Embedding ESG Decision-Making in ERP

Leveraging AI and Automation for SAP Sustainability Transformation

Powering greener decisions with intelligent ERP solutions

ESG is not just a compliance task – it's a strategic business lever.
Many organizations still fail to unlock the full potential of their sustainability data. Emission figures are often collected for annual ESG reporting but remain disconnected from day-to-day operations. The result is predictable: procurement selects suppliers without a clear CO_2e signal, logistics optimizes for cost or speed rather than carbon, and finance sees the full emissions picture only at month-end – and often based on estimates.

Market signals confirm that sustainability has moved from optional to essential. Global risk surveys continue to rank environmental and climate threats among the most severe over both short and long horizons.[1] Demand for sustainable products is expected to nearly double from USD 382.6 billion in 2025 to more than USD 692 billion by 2033.[2] While growth in the sustainability consulting market has recently slowed, segments focused on IT, data, and digital ESG enablement are projected to grow strongly in the coming years. At the same time, capital markets are reinforcing the transition, with leading institutions reaffirming their sustainability financing commitments in early 2025. Governments are also tightening climate policies, and the European Union continues to hold some of the world's most ambitious targets under its latest Nationally Determined Contributions (NDCs) to the Paris Agreement. These signals underscore the urgency of bringing decision-grade sustainability data into ERP so organizations can act proactively rather than reactively.

This paper, developed with researchers from the Technical University of Munich, synthesizes interviews with Deloitte end-to-end functional consultants and SAP sustainability experts. The findings point to recurring gaps: data often arrives too late, lacks accuracy, and is difficult to act on. As a result, many companies still manage sustainability reactively through periodic reporting, rather than steering it proactively in daily operations.

To drive change, carbon data must be accessible where it matters most – at the point of decision.
As an illustrative case, this paper focuses on CO_2e emissions, while recognizing that the same approach should extend to other ESG dimensions such as circularity. Embedding sustainability data directly in ERP ensures that environmental information shapes business decisions at their source. With automation and AI as catalysts, companies can move from static reporting to dynamic steering – turning sustainability from an obligation into a strategic asset.

[1] World Economic Forum. (2025, January 15). The global risks report 2025 (20th ed.).
[2] Business Research Insights. (2024). Sustainable products market size, share, and industry forecast, 2024–2033.

Bottlenecks and challenges that prevent ent-to-end sustainability in SAP ERP processes

While companies increasingly recognize the strategic value of carbon data, it rarely flows seamlessly through ERP environments.
Much of the carbon data that could inform decisions in procurement, planning, logistics, or finance remains fragmented, delayed, or hard to use. As a result, sustainability insights rarely reach the people and processes where they could have the greatest impact – and companies miss the chance to capture the economic value of better climate performance. Forthcoming research by Mateusz Wielopolski explores how AI can be used to determine customer willingness to pay for more sustainable products.

To pinpoint where these gaps occur, interviews were conducted with Deloitte end-to-end functional consultants. Their insights reveal recurring bottlenecks within SAP ERP processes that prevent sustainability data from being timely, reliable, and actionable. The following subsections outline where these gaps emerge – and how they affect efficiency, compliance, and competitiveness.

Fig. 1 – Current landscape of carbon data availability and usage: At a glance

GHG scope coverage

Scope 1 (Direct emissions):
Reliable, measured internally

Scope 2 (Indirect emissions from purchased energy):
Moderately reliable, based on utility data, but often delayed and region-dependent

Scope 3 (Indirect emissions across the value chain):
Weakest data quality – spend-based estimates highly uncertain, with values differing by orders of magnitude across providers[3, 4]

Integration
- Carbon data usually sits outside core ERP processes
- SAP Sustainability Footprint Management (SFM) is already in use, but SAP Green Ledger is still in pilot stages. Embedding carbon data directly into daily ERP transactions is only beginning to emerge

