Building **sustainable value chains**

How leading organizations are making value chains low-carbon and more resilient

Capgemini invent

Foreword

Industry leaders are now facing unprecedented challenges. Cost containment and escalating geopolitical tensions have underscored the critical importance of supply chain resilience and the development of future-proof products.

In this difficult context, according to our 2025 report with the World Economic Forum (WEF) "*United for Net Zero*," many industry leaders claim they are still off-track in achieving carbon reduction at the right pace. Barriers are piling up, such as demonstrating a solid business case for sustainability, evaluating carbon emissions accurately, advancing suppliers' decarbonization, and ramping up the needed climate technologies.

At the same time, front runners are leading the way by highlighting very successful examples of **sustainable value chain development as a lever for business growth**. They are going beyond commitments and carbon calculation and are leveraging sustainable action to bring **business savings, new revenue streams, and risk avoidance**. They demonstrate that through resource efficiency, value-chain transparency, and product portfolio resilience management, companies can achieve concrete business benefits while driving sustainable impact.

Building a sustainable value chain is an **iterative process**. It requires a **balanced approach** between short-term quick wins, such as energy efficiency and sustainable product design improvements, and long-term action, such as strategizing on the product portfolio, sustainable asset investment, and supply chain re-design. At the same time, **digital transformation and AI** are a formidable opportunity to get faster and improve decision-making throughout this transformation, as they help achieve better designs, more productive assets, and more flexible supply chains.

How do you build a sustainable value chain?

To inspire industry leaders in their mission to establish resilient operations and supply chain management, we have selected the most tangible initiatives that bring multi-dimensional benefits, combining operations de-risking, business benefits, and sustainable improvements. They are illustrated through proven Capgemini methodologies and client success stories.

This summary of our capabilities and proven client engagements considers companies are at different maturity stages in sustainability across engineering, manufacturing, supply chain, and climate technologies.

We hope that through this report, industry leaders can find keys to unlock sustainability benefits while safeguarding competitiveness and resilience.

Together, we endeavor to create a more sustainable future for industry and societies worldwide.

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The promise of sustainable value chains

Nowadays, global value chains are undergoing unprecedented transformations, creating both significant challenges and new opportunities.

At the forefront of these changes is resource efficiency and circularity, supply chain transparency, digital and AI adoption, and the consistent effort needed to prepare the future of industry workforce.

In the meantime, the ongoing realities of global warming have compelled us to intensify our efforts in reducing emissions. Global CO_2 emissions have grown by 60% since 1990 to nearly reach a record high of 37.41 $GtCO_2$ in 2024 (*Statista*). If this trend continues, the world will likely experience a temperature increase of between 4.1°C and 4.8°C by the year 2100. Under the Paris Agreement, all economic sectors need to adhere to the 2°C or 1.5°C carbon reduction pathway, which translates to reducing global carbon-equivalent emissions from above 50 billion tons to net zero.

The industrial sector contributes over 35% of global GHG emissions. While scope 1 and 2 address the energy-related emissions from owned and controlled sources and energy purchases, Scope 3 emissions go beyond industry's direct operations because they entail upstream and downstream value chains. Moreover, Scope 3 accounts for 70% of industry GHG emissions (Figure 2).

It's undeniable that sustainability remains a top priority on the CEO agenda, particularly net-zero targets for Scope 1 and 2 emissions. In terms of climate reduction pledges, the Science Based Targets Initiative's (SBTi) *Monitoring Report 2023* indicates that the global number of large companies with validated targets continues to grow up to 7,376 (March 2025, *SBTi* (a)) from 1,866 companies in total by the end of 2023 (*SBTi* (b)). Nonetheless, despite the promising trend, these numbers are still low compared to the total global population of companies, representing about 39% of the global economy's market capitalization (*WEF and Capgemini 2025*).

Due to the long timespan of decarbonization initiatives and mobilization constraints, tangible results are yet to materialize. Chances are that many on-going sustainability efforts lack quantitative assessment to demonstrate their financial benefits and to articulate their clear contribution to the overall business case.

