduction strategies.	Read all. This chapter provides practical strategies for your departments.	Read all to guide the implementation of reduction strategies.
Chapter 6: Roadmap for SMEs and Case Studies: Presents practical case studies on setting up a CMS, energy management, and supply chain decarbonisation.	Skimming at least one case study is suggested.	Read at least one case study relevant to your area to see practical application.	Read all to understand practical application and challenges.
Chapter 7: Lightweight Digital Solutions for Carbon Management in Manufacturing SMEs: Highlights the use of low-cost digital tools to streamline carbon management.	Skimming is suggested to understand the low-cost approach.	IT and Supply Chain teams should read this chapter to identify and implement practical digital tools.	Read this chapter to recommend and support the implementation of these tools.

Chapter 2: Mysteries and Key Questions about Carbon Management

There are several key questions and mysteries surrounding carbon management that SMEs often struggle with as they embark on their sustainability journey.

2.1 What is "Carbon" or "Carbon Footprint"?

Definition of "Carbon":

In the context of carbon and greenhouse gas (GHG) management, "carbon" typically refers to carbon dioxide (CO₂) emissions, as well as other GHGs like methane (CH₄), nitrous oxide (N₂O), and fluorinated gases. It includes direct emissions and indirect emissions:

- **Direct emissions** are those emitted from sources that are owned or controlled by the reporting entity, such as emissions from burning fuel in on-site machinery.
- **Indirect emissions**, on the other hand, are emissions that result from activities of the company but occur at sources owned or controlled by another entity, including those from use of electricity and other imported energy, and those from upstream and downstream activities. These indirect emissions are monitored because they represent a significant portion of a company's total carbon emissions and are crucial for a comprehensive emissions reduction strategy.

Note: Unless explicitly stated otherwise, the terms "Carbon" and "GHG" are intended to represent the same concept and may be used interchangeably.

Clarifying "Carbon Footprint":

The term "carbon footprint" can be misleading due to its varying interpretations. Depending on the context and purpose, it could refer to different reporting scopes and calculation methods.

In general, there are 4 quantification and reporting levels with the corresponding standards or regulations:

Quantification and Reporting Level	Commonly Used Standards or Prevailing Regulations (Examples)
Organisation level: Quantification and reporting of emissions from an entire organisation.	ISO 14064-1, GHG Protocol
Project or activity level: Emissions associated with specific projects or activities.	ISO 14064-2, The GHG Protocol for Project Accounting
Product level: Emissions over the product's lifecycle, known as Product Carbon Footprint (PCF).	ISO 14067, The Product Life Cycle Accounting and Reporting Standard
Specific Scope Subject to Regulations	EU ETS, EU CBAM, etc.

The monitoring scope, quantification methods for specific emission sources, data requirements, and other factors vary across these carbon emissions. Please refer to Section 2.2 for details of the relevant standards.

- Comparing the carbon emissions of an installation under the EU Emissions Trading System (ETS) with its competitor's total carbon emissions based on the GHG Protocol in its ESG report would lead to a misinterpretation due to different scopes and methodologies.
- Similarly, the Product Carbon Footprint of a product calculated based on ISO 14067 differs significantly from the Specific Embedded Emissions of that product under CBAM.

Call-out Box: We recommend using specific terms rather than "carbon footprint" to avoid confusion. Where "carbon footprint" is used, it should refer solely to "Product Carbon Footprint" based on ISO 14067 or similar Life Cycle Assessment (LCA) methodologies.

2.2 What is a "Carbon Management System"?

A **Carbon Management System (CMS)** is a set of guidelines and tools that help companies keep track of and reduce the greenhouse gases (GHGs) they produce. This definition is straightforward; however, there is currently no global management system standard specifically for carbon management. Instead, it is managed within the framework of the Environmental Management System (such as ISO 14001) and quantified and reported via dedicated greenhouse-gas accounting standards (such as ISO 14064-1).

Here's a simple explanation:

- **A System to Manage Emissions:** A CMS is like a roadmap that guides companies on how to measure, manage, and lower their carbon emissions using standards like **ISO 14064-1** (or GHG Protocol) for quantification and reporting. It gives you steps to follow, like:
 - Collecting information on where and how much GHGs your company is emitting.
 - Calculating the total emissions.
 - Setting goals to reduce these emissions.
- **Integration with Management Systems:** Since **ISO 14064-1** is only a standard for quantification and reporting, a CMS is often built upon and closely integrated with existing Environmental Management Systems (EMS) like ISO 14001 and Energy Management Systems (EnMS) like ISO 50001. This integration ensures that carbon management becomes part of your company's daily operations.
- **Continuous Improvement:** Just like improving any part of your business, a CMS helps you keep getting better at managing carbon. You:
 - Make a plan to reduce emissions.
 - Put that plan into action.
 - Check if it's working.
 - Adjust your plan if it's not.
- **Planning Ahead:** A CMS, guided by **ISO 14064-1** (or the **GHG Protocol**), helps you:
 - Find out where your company is making the most emissions.
 - Set realistic goals to reduce these emissions.
 - Come up with ways to meet these goals.

- Follow the rules set by governments or voluntary commitments.
- **Getting Everyone Involved:** It's not just about your company; it's about working with everyone from your employees to your suppliers and customers to reduce emissions together.
- **Keeping Records:** You need to keep good records of your emissions, what you're doing about them, and how well you're doing. This is important for:
 - Managing your business internally.
 - Reporting to others like investors or regulators.
 - Getting checked by outside auditors to make sure you're doing it right, in line with standards like **ISO 14064-1**.
- **Verification and Certification:** While not required, you can get an outside group to check your work using **ISO 14064-1** to ensure you're counting emissions correctly and that your reduction plans are working.
- **Why It's Good for Your Business:**
 - **Save Money:** By using energy and resources better, you can lower your costs.
 - **Good Reputation:** People and businesses like to work with companies that care about the environment.
 - **Stay Legal:** It helps you follow the rules and prepare for future carbon-related laws or taxes.
 - **Better Supply Chain:** It encourages your suppliers and customers to also reduce emissions, making the whole supply chain greener.
 - **Manage Risks:** It helps you plan for changes caused by climate change.

In short, a Carbon Management System, based on **ISO 14064-1** (or complemented by the **GHG Protocol**) for quantification, reporting and broader management strategies, is a practical way for companies to manage their carbon emissions. This guidebook will show SMEs how to set up or improve their CMS, leveraging these standards, to realise these benefits.

2.3 How Your Efforts and Achievements Could Be Recognised: Verification

Verification is the process that validates and confirms your company's carbon management efforts. Here's how they work and what they can achieve:

- **What it involves:** Verification is an independent assessment of your company's GHG emissions data, calculations, and reduction claims. It is typically conducted by an external, accredited verifier or auditor.
- **Based on Standards:** Verification can be done in accordance with:
 - **ISO 14064-3:** This standard provides guidelines for the verification and validation of GHG assertions. It ensures that the data and claims made by the organisation are accurate, complete, and consistent with the standards used for quantification.
 - **GHG Protocol:** Although not a verification standard itself, many companies use GHG Protocol alongside ISO 14064-3 to ensure their emissions data aligns with international best practices.
 - **Product Carbon Footprint (PCF):** Verification of PCF, based on **ISO 14067**, can confirm the carbon emissions associated with a product's lifecycle.
 - **Environmental Product Declaration (EPD):** Verification of EPDs provides a standardised way to communicate a product's environmental impacts. An EPD can include PCF as one of its environmental impact categories.
- **Results:** A verification report will:
 - Confirm the accuracy of your emissions data.
 - Validate your emissions reduction claims.
 - Identify any discrepancies or areas for improvement.
 - Provide a level of assurance (limited or reasonable) on the data's reliability.
- **Achievements:** Verification can help achieve:
 - **Credibility:** It enhances the credibility of your carbon management efforts by providing external validation.
 - **Regulatory Compliance:** Some regulations or voluntary programs might require verification to ensure compliance with emissions reporting.

- **Investor and Stakeholder Confidence:** Verified data can be more trustworthy for investors, customers, and other stakeholders.
- **Compliance with ETS and CBAM:** Verification is essential for compliance with Emission Trading Systems (ETS), such as the EU ETS, where accurate data is required for trading purposes, and for the Carbon Border Adjustment Mechanism (CBAM), where the carbon content of imported goods must be verified.

In summary, verification is the crucial steps in demonstrating the effectiveness and integrity of your carbon management system or product's environmental impact. By adhering to recognised standards like ISO 14064-1/ISO 14067, ISO 14068-1, your company can not only ensure compliance with regulatory or customer requirements but also gain a competitive edge in the market by showcasing your commitment to sustainability. This guidebook will delve into how SMEs can navigate these processes to maximise their benefits.

2.4 Megatrends: Is Carbon Compliance and Carbon Pricing Coming?

The global landscape for carbon management is rapidly evolving, driven by several megatrends that signal a shift towards mandatory carbon compliance and carbon pricing mechanisms:

- **Increased Environmental Awareness:** Public consciousness about climate change is at an all-time high. Consumers, investors, and stakeholders are increasingly demanding that companies take proactive steps to reduce their carbon emissions.
- **Regulatory Pressure:** Governments worldwide are stepping up their efforts to combat climate change:
 - **Emission Trading Systems (ETS):** Schemes, including the EU ETS and others, are expanding, with more countries and regions adopting cap-and-trade systems to limit carbon emissions.
 - **Carbon Taxes:** Some nations are implementing or considering carbon taxes to internalise the cost of carbon emissions, making polluters pay for their environmental impact.
 - **Carbon Border Adjustment Mechanism (CBAM):** The EU has introduced CBAM to prevent carbon leakage by imposing a carbon cost on imports from countries with less stringent climate policies. This initiative not only encourages more countries to consider implementing their own CBAM-like mechanisms, but

also leads more countries to build or expand their domestic ETS to avoid CBAM's additional costs.

- **Mandatory Reporting:** Regulations such as the **EU Battery Regulation** mandate companies to report on their carbon footprint, driving greater transparency in carbon emissions.
- **Corporate Initiatives:**
 - **Voluntary Carbon Markets:** Companies are voluntarily participating in carbon markets to offset their emissions and meet sustainability goals.
 - **SBTi (Science Based Targets initiative):** More companies are committing to science-based targets to reduce emissions in line with what the latest climate science deems necessary.
- **Technological Advancements:** Innovations in carbon capture and storage, renewable energy, and energy efficiency are making it easier and more cost-effective for companies to reduce their carbon emissions.
- **Investor Pressure:** Institutional investors are increasingly considering environmental, social, and governance (ESG) factors in their investment decisions, with a focus on carbon risk. This trend is driving companies to manage their carbon emissions more aggressively.
- **Supply Chain Requirements:** Large corporations are imposing carbon reduction requirements on their suppliers, creating a ripple effect throughout the supply chain, pushing SMEs to comply with carbon management standards.
- **Consumer Demand:** Eco-conscious consumers are choosing products and services based on their environmental impact, which can influence corporate behaviour towards reducing carbon emissions.

What this means for SMEs:

- **Compliance:** SMEs will likely face increasing regulatory requirements to report, manage, and reduce their carbon emissions. Compliance with these regulations will become a necessity to continue business operations and access markets.
- **Cost Implications:** Carbon pricing mechanisms, whether through taxes or trading, will add costs to carbon-intensive activities, incentivising SMEs to reduce emissions or invest in offsets.
- **Competitive Advantage:** Companies that proactively manage their carbon emissions can gain a competitive edge, attract eco-conscious

consumers, and secure investments from sustainability-focused investors.

- **Opportunities:** SMEs can find new business opportunities in carbon reduction technologies, renewable energy solutions, and by offering carbon management services to other businesses.

Carbon compliance and carbon pricing are not just emerging trends but are becoming integral components of the business landscape. SMEs should prepare for these changes by understanding the implications, adapting their business practices, and positioning themselves to benefit from the shift towards a low-carbon economy. This guidebook will provide practical steps for SMEs to navigate these megatrends effectively.

2.5 Introduction to Relevant Standards

For many companies esp. SMEs, managing carbon emissions can feel like a daunting task, but with the right standards in place, it becomes a structured and manageable process. These standards provide a common language, methodology, and framework that help in quantifying, reporting, and reducing your carbon emissions. By following these standards, companies can:

- **Improve Operational Efficiency:** Standards like ISO 9001, ISO 14001, and ISO 50001 help streamline processes, reduce waste, and optimise energy use, all of which contribute to lower carbon emissions.
- **Ensure Credibility and Transparency:** Standards like ISO 14064 and GHG Protocols provide a way to accurately measure and report your emissions, ensuring that your efforts are verifiable and credible to stakeholders.
- **Meet Regulatory Requirements:** Compliance with standards such as EU CBAM can be mandatory for companies in certain sectors accessing the EU market.
- **Set Ambitious Goals:** Initiatives like SBTi help set science-based targets, ensuring that your carbon reduction efforts align with global climate goals.
- **Communicate Environmental Impact:** Standards like ISO 14068-1 allow for clear communication of your organisation's carbon neutrality, appealing to eco-conscious consumers and investors.

Fundamental Carbon-Related Management Systems for Corporations:

- **ISO 9001: Quality Management System**

- **Objective:** Establishes a framework for improving quality and customer satisfaction through effective management systems.
- **Relevance to Carbon Management:** While not explicitly about carbon in current version, ISO 9001 provides a structured approach for managing processes, which can include carbon management practices. It encourages continuous improvement, which can be applied to reducing carbon emissions. **It is worth noting that ISO 9001 is reportedly slated for a 2026 revision to include climate-change response in the standard, requiring organisations to assess climate-related risks and their impacts.**

- **ISO 14001: Environmental Management System**

- **Objective:** Focuses on improving environmental performance through a systematic approach to environmental management.
- **Relevance to Carbon Management:** ISO 14001 sets out requirements for an environmental management system that can encompass carbon management. It promotes the identification of significant environmental aspects, including GHG emissions, and drives companies to set and achieve environmental objectives.