Collection practices
- Predominantly manual; Excel sheets still common
- Proxies and averages used when supplier data is unavailable

Timing
- Aggregated quarterly/annually for reporting
- Data usually arrives after key decisions are made

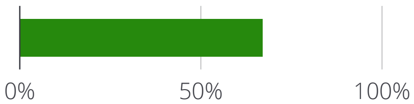
Trust and quality
- Verification inconsistent; supplier
- data non-standardized
- Low comparability across sources
- Provenance unclear (primary vs. secondary measures)

[3] Gartner, Inc. (2024, February). Forecast: Sustainability consulting services, worldwide, 2023–2027.
[4] Goldman Sachs Group, Inc. (2025, January 13). Goldman Sachs announces creation of Capital Solutions Group.

Fig. 2 – Key bottlenecks and challenges: At a glance

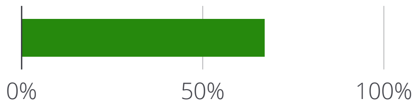
Three recurring structural gaps emerged from the interviews that limit the practical use of carbon data in business workflows: timing, usability and trust.*

Timing gap



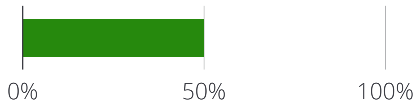
Carbon signals land after the decision point, so approvals, plans, and deliveries proceed without CO_2e context

Usability gap



CO_2e is not on screen in core apps and remains fragmented across systems, so teams are unable to act in line with each other

Trust gap



Estimates and unverified supplier data dominate, weak provenance undermines traceability and audit confidence

*Deloitte functional consultant interview, Deloitte Project Study, July–August 2025 (unpublished internal research)

Bottlenecks and challenges within SAP ERP processes

The focus is on four core SAP end-to-end processes: procure-to-pay, plan-to-produce, order-to-cash, and record-to-report. These were selected using clear selection criteria that prioritized high decision volume, frequent data handoffs, and direct links to financial postings. Each concentrates on moments where CO_2e information is generated, transformed, or consumed, making them the most consequential for embedding sustainability signals. The following subsections identify the bottlenecks in each workflow and their effects on efficiency, compliance, and competitiveness.

Procure-to-pay (P2P)

- Supplier CO_2e data missing
  → Approvals arrive delayed, defaults to cost-only
- Invoices lack emissions fields
  → Audit trail broken, compliance risk rises
- Carbon data arrives late
  → Inflated carbon cost assumptions in procurement
- Supplier hesitation to share data
  → Weak traceability and audit gaps

Plan-to-produce (P2Pr)

- Sustainability KPIs absent in planning
  → Production optimized for cost, not emissions
- Master data rushed in S/4HANA rollouts
  → Product footprints unreliable
- Generic emission factors used
  → Investment cases lack credibility
- No framework linking data to scope items
  → Missed optimization opportunities

Order-to-cash (O2C)

- Logistics emissions deprioritized
  → Transport footprint increases
- Data fragmented across systems
  → Compliance reporting slows
- Scope 3 freight data missing
  → Underreported logistics emissions
- No real-time CO_2e allocation to orders
  → Decisions lack carbon visibility

Record-to-report (R2R)

- Estimates dominate carbon data
  → Reports lack accuracy; risk of penalties
- CO_2e KPIs disconnected from finance
  → Carbon projects not funded
- Data audit-ready but too coarse
  → No real-time steering possible
- Compliance-only reporting
  → Sustainability underused as business driver