As one of the most impactful benefits, adopting sustainable practices represents an opportunity to gain cost efficiency, which is of the utmost importance for industrial leaders. Decarbonization reduces energy consumption, lowers carbon taxes, and optimizes processes, leading to significant cost savings and increased competitiveness for industrial companies.

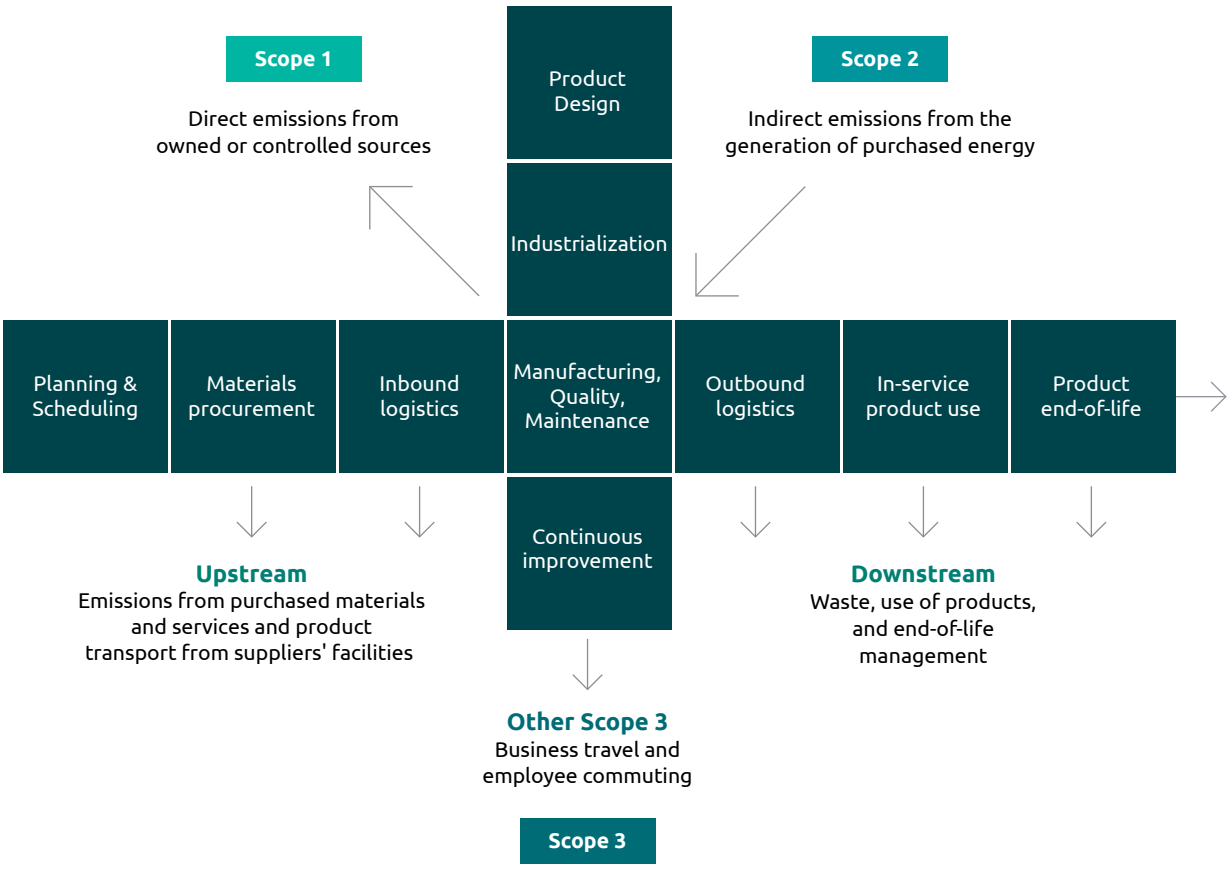
Barriers to decarbonization

The adoption of sustainable practices increases the potential for better cost efficiency, which is of the utmost importance for industry leaders. Decarbonization reduces energy consumption, lowers carbon taxes, and optimizes processes, leading to significant cost savings and increased competitiveness for industrial companies.