- **ISO 50001: Energy Management System**

- **Objective:** Provides a framework for establishing systems and processes necessary to improve energy performance, including energy efficiency, use, and consumption.
- **Relevance to Carbon Management:** By managing energy more efficiently, companies can significantly reduce their carbon emissions. ISO 50001 helps organisations establish a policy for energy efficiency, identify significant energy uses, and set targets for improvement.

Fundamental Standards for Carbon Quantification, Reporting, and Compliance:

- **ISO 14064-1 and GHG Protocols: Quantification, Verification, and Reporting**
 - **ISO 14064-1:** Specifies principles and requirements for quantifying and reporting GHG emissions and removals at the organisational level. It provides guidance on how to report GHG emissions to stakeholders.
 - **GHG Protocols:** Developed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD), these protocols offer guidance for accounting and reporting GHG emissions. Many companies use the GHG Protocol to supplement ISO 14064-1 because it offers detailed guidance on Scope 3 emissions.
- **ISO 14064-2: Project-Level GHG Quantification and Monitoring**
 - **Objective:** Provides guidance for quantifying, monitoring, and reporting GHG emissions reductions or removals at the project level.
 - **Relevance to Carbon Management:** This standard is crucial for companies involved in carbon offsetting projects or those seeking to demonstrate emissions reductions from specific initiatives.
- **ISO 14067: Product Carbon Footprint**
 - **Objective:** Provides a framework for quantifying and communicating the carbon footprint of products, including goods and services.
 - **Relevance to Carbon Management:** ISO 14067 enables companies to assess the carbon impact of their specific products across their lifecycle, from raw material extraction to disposal or recycling. This can inform product design, supply chain management, and consumer communication.
- **PAS 2060 and ISO 14068: Carbon Neutrality**
 - **PAS 2060 / ISO 14068:** Specification for the demonstration of carbon neutrality, providing requirements for quantifying, reducing, achieving and demonstrating carbon neutrality.

- **Relevance to Carbon Management:** These standards guide organisations in offsetting their carbon emissions, ensuring that claims of carbon neutrality are credible and verifiable.
- **Emission Trading Systems (using EU ETS as an example)**
 - **EU ETS:** The world's first major carbon market, it sets a cap on the total amount of certain GHGs that can be emitted by installations covered by the system. Companies receive or purchase emission allowances, which they can trade if they reduce emissions below their cap.
 - **Relevance to Carbon Management:** ETS encourages companies to reduce emissions cost-effectively, as it incentivises investment in cleaner technologies or carbon offsetting.
- **Carbon Border Adjustment Mechanism (using EU CBAM as an example)**
 - **EU CBAM:** A policy to prevent carbon leakage by imposing a carbon cost on imports from countries with less stringent climate policies. It aims to ensure a level playing field for EU industries and encourage global carbon pricing.
 - **Relevance to Carbon Management:** CBAM pushes companies to consider the carbon intensity of their global supply chains, encouraging both domestic and international companies to reduce emissions.
- **Science Based Targets initiative (SBTi)**
 - **Objective:** An internal initiative that drives companies to set ambitious targets to reduce GHG emissions in line with the latest climate science.
 - **Relevance to Carbon Management:** SBTi provides a framework for companies to align their emissions reduction efforts with the Paris Agreement's goals, ensuring that carbon management strategies are science-based and contribute to global climate efforts.

In conclusion, these standards and systems provide a robust framework for SMEs to manage, quantify, report, and reduce their carbon emissions. Adhering to these standards can help companies achieve compliance, gain competitive advantages, and contribute to global efforts to combat climate change. This guidebook will delve into how SMEs can implement these standards effectively in their operations.

Chapter 3: Strategic Recommendations for Top Management

5.1 Keys to Carbon Management: A Summary of Chapter 2

Navigating Carbon Management for HKMEs:

- **Standards and Compliance:** Carbon management involves adhering to various standards like ISO 9001, ISO 14001, ISO 50001, ISO 14064, ISO 14067, and others. These standards provide a structured approach for quantifying, reporting, and reducing emissions, ensuring that your carbon management efforts are credible and transparent.
- **Verification and Credibility:** Verification involves assessing the accuracy of GHG data to ensure that your carbon management efforts are credible and reliable. It's about confirming that the emissions data you report is accurate, complete, and consistent with recognised standards like ISO 14064-1.
- **Megatrends:** Carbon compliance and pricing mechanisms are on the rise, driven by environmental awareness, regulatory pressures like ETS and CBAM, global agreements, and investor and consumer demands. SMEs need to anticipate these trends and prepare for compliance to maintain market access and competitiveness.

Implementation Tips for Top Management and Departments:

- **Integration:** Integrate carbon management into existing management systems. For example, quality management (ISO 9001) can be adapted to include carbon metrics, ensuring that carbon reduction becomes part of the continuous improvement process.
- **Cross-Departmental Collaboration:** Carbon management should not be siloed. Engage various departments including operations, procurement, product development, and marketing, to ensure a holistic approach. For instance, procurement can focus on sourcing low-carbon materials, while marketing can communicate your sustainability efforts effectively.
- **Training and Awareness:** Educate staff on the importance of carbon management. Use practical examples to illustrate how their daily activities impact carbon emissions, encouraging them to contribute to reduction efforts.

- **Data Management:** Establish robust data collection systems to track emissions accurately. This might involve implementing software solutions or working with external consultants to ensure data integrity.
- **Engagement with Stakeholders:** Regularly communicate your carbon management strategy, progress, and achievements to stakeholders, including employees, suppliers, customers, investors, and regulators, to build trust and credibility.

5.2 Common Biases in Carbon or Sustainability Related Decision-Making

When forming carbon management strategies, top management often encounters biases that can skew decision-making:

- **Short-termism:** Focusing on immediate financial returns rather than long-term sustainability benefits.

Example: A company decides against investing in energy-efficient lighting for their warehouses because the initial investment is high, despite the long-term savings in energy costs and reduced carbon emissions.

- **Overconfidence Bias:** Believing that current efforts are sufficient or that future regulations will be less stringent than anticipated.

Example: A management team believes that their current emissions reduction efforts are already "best in class" and dismisses the need for further improvements, despite evidence that competitors are making more significant strides.

- **Confirmation Bias:** Seeking information that confirms existing beliefs or strategies while ignoring data that contradicts them.

Example: A company's leadership team seeks out research that supports their current approach to carbon compliance with minimum resources deployed, ignoring intelligences that suggest disruptive policy changes have been on the way.

- **Risk Aversion:** Being overly cautious about investing in new technologies or practices due to perceived risks or uncertainties.

Example: A business decides not to invest in renewable energy sources like solar panels due to concerns about the technology's reliability, even though the long-term benefits could significantly reduce their carbon emissions and energy costs.

- **Groupthink:** Conforming to a consensus within the management team, leading to suboptimal decisions regarding sustainability.

Example: During a management meeting, one executive suggests that their industry is not significantly impacted by carbon regulations, and everyone quickly agrees without critically evaluating the statement or exploring alternative views, leading to a consensus that might not reflect the reality of regulatory trends.

Summary: To overcome these biases and make informed decisions, it's essential for top management to consider appropriate criteria and follow a structured decision-making process.

5.3 Criteria for Carbon Management Strategy and Examples

Internal Criteria:

- **Cost-Benefit Analysis:**
Sector Example (Chemical Products): Investing in electrified production equipment might have high initial costs but can lead to long-term savings in fuel costs and compliance with future emissions regulations.
- **Operational Efficiency:**
Sector Example (Iron and Steel): Implementing energy-efficient machinery can reduce energy consumption, thereby reducing carbon emissions and operational costs.
- **Corporate Culture and Employee Engagement:**
Sector Example (Electronic Products): Encouraging Reuse and Recycle initiatives to reduce waste can foster a culture of sustainability and employee involvement.

In practice, these criteria are not evaluated in isolation but are woven together to form a cohesive strategic narrative.

Consider a mid-sized manufacturing firm evaluating a significant capital investment: upgrading its primary production line to a newer, more energy-efficient model. The **internal criteria** immediately come into play. The finance department conducts a **Cost-Benefit Analysis**, weighing the high upfront cost against projected long-term savings from reduced energy consumption and lower maintenance needs. Simultaneously, the operations team assesses the impact on **Operational Efficiency**, noting that the new line could increase output by 15% while cutting energy use per unit by 30%. This decision also touches on **Corporate Culture**; the investment signals a commitment to modernity and sustainability, which can boost employee morale and attract new talent, though it may also require retraining programs, which must be factored into the overall plan.

However, the decision cannot be made solely on internal metrics. The

External Criteria:

- **Regulatory Compliance and Anticipation:**
Sector Example (Aluminium): Anticipating and preparing for carbon pricing mechanisms like ETS or CBAM can mitigate financial risks and compliance issues.
- **Market Demand and Consumer Preferences:**
Sector Example (Fashion): Brands that adopt sustainable practices can attract eco-conscious consumers, potentially gaining market share.
- **Investor and Stakeholder Expectations:**
Sector Example (Tech): Tech companies are increasingly expected to report on carbon emissions, influencing investment decisions and attracting ESG-focused investors.
- **Innovation and Competitive Advantage:**
Sector Example (Food Products): Developing and promoting carbon-smart farming practices can not only reduce emissions but also position the company as a leader in sustainable food products.

management team must also layer on the **external criteria**. They recognise that **Regulatory Compliance** is a moving target; while their current operations meet today's standards, anticipating stricter emissions caps or a potential carbon tax in the next five years makes the investment a prudent risk-mitigation strategy. Furthermore, their largest customers—major international brands—are increasingly scrutinising their suppliers' environmental performance as part of their own Scope 3 emissions targets. This direct **Market Demand** makes the upgrade a matter of maintaining key business relationships. This is reinforced by **Investor and Stakeholder Expectations**, as the firm seeks to attract capital from ESG-focused funds. By making this investment, the company not only improves its internal efficiency but also creates a powerful **Innovation and Competitive Advantage**, allowing it to market itself as a forward-thinking, sustainable partner in a crowded global marketplace.

Ultimately, the most strategic initiatives are those that satisfy a blend of both internal and external criteria. The production line upgrade ceases to be just an operational or financial decision; it becomes a strategic imperative. It aligns cost-saving and efficiency goals with the external pressures of regulation, customer demands, and investor scrutiny. By systematically applying these criteria, top management can move beyond a simple cost-based analysis and make a holistic decision that strengthens the company's financial, operational, and market position for the long term. This comprehensive evaluation process is what transforms carbon management from a compliance burden into a strategic opportunity.

5.4 Decision-Making Process with Rating System

To counter the common decision-making biases and navigate the complexities of carbon management, a formal, structured process is not just helpful—it is essential. Such a framework moves the organisation beyond reactive, ad-hoc initiatives and towards a proactive, coherent strategy.

The following step-by-step process, which incorporates a rating system, is designed to provide this structure. It ensures that decisions are objective, transparent, and defensible, grounded in predefined criteria rather than intuition or internal politics. By systematically evaluating options and aligning them with both internal goals and external pressures, this process transforms broad strategic ambitions into a prioritised, actionable roadmap for resource allocation and implementation.

Step-by-Step Process:

1. **Assessment:** Conduct organisation and/or product-level carbon assessments using recognised standards.
2. **Criteria Definition:** Define internal and external criteria based on the company's context, sector, and strategic goals.
3. **Strategic Options Identification:**
 - **Short-term actions** to get quick wins in carbon reduction.
 - **Medium-term plans** to implement systemic changes.
 - **Long-term approaches** to shift towards low-carbon business models.
4. **Rating System:**
 - **Stakeholder Input:** Use surveys or workshops to gather input from stakeholders on each criterion.
 - **Specialist Judgments:** Engage experts to rate initiatives based on technical feasibility, impact, and cost-effectiveness.
 - **Scoring:** Assign scores to each initiative based on:
 - **Feasibility (1-5)**
 - **Impact on Emissions Reduction (1-5)**
 - **Cost-Benefit Ratio (1-5)**
 - **Alignment with Stakeholder Expectations (1-5)**
 - **Regulatory Compliance (1-5)**
 - **Innovation Potential (1-5)**

5. **Prioritisation:** Rank initiatives based on their total score, ensuring a balance between different criteria.
6. **Resource Allocation:** Allocate resources according to the prioritised initiatives, considering financial, human, and technological needs.
7. **Monitoring and Reporting:** Establish mechanisms for ongoing monitoring and transparent reporting of progress.
8. **Continuous Improvement:** Regularly review and update strategies based on new data, technology, and regulatory changes.
9. **Stakeholder Communication:** Develop a communication plan to keep stakeholders informed about your carbon management strategy, progress, and impacts.

By following this structured decision-making process with a rating system, SMEs can make more informed, balanced, and forward-looking decisions regarding carbon management, reducing the impact of biases and ensuring a strategic approach that aligns with both internal goals and external expectations.

Chapter 4: Organisation Level Carbon Monitoring, Reporting and Verification

Carbon emissions Monitoring, Reporting and Verification (MRV) at the organisational level is essential for companies to understand and manage their impact on the environment, comply with emerging regulations, and meet stakeholder expectations.

This chapter provides a structured approach to carbon quantification, following the logic and content of ISO 14064-1, with additional guidance from the GHG Protocol for Scope 3 emissions.

5.1 Establishing Management Commitment and Organisational Setup

Management Meeting:

- **Purpose:** To discuss the significance of carbon management within the organisation, establish clear objectives, and gain top management's commitment.
 - **Agenda:**
 - Review of current environmental impact and regulatory landscape.
 - Discussion on the benefits of carbon management (e.g., cost savings, regulatory compliance, competitive advantage, brand enhancement).
 - Setting strategic goals for carbon reduction.
 - Commitment to resource allocation and support from leadership.
- **Commitment:** Ensure that the top management:
 - Understands the necessity of carbon management.
 - Commits to integrating carbon management into the company's strategy.
 - Agrees to allocate necessary resources (financial, human, technological) for carbon quantification and reduction efforts.

