2023 Strategic Roadmap for Greenhouse Gas Emissions Data and Analytics

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GHG management is a cross-enterprise endeavor that requires CIO attention and expertise. This data and analytics roadmap enables your enterprise to accurately report and manage GHG emissions in order to make progress on sustainability targets and comply with environmental regulations.

Overview

Key Findings

- Greenhouse gas (GHG) emissions data and analytics must enable the right teams to identify and take the most effective actions to reduce emissions.
- The GHG emissions management software market is early in its evolution, with no established leaders and significant technology and vendor risks.
- Regulations mandating GHG reporting are driving the need for “investment grade” data that can be audited and assured by third parties.
- Enterprises that rush GHG management selection and implementation without a data and analytics roadmap risk wasting time and money on solutions that fail to meet expectations.
- There are many different categories of direct and indirect GHG emissions, and data availability is emerging piecemeal, increasing the complexity of calculating and managing emissions.

Recommendations

CIOs establishing their enterprise roadmaps for GHG data and analytics must:

- Create a cross-functional sustainability team to prioritize data collection efforts on the most material sources of emissions.
- Define and document their target GHG data and analytics architecture and capabilities before considering GHG vendors, and carefully vet vendor delivery experience and viability in their selection process.
- Meet requirements for external assurance of reported emissions by establishing GHG data governance as an enterprise-level discipline and by assigning data stewards to be responsible for data collection and data quality.
- Provide decision makers with analytics capabilities for evaluating and selecting optimal reductions based on cost, timing and magnitude.
- Monitor and engage GHG data-sharing initiatives in the value chain to improve Scope 3 emissions capabilities and to enable product carbon footprint and decarbonization capabilities.

Strategic Planning Assumptions

By 2026, 80% of global enterprises with net zero goals will restate interim milestones under stakeholder scrutiny of progress and due to underinvestment.

More than half of the enterprises that restate interim milestones will lack the analytics capabilities necessary to identify and prioritize reduction measures.

Introduction

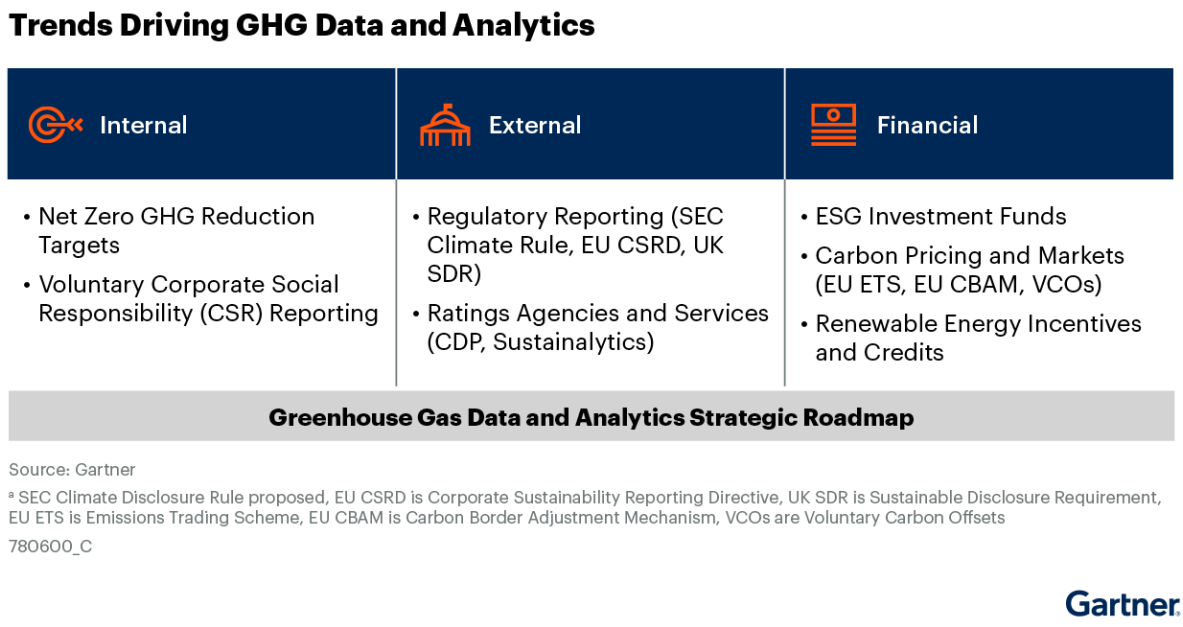
Enterprise commitments to reduce GHG emissions continue to grow. Over 2,800 companies have set science-based targets that are aligned with the Paris Agreement. [1] Plus, many more companies set emissions reduction goals based on their own ambitions. In addition, a host of regulations in various regions now mandate reporting of GHG emissions, including with external assurance.

CIOs must provide sound GHG emissions data and analytics capabilities to enable their organizations to successfully deliver on climate commitments. Powerful analytics are essential for mapping, implementing, and investing in emissions reduction pathways. Ninety percent of business leaders responding to the 2022 Gartner Sustainability Opportunities, Risks and Technologies Survey agreed that digital technology is essential versus not essential to improving sustainability impact. [2]

However, our interactions with CIOs demonstrate that GHG emissions data and analytics are not being developed as a strategic technology in many organizations. Instead, CIOs are scrambling to catch up with sustainability leaders who want to rush into vendor solution selection in order to reduce administrative burden, alleviate staff burnout and allocate limited resources to carbon reduction planning.

What is clear is that CIOs must get a grip on the GHG data and analytics issue as pressure to report emissions and to demonstrate progress against reduction targets increases over time. This pressure is being driven by ratings agencies, regulatory expectations and financial markets, among others (see Figure 1).