However, tangible results are yet to materialize. Several challenges continue to hinder the scaling up of decarbonization efforts. Our "United for Net Zero" report with the WEF found these challenges include:

- Difficulty in creating positive business case and matching short-term business priorities with long-term sustainable goals.
- Complexity in tracking carbon emissions, especially on Scope 3.
- Difficulty in decarbonizing the supply chain.
- Complexity in scaling the low-carbon technologies necessary for value chain decarbonization.

Figure 1 Stakes and key levers of Scope 3 decarbonization



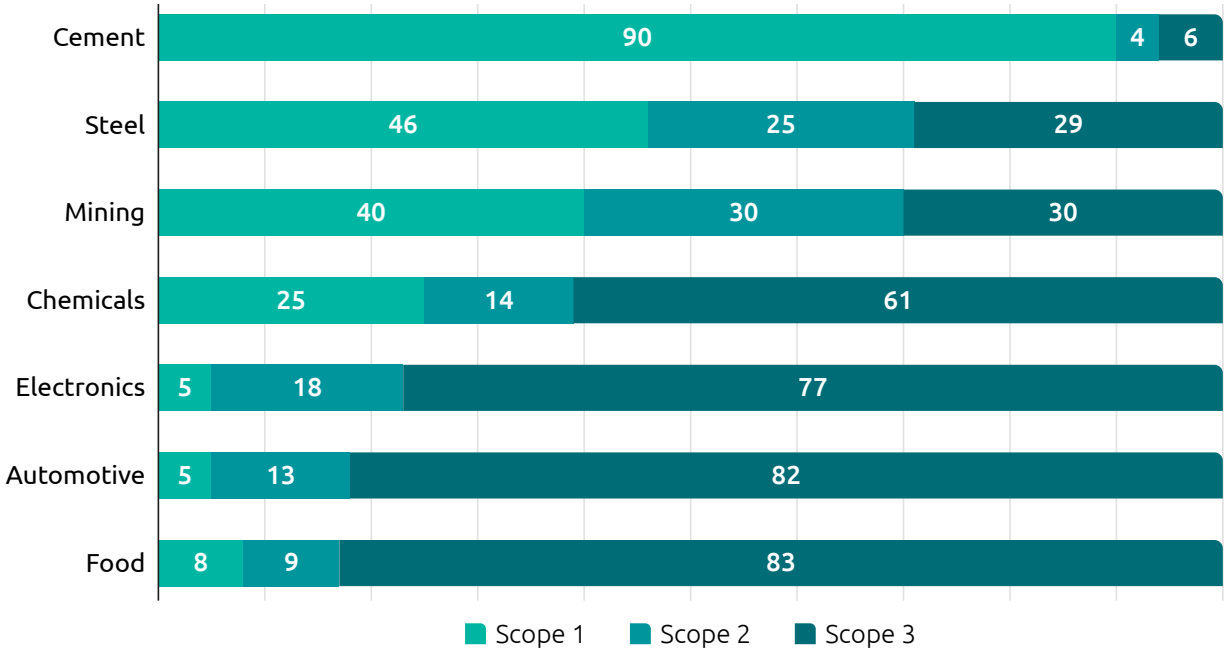
Notably, 50% of companies report being off-track for Scope 3 decarbonization. Furthermore, 67% express low confidence in their ability to deliver mature roadmaps. To overcome these barriers, companies can focus on improving material efficiency, integrating sustainable procurement practices, and enhancing supplier engagement through technical support and knowledge sharing (ibid).

One of the challenges of decarbonization within industries is that there are a variety of problems to address for different sectors. For example, while industries like cement, steel, and mining retain highly carbon-intensive operations, the Scope 3 category becomes significant for other industries, such as chemicals, electronics, and food. This means that any net-zero efforts in those sectors are likely to require intense cooperation from suppliers, manufacturers, and consumer brands (*WEF and Capgemini 2023*) (Figure 2).