Carbon Management Team:

- **Team Formation:**
 - **Composition:** Include members from various departments such as production, R&D, supply chain / procurement, finance, marketing, and sustainability / ESG / EHS, ensuring a holistic approach to carbon management.
 - **Roles:**
 - **Carbon Management Coordinator:** Oversees the entire carbon management process.
 - **Data Collectors:** Responsible for gathering and organising emissions data.
 - **Reporting Officer:** Prepares reports and ensures transparency in carbon reporting.
 - **Sustainability Champions:** Act as ambassadors for sustainability within their departments.
- **Roles and Responsibilities:** Clearly define the responsibilities of each team member to ensure accountability and efficiency in executing carbon management strategies.

Integration into Organisational Structure:

- **Policy Development:**
 - Develop or revise the company's environmental policy to explicitly include carbon management objectives, aligning it with ISO 14001 if applicable.
 - Incorporate carbon management into the company's broader sustainability strategy.
- **Communication Strategy:**
 - **Internal Communication:** Ensure that all employees understand the company's commitment to carbon management. Use internal channels like newsletters, intranet, and meetings to disseminate information.
 - **Training and Awareness:** Conduct training sessions to educate staff on carbon management practices, their roles, and how they can contribute to the company's goals.

- **Incentives and Recognition:**
 - Establish programs to recognise and reward departments or individuals who contribute significantly to carbon reduction efforts, fostering a culture of sustainability.
- **Monitoring and Review:**
 - Set up regular review meetings to assess progress against carbon reduction targets, allowing for adjustments in strategy or resource allocation.

By establishing a strong management commitment and setting up a dedicated organisational structure for carbon management, SMEs can ensure that their efforts are not only initiated but also sustained and integrated into the fabric of the organisation. This foundational step is crucial for successful carbon quantification, reporting, and reduction activities.

5.2 Setting the Organisational Boundaries

There are two primary methods for setting organisational boundaries for carbon emissions: **Operational Control** and **Financial Control**. These methods help define which emissions should be included in a company's carbon inventory, ensuring a clear and consistent approach to carbon quantification.

Operational Control:

- **Definition:** Emissions are accounted for if the company has the authority to introduce and implement its operating policies at the facility or operation.
- **Example:** A manufacturing company might own and operate its production lines, warehouses, and company vehicles, making these operations under its control.

Financial Control:

- **Definition:** Emissions are accounted for if the company has the financial power to direct the operating policies of an operation with a view to gaining economic benefits from its activities.
- **Example:** A company that fully owns a subsidiary company would account for 100% of the emissions from that subsidiary.

Steps to Set Organisational Boundaries:

1. **Identify Operations:** List all operations, facilities, and activities that fall under the company's control or ownership.
2. **Choose Consolidation Approach:** Decide on either:
 - **Operational Control:** Include all emissions from operations where the company has control.
 - **Financial Control:** Include emissions from operations where the company has financial control.
3. **Document Justification:** Provide rationale for the chosen boundaries:
 - **Common Rationale for Choosing Operational Control:** Chosen because it aligns with how the company manages its operations, ensuring all emissions from activities under the company's direct influence are accounted for.
 - **Common Rationale for Choosing Financial Control:** Selected to reflect the company's financial interests, particularly useful for companies with complex ownership structures or joint ventures.

Remark: *A company can choose either **Operational Control** or **Financial Control** for a particular report, but not both simultaneously. For transparency and consistency, once a method is chosen, it should be applied consistently over time unless there are significant changes in the company's structure or operations.*

By setting clear organisational boundaries, SMEs can accurately quantify their carbon emissions, ensuring that their carbon management efforts are comprehensive, transparent, and aligned with standards like ISO 14064-1. This step is fundamental in establishing a baseline from which carbon reduction strategies can be developed and measured.

5.3 Identifying GHG Emissions Sources

Quantifying carbon emissions involves identifying and categorising all sources of greenhouse gas (GHG) emissions associated with the organisation's operations. Here are the key scopes of emissions:

Direct Emissions (Scope 1 Emissions):

- **Definition:** Direct GHG emissions from sources that are owned or controlled by the company.

- **Examples:**

- **Stationary Combustion:** Emissions from burning fuels in boilers, furnaces, or turbines for heating, cooling, or electricity generation.
- **Mobile Combustion:** Emissions from company-owned or controlled vehicles (e.g., cars, trucks, forklifts).
- **Fugitive Emissions:** Leaks from equipment like refrigerants, natural gas, or industrial gases.
- **Process Emissions:** Emissions from chemical reactions or physical processes within the company's operations (e.g., cement production, chemical manufacturing).
- **Direct emissions from Land Use, Land-Use Change and Forestry (LULUCF):** emissions arising from a change in land-use category or internal land-management practices that reduce carbon stocks in carbon pools (including living biomass, soil organic carbon, etc.) or emit N₂O, as well as the associated CO₂ releases (with alternative quantification methodologies selectable over a 20-year time horizon).

Indirect Emissions from Uses of Imported Energy (Scope 2 Emissions):

- **Definition:** Indirect GHG emissions from uses of purchased / imported electricity, heat, or steam.
- **Examples:**
 - **Electricity Purchases / Imported:** Emissions associated with the generation of electricity bought from the grid.
 - **Heat and Steam Purchases / Imported:** Emissions from external sources providing heat or steam to the company.

Other Indirect Emissions (Scope 3 Emissions):

- **Definition:** Other indirect emissions that occur in the value chain of the company, including both upstream and downstream activities.
- **Categories** (as per GHG Protocol):
 - **Purchased Goods and Services:** Emissions from the production of products and services purchased by the company.
 - **Capital Goods:** Emissions associated with the production of capital goods like machinery and equipment.

- **Fuel and Energy Related Activities:** Upstream emissions from extraction, production, and transportation of fuels and energy.
- **Upstream Transportation and Distribution:** Emissions from transportation and distribution of purchased products.
- **Waste Generated in Operations:** Emissions from the disposal and treatment of waste generated by the company's operations.
- **Business Travel:** Emissions from employee travel for business purposes.
- **Employee Commuting:** Emissions from employees commuting to and from work.
- **Upstream Leased Assets:** Emissions from leased assets not included in Scope 1 or 2.
- **Downstream Transportation and Distribution:** Emissions from transportation and distribution of sold products.
- **Processing of Sold Products:** Emissions from processing of products by third parties.
- **Use of Sold Products:** Emissions from the use phase of sold products.
- **End-of-Life Treatment of Sold Products:** Emissions from disposal or recycling of sold products.
- **Downstream Leased Assets:** Emissions from assets leased to other entities.
- **Franchises:** Emissions from franchise operations.
- **Investments:** Emissions from investments not included in Scope 1 or 2.

Steps to Identify Emissions Sources:

1. **Operation Review:** Conduct a review / audit exercise on all company operations to identify potential emission sources.
2. **Data Collection:** Gather data on fuel usage, energy consumption, travel, waste generation, and product lifecycle.
3. **Categorisation:** Classify each source into the appropriate scope (1, 2, or 3) based on control and ownership.

4. **Prioritisation:** Identify which sources contribute most significantly to the company's carbon emissions for focused reduction efforts.
5. **Documentation:** Keep detailed records of emissions sources, including descriptions, quantities, and GHG types.

By thoroughly identifying and categorising GHG emissions sources, companies can establish a comprehensive baseline for their carbon inventory, which is crucial for developing effective carbon reduction strategies and for transparent reporting in line with standards like ISO 14064-1 and the GHG Protocol.

5.4 Collecting Data for Emissions Quantification

Accurate data collection is the cornerstone of effective carbon quantification. Here's how companies can approach this critical step:

Data Sources and Collection Methods:

Scope 1 Emissions (Direct Emissions):

- **Utility Bills*:**
 - **Electricity Generation:** If a manufacturing company generates its own electricity (e.g., through diesel generators), utility bills or meter readings will provide data on fuel consumption for this activity.
 - **Natural Gas:** For heating or as a raw material, natural gas consumption can be tracked through utility bills.
- **Fuel Receipts*:**
 - **Fuel for Vehicles:** Collect receipts for fuel used in company-owned vehicles or machinery used in manufacturing processes.
 - **Stationary Combustion:** Records of fuel purchases for boilers, furnaces, or any combustion equipment not linked to utility bills.

** In practice, companies typically retain bills, invoices, and on-site meter readings (including online system data). When multiple record types coexist, meter readings (i.e. actual usage data) should be taken as authoritative, since billing or invoicing periods may not align exactly with actual usage periods, leading to discrepancies. Furthermore, cross-checking meter readings against bill/invoice data can further verify accuracy and consistency.*

- **Direct Link:** If the company has a direct link to an energy supplier (like a gas pipeline), meter readings or contractual agreements can provide precise data on energy consumption.
- **Fugitive Emissions:**
 - **Refrigerants:** Track the purchase and disposal records of refrigerants used in cooling systems or air conditioning units to estimate fugitive emissions.
- **Process Emissions:**
 - **Manufacturing Processes:** Monitor and record emissions from specific processes like cement production, chemical reactions, or metal smelting.

Scope 2 Emissions (Indirect Emissions from Imported Energy):

- **Electricity Purchases:**
 - **Utility Bills:** Collect electricity bills to quantify emissions associated with the purchased electricity.
 - **Power Purchase Agreements (PPA):** If the company has a PPA for renewable energy, emissions can be calculated based on the energy provided under the agreement, often resulting in lower or zero emissions.
- **Heat and Steam Purchases:**
 - **Contracts and Invoices:** Data from contracts or invoices with external providers of heat or steam will be necessary to calculate associated emissions.

Scope 3 Emissions (Other Indirect Emissions):

Please refer to Section 4.5 which specifies details of Scope 3 Emissions and data collection.

Steps for Data Collection:

1. **Define Data Needs:** Determine what data is required for each emissions source identified in the previous step.
2. **Establish Data Collection Protocols:**
 - **Standardise Units:** Ensure all data is collected in consistent units (e.g., kWh for electricity, litres for fuel).

- **Frequency:** Decide how often data should be collected (e.g., monthly, quarterly, annually).
- **Responsibility:** Assign responsibilities for data collection to specific individuals or teams.

3. Implement Data Collection Systems:

- **Automated Systems:** Use software or tools to automatically collect data from meters, sensors, or utility providers.
- **Manual Data Entry:** Implement a system for manual data entry where necessary, ensuring accuracy through double-checking or verification processes.
- **Integration:** Integrate data collection into existing business processes or ERP systems for efficiency.

4. Quality Assurance:

- **Accuracy:** Verify the accuracy of collected data through spot checks or third-party validation.
- **Completeness:** Ensure all relevant emissions sources are captured and no significant data is missing.
- **Consistency:** Use consistent methodologies over time to allow for comparable data year on year.

5. Data Storage and Management:

- **Database:** Store data in a secure, accessible database that can be updated and queried easily.
- **Data Privacy:** Ensure compliance with data protection regulations when handling personal or sensitive information.

6. Engagement with Stakeholders:

- **Suppliers:** Engage with suppliers to collect upstream emissions data.
- **Employees:** Encourage employees to provide accurate data for commuting and business travel.
- **Customers:** If applicable, gather data on product use to estimate downstream emissions.

Data Quality and Accuracy:

- **Primary vs. Secondary Data:** Use primary data (directly measured or collected) where possible, as it's generally more accurate than secondary data (estimated or from databases).
- **Uncertainty Management:** Acknowledge and document potential sources of uncertainty in data collection to inform future improvements.

By following these steps, companies can ensure that the data collected for carbon quantification is comprehensive, accurate, and usable for effective emissions management. This data will serve as the foundation for calculating emissions, setting reduction targets, and reporting progress transparently.

5.5 Managing Scope 3 Emissions**Categorisation of Scope 3 Emissions:**

Scope 3 emissions, also known as value chain emissions, encompass all indirect emissions not covered in Scope 2. They are divided into 15 categories as per the GHG Protocol:

1. Purchased Goods and Services:

- **Description:** Emissions from the production of products or services purchased by the company.
- **Example:** A furniture manufacturer would account for emissions from the production of wood, fabric, and other materials it buys.

2. Capital Goods:

- **Description:** Emissions associated with the production of capital goods like machinery, vehicles, and buildings.
- **Example:** The emissions from manufacturing a new production line or purchasing a fleet of delivery trucks.

3. Fuel- and Energy-Related Activities Not Included in Scope 1 or 2:

- **Description:** Emissions from the extraction, production, and transportation of fuels and energy purchased and used by the company, not already covered in Scope 1 or 2.
- **Example:** Upstream emissions from coal mining used to generate the electricity the company buys from the grid.

4. Upstream Transportation and Distribution:

- **Description:** Emissions from transportation and distribution of purchased products from suppliers to the company.
- **Example:** Emissions from trucks delivering raw materials to a factory or from shipping goods via freight.

5. Waste Generated in Operations:

- **Description:** Emissions from the disposal and treatment of waste generated by the company's operations.
- **Example:** Emissions from landfill decomposition or incineration of waste produced during manufacturing.

6. Business Travel:

- **Description:** Emissions from employee travel for business purposes.
- **Example:** Emissions from accommodation, flights, train journeys, or car rentals for meetings, conferences, or site visits.

7. Employee Commuting:

- **Description:** Emissions from employees commuting to and from work.
- **Example:** Emissions from employees driving personal vehicles or using public transport to get to the office.

8. Upstream Leased Assets:

- **Description:** Emissions from leased assets not included in Scope 1 or 2, like leased vehicles or equipment.
- **Example:** Emissions from a leased office space where the company does not own the building but controls its operations.

9. Downstream Transportation and Distribution:

- **Description:** Emissions from transportation and distribution of sold products from the company to the customer.
- **Example:** Emissions from delivery trucks or ships transporting the company's products to retailers or end-users.