Figure 1: Trends Driving GHG Data and Analytics



Source: Gartner

[a] SEC Climate Disclosure Rule proposed, EU CSRD is Corporate Sustainability Reporting Directive, UK SDR is Sustainable Disclosure Requirement, EU ETS is Emissions Trading Scheme, EU CBAM is Carbon Border Adjustment Mechanism, VCOs are Voluntary Carbon Offsets

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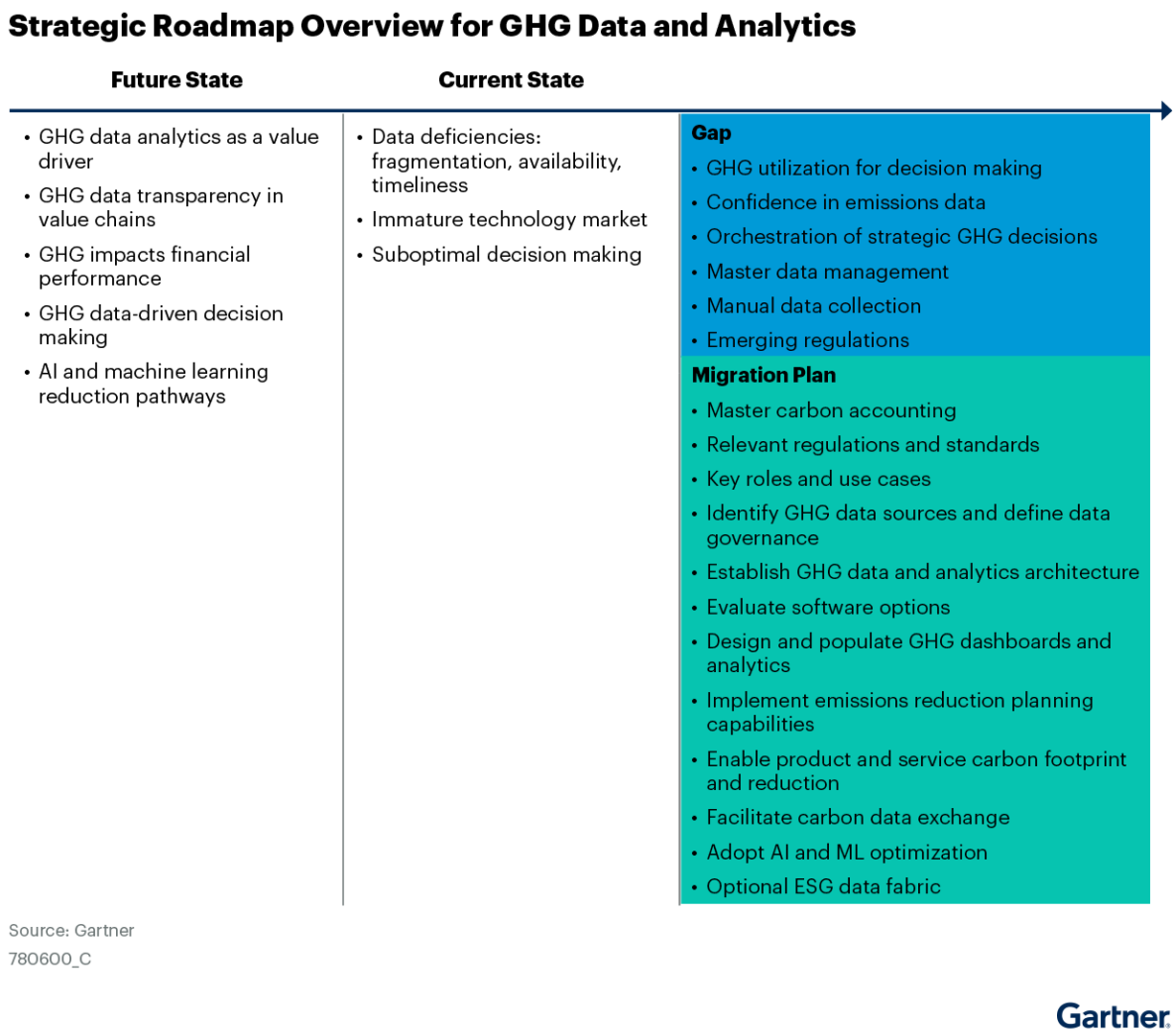
The purpose of this research is to provide CIOs with a strategic roadmap as to how to develop GHG data and analytics capabilities over time. This roadmap focuses on GHG emissions generated by the enterprise and value chain (Scopes 1 and 2 and aspects of Scope 3). It does not include financial services concerns such as financed emissions and climate risks of an investment portfolio (see Figure 2).

Figure 2: Strategic Roadmap Overview for GHG Data and Analytics

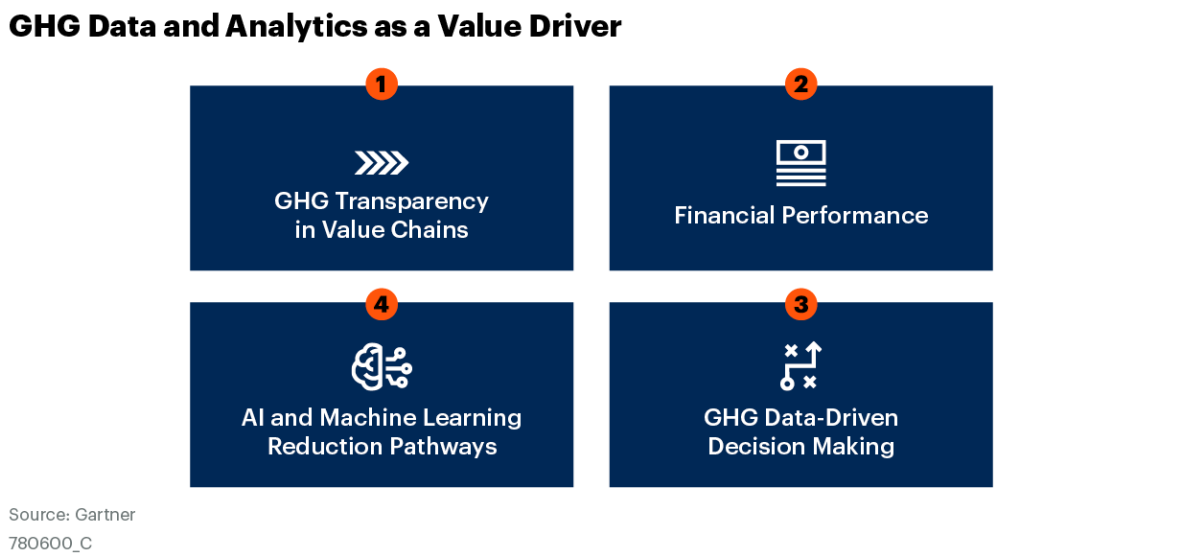


Future State

GHG Data and Analytics as a Value Driver

By the end of the decade, GHG data and analytics will be a driver of strategic value — or loss — for enterprises. Granular GHG emission data will be needed in response to four macro trends: (1) demands for value chain transparency, (2) linking emissions to financial reporting, (3) integration of emissions into strategic and operational decision making, and (4) leveraging AI and machine learning as enablers of the energy transition (see Figure 3).