To facilitate access to evidence for industry stakeholders and decision-makers, this summary focuses on our experiences with clients making their value chains sustainable and resilient, with the aim of:

1. *Highlighting tangible and successful approaches to executing sustainable value chain transformation, encompassing engineering, manufacturing, and supply chain scopes.*
2. *Providing real-life client stories, illustrating how their value chain has been transformed through sustainability mechanisms.*
3. *Depicting digitalization and data as enablers and accelerators of scaling up sustainable transformation across all business areas.*

Figure 2 Percent of CO_2-equivalent emissions by scope for selected industries in 2019 (WEF, Capgemini)



When sustainability meets resilience and growth

Driven by digital enablers and backed by our expertise in leading sustainability initiatives, we have developed a macro-level portfolio of offers relevant to sustainability transformation.

While many industrial companies have already developed a sustainable business strategy, and even begun industrializing CO_2 and overall ESG performance calculation, our report focuses on the sustainable value chain pillar. This is because it is of crucial importance as it encompasses the needed transformations across products, manufacturing, and supply chains to drive sustainable change.

We are deeply committed to driving the transformation of global industries toward a sustainable future by scaling sustainable value chains and delivering tangible benefits to businesses.

First, a transformative shift toward a sustainable products portfolio is essential, encompassing long-lasting designs, green materials, and circularity. Second, a comprehensive overhaul of operational models and assets is critical, prioritizing resource efficiency and the transition from fossil-based to low-carbon energy in manufacturing plants. Finally, a shift from isolated company strategies to collaborative value chain management is strongly advocated. This involves forging robust partnerships with upstream suppliers and downstream clients and partners, which enables sustainable and circular transformation of the value chain.

In practice, this strategic transformation can be accelerated through the drivers of data and digital technologies, end-to-end greenfield infrastructure acceleration, and sustainable innovation. It is critically important to demonstrate a solid business case of initiatives, and should not only cover short-term savings, but also long-term risk avoidance.

Figure 3

Capgemini's strategic vision for sustainable transformation

A breakthrough shift towards sustainable products...

Requires the revamping of entire operations and assets...

And mindset switch from single company strategy to value chains' collaboration

Powered by

- Data and digital technologies
- End-to-end greenfield infrastructure acceleration
- Sustainable innovation
- Business case

Based on over **100 of our references across industries and geographies, we have constructed this sustainable value chain framework** to reshape the value chain of tomorrow, divided into three subjects: sustainable manufacturing, sustainable supply chain and sustainable product design. For each of the subjects, business benefits materialized:

- **Sustainable Product Design:**

  By integrating eco-friendly materials and energy-efficient processes early in the design phase, companies can reduce material costs, extend product lifespan, and enhance market competitiveness.