10. Processing of Sold Products:

- **Description:** Emissions from further processing of intermediate products sold by the company.

- **Example:** A steel manufacturer would account for emissions from customers who process the steel into final products.

11. Use of Sold Products:

- **Description:** Emissions from the use of products by end-users.
- **Example:** Emissions from vehicles using gasoline.

12. End-of-Life Treatment of Sold Products:

- **Description:** Emissions from disposal or recycling of products sold by the company.
- **Example:** Emissions from landfills where electronic products are disposed of or from the recycling process of packaging materials.

13. Downstream Leased Assets:

- **Description:** Emissions from assets leased to other entities.
- **Example:** Emissions from a building or equipment the company leases out to another business.

14. Franchises:

- **Description:** Emissions from operations of franchises not included in Scope 1 or 2.
- **Example:** Emissions from a fast-food franchisee's operations if the company is the franchisor.

15. Investments:

- **Description:** Emissions from investments not included in Scope 1 or 2, such as equity investments in other companies.
- **Example:** Emissions from companies in which the company has a financial interest but not operational control.

Each category represents a different part of the company's value chain where emissions can occur, from the extraction of raw materials to the end-of-life treatment of sold products.

Data Challenges:

- **Complexity:** Scope 3 emissions involve a broad range of activities, making data collection complex and time-consuming.
- **Lack of Direct Control:** companies often have less control over Scope 3 emissions sources compared to Scope 1 and 2, complicating data acquisition.
- **Data Availability:** Suppliers and customers might not have or be willing to share emissions data, leading to gaps in the inventory.
- **Estimation:** For some categories, companies must rely on industry averages, proxies, or estimates, which can introduce uncertainty.
- **Scope:** Determining the boundaries of what constitutes 'relevant' Scope 3 emissions can be challenging.
- **Variability:** Emissions from Scope 3 activities can vary significantly over time due to changes in supplier practices, consumer behaviour, or product lifecycle.

Engaging with Suppliers and Customers:

- **Supplier Engagement:**
 - **Data Request:** Establish clear communication channels to request emissions data from suppliers.
 - **Supplier Development:** Work with suppliers to improve their carbon accounting practices, possibly through training or incentives.
 - **Contractual Agreements:** Include environmental performance clauses in supplier contracts to encourage reduction efforts.
- **Customer Engagement:**
 - **Product Information:** Provide customers with information on how to use products in an environmentally friendly manner to reduce emissions during the use phase.
 - **Product Design:** Design products with end-of-life treatment in mind to minimise emissions from disposal or recycling.
 - **Marketing:** Use marketing to promote sustainability and encourage customers to make greener choices.

- **Supply Chain Collaboration:**
 - **Joint Initiatives:** Collaborate with supply chain partners on sustainability projects or industry-wide initiatives.
 - **Transparency:** Foster transparency by sharing your company's emissions reduction goals and progress, encouraging others to follow suit.
- **Internal Communication:**
 - **Training:** Educate employees on the importance of Scope 3 emissions and how their actions can influence them.
 - **Incentives:** Implement internal programs that incentivise employees to reduce emissions in their daily activities or travel.
- **External Support:**
 - **Consultancy:** Engage with carbon management consultants or use industry tools to help quantify and manage Scope 3 emissions.

By categorising Scope 3 emissions, addressing data challenges, and engaging with the supply chain, SMEs can better manage these indirect emissions, contributing to a more comprehensive approach to carbon reduction.

Differences and Recommendations for Data Collection Between Scope 3 and Scopes 1 & 2

Compared with the carbon-emissions accounting methodologies for Scopes 1 and 2, Scope 3 presents significant differences and challenges:

1. Scope 1 focuses on direct GHG emissions from sources owned or controlled by the company (e.g., on-site combustion of fossil fuels in boilers or furnaces).
2. Scope 2 covers indirect emissions from purchased energy (e.g., electricity, steam, heat or cooling), typically quantified via well-established emission-factor methods applied to utility bills or meter data.

By contrast, Scope 3's boundary is much broader, encompassing *all* other indirect emissions throughout the company's value chain—both upstream (e.g., raw-material extraction, inbound transportation) and downstream (e.g., product distribution, use-phase impacts, end-of-life treatment). Because Scope 3 involves multiple actors and long, complex supply chains, obtaining primary activity data is extremely difficult.

- **Logistics example:**
 - You must track fuel types and consumption for each transport leg.
 - You must allocate emissions across different modes (road, rail, air) and various carriers.
 - A more efficient alternative is to collect shipment tonne-kilometres (tkm) and apply standardised emission factors in a calculation model to estimate total CO₂e.
- **Data-system gaps:**
 - Traditional supply-chain platforms often record only ship-from/ship-to locations, lacking critical fields for transport distance and cargo weight—so logistics emissions cannot be accurately quantified.
 - Employee commuting and business-travel emissions are likewise hard to capture without a systematic data-collection mechanism.

Recommendations to Enhance Scope 3 Data Collection

1. Integrate Scope 3 fields into existing enterprise systems:
 - In your HR or time-and-attendance system, record each employee's commuting mode and distance. Combine this with annual commuting days to estimate individual CO₂e using published emission factors (e.g., DEFRA, EPA).
 - In your supply-chain management system, add mandatory fields for transport distance (km) and cargo weight (tonnes) on every shipment record.
2. Adopt standardised calculation models:
 - Use the collected tkm and mode-specific emission factors (kg CO₂e/tkm) to derive transport emissions via a consistent, auditable methodology.
3. Build a value-chain-wide data-collection framework:
 - Engage key suppliers and logistics providers to secure primary activity data (fuel use, mileage).
 - Leverage IoT telematics or transportation-management-system (TMS) integrations to automate data feeds.

Only by establishing a granular, end-to-end data-collection system can organisations reliably quantify and manage Scope 3 emissions, thus enabling robust GHG reporting and targeted mitigation across the full value chain.

5.6 Calculating Emissions

Once the data has been collected, the next step is to calculate the carbon emissions associated with each source. Here is a structured approach to emissions calculation:

Emissions Calculation Methodology:

1. Identify Activity Data: Use the collected data to determine the amount of activity that produces emissions. This might include:

- **Volume of fuel** consumed (e.g., litres of gasoline, cubic meters of natural gas).
- **Electricity usage** in kWh.
- **Distance travelled** by company vehicles in kilometres.
- **Weight of waste** generated or disposed of.
- **Others.**

2. Select Emission Factors: Emission factors are coefficients that represent the average amount of GHG emissions released per unit of activity. More details will be provided at the latter part of this section.

3. Apply the Calculation Formula:

- ***Emissions = Activity Data x Emission Factor***
- For example:
 - **Scope 1:** If a company uses 1,000 litres of gasoline in its fleet, and the emission factor for gasoline combustion is 2.3 kg CO₂e/litre, then emissions would be 1,000 x 2.3 = 2,300 kg CO₂e.
 - **Scope 2:** If the company consumes 100,000 kWh of electricity from the grid, and the emission factor for the grid electricity is 0.5 kg CO₂e/kWh, then emissions would be 100,000 x 0.5 = 50,000 kg CO₂e.

4. Account for GHG Types: Different GHGs have different global warming potentials (GWP). Common GHGs include:

- **CO₂** (Carbon Dioxide) - GWP of 1*
- **CH₄** (Methane) - GWP of 25*
- **N₂O** (Nitrous Oxide) - GWP of 298*

- **F-Gases** (e.g., HFCs, PFCs) - Varying GWP, often significantly higher than CO₂

Convert all GHG emissions to CO₂ equivalents (CO₂e) using the respective GWP.

** Note: The GWP values mentioned here are based on the Fourth Assessment Report (AR4) by the IPCC, which are commonly used under some reporting standards and protocols (such as EU ETS and EU CBAM). However, the latest values from the Sixth Assessment Report (AR6) provide updated GWPs that reflect the most recent scientific understanding of the climate impact of different greenhouse gases. These updated values might differ, potentially affecting the CO₂ equivalents used in emissions calculations. Companies should be aware of these changes and consider transitioning to AR6 values for future reporting to ensure alignment with the latest scientific consensus on climate change impacts.*

5. Summarise Emissions:

- Calculate emissions for each source and scope separately.
- Aggregate emissions to get total Scope 1, Scope 2, and Scope 3 emissions.

6. Consider Uncertainty:

- Acknowledge and document potential sources of uncertainty in the calculation process, such as variability in emission factors or inaccuracies in activity data.

Emissions Factors:

Finding Emission Factor Sources:

- **National Inventories:** Utilise national environmental agencies or other offices for country-specific emission factors. If national inventories do not provide factors for a specific emission source, companies can consider the other options.
- **IPCC Guidelines:** Access the IPCC Emission Factor Database for a wide range of global factors.
- **Industry Associations:** Look for industry-specific databases or reports from associations like the World Business Council for Sustainable Development (WBCSD) or sector-specific initiatives.

- **Governmental and Non-Governmental Organisations:** Use resources from organisations like the GHG Protocol, which provide factors for different sectors and activities.
- **Utility Providers:** Contact local electricity and gas providers for specific emission factors.

Choosing the Right Emission Factor:

- **Relevance:** Select factors that are most relevant to your operations, location, and the specific fuels or energy sources used.
- **Specificity:** Opt for factors that are as specific as possible (e.g., regional vs. national, or type of fuel used in your machinery).
- **Consistency:** Use emission factors from the same source or methodology over time to ensure comparability in your emissions reporting.
- **Verification:** Choose factors that are peer-reviewed or verified by reputable organisations or scientific bodies.
- **Scope:** Ensure the factor covers all relevant GHGs for your operations (CO₂, CH₄, N₂O, and F-gases).
- **Regulatory Compliance:** Use factors that align with mandatory reporting requirements or standards like ISO 14064-1.

Maintaining Up-to-Date Emission Factors:

- **Regular Updates:** Check for updates from the sources you use annually or as recommended by the source.
- **Subscription:** Subscribe to newsletters or updates from organisations providing emission factors.
- **Scientific Literature:** Keep an eye on scientific publications for new research on emission factors.
- **Database Maintenance:** If using a software tool, ensure the tool automatically updates emission factors or provides an update notification service.
- **Documentation:** Document when and why you've changed emission factors, including the transition from AR4 to AR6 values if applicable.
- **Training:** Train your team on the importance of using current emission factors and how to access and apply them correctly.

- **Stakeholder Engagement:** Collaborate with industry peers or join working groups focused on carbon accounting to stay informed about best practices and updates in emission factors.

Reporting and Documentation:

- Document the methodology, emission factors used, and any assumptions made during the calculation process. This documentation is crucial for transparency and verification.

By following this methodology, companies can accurately quantify their carbon emissions, providing a solid foundation for setting reduction targets, tracking progress, and reporting in line with standards like ISO 14064-1.

5.7 Uncertainty and Recalculation

Accurate emissions reporting is not just about collecting data; it's also about understanding the inherent uncertainties in the process and having a policy in place to address changes that can affect the comparability of emissions data over time. Here, we delve into methods for assessing uncertainty and establishing a recalculation policy to ensure that your company's carbon management remains robust, credible, and compliant with evolving standards and regulations.

This section is particularly aimed at colleagues with a technical / engineering background who are responsible for maintaining the accuracy and reliability of the company's carbon emissions.

Assessing Uncertainty:

- **Quantitative Methods:**
 - **Monte Carlo Simulation:** Use statistical methods like Monte Carlo simulations to quantify the uncertainty in emission calculations by running multiple scenarios with varying input data.

Suppose your company has a fleet of delivery vehicles, and you're trying to calculate the emissions from fuel consumption. The fuel efficiency of the vehicles varies due to factors like age, maintenance, and driving conditions. With Monte Carlo simulation, you could simulate various scenarios with different fuel efficiencies, load weights, etc., to understand the range of possible emissions outcomes.
 - **Error Propagation:** Calculate the combined uncertainty from individual sources using error propagation formulas, considering

the precision of measurement devices, variability in emission factors, and activity data.

If you've measured the weight of waste your company produces with an accuracy of $\pm 3\%$, and the emission factor for waste decomposition has an uncertainty of $\pm 15\%$, error propagation would tell you that your total emissions calculation for waste might have an uncertainty of $\pm 15.3\%$ (combining the errors).

- **Qualitative Assessment:**

- **Expert Judgment:** Involve experts to assess the reliability of data sources and methodologies, identifying areas with potential high uncertainty.

For example, your company uses a specialised industrial gas for manufacturing, and the emission factor for this gas isn't widely published. An expert might assess that, based on similar gases, there's a 20% uncertainty in the emission factor, which would affect the overall uncertainty of your emissions calculation.

- **Sensitivity Analysis:** Analyse how changes in key input data or assumptions affect the overall emissions result to identify critical uncertainties.

If your manufacturing company's emissions are significantly influenced by the efficiency of your production line, sensitivity analysis would show how much the emissions change if you increase or decrease the production efficiency by 5%, helping to pinpoint where the most significant uncertainties lie.

- **Data Quality Indicators:**

- **Accuracy:** Assess the accuracy of the data by comparing it with known benchmarks or through third-party validation.
- **Completeness:** Evaluate whether all relevant emissions sources are included and whether there are significant gaps in data.
- **Consistency:** Ensure the methodology is consistently applied over time to allow for meaningful comparison.
- **Relevance:** Determine if the data and methodologies used are relevant to the company's operations and the scope of the inventory.

- **Uncertainty Documentation:**

- Document all sources of uncertainty, including assumptions, data gaps, and the quality of data sources. This documentation helps in understanding the reliability of the emissions inventory.