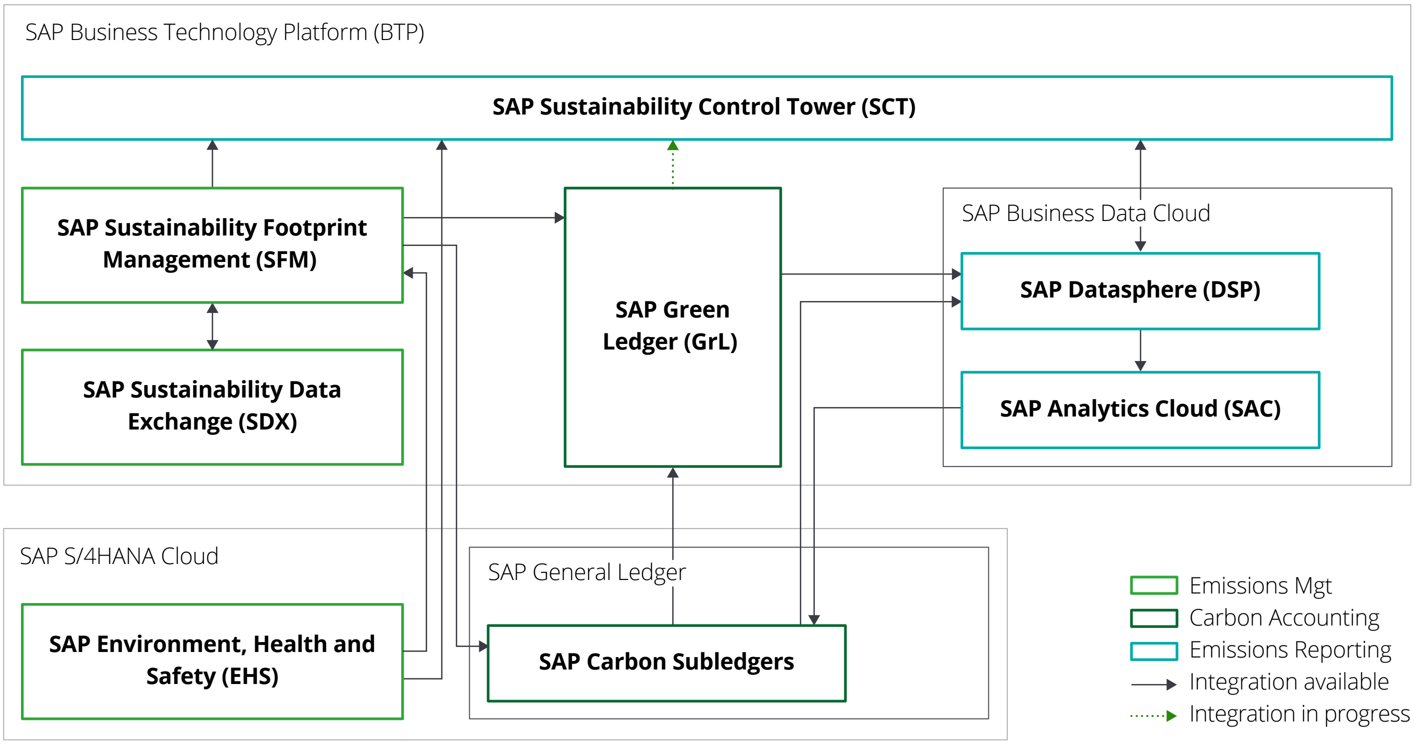
Together, the findings show that carbon information exists but is not decision ready. Timing, usability, and trust gaps cluster at specific control points across P2P, P2Pr, O2C, and R2R. The next chapter sets out where the carbon signal should appear in ERP applications and data flows, and the foundations required for reliability and assurance: aligned data models, role-based visibility, and verifiable provenance. This provides a basis for shifting from periodic reporting to operational steering.

From footprint to financials: Embedding sustainability in ERP processes

Embedding sustainability in ERP processes turns carbon and ESG metrics into operational signals.
This section explains why that shift closes the timing, usability, and trust gaps from Section 2, outlines the SAP landscape that carries footprints with transactions, defines the building blocks of actionable data, and pinpoints where to embed metrics across SAP S/4HANA for the greatest value. While SAP Green Ledger ensures that sustainability metrics are embedded directly into financial processes, a unified data foundation such as SAP Business Data Cloud (BDC) enables organizations to complement ERP data with information from other sources. This broader integration ensures that ESG reporting and analytics are based on complete, harmonized datasets, supporting more accurate insights and decision-making across the enterprise.