Figure 3: GHG Data and Analytics as a Value Driver



GHG Data Transparency in Value Chains

By the end of the decade, visibility of emissions performance will be available at both an enterprise and a product/service level. Moreover, this data will be dynamic, adjusting for changes in the operating environment across the value chain. This will result in more transparency, including GHG emissions disclosures in financial reports, annual ESG reporting that includes progress in reducing emissions across value chains, and product-level carbon footprint data. CIOs need to ensure that the underlying datasets are in place to support these disclosures.

Capturing Scope 3 value chain data means that challenges around data sharing, management and capture must be overcome. CIOs also need to help users understand the level of confidence and accuracy of performance data. This data not only has the potential to inform raw material, shipping route and manufacturing decisions, but will also impact consumer product preferences and brand loyalty.

Initial value chain transparency initiatives are in pilot. Projects include Catena-X for the automotive industry and the cross-industry Pathfinder Framework.

GHG Impacts Financial Performance

GHG performance will directly impact financial performance by 2030. Historically, investors have put pressure on enterprises to set emissions reduction goals and understand climate change risks, using mechanisms such as the Taskforce for Climate-Related Financial Disclosures (TCFD). [3] As more data becomes available, investors will also be able to track GHG reduction progress.

Increasingly, countries and trading blocs are putting GHG regulations in place. Traditionally this has been in the form of carbon trading markets, such as the EU's emissions trading scheme. But we are now seeing the EU put in place the Carbon Border Adjustment Mechanism (CBAM), which imposes payments for selected imports into the EU trading bloc based on their GHG emissions (see Note 1). Another example is the EU Digital Product Passport [4] initiative, which will require sustainability impact data to be available in a digital format for products sold in the EU. These regulations are expanding over time as policymakers become more aggressive in their efforts to combat emissions.

For CIOs, providing accurate GHG emissions data is paramount, as this will have a direct impact on enterprise financial performance, regulatory compliance and license to operate in certain jurisdictions. CIOs must plan for how they will incorporate GHG data for financial decision making.

GHG Data-Driven Decision Making

Effective decision making to reduce emissions and make progress toward goals relies on having the right data at the right time. The ultimate objective of GHG data and analytics is to support the enterprise in meeting emissions reduction goals using the most financially effective pathways possible. Although combined financial savings and GHG reductions are easily attained through energy conservation in the initial stages of an emissions reduction program, investments will be needed to meet ambitious longer-term goals.

CIOs and their teams need to map GHG data requirements for a range of decisions — from tactical to strategic. They also need to assess which types of decisions can be automated and which need human oversight.

AI and Machine Learning Reduction Pathways

Machine learning and AI will become essential enabling technologies for mastering the complexities of identifying emissions reduction opportunities and establishing optimal reduction pathways for achieving targets. AI can also play a role in data collection, management and emissions calculations.

Trained models will be able to quickly select, for example, the best renewable energy options based on price, availability and contribution to GHG goals. CIOs will need to make sure that high-fidelity data sources are continuously updated for optimal execution. AI can also be used to reduce the reporting burden, uplifting executive leaders and sustainability professionals from data processing and wordsmithing to action.

Current State

Limited GHG data and analytics capabilities make it difficult for enterprises to achieve their GHG emissions reduction goals. This is a precarious position, and CIOs must act by first understanding the challenges, and second by implementing a GHG data and analytics roadmap. There are two principal challenges with the current methods of managing GHG data — data availability and decision making.

Data Deficiencies

The data needed to calculate GHG emissions is distributed across multiple different systems and platforms. In low-to-mid maturity organizations, sustainability professionals often use email to collect raw data and then use spreadsheets to calculate emissions. This approach does not scale and bogs down sustainability professionals in data chasing and administrative work.

Many organizations start by focusing on annual GHG emissions reporting. This historical focus shows past performance, but it is not current enough to monitor progress and take corrective actions when necessary. The root causes of GHG data deficiencies are fragmentation, availability and timeliness, and these problems are compounded by the fact that the market for GHG reporting and management software is crowded, overhyped and immature:

- **Fragmentation:** GHG is not a standard data entity found in existing systems of record. It must be calculated using raw data from a variety of systems, sources and organizations.
- **Availability:** The raw data to calculate emissions is typically not available for every emissions source across every category and scope of emissions. This is especially the case for some Scope 3 emissions.
- **Timeliness:** Considerable time can elapse between when emissions occur and when the data is available to calculate them. This makes it difficult to provide situational awareness and inform operational decisions.

Executive leaders typically view GHG emissions data with the same confidence as they do financial data. However, the error bar associated with GHG accounting varies based on the calculation methodologies selected, as put forward by the GHG Protocol. [5] When source data is not available, estimates based on acceptable methodologies and third-party datasets are necessary.

> **"Just as we have a financial budget, we have a GHG emissions budget that we must adhere to on a monthly basis."**
>
> — *Supply chain leader*

Immature Technology Market: The GHG emissions management and reporting market is crowded with vendors claiming to have complete solutions. But most solve only part of the problem, with differing degrees of accuracy. Vendors also focus on features and functionality attractive to sustainability teams when demonstrating their technology, rather than on the technical underpinnings. CIOs must provide technical expertise when evaluating solutions, with particular attention to data and analytics capabilities and architecture.

CIOs can get started by mapping how GHG emissions data is currently collected by the organization. Draw up a set of priorities as to where GHG data in decision making has the most impact.

Suboptimal Decision Making

Gartner predicts that by 2026, 80% of global enterprises with net zero goals will restate interim milestones under stakeholder scrutiny of progress and due to underinvestment. More than half of the enterprises that restate milestones will lack the data and analytics capabilities needed to select optimal reduction pathways.

Enterprises often take actions on GHG emissions that are most readily available and easy to implement, but not necessarily those that are most effective in delivering significant emissions reductions. Executive leaders need to take a strategic approach in order to identify emissions reduction pathways. However, their decision making is impaired due to shortcomings in data and analytics. CIOs must fill the gap by building a GHG emissions data and analytics infrastructure that makes the right information available at the point of decision. This includes understanding current performance, but also having the ability to forecast future performance based on strategic decisions on investment and positioning of the product portfolio. This level of data granularity is not currently available in most enterprises.

Decision making in enterprises is also often siloed, with a lack of orchestration leading to poor capital and operational efficiency. For example, a logistics leader could spend $500,000 on a green transportation solution delivering a top-line 5% GHG emissions saving; however, the same money could have been spent on manufacturing and delivered 10% GHG emissions savings. Lack of data results in poor orchestration and suboptimal financial performance of GHG reduction measures.