Recalculation Policy:

- **When to Recalculate:**

- **Structural Changes:** Significant changes in the company structure, like mergers, acquisitions, or divestitures, necessitate a recalculation to reflect the new organisational boundary.
- **Methodology Updates:** If there are changes in the calculation methodology, such as switching from AR4 to AR6 GWP values or adopting new emission factors, recalculation ensures comparability.
- **Significant Errors:** If errors or inaccuracies are discovered in the original calculations that significantly impact the baseline or reported emissions.
- **Regulatory Requirements:** Compliance with new or updated regulations or standards that require recalculation for consistency.

- **How to Recalculate:**

- **Base Year Adjustment:** Adjust the base year emissions to account for structural changes or methodological updates.
- **Intensity Metrics:** Recalculate emissions intensity metrics to reflect changes in production levels, company size, or other normalisation factors.
- **Documentation:** Clearly document the reasons for recalculation, the methodology used, and any changes in emission factors or data sources.
- **Consistency:** Ensure that the recalculation method is applied consistently across all relevant years to maintain comparability.
- **Verification:** Consider having the recalculated data verified by an independent third party for credibility.

- **Communication:**

- Inform stakeholders about the recalculation, explaining why it was necessary and how it impacts the reported emissions. This

transparency helps maintain trust in the company's carbon management efforts.

By addressing uncertainty and establishing a recalculation policy, companies can ensure their carbon emissions reporting remains accurate, comparable over time, and compliant with evolving standards and regulations. This process supports effective carbon management, allowing the company to track progress, set realistic targets, and demonstrate commitment to sustainability.

5.8 Reporting and Verification

Reporting Principles:

When reporting GHG emissions, companies should adhere to the following key principles to ensure the integrity and usefulness of their carbon inventory:

- **Relevance:** Ensure the reported emissions are pertinent to the company's operations and its stakeholders, providing information that influences decisions or actions towards carbon management.
- **Completeness:** Report all relevant GHG emissions sources and activities within the chosen inventory boundary, avoiding any significant omissions.
- **Consistency:** Apply consistent methodologies, data collection procedures, and emission factors over time to allow for meaningful comparisons. If changes are made, they should be documented and justified.
- **Transparency:** Clearly document all assumptions, methodologies, exclusions, and uncertainties in the GHG inventory so that stakeholders can understand and evaluate the data's reliability.
- **Accuracy:** Strive for a high level of accuracy in the quantification of emissions, minimising uncertainties as far as practical, and providing enough detail for external verification.

Verification:

Verification is the process of reviewing and assessing the accuracy and completeness of your GHG emissions data. Here's how companies can approach verification:

- **Internal Verification:**
 - **Internal Audits:** Conduct internal reviews or audits to check for errors, consistency, and adherence to the company's carbon management policies.
 - **Data Validation:** Use internal checks and balances, like cross-referencing data from different sources or departments, to validate the accuracy of emissions data.
- **External Verification:**
 - **Third-Party Auditors:** Engage independent third-party auditors to verify your GHG inventory. They provide an unbiased assessment of your carbon accounting practices.
 - **Accreditation:** Choose verification bodies accredited by recognised standards like ISO 14065, which outlines requirements for GHG validation and verification bodies.

GHG Inventory Report:

The structure and content of the GHG inventory report should be comprehensive, clear, and accessible:

- **Executive Summary:**
 - Provide an overview of the company's carbon emissions, key findings, and any significant changes from previous reports.
- **Organisational Boundaries:**
 - Define the organisational scope of the inventory, including which entities are included or excluded.
- **Operational Boundaries:**
 - Outline which emission sources and activities are included (e.g., Scope 1, 2, and relevant Scope 3 categories).
- **Emissions Summary:**
 - Present total GHG emissions by scope, broken down by emission source or activity. Include trends over time if applicable.
- **Calculation Methodologies:**
 - Detail the methods used for data collection, emission factor selection, and calculations, ensuring transparency.

- **Data Quality and Uncertainty:**
 - Discuss the quality of data, potential sources of uncertainty, and how these were addressed.
- **Reduction Initiatives:**
 - Highlight any carbon reduction strategies, projects, or initiatives undertaken by the company.
- **Year-on-Year Changes:**
 - **Emissions Trends:** Report the periodical (normally year-on-year) changes in emissions, showcasing the progress or regression in carbon management efforts.
 - **Explanation of Changes:** Importantly, explain why these changes occurred, whether due to operational changes, new initiatives, or external factors like changes in emission factors or company growth.
- **Verification Statements:**
 - Include statements from internal or external verifiers attesting to the accuracy and completeness of the GHG inventory.
- **Appendices:**
 - Provide additional data, methodologies, or supporting documentation as needed.

By following these principles and processes, companies can produce credible GHG reports that not only fulfil compliance requirements but also build trust with stakeholders, support internal carbon management efforts, and contribute to the broader goal of reducing carbon emissions. Including year-on-year changes and their explanations provides a narrative of the company's carbon management journey, making the report more insightful and actionable.

5.9 Continuous Improvements

Continuous improvement is the cornerstone of effective carbon management, ensuring that emissions reduction efforts are not one-off projects but are fed into the organisation's ongoing operations.

This section will explore how companies can leverage their emissions data to set ambitious yet achievable reduction targets, and how to integrate these

targets into existing management systems to drive sustained progress towards lower carbon emissions.

Setting Targets:

- **Base Year:** Establish a base year (normally based on the exercise of the previously mentioned steps), which serves as the reference point for all future emissions reduction targets. This year should be representative of normal operations, free from significant anomalies, and allows for accurate comparison of emissions over time.
- **Benchmarking:** Use your GHG inventory data to benchmark your company's emissions against industry standards, competitors, or your own historical performance. This helps in understanding where you stand and what's achievable.
- **(Optional but Suggested) Science-Based Targets:** Align your reduction goals with the latest climate science by adopting science-based targets (SBTi), which ensure your company's efforts contribute to the global efforts.
- **SMART Targets:** Set Specific, Measurable, Achievable, Relevant, and Time-bound targets. For instance:
 - **Specific:** Reduce Scope 1 emissions by 20%.
 - **Measurable:** By 1,000 tonnes CO₂e per year.
 - **Achievable:** Based on feasible improvements in energy efficiency and fuel switching.
 - **Relevant:** Targets should align with your business strategy and contribute to overall sustainability goals.
 - **Time-bound:** To be achieved by the end of the next fiscal year.
- **Data-Driven:** Use the quantified emissions data to set realistic and informed targets. For example, if your data shows a significant portion of emissions comes from purchased goods, set targets for supplier engagement or material substitution.
- **Long-Term Vision:** While setting short-term targets, also consider a long-term vision for carbon neutrality or net-zero emissions to guide your company's future strategy.

Management Systems:

- **Integration into Business Operations:**
 - Incorporate carbon management into your company's strategic planning, budgeting, and operational decision-making processes. This ensures that carbon reduction is not an add-on but part of the core business strategy.
- **ISO 14001 and Other Standards:**
 - Utilise environmental management systems like ISO 14001, which provides a framework for managing environmental impacts, including GHG emissions. Compliance with such standards can drive continuous improvement.
 - More details will be provided in the Chapter 5.
- **Performance Metrics:**
 - Establish key performance indicators (KPIs) related to carbon emissions and track them regularly. Metrics might include:
 - Emissions per unit of product or revenue.
 - Energy efficiency improvements.
 - Percentage of renewable energy use.
- **Regular Review and Reporting:**
 - Set up a schedule for regular review of emissions data, progress against targets, and the effectiveness of reduction initiatives. Use this information to update your management systems and strategies.
- **Employee Engagement:**
 - Embed carbon reduction practices into employee responsibilities and incentivise or reward behaviours that contribute to lower emissions. Training and awareness programs can foster a culture of sustainability.
- **Supplier and Customer Engagement:**
 - Extend your management systems to include supplier performance in carbon management. Similarly, engage with customers to promote products or services that have lower carbon emissions.

- **Continuous Monitoring:**
 - Implement systems for real-time or near-real-time monitoring of energy usage, waste generation, and other key factors influencing emissions to allow for timely interventions.
- **Feedback Loops:**
 - Establish feedback loops where lessons learned from carbon management initiatives are fed back into the system to refine processes, targets, and strategies.

By setting informed targets based on a well-established base year and integrating carbon management into your company's operations, companies can ensure that continuous improvement in carbon reduction becomes part of the company's DNA. This approach not only helps in reducing emissions but also fosters innovation, cost savings, and improved market positioning in a world increasingly focused on sustainability.

Chapter 5: Strategy and Operation for Carbon Emissions Reduction

In this chapter, we delve into practical strategies and operational frameworks that companies can adopt to reduce their carbon emissions effectively.

As organisations increasingly recognise their role in addressing climate change, the focus shifts from mere reporting to strategic carbon management. Here, **we explore how companies can integrate carbon reduction into their core business practices via standards and measures that are inter-related with the carbon management efforts set out in Chapter 4**, ensuring not only environmental sustainability but also long-term economic viability.

5.1 Managing and Reducing Emissions in Operation: ISO 14001

Carbon Management as an Integral Part of Environmental Management System:

Carbon management is a crucial component of an Environmental Management System (EMS), particularly when implementing ISO 14001:

- **Overview of ISO 14001:** ISO 14001 is the international standard for environmental management systems. While it encompasses various environmental impacts, carbon management can be integrated to address GHG emissions systematically.
- **Integration with Carbon Management:** Here's how companies can incorporate carbon reduction strategies into an ISO 14001 system:
 - **Setting Environmental Objectives:** Establish objectives that explicitly include carbon emissions reduction targets. These objectives should align with the company's commitment to sustainability and regulatory compliance.
 - **Operational Control:** Implement controls to minimise environmental impacts, including emissions:
 - **Energy Efficiency:** Energy management is key, but operational controls should also include energy conservation practices.
 - **Waste Management:** Minimise waste generation and manage waste disposal to reduce emissions from landfill and waste treatment.

- **Design and Procurement:** Incorporate environmental criteria into design processes and purchasing decisions to reduce the carbon footprint of materials and supplies.
- **Monitoring and Measurement:**
 - Regularly monitor and measure GHG emissions to track progress against set targets.
 - Use tools like carbon emissions calculators or GHG inventories to quantify emissions.
- **Communication:** Engage employees, suppliers, and stakeholders with clear communication about the company's carbon management efforts and performance.
- **Management Review:** Include carbon performance in regular management reviews to assess the effectiveness of the EMS in reducing emissions and to adjust strategies as needed.

Reducing Direct Emissions through EMS:

For direct emissions (Scope 1) that are not energy-related, an EMS can implement specific measures:

- **Process Emissions:**
 - **Process Optimisation:** Optimise manufacturing processes to minimise emissions. For example, reducing the use of chemicals that release GHGs or improving process efficiency to reduce waste.
 - **Technology Upgrades:** Invest in cleaner technologies or modify existing processes to reduce or capture emissions. For instance, installing catalytic converters on combustion engines to reduce NOx emissions.
- **Fugitive Emissions:**
 - **Leak Detection and Repair (LDAR) Programs:** Establish a program to detect and repair leaks of refrigerants, solvents, and other GHGs. Regular inspections and maintenance schedules can significantly reduce these emissions.
 - **Equipment Sealing:** Upgrade or maintain equipment to ensure it is properly sealed, reducing the escape of GHGs.

- **Refrigeration and Air Conditioning:**
 - **Refrigerant Management:** Properly manage refrigerants by using low-GWP alternatives, ensuring no leaks, and following best practices for end-of-life management.
 - **Efficient Cooling Systems:** Choose energy-efficient cooling systems that also minimise refrigerant emissions.
- **Wastewater Treatment:**
 - **Anaerobic Treatment:** Use anaerobic digestion to treat wastewater, capturing methane for energy use or flaring it to reduce its climate impact.
 - **Efficient Treatment Methods:** Implement treatment methods that are less energy-intensive and produce fewer GHG emissions.
- **Transport and Distribution:**
 - **Fleet Management:** Optimise the fleet for lower emissions by using alternative fuels, improving vehicle maintenance for better fuel efficiency, or transitioning to electric or hybrid vehicles.
 - **Route Optimisation:** Use logistics software to plan routes that minimise fuel consumption and emissions.
- **Agricultural Operations** (if applicable):
 - **Soil Management:** Implement practices like no-till farming or cover cropping to reduce emissions from soil disturbance.
 - **Livestock Management:** Improve feed efficiency, manage manure to reduce methane emissions, and consider alternative protein sources.

By integrating carbon management into the EMS framework of ISO 14001, companies can ensure that their environmental efforts directly contribute to reducing their carbon emissions. Furthermore, by targeting direct emissions sources through specific operational controls, companies can effectively manage and minimise their environmental impact beyond energy efficiency measures.

5.2 Managing and Reducing Energy related Emissions in Operation: ISO 50001

According to the data by Climate Watch, the energy sector produces the most greenhouse gas emissions by far, accounting for 75.7% of all emissions worldwide, including 29.7% of all emissions from **electricity and heat** and 12.7% from **manufacturing and construction**.

Energy management is critical for manufacturing companies seeking to reduce their carbon emissions, particularly through direct emissions (Scope 1) and indirect emissions (Scope 2):

- **Direct Emissions (Scope 1):**
 - **Fossil Fuel Combustion:** Energy management can directly reduce on-site Scope 1 emissions from fossil-fuel combustion (e.g., in heating, cooling or mechanical-drive applications). Specifically, by improving energy-use efficiency, a company lowers its operational fossil-fuel consumption and thereby mitigates direct CO₂ emissions from combustion at the source.
 - **Fugitive Emissions:** Energy management practices can also include maintenance schedules to prevent leaks from equipment, reducing fugitive emissions of GHGs like refrigerant and methane.
- **Indirect Emissions (Scope 2):**
 - **Purchased Electricity:** The efficiency of energy use within a company directly affects the amount of electricity purchased from the grid, which often comes from fossil fuels. Reducing electricity consumption through energy management lowers these indirect emissions.
 - **Steam and Heat:** If your production process involves steam or heat supplied by a utility, energy management can optimise usage, reducing the demand for these resources and the associated emissions.