Overview of end-to-end system scope and architecture
Figure 3 shows how sustainability applications on the SAP Business Technology Platform (BTP) and S/4HANA work together. Footprints are calculated, exchanged with partners, and put into a financial context, so decisions reflect both money and carbon.

Fig. 3 – Overview of SAP sustainability tools and integrations on SAP BTP



SAP Green Ledger (GrL) records CO_2e quantities per financial account so carbon can be linked to the SAP General Ledger. **SAP Carbon Subledgers** capture ERP and material-level footprints and feed the GrL. **SAP Environment, Health and Safety (EHS)** provides corporate emissions data.

SAP Sustainability Footprint Management (SFM) retains a distinct role for calculating and managing product, process, and corporate footprints for Scopes 1 to 3. It acts as the footprint inventory and publishes calculated footprints to S/4HANA for use in business processes.

SAP Sustainability Data Exchange (SDX) provides a data-sharing channel for supplier-verified product footprints and bill of materials (BOM) information. Supports exchange with customers, auditors, and certifiers based on interoperability standards, and feeds SFM to keep models current.

SAP Business Data Cloud (BDC) provides an open, governed data foundation that unifies SAP and non-SAP data across hybrid and multi-cloud environments. BDC ensures harmonized sustainability data, and enables real-time insights and compliance. In combination with (SAP) Databricks, organizations can apply AI/ML for advanced use cases such as predictive carbon impact analysis and ESG anomaly detection. Together, they deliver a scalable, intelligent data layer that drives sustainability and innovation.

SAP Datasphere (DSP) – as part of BDC – DSP provides a unified analytical layer by combining finance data, Green Ledger entries, and operational footprint data. As a general reporting and data management tool, it can also be leveraged for sustainability analytics and integration.

SAP Analytics Cloud (SAC) – as part of BDC – SAC delivers dashboards, planning, and scenario analysis. As a general-purpose reporting tool, it can be leveraged for sustainability use cases.

SAP Sustainability Control Tower (SCT) enables upstream and downstream visibility in supply chain data, supporting transparency and compliance. It allows tracking of sustainability-related KPIs across suppliers and value chains to monitor performance and progress.

SAP Business Technology Platform (BTP) is SAP's cloud platform that unifies data, integration, and AI services with developer tools to build, extend, and connect enterprise applications.

SAP Signavio supports process modelling, monitoring, and optimization. It can be used to integrate sustainability criteria into business processes and identify ESG-relevant process improvements.

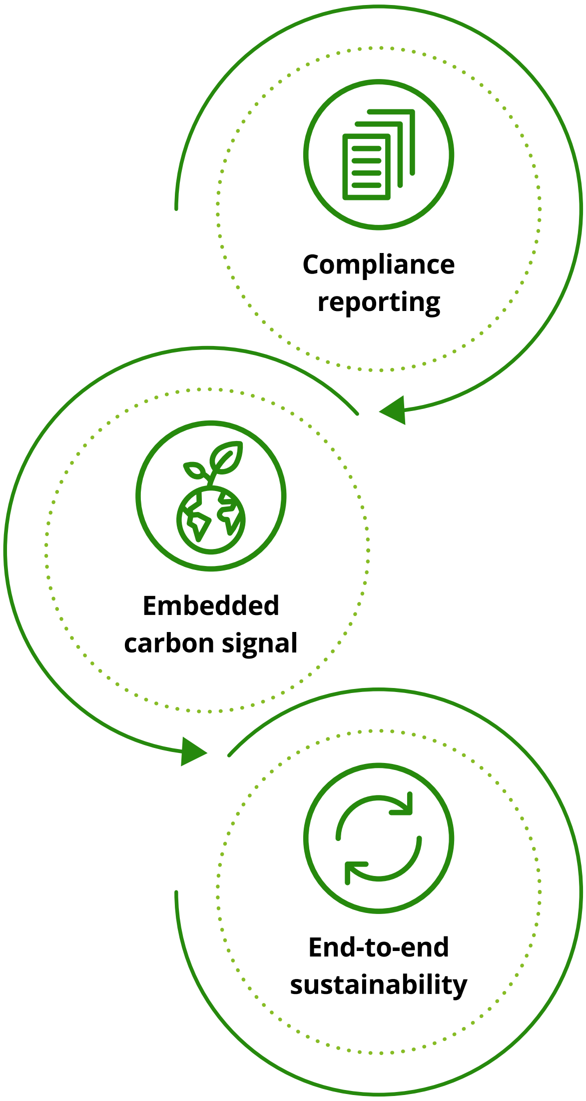
The need to embed sustainability in ERP processes