Gap Analysis and Interdependencies

CIOs must be aware of gaps, independencies and potential traps before migrating from the current to the future state. The gaps will vary based on the maturity of GHG data collection. Assess the following gaps and interdependencies for your organization:

- **Decision Making —** Assess the extent to which GHG emissions are utilized in decision making today. Define the types of decisions where leveraging GHG emissions data can have an outsized impact on making progress toward emissions reduction goals.
- **Confidence —** In collaboration with the sustainability team, identify the confidence that can be placed in current GHG emissions datasets. Check if the accuracy of data needed can support decisions today and meet current and anticipated future regulations.
- **Orchestration —** Check how strategic GHG decisions are orchestrated across the organization to optimize emissions reduction pathways. Identify where there are silos in decision making. Probe for additional use cases beyond reporting and management, such as creating product carbon footprints, carbon labeling and sharing carbon data across the value chain.

- **Master Data Management** — Review the adequacy of current master data management strategies for collating and aggregating GHG emissions data.
- **Bottlenecks** — Identify points of manual data entry that become bottlenecks to understanding performance. Assess opportunities for automation.
- **Urgency** — Collaborate with legal, sustainability and finance teams to understand how data quality expectations are changing based on regulatory pressure. Profile the regulatory landscape, and use this as an input when developing the business case for solutions.

Migration Plan

CIOs and their teams that follow this migration plan will progress through three major phases, as illustrated below.

Short Term

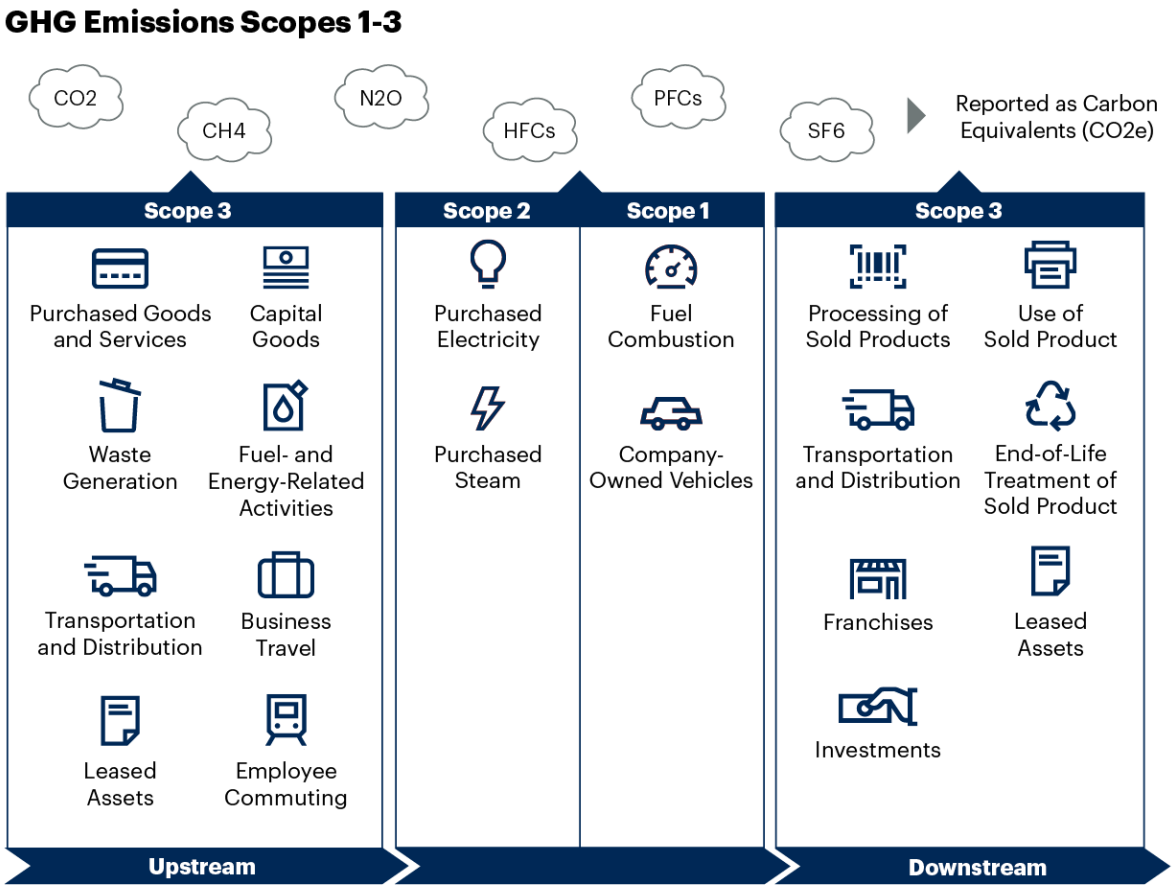
This portion of the roadmap consists of the action executive leaders must take to establish the direction and scope of the GHG data and analytics roadmap. The outcome of this phase is initial data collection and the foundational analysis necessary to reliably report GHG emissions, while meeting external assurance requirements for reported data.

Master Carbon Accounting

CIOs must track emissions (measured in tonnes of CO2 equivalent) for the enterprise and value chain. Start by familiarizing yourself with the GHG Protocol, which is the broad accounting framework to capture and calculate emissions. Think of these emissions as a debit in the enterprise carbon account. CIOs also need to capture data on any credits created using renewable energies, from the purchase of voluntary or mandatory carbon offsets, or other reduction measures.

This data is needed retrospectively for ESG reports that show both overall emissions, as well as the measures and actions taken to reduce them. Plus, a forecast position is needed to understand future performance and pathways to achieve goals. Figure 4 shows the different reporting categories defined by the GHG protocol. Note that each category has different reporting methodologies, ranging in accuracy. Each category also has distinct data collection requirements.

Figure 4: GHG Emissions Scopes 1-3



Source: Gartner
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An aggregated view of emissions does not enable action. CIOs must be able to report emissions data back to point of origin. This enables the pareto principle to be applied, so that the enterprise can focus efforts on the most significant causes of emissions, commonly referred to as “emissions hot spots.” To empower decision making, it is useful to give a breakdown of emissions by:

- Business unit or region
- Function or departmental area
- Business activity (for example, travel)
- Supply chain
- Assets or facilities

- Product

The outcome of sound GHG emissions accounting is a carbon ledger that tracks emissions over time, enabling trend and regression analysis.

It is also prudent for CIOs to familiarize themselves with enterprise emissions reduction goals as these will need to be built into budget mechanisms. Not all enterprises collect end-to-end GHG emissions data today; therefore, estimates may need to be used in some instances.