Given the importance of energy management in reducing emissions, implementing a structured approach such as **ISO 50001** becomes highly beneficial.

Implementing ISO 50001 for Carbon Management and Emissions Reduction:

- **Understanding ISO 50001:** ISO 50001 is an international standard that outlines requirements for establishing, implementing, maintaining, and

improving an Energy Management System (EnMS). It provides a framework for companies to systematically manage energy performance, thereby reducing carbon emissions.

- **Energy Baseline and Energy Performance Indicators:**
 - Establish an energy baseline to measure performance against. This helps in tracking improvements and setting realistic targets.
 - Develop key Energy Performance Indicators (EnPIs) to monitor energy consumption and efficiency, such as energy intensity (energy use per unit of production).
- **Energy Audits / Reviews:**
 - Conduct regular energy audits / reviews to identify energy wastage, inefficiencies, and opportunities for savings. This can include:
 - Inspecting insulation and building envelope for heat loss.
 - Assessing HVAC systems for efficiency.
 - Analysing lighting and equipment for energy-saving potential.

Practical Measures for Companies to Implement Energy Management:

- **Energy Efficiency Programs:**
 - Implement energy-saving programs like:
 - **Lighting:** Replace traditional light bulbs with energy-efficient LED lighting, which can reduce lighting energy use.
 - **Equipment Upgrades:** Upgrade to more energy-efficient machinery or retrofit existing equipment with energy-saving technologies like variable speed drives (VSDs).
 - **HVAC Maintenance:** Regular maintenance of heating, ventilation, and air conditioning systems to ensure they operate at peak efficiency.
- **Behavioural Changes:**
 - Train employees on energy conservation practices such as turning off equipment when not in use, optimising machine settings for energy efficiency, and closing doors and windows to prevent unnecessary heating or cooling.

- **Energy Monitoring:**
 - Use simple energy monitoring devices or invest in a Building Energy Management System (BEMS) to track energy usage in real-time, allowing for immediate response to inefficiencies.
- **Insulation and Building Envelope:**
 - Improve insulation in walls, roofs, and floors to reduce heat loss, which can be a significant source of energy waste in manufacturing facilities.
- **Compressed Air Systems:**
 - Optimise compressed air systems, which are often energy-intensive in manufacturing. Regular maintenance and leak detection can save considerable amounts of energy.
- **Energy Management Software:**
 - Utilise software solutions to analyse energy data, predict consumption patterns, and suggest energy-saving measures tailored to your operations.
- **Energy Recovery:**
 - Implement heat recovery systems to reuse waste heat from processes or machinery, reducing the need for additional energy input for heating.
- **Renewable Energy:**
 - Investigate options for on-site renewable energy generation like solar panels, which can reduce grid electricity usage and Scope 2 emissions.

By focusing on energy management, companies can not only reduce operational costs but also make substantial progress in their carbon management strategy. ISO 50001 provides a proven framework to guide this process, ensuring continuous improvement in energy efficiency and a direct impact on reducing GHG emissions from Scope 1 and Scope 2 sources.

5.3 Managing and Reducing Supply Chain Emissions: ISO 20400

Why Supply Chain Emissions are Important:

- **Significant Contribution:** Supply chain emissions (majority of Scope 3 Emissions) can account for a substantial portion of a company's carbon

inventories, often exceeding the emissions from its direct operations. According to the research by World Economic Forum, eight supply chains, including food, construction, fashion, fast-moving consumer goods, electronics, automotive, professional services, account for more than 50% of global emissions.

- **Indirect Influence:** companies can influence them indirectly through procurement practices and supplier relationships.
- **Reputation and Market Access:** Reducing supply chain emissions can enhance a company's reputation, open up new markets, and meet the increasing demand for sustainable products and services.
- **Regulatory Compliance:** Future regulations may require companies to report and manage Scope 3 emissions, making supply chain decarbonisation a proactive step towards compliance.

Introduction to ISO 20400:

- **Sustainable Procurement:** ISO 20400, titled "Sustainable Procurement — Guidance", provides a framework for integrating sustainability considerations into procurement processes. It aims to help organisations achieve sustainable development objectives through procurement decisions.
- **Relevance to Carbon Management:** ISO 20400 offers guidance on how procurement can contribute to carbon reduction:
 - **Prioritising Sustainability:** Encourages the consideration of environmental impacts, including carbon emissions, in purchasing decisions.
 - **Life Cycle Perspective:** Promotes life cycle thinking, assessing the carbon footprint of products and services from raw material extraction to end-of-life disposal.
 - **Supplier Engagement:** Outlines the importance of working with suppliers to drive sustainability improvements throughout the supply chain.

Implementing Supplier Engagement Measures:

- **Supplier Selection Criteria:**
 - Include environmental performance as part of supplier selection criteria:

- Evaluate suppliers based on their carbon emissions, energy efficiency, and sustainability policies.
- Consider certifications like ISO 14001 or ISO 50001 as indicators of a supplier's commitment to environmental management.
- **Collaborative Initiatives:**
 - Develop joint programs with suppliers to reduce emissions:
 - Set up supplier forums or workshops to discuss and share best practices on carbon management.
 - Create shared goals for carbon reduction, encouraging suppliers to adopt sustainable practices.
 - Collaborate on research and development for lower-carbon materials or processes.
- **Training and Capacity Building:**
 - Support suppliers in reducing their carbon emissions:
 - Provide training on carbon accounting, energy efficiency, and waste reduction.
 - Offer technical assistance or funding for energy audits or energy-efficient upgrades.
 - Share knowledge on carbon reduction technologies and practices.

Conducting Supplier Performance Evaluation:

- **Carbon Footprint Assessment:**
 - Work with suppliers to quantify their carbon emissions, using tools like product carbon footprint (PCF) or supplier GHG inventories.
- **Key Performance Indicators (KPIs):**
 - Establish KPIs to track supplier carbon performance:
 - Emissions per unit of product or service.
 - Energy intensity (energy use per unit of production).
 - Percentage of renewable energy used.

- **Regular Reporting:**
 - Require suppliers to report their environmental performance regularly, allowing for ongoing monitoring and feedback.
- **Audit and Verification:**
 - Conduct or support third-party audits to verify supplier claims regarding carbon emissions and sustainability practices.

By embracing ISO 20400 and implementing strategic supplier engagement, companies can significantly reduce their Scope 3 emissions, fostering a more sustainable supply chain. These practices not only help in managing carbon emissions but also promote a culture of sustainability throughout the supply chain, contributing to broader environmental and social objectives.

5.4 Managing and Reducing Carbon Emissions at Source: PCF and Product Eco-design

According to ISO 14001, when an organisation identifies the environmental aspects of its activities, products and services, it must consider all life-cycle stages over which it can exert control or influence. Integrating the Environmental Management System (EMS) with design and development offers the advantage of driving the organisation to:

- Identify, at each life-cycle stage, the environmental aspects related to the product and
- Assess the corresponding environmental impacts.

ISO 9001 specifies requirements for design management processes but does not explicitly address environmental impacts. ISO 14006, *Environmental management systems — Guidelines for incorporating Eco-design*, bridges this gap by combining the ISO 14001 EMS framework with Eco-design methodologies. It enables organisations to systematically reduce environmental burdens throughout the design and development phases, while preserving the EMS's adaptability and operational feasibility.

Product Carbon Footprint (PCF):

- **Concept:** The PCF quantifies the total greenhouse gas emissions associated with a product over its entire lifecycle, from raw material extraction to disposal or recycling. It includes emissions from production, transportation, use, and end-of-life treatment.

- **Standards:** The standard **ISO 14067** provides a framework for calculating and reporting PCF. **ISO 14040 and ISO 14044**, the standards outline the principles and framework for Life Cycle Assessment (LCA), are essential for determining the PCF by assessing the environmental impacts associated with all stages of a product's life cycle.
- **Importance in Design and Marketing:**
 - **Design:** Understanding the PCF helps designers make informed decisions to minimise emissions at each stage of the product's life cycle, leading to more sustainable products.
 - **Marketing:** A lower PCF can be a significant selling point, appealing to environmentally conscious consumers and providing a competitive advantage in markets where sustainability is valued.

Eco-design Principles:

- **Material Selection to Reduce Embodied Carbon:**
 - **Life Cycle Assessment (LCA):** Conduct LCAs to understand the carbon impact of different materials, guiding material choices towards those with lower environmental footprints.
 - **Sustainable Materials:** Use materials with lower embodied carbon, such as recycled content or renewable resources like bamboo or bioplastics.
 - **Lightweighting:** Design products to use less material without compromising functionality, reducing the energy required for production and transportation.
- **Energy Efficiency in Product Use Phase:**
 - **Energy-Efficient Design:** Incorporate features that reduce energy consumption during the product's use, like energy-saving modes, efficient motors, or insulation.
 - **Standby Power:** Minimise standby power consumption to reduce emissions over the product's lifetime.
 - **End-User Education:** Provide instructions or features that encourage users to operate the product in an energy-efficient manner.

- **End-of-Life Management to Minimise Carbon Impact:**
 - **Design for Disassembly:** Ensure products can be easily disassembled for recycling or remanufacturing, reducing waste and emissions from disposal.
 - **Recyclability:** Use materials that can be recycled at the end of the product's life, minimising landfill waste and associated emissions.
 - **Take-Back Programs:** Implement programs to take back products for recycling or refurbishment, closing the loop on the product lifecycle.

Tools and Methodologies:

- **Checklists and Guidelines:** Utilise design checklists or eco-design guidelines provided by organisations like the European Commission or the U.S. EPA.
- **LCA Software:** Use software like OpenLCA, SimaPro to evaluate the environmental impact of products over their lifecycle.
- **Design for Six Sigma (DFSS):** Incorporate environmental considerations into the Six Sigma design process for continuous improvement in sustainability.

Low-carbon Product Eco-design Examples:

- **Refrigerator by Company A:**
 - This company redesigned their refrigerator model to incorporate eco-design principles:
 - **Material:** Used recycled steel for the body, reducing the embodied carbon by 25%.
 - **Energy Efficiency:** Improved insulation and optimised the cooling system, reducing energy consumption by 30% during use.
 - **End-of-Life:** Designed the refrigerator for easy disassembly, with 95% of materials being recyclable or reusable.
- **Smartphone by Company B:**
 - **Material:** Increased the use of recycled plastics, significantly reducing the carbon footprint of the device.

- **Energy Efficiency:** Implemented power-saving features and optimised battery life, reducing the energy required for charging.
- **End-of-Life:** Developed a take-back program for old devices, which are then either refurbished or recycled, reducing waste and emissions.
- **Eco-friendly Packaging by Company C:**
 - **Material:** Switched to biodegradable packaging materials from renewable sources, reducing the carbon emissions from packaging by 50%.
 - **Design:** Created packaging that was both protective and minimal, reducing the amount of material used.
 - **End-of-Life:** Ensured that all packaging was compostable or recyclable, minimising the carbon impact at the end of its life.

By incorporating carbon considerations into product lifecycle and design, companies can design and produce products that are not only environmentally friendly but also align with consumer demand for sustainability. These practices help in reducing the overall carbon emissions of the company and carbon footprints of its products, contributing to a more sustainable future.

Chapter 6: Roadmap for SMEs and Case Studies

Case Study 1: Baseline Assessment and Carbon Management System Set-up

Overview

Claire, the Environmental, Health, and Safety (EHS) Director at Company Jets, a toy manufacturer, was tasked with conducting a **carbon baseline assessment** and establishing a **carbon management system (CMS)** in accordance with **ISO 14064-1**. This project aimed to quantify, manage and reduce emissions from the company's operations.

The case study highlights Claire's step-by-step journey to identify emission sources, quantify them, and implement a CMS tailored to the company's manufacturing context. It emphasises manufacturing-specific elements and illustrates technical details with numerical examples, ensuring alignment with ISO 14064-1 principles.

Step 1: Identifying Relevant Goods and Emission Categories

Action Taken

Claire began by identifying the relevant goods produced by Company Jets and determining the emission categories specific to the manufacturing processes. She followed ISO 14064-1 guidelines to establish a robust framework for identifying and quantifying emissions sources.

Key Activities

- **Mapping the Manufacturing Goods:** Identified the primary toy products manufactured, such as plastic figurines and electronic educational toys.
- **Categorising Emissions:**
 - **Scope 1 (Direct Emissions):** Emissions from on-site fuel combustion in production machinery and heating systems.
 - **Scope 2 (Indirect Emissions):** Emissions from purchased electricity used for operating assembly lines and auxiliary facilities.
 - **Scope 3 (Other Indirect Emissions):** Emissions from upstream raw material production (e.g., plastic resins and electronic components) and downstream logistics for product distribution.

Manufacturing-Specific Example

The production of plastic figurines involves injection moulding, an energy-intensive process powered by electricity, which is a significant contributor to Scope 2 emissions. Meanwhile, Scope 1 emissions stem from natural gas used in heating moulds for the manufacturing process.

Step 2: Defining System Boundaries

Action Taken

Claire defined the **system boundaries** to determine which manufacturing processes and facilities would be included in the CMS. This ensured a comprehensive approach to quantifying emissions from all relevant activities, as required by ISO 14064-1.

Key Activities	System Boundaries for Toy Manufacturing
• Operational Boundaries: Included emissions from the production facility, warehouses, and company-owned distribution vehicles. • Manufacturing Process Boundaries: Focused on key production steps, such as: ○ Injection Moulding: Transforming plastic resins into toy components. ○ Assembly Lines: Combining plastic parts with electronic components. ○ Packaging: Using cardboard and plastic for final product packaging.	• Input Activities: Raw material sourcing (e.g., plastic resins, electronic components). • Core Production Activities: Injection moulding, assembly, and packaging. • Output Activities: Storage, distribution, and waste management.

Step 3: Identifying Emission Sources in Manufacturing

Action Taken

Claire identified and categorised all emission sources specific to the manufacturing processes. This step was critical for ensuring that the CMS captured all emissions.