Three recurring bottlenecks limit impact: timing, usability, and trust. These three bottlenecks underpin the need to embed sustainability data in ERP processes; enabling the right signal in front of decision-makers at the moment of work. Carbon values and their credibility travel with everyday orders, receipts, deliveries, and financial entries, so no one waits for month-end reports or hunts through spreadsheets. Decisions move faster, approval loops shrink, and the record is auditable by default. In short, this turns ESG figures from static reports into live inputs that remove frictions and reduce rework, increasing business value.

Tracking sustainability metrics across ERP and the power of the SAP S/4HANA landscape

Embedding sustainability metrics across ERP turns each purchase order, goods movement, production confirmation, delivery, and journal entry into a carbon-aware record. In S/4HANA, greenhouse gas quantities align with financial dimensions in the universal journal so carbon and money can be analyzed together. Product and corporate footprints flow from calculation to daily work. Supplier-verified footprints enrich Scope 3 decisions. The same data powers planning, steering, and disclosure, which shortens the path from insight to action.

Fig. 4 – From Compliance to Strategic Advantage



Power of the SAP S/4HANA landscape: how it achieves end-to-end tracking

- **Universal journal and Green Ledger** align GHG quantities with finance for dual-axis steering.
- **Logistics and production integration** record CO_2e alongside goods movements and confirmations so the signal follows the document flow.
- **Footprint intelligence from SFM and SDX** map versioned product and corporate footprints to materials and BOMs and bring in supplier-verified data to reduce estimates in Scope 3.
- **Record-to-report with carbon data** consolidates CO_2e with financials for consistent KPIs and disclosure.
- **Analytics and planning on one model** use embedded analytics, Datasphere, and SAP Analytics Cloud to enable fast scenarios and clear trade-offs.
- **Controls, provenance, and BTP extensibility** apply role-based access, maintain provenance and use extensions for in-flow automation that speeds up approvals.

What this enables

- Live, end-to-end visibility of CO_2e at the point of decision
- Dual-axis steering on money and carbon in the same workflows
- Audit-ready traceability with clear provenance and measurement basis
- Faster planning cycles and scenario modeling on one trusted dataset
- Marginal abatement cost curve (MACC) management directly in ERP – evaluating decarbonization measures by cost-effectiveness and impact
- Financial risk and opportunity assessments supported by SAP, integrating sustainability metrics into enterprise risk management and valuation

Four building blocks of actionable data

To close timing, usability and trust gaps, carbon information must become actionable, i.e., delivered at the right moment, in a decision-ready format, with the trust needed to guide trade-offs. The four building blocks below outline what makes carbon data actionable in practice, showing how it can move from passive reporting to active decision-making.

Together, these four capability objectives set the target state for turning carbon data into a decision-driving asset – timely, credible, and seamlessly integrated into daily workflows.

Fig. 5 – Four building blocks of actionable data

Real-time operational intelligence (timing)
Post transaction-level CO_2 so procurement, production and logistics see the footprint of each purchase order (PO), batch and shipment as it happens, closing the gap between measurement and action.