Identify Relevant Regulations and Reporting Standards

ESG reports are often assured by third-party providers against reporting standards that define data quality or specific metrics. CIOs must familiarize themselves with the following data collection and reporting standards (see A Communicator's Guide to ESG Reporting Frameworks).

- **GRI:** The Global Reporting Initiative provides reporting standards for a range of issues from GHG emissions to biodiversity to tax and waste. Companies select the most relevant standards based on a materiality assessment. [6]
- **SASB:** The Sustainability Accounting Standards Board traditionally has enabled sustainability disclosures about risks and opportunities. The IFRS Foundation is now responsible for SASB. [7]
- **TCFD:** The Taskforce for Climate Related Disclosures provides a framework for enterprises to account for and understand future climate change risks. [3]
- **IFRS:** The International Sustainability Standard (ISSB) is finalizing several reporting requirements including climate risk and Scope 3 reporting. [8]
- **CDP.** Companies can choose to make voluntary submissions to the CDP on an annual basis on issues such as carbon, water and forests. These submissions are scored and publicized to stakeholders. [9]

Examples of relevant regulations that will impact GHG emissions reporting are:

- **SEC:** The U.S. Securities and Exchange Commission is proposing that companies will be required to disclose material climate risk to their business and GHG emissions data. [10]

- **UK Companies Act:** Enterprises in the U.K. subject to the 2006 Companies Act must disclose the GHG emissions from their operations. [11]
- **CSRD:** The EU's Corporate Sustainability Reporting Directive strengthens rules on enterprise environmental and social reporting. [12]

Identify Key Roles and Use Cases

Many of our client interactions focused on GHG are initially triggered by concerns about reporting enterprise emissions. However, requirements for GHG data and analytics across various functions are rapidly emerging (see Table 1).

Table 1: Key GHG Roles and Use Cases

(Enlarged table in Appendix)

Role	Example Data and Analytics Use Case
Board of Directors	Provide governance and oversight of emissions measurement and reduction programs.
Executives	Ensure progress toward climate ambitions.
Audit and Assurance	Ensure data integrity, quality and governance for assurance by third-party examiners.
Finance	Evaluate and select optimal GHG cost-reduction options.
Compliance	Track regulatory landscape and meet disclosure requirements.
IT	Measure and reduce emissions from enterprise IT assets and operations.
Research and Development	Design carbon out of products.
Supply Chain	Reduce carbon in purchased goods and services.
Real Estate	Measure and reduce emissions from corporate facilities.
Shipping and Logistics	Compare GHG intensity of different shipping options.
Marketing	Identify market opportunities and options for low-carbon products.
Employees	Use carbon calculators to measure and reduce work-related emissions (e.g., commuting, travel)
Benefits	Offer incentive payments for employees investing in renewable energy.

Source: Gartner

Identify Data Sources

Use this information to prioritize the types of data challenges that need to be addressed immediately and those that can wait. As part of this process, an inventory of current data sources should be collected:

- **Operational Data** — Identify energy data for operations. Obtain emission factors, and review the processes in place to update factors and restate datasets. Clarify how source data (utility and fuel bills) are used to collect, reconcile and verify data. For a list of utility bill management vendors, see Note 3.
- **Value Chain Data** — Assess the data needed from partners upstream and downstream in the value chain. Define how the data will be collected, including frequency and accuracy required. Review how this data will be integrated into operational decisions such as supplier selection. As Scope 3 emissions reduction relies on supplier goodwill, check that the data is not being used for commercial purposes that could impact supplier competitive positioning.
- **Third-Party Data** — Catalog the sources of third-party data used, such as emissions factors used to convert energy units to CO2e. In some cases, it may be necessary to fill gaps in data availability by using reference datasets such as Life Cycle Assessment (LCA) datasets available in the public domain from academic sources or information services. [13]

Data Governance

Document data management and control processes to support third-party assurance, including the ability to track and review any changes to data values such as error corrections, end-of-period adjustments or changes in emissions factors. Define the roles, responsibilities and procedures for GHG data management. Define the level of board oversight for data management and escalation pathways and scenarios.

Midterm

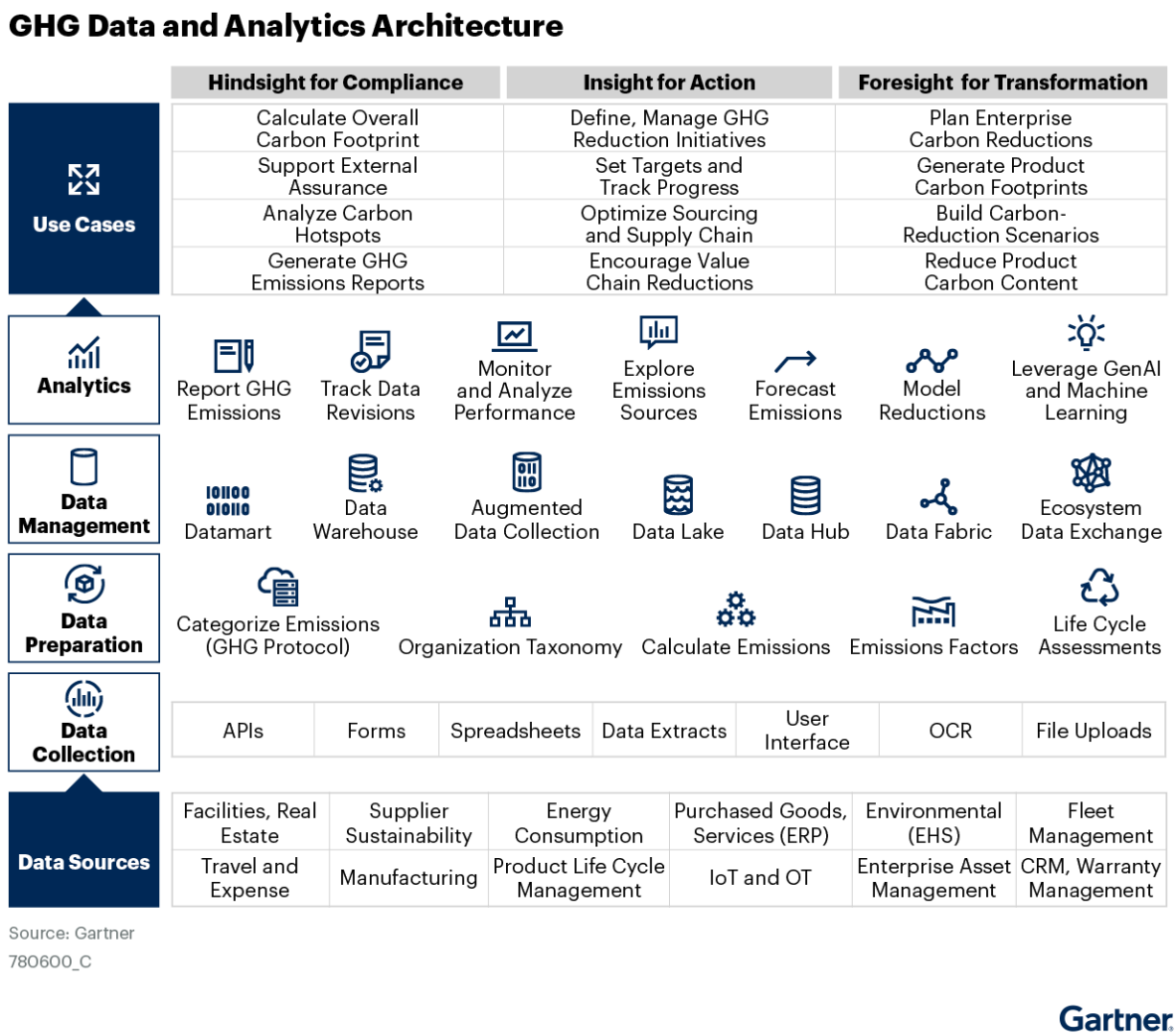
Midterm actions will lead to GHG data and analytics that provide visibility into GHG performance on an ongoing basis. This includes providing teams with a dashboard so they can view and analyze their performance, and diagnose the sources of emissions so they can begin adopting a solution-oriented approach to reducing emissions. The shift is from ad hoc reporting to consistent reporting over time. Data is used for hindsight to understand historic performance, but also insight, for immediate decision making.