Key Manufacturing Emission Sources

- **Scope 1:**
 - Fuel combustion in gas-fired Mold heating systems.
 - Diesel consumption in forklifts used for moving materials within the facility.
- **Scope 2:**
 - Electricity consumption in injection moulding machines and assembly lines.
- **Scope 3:**
 - Embedded emissions in plastic resins and electronic components procured from suppliers.
 - Emissions from the disposal of plastic and packaging waste.

Step 4: Quantifying Emissions from Manufacturing Processes

Action Taken

Claire applied ISO 14064-1 methodologies to quantify emissions from manufacturing activities. Numerical examples illustrate the calculation process.

Numerical Examples of Some Emission Sources

1. Scope 1 Emissions Calculation:

Formula*:

Emissions (tCO₂e) = Fuel Consumption × Emission Factor × Net Calorific Value

- **Input Data:**
 - *Fuel type: Natural gas.*
 - *Annual consumption: 10,000 m³.*
 - *Conversion factor (NCV): 0.03517 TJ / 1,000 m³.*

- *Emission factor: 56.1 tCO₂ / TJ.*

- **Calculation:**

$$\text{Emissions} = 10,000 \times 0.03517 \times 56.1 = \mathbf{19.70 \text{ tCO}_2\text{e.}}$$

** It can also be calculated using the calorific value, the carbon content per unit of calorific value, and the carbon oxidation rate.*

2. Scope 2 Emissions from Electricity Usage in Injection Moulding:

Formula:

$$\text{Emissions (tCO}_2\text{e)} = \text{Electricity Consumption} \times \text{Grid Emission Factor}$$

- **Input Data:**

- *Electricity consumption: 750,000 kWh (750 MWh).*
- *Grid emission factor: 0.45 tCO₂/MWh (based on the national grid average).*

- **Calculation:**

$$\text{Emissions} = 750 \times 0.45 = \mathbf{337.5 \text{ tCO}_2\text{e.}}$$

3. Scope 3 Emissions from Plastic Resins:

Formula:

$$\text{Emissions (tCO}_2\text{e)} = \text{Quantity of Material (t)} \times \text{Emission Factor (tCO}_2\text{/t)}$$

- **Input Data:**

- *Quantity of plastic: 1,500 t.*
- *Emission factor for plastic resin (provided by a supplier): 2.4 tCO₂/t.*

- **Calculation:**

$$\text{Emissions} = 1,500 \times 2.4 = \mathbf{3,600 \text{ tCO}_2\text{e.}}$$

Step 5: Implementing the Carbon Management System (CMS)

Action Taken

Claire established a CMS tailored to the needs of a manufacturing company, focusing on key production processes and emissions sources.

Key Components of the CMS

1. Integration with EMS:

- Incorporated the CMS into Company Jets' pre-existing Environmental Management System (EMS), aligning carbon-related goals with broader environmental objectives such as resource efficiency and waste reduction, ensuring compliance with ISO 14001 framework and leveraging existing processes for streamlined implementation.

2. Data Monitoring:

- Installed energy meters on injection moulding machines to monitor electricity use.
- Tracked natural gas and diesel consumption for Scope 1 emissions.

3. Data Consolidation:

- Developed a light-weight database to store data on raw material inputs, energy consumption, and production volumes.
- Used ISO 14064-1 reporting templates to organise and standardise data.

4. Reduction Targets:

- Set a goal to reduce electricity consumption in production by 15% over three years through energy-efficient equipment upgrades.

Step 6: Reporting and Verification

Action Taken

Claire ensured the CMS complied with ISO 14064-1 reporting requirements by preparing emissions reports and engaging a third-party verifier to confirm data accuracy.

Key Activities

- **Internal Audits:** Conducted internal reviews of data collected from manufacturing processes.
- **Third-Party Verification:** Hired an accredited verifier to validate emission calculations and ensure alignment with ISO 14064-1.

- **Reporting:** Prepared an annual emissions inventory report, highlighting emissions from key manufacturing processes.

Step 7: Driving Emissions Reduction in Manufacturing

Action Taken

Claire collaborated with the production team to implement emission reduction measures specific to manufacturing activities.

Key Initiatives

- **Energy Efficiency:**
 - Replaced outdated injection moulding machines with energy-efficient models, reducing electricity consumption by 20%.
 - Improved insulation in gas-fired heating systems to reduce natural gas usage.
- **Raw Material Optimisation:**
 - Partnered with suppliers to source recycled plastics, reducing Scope 3 emissions.
- **Waste Management:**
 - Implemented a waste recycling program to minimise emissions from plastic and packaging disposal.

Key Outcomes

1. **Baseline Established:** Claire successfully quantified emissions for the baseline year, which became the benchmark for upcoming improvements.
2. **CMS Implemented:** A robust carbon management system was established, enabling regular monitoring and reporting of manufacturing emissions.
3. **Reduction Achieved:** Initial measures led to a 5% reduction in Scope 2 emissions within the first year.

This case study demonstrates how a manufacturing company like Company Jets can apply ISO 14064-1 principles to establish a CMS, focusing on emissions from manufacturing processes and aligning with international standards for carbon management.

Case Study 2: Energy Management and Process Optimisation for Decarbonisation

Overview

Wesley, the Facility Manager and Energy Engineer at Company Keys, a specialty polymer manufacturer, was tasked by management with developing a decarbonisation roadmap that also delivered operational cost savings. He recognised that a systematic approach was essential for success.

This case study outlines the steps taken to establish an Energy Management System (EnMS) based on ISO 50001, implement targeted energy efficiency measures, integrate renewable energy, optimise core chemical processes, and improve material and waste circularity. Each initiative was presented with a clear business case, linking carbon reduction to financial performance.

Step 1: Establishing an Energy Management System (EnMS)

Action Taken

Wesley initiated the process by setting up an EnMS aligned with ISO 50001 to systematically manage and reduce energy consumption and emissions.

Key Activities

- **Energy Policy:** Developed and communicated an energy policy that committed to energy efficiency and emissions reduction.
- **Energy Planning:** Conducted an energy review to identify significant energy uses:
 - **Scope:** Included all manufacturing processes, utilities, and administrative areas.
 - **Energy Performance Indicators (EnPIs) and Energy Baselines:** For key energy uses, establish EnPIs that quantitatively characterise energy performance, and develop an energy baseline based on historical data to serve as a comparative reference.
 - **Energy Objectives, Targets and Implementation Plan:** Define appropriate energy objectives and performance targets, and develop a corresponding implementation plan.
- **Implementation and Operation:**
 - Trained staff on energy conservation practices.

- Implemented energy-saving measures in operations.
 - Integrate energy-efficiency considerations into design and procurement activities.
- **Checking:**
 - Installed energy meters to monitor usage.
 - Set up a system for regular energy audits.
- **Management Review:** Regularly reviewed the EnMS performance to ensure continuous improvement.

Numerical Example

- **Energy Performance Indicators (EnPI) and Energy Baseline (EnB):** Keys Company's annual energy consumption is 10,000 MWh, and its annual production is 10,000 kg.
- The total energy consumption per kg of product is defined as the EnPI.
- Keys Company determines the year's average comprehensive energy consumption per unit of product as its energy baseline (EnB):
 - ***Total energy consumed per unit (kg) of products: 1 MWh/kg.***
 - ***Electricity consumed per unit (kg) of products: 0.6 MWh/kg.***
 - ***Natural Gas consumed per unit (kg) of products: 0.4 MWh/kg.***

Step 2: Energy Efficiency Improvements

Action Taken

Wesley focused on upgrading equipment to improve energy efficiency.

Key Activities

Equipment Upgrades:

- Replaced old, inefficient pumps on the main reactor cooling loop and motors on the primary agitators with high-efficiency models.
- Installed variable frequency drives (VFDs) on key distillation column pumps to match energy use precisely with process demand.

Numerical Example

The energy savings from upgrading a single large pump were calculated to demonstrate the potential:

- Old Pump System Consumption: 200 MWh per year (at 70% efficiency).
- New Pump System Efficiency: 85%.
- New Energy Consumption: The new energy required is the old consumption adjusted by the ratio of efficiencies.

New Consumption = 200 MWh $\times$ (70% / 85%) = 164.7 MWh.

- Annual Electricity Savings:

Savings = Old Consumption - New Consumption = 200 MWh - 164.7 MWh = 35.3 MWh.

- Emissions Reduction: 35.3 MWh $\times$ 0.5 tCO₂e/MWh = 17.7 tCO₂e.

Step 3: Use of Renewable Energy

Action Taken

Wesley worked with Production team and R&D team and convinced the company management to harness renewable energy by installing solar panels on the roofs of the factory and warehouse buildings.

Key Activities

Solar Installation:

- Assessed roof space and solar potential.
- Installed a 1 MW solar photovoltaic (PV) system.

Numerical Example

- **Solar Panel Capacity:** 1 MW
- **Annual Solar Energy Production:** 1,200 MWh (assuming 1,200 hours of effective sunlight per year).
- **Carbon Emission Reduction:** If 1 MWh of grid electricity produces 0.5 tCO₂, the solar installation reduces 600 tCO₂e annually.

Step 4: Process Optimisation

Action Taken

Wesley worked with Production team and implemented advanced process control and optimisation techniques to enhance efficiency and reduce waste.

Key Activities

Process Control and Heat Integration:

- Implemented advanced process control (APC) systems to optimise reaction temperatures and residence times, reducing the creation of off-spec product.
- Installed heat exchangers to recover low-grade heat from reactor cooling jackets, using it to pre-heat boiler feedwater and reduce natural gas consumption.

Numerical Example

- **Old Process:** Each batch produced 50 kg of off-spec product that required energy-intensive rework, with the batch consuming 50 MWh of energy.
- **Optimised Process:** Tighter controls reduced off-spec product to 40 kg and lowered the energy needed per batch to 40 MWh.
- **Energy Savings:** 10 MWh of energy saved per batch.

Step 5: Using Recycled Materials

Action Taken

Company Keys started using recycled materials in their production processes to reduce the carbon emissions associated with raw material sourcing.

Key Activities

- **Material Sourcing:**
 - Replaced virgin raw materials with recycled options where possible, like using recycled plastics for packaging.
 - Negotiated with suppliers for lower carbon materials.

Numerical Example

- **Baseline Scenario (Before):**
 - *Material Used:* 500 tons of virgin plastic.
 - *Emissions Factor (Virgin):* 2.4 tCO₂e/t.
 - *Baseline Emissions* = 500 t × 2.4 tCO₂e/t = 1200 tCO₂e.

- **New Scenario (After Substitution):**

- *Material Mix: 300 tons of virgin plastic and 200 tons of recycled plastic.*
- *Emissions Factor (Recycled): 1.5 tCO₂e/t.*
- *New Emissions = (300 t × 2.4 tCO₂e/t) + (200 t × 1.5 tCO₂e/t) = 720 + 300 = 1,020 tCO₂e.*

- **Annual Emissions Reduction:**

Reduction = Baseline Emissions - New Emissions = 1,200 – 1,020 = 180 tCO₂e.

Step 6: Waste Reduction and Recycling

Action Taken

Wesley focused on reducing waste and enhancing recycling efforts to minimise emissions from waste treatment.

Key Activities

- **Waste Management:**
 - Implemented a waste segregation program.
 - Established partnerships with recycling companies to manage waste more sustainably.

Numerical Example

- **Waste Before:** 500 tons per year, with 250 tons going to landfill.
- **Waste After:** 400 tons per year, with 50 tons going to landfill (the rest recycled or reused).
- **Landfill Emissions:** If landfill emissions are 0.5 tCO₂e per ton of waste, the reduction in emissions from waste management would be (250 - 50) × 0.5 = 100 tCO₂e.

Key Outcomes

1. **Systematic Management:** Successfully established an EnMS aligned with ISO 50001, providing a robust framework for continuous improvement.

2. **Measurable Energy Reduction:** Equipment upgrades and process optimisation initiatives led to a verified reduction in energy consumption of over 200 MWh annually.
3. **Strategic Impact:** Wesley demonstrated that decarbonisation and cost-efficiency are linked. The energy efficiency measures not only reduced operational costs but also lowered the baseline demand, making the 1 MW solar array more impactful as it now covers a larger percentage of the facility's needs.
4. **Supply Chain Decarbonisation:** The shift towards recycled materials and improved waste management significantly decreased the company's Scope 3 emissions, strengthening its position as a sustainable supplier.

This case study illustrates how a chemical manufacturer can implement a range of carbon reduction strategies, from energy management to waste reduction, aligning with international standards and contributing to a lower carbon emission level.

Case Study 3: Supply Chain Decarbonisation

Overview

Zara, the Supply Chain Senior Manager at Company Lighthouse, an electrical product manufacturer, was tasked with tackling the company's largest source of emissions. An initial analysis revealed that 75% of the company's total carbon footprint was Scope 3, with the top 50 strategic suppliers accounting for the majority of these supply chain emissions. Her mission was to not just engage these partners, but to achieve a measurable reduction in their shared footprint.

This case study explores how Zara navigated the complexities of integrating carbon considerations into the supply chain, overcoming resistance, and fostering cooperation for a sustainable future.

Measure 1: Updating Procurement Policy

Action Taken

Zara began by working with CFO and Finance team and revising Company Lighthouse's procurement policy to include carbon emissions disclosure and performance as key performance indicators (KPIs).

Key Activities

- **Policy Development:**
 - Integrated environmental performance into supplier selection criteria, including carbon emissions data.
 - Introduced financial incentives for suppliers demonstrating lower carbon emissions, like better payment terms or priority in contract renewals.
- **Prioritised Engagement:**
 - Focused initial efforts on the top 50 suppliers identified in the emissions "hot spot" analysis, rather than a blanket approach.

Challenges Faced

- **Supplier Pushback:** Some suppliers resisted disclosing their carbon emissions, fearing it might reveal inefficiencies or lead to competitive disadvantages.