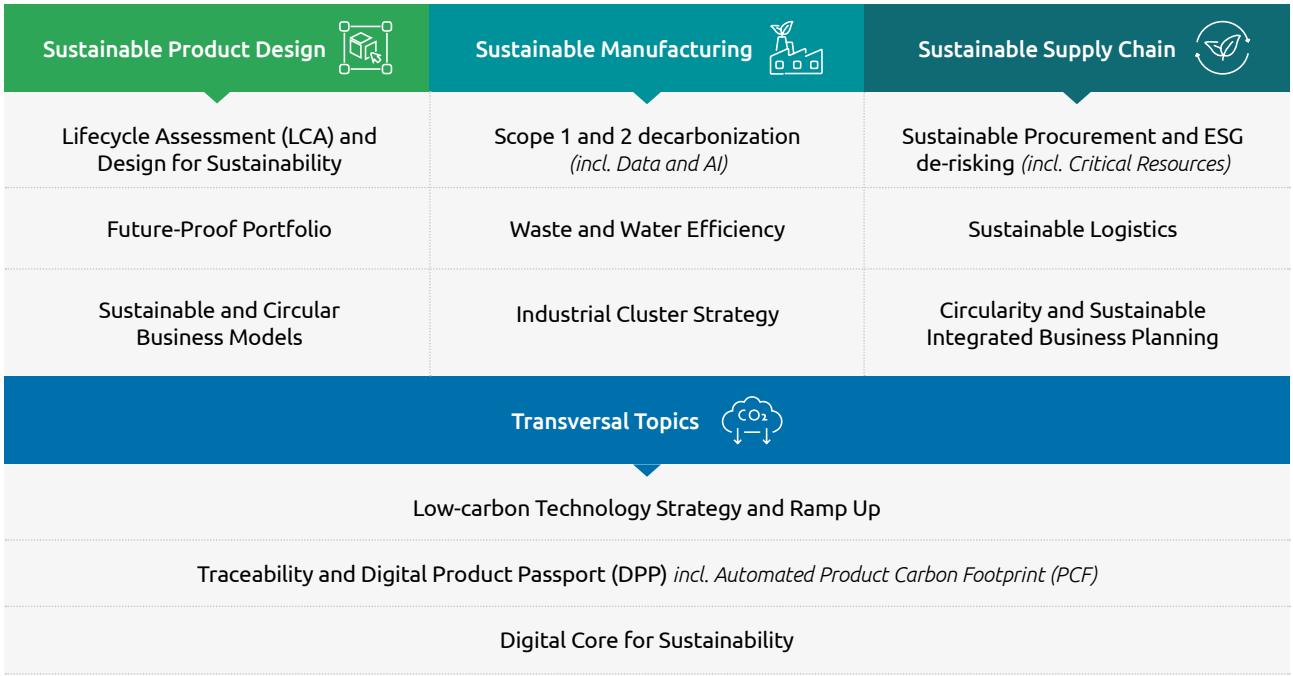
- **Sustainable Manufacturing:**

  Optimizing energy use, minimizing waste, and adopting circular production models lower operational costs while improving efficiency and regulatory compliance.

- **Sustainable Supply Chain:**

  Enhancing logistics efficiency, sourcing responsibly, and reducing resource dependency mitigate risks, lower procurement costs, and improve resilience against market fluctuations.

Figure 4 Capgemini's sustainable value chain framework of actions



Each gray box represents an initiative that can be independently tackled by industry leaders willing to improve the sustainable impact in their respective business area.

To help support the practicality of those initiatives, we have selected tangible, real-life client stories that illustrate our work in each subject area. The following pages provide an abstract of those client stories.

Stories from the field

Sustainable Product Design

1. Lifecycle Assessment (LCA)

Our experts helped a packaging manufacturer develop its next-generation electronic perfume dispenser. To achieve this, a data-driven life-cycle assessment (LCA) was performed, revealing hotspots and priority actions that included weight reduction, parts reduction, and material switching; This informed research and innovation teams on design improvements. The new product designed aims to divide carbon footprint by three, compared to traditional products, moving from 10 to 3 kgCO_2eq. The project also supported manufacturability improvements, further reducing cost and environmental impacts across the product lifecycle.

2. Design for Sustainability *(incl. Sustainable Packaging)*

Design for Value and Sustainability

We supported a life sciences manufacturer looking to improve its microbiological instruments value and environmental impact. An assessment of value-adding factors was performed (usage, feasibility, ergonomics, sustainability) as well as a deep dive into the technological aspects of embedding intelligence into the system. This resulted in an innovative device design and a roadmap towards product-as-a-service and circularity. The results were significant as the new design version facilitated the reduction of plastic quantity by 3, the carbon footprint of logistics by 60%, and energy consumption by 47%.

Sustainable Packaging

Our experts supported a FMCG giant in the hair care sector to perform a 360° packaging solutions re-design (primary, secondary, tertiary) leveraging an analytics solution. The project enabled higher shipping load efficiency and significant carbon and cost reductions due to novel materials integration. These recommendations resulted in cost savings of ~€40 million across seven opportunity categories and geographies.