Establish GHG Data and Analytics Architecture

CIOs and their teams need to map the capabilities of a robust data architecture (see Figure 5). These include:

- Aggregation of diverse and distributed dataset to calculate GHG emissions, which includes:
  - Capture energy consumption data directly from energy providers, using APIs to pull billed data and reconciling billed information with energy management and optimization systems.
  - Record metrics from direct emissions monitoring systems for Scope 1 emissions, such as fugitive emissions or smokestack effluents, by leveraging IoT or OT devices. (Note that non-CO2 emissions need to be converted to CO2 equivalents using global warming potentials.)
  - Verify Scope 3 data by material category for suppliers and then aggregate.
- Assess opportunities to move away from manual data entry by using APIs. Build in automated error checking, highlighting datasets that need further inspection and correction.
- Put in place classification systems to ensure that data is aggregated into the right categories as per the GHG protocol guidelines. Make sure that the metadata is categorized and that there is a clear audit trail for assurance purposes.
- Leverage workflow solutions where manual data entry will be relied on. Assign data stewards responsible for timely provision of accurate data in their areas of responsibility.
- Some enterprises will also rely on carbon offsets to reduce GHG emissions. CIOs need to integrate these credits into their carbon accounting. They need to show traceability of carbon offsets back to the issuing party. There are legitimate concerns around the credibility of carbon offsets (see How to Effectively Navigate 3 Common Voluntary Carbon Offset Risks and Quick Answer: How Do We Assure the Quality of Voluntary Carbon Offset Purchases?).

Figure 5: GHG Data and Analytics Architecture



Source: Gartner
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Design and build — or buy — an appropriate data management solution for GHG data. If the organization is limited in complexity, a data mart approach may be sufficient. Larger enterprises with more complex requirements should consider a data warehouse. A data lake is useful if a large amount of source data needs to be stored in its original format for assurance or other purposes.

Evaluate Software Options

We advise CIOs to seriously consider evaluating and purchasing software services with GHG management capabilities, instead of trying to build these capabilities in-house. This is particularly relevant for large global enterprises and where enterprises are reporting on complex Scope 3 data.

This is an active but immature market. Be clear on requirements and business needs before assessing vendor solutions. The market consists of pure-play ESG or GHG accounting vendors, enterprise software vendors, and vendors from adjacent markets such as EHS and governance, risk and compliance (GRC). GHG data must also feed ESG reports (see Market Guide for ESG Management and Reporting Software).

Design and Populate GHG Dashboards and Analytics

GHG dashboards create transparency of performance while informing decision making. This creates situational awareness for the overall enterprise GHG position. CIOs should consider the following capabilities for these dashboards:

- **Trend** — GHG dashboards must be able to provide trend data over time. Note that current and historic datasets will need to be updated as carbon factors change.
- **Targets and Progress Tracking** — Long-term reduction targets need to be broken down into achievable near-term milestones. Analytics must track emission reduction progress at an enterprise level, but also decompose to provide feedback at a level where leaders and their teams can take responsibility for progress.
- **Regression** — Leaders must have the ability to undertake regression analysis, which enables enterprises to control for production volume. This enables them to understand if performance is being driven by increased product throughput, business growth and expansion, or if genuine performance improvements are being made.
- **Intensity Measures** — Intensity measures enable executive leaders to understand the level of efficiency by manufacturing plant or by product (SKU) or other factors such as facility footprints, shipping weights and distances.
- **Hot Spot Analysis** — Hot spot analysis enables executive leaders to identify GHG emissions drivers, enabling actions to be targeted where the most significant gains can be made.

CIOs and their teams should develop data analytics capabilities that are relevant to role and use case. Multiple dashboards will be needed at different levels of the organization, providing data that is most relevant to the decision maker.

Long Term

Long-term actions will provide the advanced analytical capabilities needed for the enterprise to progress toward its climate ambitions, such as achieving net zero by a specified date, and to successfully transform to a low-carbon economy. Data and analytics must be robust enough to support strategic planning, including scenario analysis and structuring the optimal portfolio of emission reduction measures. This also includes changes in corporate structure, operations or business strategy, which can include acquisitions, divestitures, strategic investments in renewable energy and restructuring of value chains to reduce indirect emissions.