Decision-ready KPIs in core apps (usability)
Surface emissions intensity, carbon cost and green-budget consumption in SAP Fiori and SAC so managers weigh CO_2 alongside euros and lead time in one view.

Actionable data

Tipping-point analytics for strategic choices (usability and timing)
Combine live carbon data with scenario modeling to identify when switching suppliers, re-routing freight or retrofitting equipment delivers greater value than cost.

Assurance-ready reporting that loops into planning (trust and usability)
Provide verifiable, traceable data for CSRD/ISSB*-aligned disclosure, and feed FP&A for carbon-aligned budgets and internal carbon pricing.

*CSRD = Corporate Sustainability Reporting Directive, ISSB = International Sustainability Standards Board

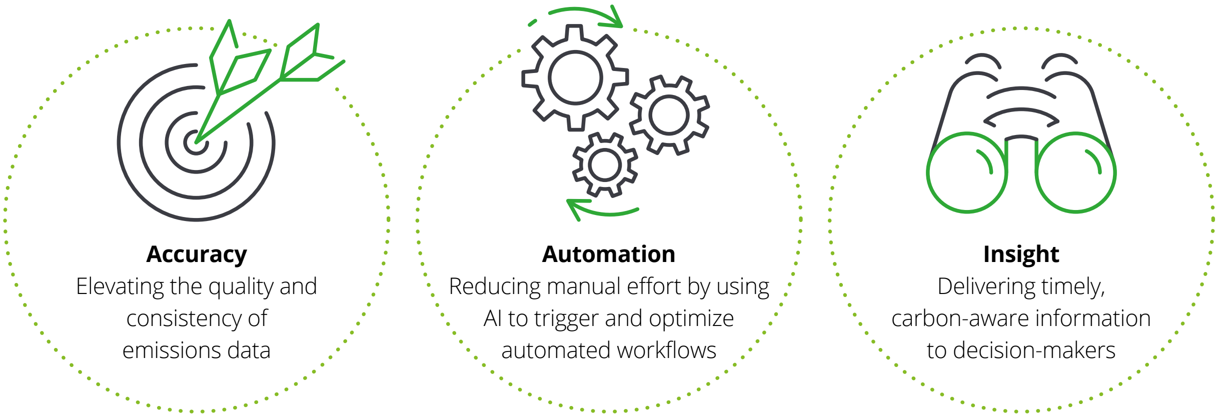
AI and automation in S/4HANA: From reporting to steering

Don't just report. Steer. AI and automation can shift ESG from a reporting exercise to a real-time control system. AI and automation can create value across the full SAP S/4HANA landscape – from procure-to-pay and plan-to-produce, to order-to-cash and record-to-report. They can close critical gaps in timing, usability, and trust by embedding carbon signals directly in core business processes through on-screen guidance, prescriptive analytics, and closed-loop postings across applications and ledgers.

Where automation and AI could shine the most
In interviews with Deloitte functional consultants and SAP product experts, three priorities consistently emerged where AI could deliver the greatest impact: improving the accuracy of emissions data, automating manual effort, and equipping decision-makers with timely, carbon-aware insights.

Interviews with Deloitte functional consultants and SAP product experts point to three priorities where AI can unlock the greatest value:

Fig. 6 – Enhanced Carbon Data Solutions



AI use case visions

Fixing timing, accuracy, and manual effort creates the foundation. What matters next is use.

The next subsection shows how to surface CO_2e in record-to-report, plan-to-produce, and inventory-to-deliver so users can compare options, apply simple guardrails like an internal carbon price and thresholds, and record decisions with clear provenance. The aim is clear choices, faster approvals, and measurable impact in day-to-day work.

Vision 1: Accounts payable zero-click carbon posting

In **record-to-report**, accounts payable teams search PDFs for emissions lines and retype values. Invoices get parked. Close slows and audits are harder.