3. Future-proof Portfolio

A retailer sought our support in qualifying 25 short- and mid-term ESG and climate risks, impacting 60,000 products sold worldwide. The project provided engineering and procurement teams with an executive analytics dashboard for 15 commodities, assessing ESG risks on one hand and CO_2 and biodiversity impacts on the other hand. This helped to inform design and sourcing decisions, enabling the switch towards a sustainable product portfolio, which enhances business resiliency.

4. Sustainable and Circular Business Models

Following our collaboration, a mineral water company developed a profitable and environmentally ambitious multi-way value chain for bottled mineral water, from manufacturing to end- of-life. We leveraged our Capgemini circular business model framework to explore and develop six new concept business models and supported testing in real life – from material extraction to end-of-life treatment. This helped select and build the most suitable one according to cost, sustainability and legal constraints. According to Industry's benchmark, moving to circular economy helps achieve GHG emissions reduction by 39%, and remanufactured products can save up to 50% costs and 70% of materials (*Circle Economy Foundation 2024* and *Zhe Wang et al 2018*). Moreover, our automotive industry research indicates that 91% of customers are willing to invest more for an enhanced service experience, which will in turn lead to new revenue streams (*Capgemini 2023*).

Sustainable Manufacturing

1. Scope 1 and 2 Decarbonization *(incl. Data and AI)*

End-to-end Scope 1 and 2 Assessment and Reduction

We helped a materials manufacturer define its Scope 1 and 2 reduction strategy through CO_2 emissions analytics in 17 sites and decarbonization levers identification (e.g., equipment performance, process evolution, fuel switching). After assessing scenarios (payback, maturity, human and financial resources, subsidies), a decarbonization roadmap was built which resulted in a CO_2 reduction of 27% for scope 1 and 13% for scope 2.

AI-driven Asset Energy Optimization

Our experts enabled a heavy industry leader to leverage AI to optimize the energy consumption of its kilns, through 360° data-science modeling of the assets, exhibiting energy over-consumption root causes. We also facilitated predictive models for operators' assistance and optimal piloting. Our collaboration leveraged ontologies and digital twin technologies, leading to 15% energy savings. Furthermore, the project was a cornerstone for use cases replication acceleration, with a development cycle reduction of about 70%.

2. Waste Reduction

A battery manufacturer needed to restructure its waste management approach. We leveraged a lean, data-based approach while utilizing automation. In battery gigafactories, scrap represents expenses between €10-100 million, as one to three kilotonnes (kT) of scrap is generated and needs to be collected and recycled. Through a Define, Measure, Analyze, Improve, and Control (DMAIC) methodology and data analytics, an 8D action plan was structured, resulting in an 86% reduction in scrap during the industrial ramp-up phase. This represented €7 million of material savings in six months of work, on top of the enhanced productivity and savings linked to recycling services. The analytics tool and operators' training enabled the organization to enhance waste prevention and process standardization.

3. Water Efficiency

An automotive OEM reached out to our experts for support addressing its water footprint and its energy and chemicals usage in two sites. To achieve reductions, we developed simulations and digital twins of equipment for teams to visualize water flow and footprint, energy usage, and chemicals and pollutants output. This entailed detecting anomalies and taking mitigation actions. The tool's deployment resulted in water usage optimization and water stress prediction, which enabled adaptive usage with flow change. The best technological scenario assessed resulted in a reduction of 300% of water use, 130% less wastewater treatment, and 400% cost savings overall.

4. Industrial Cluster Strategy

By supporting a coalition of 39 French cities located within a 200km radius, we were able to enhance their collective sustainability efforts through coordinated strategies and shared initiatives. The ambition was to accelerate industrial decarbonization. Our study covered opportunity studies for low-carbon technologies (CCUS, hydrothermal gasification, O2/effluents valorization, heat networks etc.), regional diagnosis and feasibility analysis, and synergies identification. Over 60 solutions and synergies were analyzed, including CO_2 and cost analytical modeling. We helped create a CO_2 ecosystem involving 20 players.