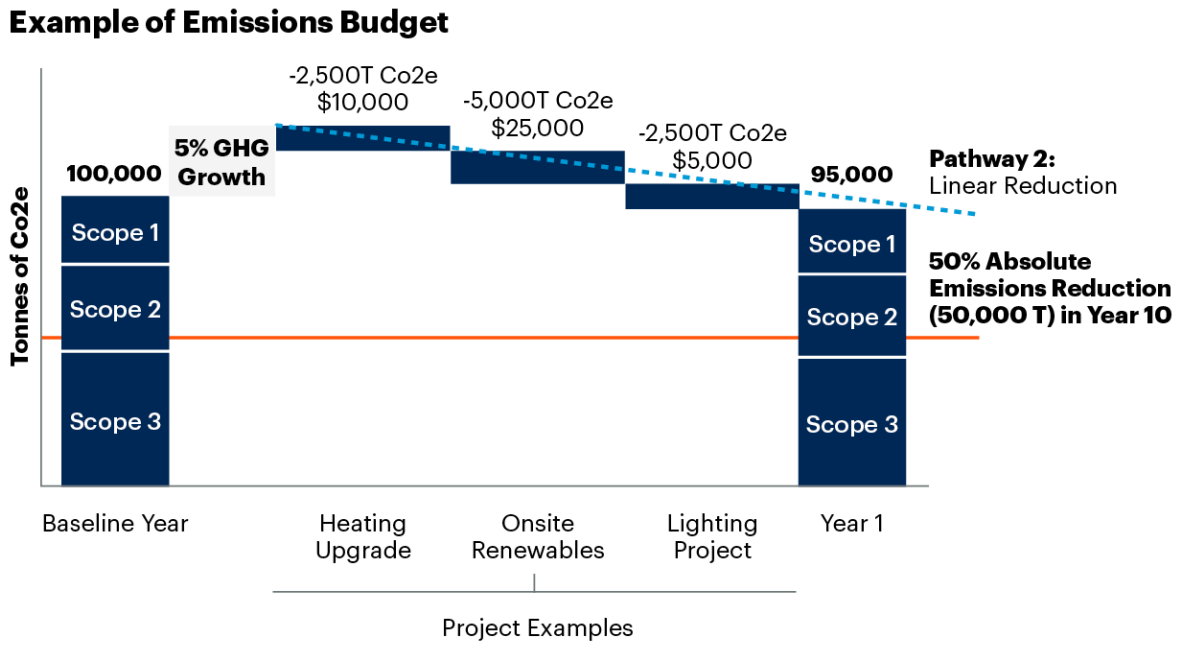
Implement Emissions Reduction Planning Capabilities

CIOs need to ensure that planners include the following data and analytics capabilities required for GHG reduction decision support and strategic planning:

- **Repository of GHG reduction options and opportunities.** The size, timing, duration and cost of each reduction option needs to be captured and cataloged in an enterprise database that is continuously updated as new options emerge.
- **Financial data** to compare and prioritize GHG reduction options based on cost-effectiveness, technical feasibility, implementation complexity and risk. The capability to set and use an internal carbon price can inform business cases for emissions reductions.
- **Modeling capabilities** to enable planners to project the GHG impacts of different strategic actions, such as divestitures, acquisitions or investments in renewable energy assets or projects. It also includes changes to value chains such as shifting production locations or energy sources, selecting alternative materials or suppliers, or optimizing shipping and transportation.

Figure 6 shows an example emissions reduction plan, sometimes referred to as a marginal abatement cost curve (see Note 2). The size of the available reduction needs to be balanced with the cost of achieving the reduction to gain maximum benefits with financial considerations.

Figure 6: Example of Emissions Budget



An actual carbon budget must project reductions far enough into the future to align with emissions reduction milestones and target dates.

Enable Product and Service Carbon Footprint Calculation and Reduction

CIOs need to prepare the data foundations for product carbon footprints (PCF) that estimate the CO2 content of specific product SKUs. PCF data will become increasingly available to consumers in the form of product carbon labels and product life cycle datasheets in the 2025 to 2030 time frame. A key regulatory driver is the European Union Digital Product Passport [14] to enable sharing of key product-related information that is essential for products' sustainability and circularity. These requirements will also impact transportation services and packaging, which further impact PCFs.

CIOs in manufacturing enterprises, in particular, therefore need to include foundational data and analytics capabilities for product carbon footprints in their roadmaps, including:

- Scope 3, Category 1 purchased goods data collection from ERP systems
- Bill of materials (BOMs) from manufacturing systems to determine carbon content
- Allocation of Scope 1 and Scope 2 direct emissions to products

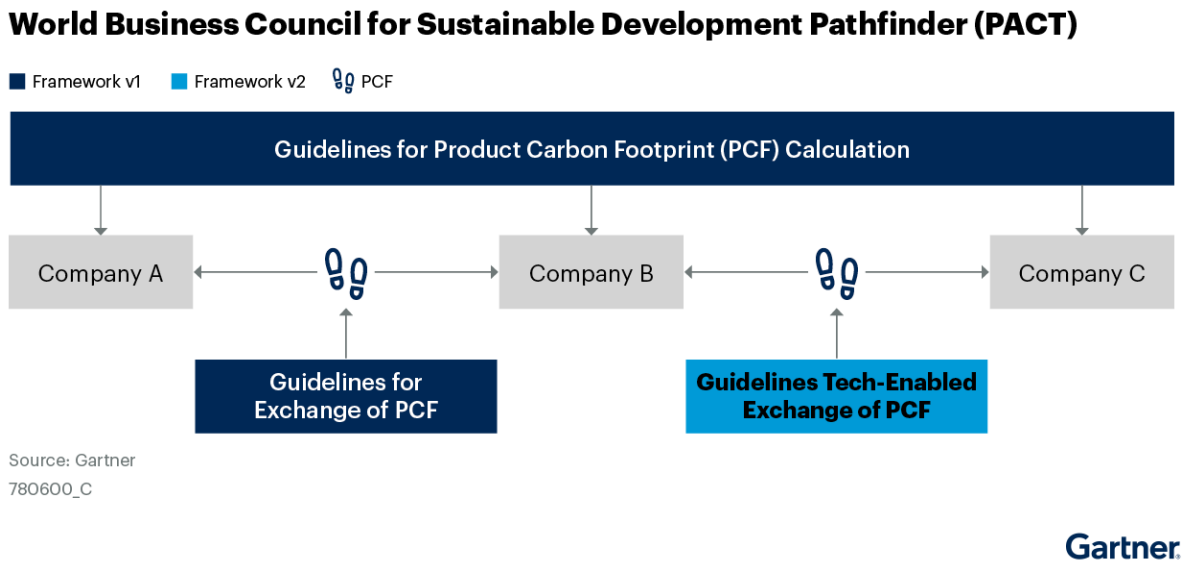
- Incorporation of carbon content into product design and product life cycle management systems

CIOs in other sectors that do not make products inevitably buy them. Therefore, they will need to provide data to procurement teams to incorporate carbon content from purchased goods and services into sourcing decisions.