Overcoming Challenges

***The Showdown:** During a high-stakes meeting with their primary supplier of aluminium casings, one of the top five emissions sources, Zara faced a standoff. The supplier threatened to pull out over the new reporting requirements. She calmly presented data showing how their direct competitors were already marketing their use of low-carbon aluminium, gaining a potential market edge. After an intense negotiation, the supplier agreed to a pilot program, realising the long-term strategic benefits.*

- **Engagement and Education:** Zara organised a series of workshops to educate suppliers on the importance of carbon management:
 - Highlighted how carbon disclosure could improve their market position.
 - Engaged carbon management specialists to equip suppliers with the knowledge and tools for carbon emission quantification.
- **Information Collection Template:**
 - Zara introduced a standardised template for carbon disclosure – see more details at Masure 2.
- **Phase-In Approach with a Transitional Period:**
 - To ease suppliers into the new requirements, Zara implemented a phased approach with a transitional period. This allowed

suppliers time to adapt, gather necessary data, and make improvements without immediate pressure, ensuring a smoother transition and reducing initial resistance.

Measure 2: Carbon Information Collection

Action Taken

Zara designed a formal template for collecting carbon information from suppliers, planning to integrate this into the existing supply chain management system.

Key Activities

- **Two-Tiered Template Creation:** Developed a phased approach to data collection.
 - **Tier 1 (Broad Engagement):** A simple template for all suppliers focusing on corporate-level emissions (Scope 1 & 2) and qualitative reduction plans.
 - **Tier 2 (Strategic Suppliers):** A more detailed template for the top 50 suppliers requesting the **Product Carbon Footprint (PCF)** for the specific components supplied to Company Lighthouse.
- **Platform Integration:** Recognising the complexity of collecting and managing data from hundreds of suppliers, Zara's team decided to develop a lightweight supply chain sustainability platform with standardised questionnaires and benchmarking tools, integrating the verified data into their internal ERP system.

Challenges Faced

- **Data Inconsistency:** Suppliers provided data in different formats, making aggregation difficult.
- **Reluctance to Share:** Some suppliers were hesitant to share detailed emissions data, citing confidentiality concerns.

Overcoming Challenges

- **Standardisation:** Provided clear instructions and examples on how to complete the template, ensuring consistency.
- **Trust-Building:** Assured suppliers of data confidentiality through legal agreements and demonstrated how the data would be used only for internal benchmarking and improvement.

Measure 3: Integrating Carbon into Supplier Due Diligence

Action Taken

Zara made carbon performance a critical part of the due diligence process during supplier audits.

Key Activities

- **Audit Framework:** Revised the supplier audit checklist to include:
 - **Carbon Management Systems:** Evaluation of the supplier's policies and systems for managing carbon.
 - **Data Verification:** Cross-checking reported Product Carbon Footprint (PCF) data against production processes during on-site visits.
 - **Reduction Efforts:** Evidence of concrete initiatives to reduce emissions, not just plans.
- **Incentivising Improvements:** Provided feedback and recommendations for improvement, with potential for increased business volume for those making significant progress.

Challenges Faced

- **Audit Pushback:** Some suppliers viewed the carbon audit as an additional burden or an unnecessary cost.
- **Complexity:** Assessing carbon performance required new expertise within the audit team.

Overcoming Challenges

- **Value Proposition:** Zara communicated how carbon audits could lead to operational efficiencies and cost savings for suppliers, demonstrating successful case studies where carbon management led to financial benefits.
- **Training:** Trained the internal audit team on carbon accounting and management, ensuring they could provide valuable insights to suppliers.

Key Outcomes

1. **High Supplier Engagement:** The new policy and phased approach led to a 90% participation rate from the top 50 strategic suppliers within two years.

2. **Actionable Data and Insights:** The sustainability platform now provides real-time dashboards on supplier performance, including verified PCF data for over 200 critical components.
3. **Measurable Emissions Reduction:** The combination of engagement and due diligence has resulted in a verified 8% reduction in emissions intensity from the targeted supplier group, putting Company Lighthouse on track to meet its Scope 3 reduction goals.

Zara's journey at Company Lighthouse showcases the importance of strategic supplier engagement, overcoming resistance through education, collaboration, and demonstrating mutual benefits, leading to a more sustainable supply chain.

Chapter 7: Lightweight Digital Solutions for Carbon Management in Manufacturing SMEs

Carbon management might seem like a difficult task, especially if you're running a small or medium-sized manufacturing enterprise (SME) with little to no experience in this area. However, with the right tools, which many SMEs already have access to, managing your carbon emissions can become part of your daily business operations, saving you time and money.

Why should you care about managing your carbon emissions? Here are some compelling reasons:

- **Compliance:** Regulations are getting stricter. Digital tools help you stay compliant without breaking the bank.
- **Efficiency:** You can track where you're using energy or resources inefficiently and make improvements.
- **Customer Trust:** More consumers and business partners are looking for sustainable practices. Showing your efforts can boost your business's reputation.
- **Cost Savings:** Reducing waste and energy consumption directly impacts your bottom line positively.

This chapter will guide you through how to leverage everyday digital tools for effective carbon management with minimum or even nil additional cost.

7.1 Leveraging Existing Tools for Carbon Management

Let's dive into how you can use tools you might already be familiar with:

- **Leveraging Templates**
 - It is difficult to build anything from ground zero. You may wish to look for templates that can guide you on what data to collect and how to present it.
 - Look for templates from regulatory bodies, such as the communication template for EU CBAM purposes (as set out in the *Carbon Management Guidelines for EU CBAM Compliance*), or global organisations such as WRI's calculation tools based on GHG Protocol.

- If your customers are industry leaders, they might provide you with templates or data structures for sustainability management including carbon monitoring and reporting.
- Adopting these can make your reporting process smoother and align with market expectations.
- **Microsoft Office & Google Apps:**
 - Start by setting up a simple spreadsheet where you can record your energy usage, waste production, and emissions. Use formulas to calculate your carbon emissions over time.
 - **Macros and Scripts:** Don't know coding? No problem! Use pre-built macros or simple scripts to automate data entry or dataset generating, reducing errors and saving time. For example, some companies may consider an automatic solution to generating XML / CSV / XLS files for compliance and/or data communication with the customers.
 - **Collaboration:** Share your spreadsheets through OneDrive, SharePoint, or Google Drive so everyone in your team can contribute and access the latest data.
 - **Visual Reporting:** Tools like Power BI or Google Data Studio can turn your data into easy-to-understand graphs and dashboards. This helps in communicating your progress to stakeholders.
- **ERP/SAP Systems:**
 - **Data Source:** Your ERP system already tracks a lot of your business activities. Use this data to calculate emissions from energy use, material usage, production, etc.
 - **Customisation:** Work with your IT team or consultants to customise your ERP to include carbon metrics. For example, you can track how much energy is used per product manufactured.
 - **Reporting Tools:** Many ERP systems, like SAP Business One, have built-in reporting features that can be tailored for environmental reporting. Use these to generate compliance reports.
 - **Integration:** Integrate your ERP data with Excel or Google Sheets for further analysis or with external tools for more detailed carbon accounting.

7.2 Implementation Steps for SMEs

Here's how to get started:

- **Data Collection:**
 - Automate as much data collection as possible. Use Google Forms for easy input from employees or set up macros in Excel to pull data from your ERP system.
 - Regularly update your data to keep your carbon management up to date.
- **Data Analysis:**
 - Use pivot tables, charts, or visualisation tools to make sense of your data. Look for trends, anomalies, and areas for improvement.
- **Employee Engagement:**
 - Train your employees on why carbon management matters and how to use the tools. Encourage them to participate by providing simple, user-friendly interfaces for data entry.
- **Reporting and Compliance:**
 - Set up automated reports that align with regulatory standards or customer requirements. Use templates provided by authorities or industry leaders.

7.3 Future Trends and Upgrades

As technology evolves, here are some trends to keep an eye on:

- **AI for coding:** Many SMEs (even larger companies) may face lack of in-house IT specialists for coding or other IT tasks. You may leverage AI tools such as Cursor or Windsurf to facilitate the tasks.
- **Third-Party Applications:** Look for apps that can easily integrate with your existing systems for more sophisticated carbon management.
- **IoT for Data Monitoring:** IoT devices can provide real-time data on energy use, emissions, and other metrics, enhancing your data accuracy.
- **Blockchain or Centralised Platform for Supply Chain Transparency:** Many mega groups / larger companies have already adopted **Blockchain or Centralised Platform** for supply chain transparency and management. You may wish to know more about it and work out a solution responding to the data requests.

Carbon management doesn't have to be complex or expensive for SMEs. By leveraging tools you're already using, like Microsoft Office, Google Apps, or your ERP system, you can start making a difference in your environmental impact today. Remember, every small step towards sustainability counts, and with these digital solutions, you're well-equipped to make those steps count.

Chapter 8: Guidebook Recap and Call to Action

Recap of Key Points

In this guidebook, we have covered a comprehensive journey through the essentials of carbon management for Hong Kong Manufacturing Enterprises (HKMEs):

- **Understanding Carbon Management:** We began with demystifying what carbon and carbon footprint mean, emphasising the distinction between direct and indirect emissions, and introduced various standards for quantification and reporting.
- **Carbon Management Systems (CMS):** We explored how CMS integrates with existing management systems like ISO 14001 and ISO 50001, promoting continuous improvement, planning, stakeholder engagement, and verification to ensure credibility and compliance.
- **Verification and Certification:** The importance of independent verification was highlighted, detailing how it confirms the accuracy of emissions data and supports regulatory compliance and stakeholder trust.
- **Global Trends and Compliance:** We discussed the emerging trends towards carbon pricing, the EU's Carbon Border Adjustment Mechanism (CBAM), and how these influence HKMEs' operations and market competitiveness.
- **Strategic Recommendations:** Tailored advice for top management on integrating carbon management into business strategy, overcoming decision-making biases, and setting criteria for effective carbon management initiatives.
- **Sector-Specific Guidance:** Detailed case studies and strategies for specific sectors, showing how to manage carbon in industry-specific contexts.
- **Practical Implementation:** We provided step-by-step guidance on setting up or enhancing CMS, reducing emissions, and preparing for compliance with current and future regulations.
- **Digital Solutions:** The guidebook outlined lightweight digital tools to streamline carbon management processes, particularly for SMEs.

Call to Action

For HKMEs:

- **Embrace Carbon Management:** Start or enhance your carbon management practices today. Use this guidebook as your roadmap to reduce emissions, improve sustainability, and prepare for regulatory compliance.
- **Set Ambitious Targets:** Commit to science-based targets through initiatives like SBTi. Aim not just for compliance but for leadership in sustainable manufacturing.
- **Educate and Engage:** Train your staff at all levels about carbon management. Engage your supply chain partners in your carbon reduction journey.
- **Implement and Innovate:** Utilise the digital tools and sector-specific strategies provided in this guidebook. Innovate in your processes to lower your carbon emissions.
- **Stay Informed:** Keep abreast of global trends, regulatory changes, and technological advancements in carbon management. Adapt your strategies as necessary to remain competitive.
- **Seek Verification:** Have your carbon management efforts independently verified to enhance credibility, meet regulatory requirements, and attract eco-conscious consumers and investors.

For Industry Leaders and Stakeholders:

- **Promote Collaboration:** Work with industry peers to share best practices, collaborate on supply chain initiatives, and push for industry-wide sustainability improvements.
- **Advocate for Policy:** Engage with policymakers to ensure that regulations support sustainable business practices while maintaining a level playing field.
- **Invest in Sustainability:** Investors, consider the carbon management capabilities of companies as a key criterion for investment, driving the market towards sustainability.

For Government and Regulatory Bodies:

- **Support SMEs:** Provide resources, incentives, and clear guidelines to help SMEs manage carbon effectively.

- **Harmonise Regulations:** Work towards global harmonisation of carbon management standards and regulations to prevent carbon leakage and encourage global participation in carbon reduction.

For All:

- **Act Now:** The time for action is now. Each step towards carbon management not only contributes to global climate efforts but also positions your enterprise for future success in a carbon-conscious world.

List of Abbreviations

Abbreviation	Full Form
AR4	Fourth Assessment Report (IPCC)
AR6	Sixth Assessment Report (IPCC)
BEMS	Building Energy Management System
CBAM	Carbon Border Adjustment Mechanism
CH ₄	Methane
CMS	Carbon Management System
CO ₂	Carbon Dioxide
CO ₂ e	Carbon Dioxide Equivalent
DFSS	Design for Six Sigma
EMS	Environmental Management System
EnMS	Energy Management System
EPD	Environmental Product Declaration
ERP	Enterprise Resource Planning
ETS	Emissions Trading System
EU ETS	European Union Emissions Trading System
GHG	Greenhouse Gas
GWP	Global Warming Potential
HFCs	Hydrofluorocarbons
HKMEs	Hong Kong Manufacturing Enterprises
HVAC	Heating, Ventilation, and Air Conditioning

ICCN	Institute for Climate and Carbon Neutrality
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organisation for Standardization
LCA	Life Cycle Assessment
LDAR	Leak Detection and Repair
NCV	Net Calorific Value
N₂O	Nitrous Oxide
PAS 2060	An Internationally Applicable Standard for Carbon Neutrality
PCF	Product Carbon Footprint
PFCs	Perfluorocarbons
PPA	Power Purchase Agreement
R&D	Research and Development
SBTi	Science Based Targets initiative
SMEs	Small and Medium-Sized Enterprises
SOP	Standard Operating Procedure
TSF	Trade and Industrial Organisation Support Fund
tCO₂e	Metric Ton of Carbon Dioxide Equivalent
UNFCCC	United Nations Framework Convention on Climate Change
VFDs	Variable Frequency Drives
WBCSD	World Business Council for Sustainable Development
WRI	World Resources Institute

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