What changes?

Automation on SAP BTP with Document Information Extraction and SAP Build Process Automation reads each invoice on arrival. It captures kg CO_2e with extraction confidence, maps it to vendor and controlling dimensions, and creates a carbon journal entry in Green Ledger. When a product or supplier footprint is available in SFM, it is applied. Otherwise a factor is derived from the SFM footprint library with provenance. SDX carries PCFs but does not connect to invoicing, so enrichment runs in S/4HANA or on BTP rather than through SDX.

Where does it show up in SAP?

Financial postings continue in S/4HANA FI-AP. Green Ledger holds CO_2e quantities with scope layering, origin, and uncertainty for audit and later true-up. Valuation and analysis run in SAC or Datasphere alongside financials.

Vision 2: Process-aware Green Ledger copilot

In **plan-to-produce**, planners and schedulers lack in-moment carbon signals. Month-end insights arrive after decisions are set.

What changes?

A side panel adds CO_2e context in production screens. Green Ledger provides traceable quantities with source and uncertainty. An SAP AI Core service classifies carbon entries by plant, material, and work center.

Where does it show up in SAP?

Recommendations appear in Manage Production Orders and on the Production Scheduling Board. Green Ledger supplies traceable CO_2e. Valuation and planning run in SAC or Datasphere.

Vision 3: Route every shipment with a CO_2e lens

In **inventory-to-deliver**, let planners compare cost, service, and CO_2e side by side, then adopt greener options such as rail, consolidation, or timing.

What changes?

Greener-mode adoption. Consolidation rate. CO_2e per shipment and per km. Cost delta versus baseline. On-time performance. Display provenance and confidence. Log overrides with reasons.

Where does it show up in SAP?

In Transport Management (TM), a comparison panel shows route or mode options with cost, service, CO_2e per shipment, and intensity. A BTP service calculates options using SFM factors and simple heuristics for consolidation and timing. The tool recommends the lowest total including carbon and shows the tipping point where the greener option wins. After execution, TM posts shipment actuals. SFM computes actuals where needed and publishes to post carbon-only entries to Green Ledger.

Conclusion

Sustainability data should not live in quarterly reports—it should power everyday decisions.
By embedding automation and AI at the points where choices are made, carbon intelligence shifts from regulatory obligation to strategic advantage. This paper explores how automation and AI can turn isolated carbon figures into live strategic levers. When carbon inputs are verified at the moment of capture and integrated into automated workflows, manual pain points disappear. The research shows that most organizations already hold carbon data—but it isn't decision-ready. Timing, usability, and trust gaps cluster at control points across procure-to-pay, plan-to-produce, order-to-cash, and record-to-report, meaning the signal often misses the moment of work.

Embedding sustainability data within ERP systems closes these gaps. Verified footprints travel with each transaction, aligning CO_2e with financial dimensions for dual-axis steering. The SAP landscape described in this paper provides the backbone for that shift— among other - SFM as the footprint inventory, SDX for data exchange, Green Ledger for auditable quantities, and SAC or Datasphere for planning and analytics.