Sustainable Supply Chain

1. Sustainable Procurement

We helped an automotive manufacturer execute a comprehensive sustainable procurement initiative to reduce Scope 3.1 emissions. The project enabled the company to identify reduction measures, including cost and benefit analysis, suppliers' hotspot engagement, definition of joint reduction roadmaps, and integration of emissions in procurement processes and governance. The project enabled the company to assess 31 emission reduction levers and four SBTi scenarios for board decision making. It also led to 25 suppliers being engaged and over 150 procurement experts upskilled.

2. Supply Chain ESG De-risking *(incl. Critical Resources)*

Supply Chain ESG Risk Exposure

Looking to conduct a 360° ESG and operational and financial risks assessment of its supply chain, we provided a groceries retailer a data-driven risk model. This included forecasts on cost increases, supply chain discontinuity, and production capacity limitation. The model and its mitigation plan improved procurement teams' operational decision making.

Critical* Resources *Management

A construction company sought support on several fronts. We helped to develop a scientific approach for nine critical resources (sand, copper, lithium, cobalt, etc.) to assess their criticality scoring, price, and risk by 2040. Moreover, we outlined mitigation scenarios.

3. Sustainable Logistics

An electric vehicle manufacturer contacted our experts for help proposing a climate roadmap to reach net zero in Scope 3 by 2040. This entailed creating a comprehensive sustainable logistics plan, including analytical capabilities for transport emissions, load and route optimization, alternative fuels, and partnership engagements. The project defined requirements for car programs and Request for Proposal (RfP) processes and led to the creation of a supplier partnership strategy for zero-emission logistics by 2030.

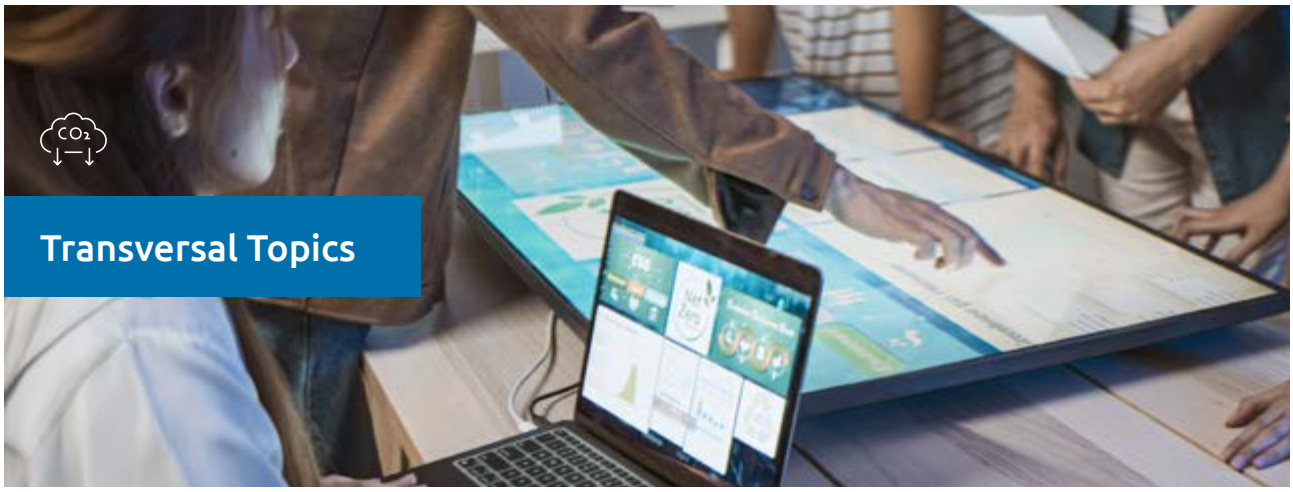
4. Circularity and Sustainable Business Planning (IBP)

Circularity Operationalization

We supported a tobacco manufacturer looking to operationalize its waste circularity strategy for electronic devices worldwide. The project included designing and analyzing feasibility scenarios, streamlining recycling and repairing activities in suitable countries (based on regulations), implementing reverse logistics including hubs design and deployment, and deploying strategy, controlling, and governance frameworks.