Facilitate Carbon Data Exchange

Value chain partners will experience high administrative burdens and costs from tracking and supplying detailed carbon data up and down supply chains. An ecosystem approach to carbon data exchange can reduce costs and support sector-level product carbon reduction initiatives through the controlled flow of carbon data across value chains. CIOs in enterprises facing such demands should identify and track cross-industry data exchange initiatives, and participate in relevant pilot projects as and when they become available. Examples include Catena-X for the automotive industry and Partnership for Carbon Transparency (PACT) (see Figure 7).

Figure 7: World Business Council for Sustainable Development Pathfinder (PACT)



Many vanguard CIOs are taking an active role in shaping and influencing these initiatives, including appointing key IT staff to serve as representatives and delegates.

Adopt Artificial Intelligence and Machine-Learning-Based Optimization

Artificial intelligence shows great promise for managing evolving regulations, implementing intricate sustainability frameworks and performing complex carbon calculations. Therefore, CIOs need to include AI and machine learning in their data and analytics roadmap.

CIOs and their teams should include the following on their consideration list for roadmap items:

- Large language models (LLMs) for regulatory compliance and to identify and apply relevant frameworks and standards.
- Third-party services that leverage AI to capture and compare sustainability metrics for benchmarking.
- Machine learning algorithms to identify and evaluate carbon reduction options, identify opportunities from subsidies, taxes and incentives, and incorporate shifting energy prices into ROI calculations.

For a more comprehensive listing of AI-related sustainability use cases, see Balance the Environmental Perils and Promises of Generative AI.

Optional ESG Data Fabric

A longer-term option for CIOs in complex global enterprises is to adopt a data fabric framework for the collection, management and analysis of ESG data across all material sustainability concerns. This approach can enable different sustainability and ESG software point solutions to be connected over time. This can help protect and future-proof software investments, as well as provide flexible and reusable data pipelines, services and semantics (see Quick Answer: What is Data Fabric Design?).

Evidence

[1] Companies Taking Action, Science-Based Targets initiative (SBTi).

[2] **2022 Gartner Sustainability Opportunities, Risks and Technologies Survey.** This survey was conducted to identify how sustainability can foster opportunities, mitigate risks, amplify responsible digital technologies and control energy costs. The research was conducted online from 21 June through 21 July 2022. In total, 221 respondents were interviewed across North America (n = 75), Europe (n = 77) and Asia/Pacific (n = 69). Respondents represented qualifying organizations in information technology, manufacturing, financial services, retail and other industries, with reported enterprisewide annual revenue for fiscal year 2021 of at least $250 million. Qualified organizations also were currently engaged in sustainability-related activities. Respondents were leaders or executives in director roles or above and were directly involved in making sustainability-related decisions. *Disclaimer: Results of this survey do not represent global findings or the market as a whole, but reflect the sentiments of the respondents and companies surveyed.*

[3] Q&A: Climate Risk Expert Tom Wood Explains Mandatory TCFD Disclosures, Emitwise.

[4] The EU Digital Product Passport, World Business Council.

[5] Greenhouse Gas Protocol.

[6] The Global Leader for Impact Reporting, GRI.

[7] SASB Standards Connect Business and Investors on the Financial Effects Of Sustainability, SASB Standards.

[8] IFRS

[9] The A List 2022, CDP.

[10] Statement on the Enhancement and Standardization of Climate-Related Disclosures for Investors, U.S. Securities and Exchange Commission.

[11] The Companies Act 2006 (Strategic Report and Directors' Report) Regulations 2013, Legislation.gov.uk

[12] Corporate Sustainability Reporting Directive. European Commission.

[13] Life Cycle Initiative.

[14] Digital Product Passports: What Does the Sustainable Products Initiative Bring?, European Policy Centre.

Note 1: Carbon Border Adjustment Mechanism

The Carbon Border Adjustment Mechanism is a tariff on high emissions raw materials that are imported into the EU. The objective is to prevent carbon leakage in the form of raw materials that are produced cheaply with high-emission energy and processes. The products initially covered include cement, iron and steel, aluminium, fertilizer, electricity and hydrogen. The tariff, slated for implementation in late 2023, will also protect EU-based producers with higher cost structures due to adoption of renewable energies and investments in emissions-reducing technologies and processes.

Note: 2 Marginal Abatement Cost Curves

Marginal abatement cost curves (MACC) are an analytical approach for identifying optimal GHG reduction options based on timing, cost and scope. They can be at a macro level, such as the IEA MACC for global methane emissions, or at a micro level, such as for a corporation or production process. MACCs are a form of foresight modeling to evaluate different reduction pathways to achieving CO2e reduction targets. Heads of sustainability and other planners must have the data and analytics necessary to evaluate and present the best portfolio of reduction options and their associated costs. Analytics need to be flexible in order to account for sudden shifts in government subsidies, carbon prices and penalties, and energy prices (both conventional and renewable).

Note 3: Utility Bill Management Vendors

- Enablon (Wolters Kluwer)
- Engie (Ecova)
- EnergyCap
- Energy Watchdog
- Arcadia (Urjanet)
- Watchwire
- Pear AI
- THG Energy Solutions
- Omega X

Recommended by the Authors

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Strategies to Plan for GHG Emissions Reduction

Quick Answer: How Does Life Cycle Analysis Advance Sustainability?

Data Hubs, Data Lakes and Data Warehouses: How They Are Different and Why They Are Better Together

Research Roundup for Reducing Greenhouse Gas Emissions Across the Enterprise

Table 1: Key GHG Roles and Use Cases

Role	Example Data and Analytics Use Case
Board of Directors	Provide governance and oversight of emissions measurement and reduction programs.
Executives	Ensure progress toward climate ambitions.
Audit and Assurance	Ensure data integrity, quality and governance for assurance by third-party examiners.
Finance	Evaluate and select optimal GHG cost-reduction options.
Compliance	Track regulatory landscape and meet disclosure requirements.
IT	Measure and reduce emissions from enterprise IT assets and operations.
Research and Development	Design carbon out of products.
Supply Chain	Reduce carbon in purchased goods and services.
Real Estate	Measure and reduce emissions from corporate facilities.
Shipping and Logistics	Compare GHG intensity of different shipping options.
Marketing	Identify market opportunities and options for low-carbon products.
Employees	Use carbon calculators to measure and reduce work-related emissions (e.g., commuting, travel)
Benefits	Offer incentive payments for employees investing in renewable energy.

Source: Gartner