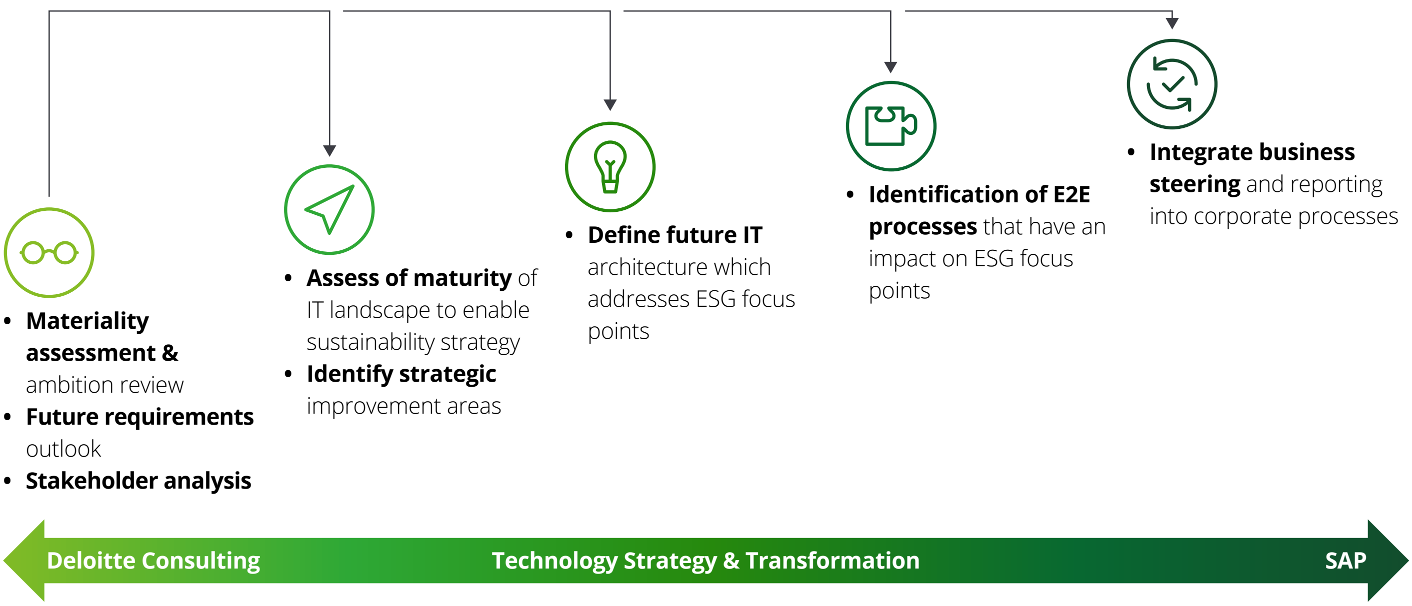
To realize this in practice, sustainability must operate in the flow of work.
Decision-ready CO_2e should sit alongside price, lead time, and quality within the applications people already use—so the signal appears at the moment of choice. Verify data at capture, and when supplier inputs are missing, enrich with clearly labeled estimates. Standardize units and factors so numbers remain comparable across processes. Maintain full provenance from invoice or PCF through calculation to ledger for seamless assurance. Execute policy directly in the system using internal carbon prices, budgets, and guardrails—ensuring consistent rules across the enterprise.

Start small: choose one high-volume decision point such as purchase order approval or transport planning and run a focused four-to-six-week pilot. **Track adoption, quality, timeliness, and impact.** Learn from the results, then scale the pattern to adjacent categories and processes.

The Path Forward. 5-step approach to a wholistic ESG process design to be integrated into the S/4HANA Landscape
A structured, five-step roadmap supports this transformation in the S/4HANA environment. Step 1 defines material topics, target boundaries, and external requirements through stakeholder analysis. Step 2 assesses the current IT and data landscape to identify gaps preventing decision-ready carbon data. Step 3 designs the target information and control architecture, including data models, provenance tags, and roles. Step 4 pinpoints the end-to-end processes with the highest leverage—such as procure-to-pay, plan-to-produce, order-to-cash, and record-to-report—and selects pilots. Step 5 embeds steering and reporting into corporate processes with dashboards, planning, and assurance packs.

Organizations that embed these practices will not only meet tightening disclosure requirements but also lead on cost efficiency, resilience, and brand trust. Those that continue treating carbon as an afterthought will face a growing carbon penalty—in slower decisions, higher risk premia, and missed inflection points.

Fig. 7 – The path forward: five-step approach to a holistic ESG process design to be integrated into the S/4HANA landscape



Source: Deloitte, SAP Sustainability Event: End-to-end Green Ledger (2025)

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Notes:

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