Sustainable IBP

Our collaboration with a company in the consumer products industry helped to achieve food waste control to align with its CSR ambition. After a comprehensive planning process analysis, a custom application leveraging ML was built to enhance the planning cycle for waste avoidance, prescribe best actions, and automate visibility on waste risks. The solution reduces up to 50% of waste and unlocks €37 million over three years across Europe, reducing 15T of CO_2.



Transversal Topics

1. Low-carbon Technology Strategy and Ramp Up

Low-carbon Technology Strategy

We helped a steel producer develop a Carbon Capture, Utilization, and Storage (CCUS) solution by conducting a market study on the future demand, supply, pricing, and production costs of low-carbon steel. This was geared towards securing its projects' Final Investment Decision (FID) stage. The study combined qualitative and quantitative methods, including benchmarks on production processes, regulatory impacts assessment (EU ETS, CBAM, etc.), and green premiums. It resulted in a strategic map for low-carbon steel through 2032.

From our analysis, total low-carbon steel production is expected to reach 81.4 megatonnes (MT.) by 2032, with quantified H2 adoption and CCUS investment, as well as green premiums for each technology.

Low-carbon Technology Ramp-up

A steel manufacturer contacted our experts for help developing its strategic and tactical workforce planning for its new green steel plant. A staffing plan was set up and detailed to support the growth of their workforce from 1,800 to over 2,000 employees. This was driven by their decarbonization project and ramp down, while decommissioning a legacy plant. A five-year master plan for recruitment, talent management, training, change management, risks, and communication was developed to prepare implementation, including re-skilling and synergies with the workforce from the legacy plant.

2. Traceability and Digital Product Passport
(incl. Automated Product Carbon Footprint)

Traceability and Digital Product Passport

In the luxury sector, we helped a company set up its group-level traceability program, driven by the need to comply with REACH regulations. This led to the development of a traceability framework and governance, refined processes to monitor products at batch level, and a revitalized IT landscape (ERP, WMS, etc.). It enabled the company to engage 25 business lines and over 200 stakeholders, track 100% of materials and finished products in a digital passport, deploy 15 use cases, and develop over 30 features.

Automated Product Carbon Footprint

With our help, an automotive parts manufacturer was able to completely automate its product carbon footprint evaluation, leveraging a common data model and platform. The company's corporate carbon footprint is dominated by steel and metal-based materials sourced from over 8,000 suppliers. The company also has an extensive product range of 350k references and operates 75 global plants. The project facilitated a comprehensive decarbonization roadmap to be developed, per product and business unit, enabling accelerated decision making for all stakeholders.

3. Digital Core for Sustainability

A consumer products giant engaged our experts to help embed a sustainability component on top of SAP S/4 HANA implementation, leveraging newly designed data and process standards harmonization. Sustainability requirements were prioritized, with an analytics program built to embed sustainability use cases into operations' processes, including product-level sustainability metrics for operations and logistics teams.

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Marketing and Creative Support: Capgemini Invent Global Marketing

About Capgemini Invent

As the digital innovation, design and transformation brand of the Capgemini Group, Capgemini Invent enables CxOs to envision and shape the future of their businesses. Located in over 30 studios and more than 60 offices around the world, it comprises a 12,500+ strong team of strategists, data scientists, product and experience designers, brand experts and technologists who develop new digital services, products, experiences and business models for sustainable growth.

Capgemini Invent is an integral part of Capgemini, a global business and technology transformation partner, helping organizations to accelerate their dual transition to a digital and sustainable world, while creating tangible impact for enterprises and society. It is a responsible and diverse group of 340,000 team members in more than 50 countries. With its strong over 55-year heritage, Capgemini is trusted by its clients to unlock the value of technology to address the entire breadth of their business needs. It delivers end-to-end services and solutions leveraging strengths from strategy and design to engineering, all fueled by its market leading capabilities in AI, generative AI, cloud and data, combined with its deep industry expertise and partner ecosystem. The Group reported 2024 global revenues of €22.1 billion.

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