

Green Business Strategies: Sustainable Technologies and Digital Transformation



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ABSTRACT

In an era defined by climate change and environmental urgency, businesses are increasingly adopting green strategies to align with global sustainability goals and consumer expectations. This article explores the intersection of green business practices and digital transformation, highlighting how emerging technologies—such as artificial intelligence, cloud computing, IoT, and digital twins—enable organizations to reduce their environmental footprint while driving innovation and operational efficiency. The integration of sustainable technologies across various business functions supports renewable energy adoption, smart manufacturing, carbon tracking, and responsible resource management. Despite challenges such as initial investment costs and the risk of greenwashing, companies that embrace this dual transformation stand to benefit from long-term cost savings, regulatory compliance, brand trust, and competitive advantage. The article concludes that the convergence of digital innovation and sustainability is essential for building resilient, future-ready business models in an increasingly green economy.

Keywords: Green business, digital transformation, sustainable technologies, environmental sustainability, corporate social responsibility, renewable energy, artificial intelligence

Introduction

As the global economy grapples with the urgent realities of climate change, resource depletion, and shifting consumer expectations, the traditional approach to business is being fundamentally redefined. Organizations are increasingly expected to go beyond profit-making and demonstrate a commitment to environmental and social responsibility. In this evolving landscape, green business strategies have emerged as essential drivers of sustainable growth [1-2]. These strategies prioritize minimizing environmental impact, optimizing resource use, and aligning operations with long-term ecological goals.

At the same time, the rapid advancement of digital technologies is transforming how businesses operate, communicate, and deliver value. This wave of digital transformation—encompassing tools such as artificial intelligence (AI), cloud

computing, the Internet of Things (IoT), and big data analytics—is not only enhancing efficiency but also creating new opportunities to tackle sustainability challenges in innovative ways [3]. When leveraged effectively, digital technologies can enable organizations to reduce energy consumption, eliminate waste, improve supply chain transparency, and design more sustainable products and services.

The intersection of these two powerful forces—green business practices and digital transformation—represents a new paradigm for corporate strategy. No longer mutually exclusive, they are now deeply intertwined: sustainability is becoming digital, and digital transformation is becoming green. This integration is helping forward-thinking businesses build resilience, meet regulatory requirements, attract environmentally conscious consumers, and gain competitive advantage in an increasingly eco-aware marketplace [4]. This article explores how sustainable technologies, enabled by digital transformation, are reshaping the future of business. It examines the tools, benefits, challenges, and future outlook of this green-digital synergy, offering insight into how companies can thrive by aligning innovation with environmental responsibility. In the face of escalating climate challenges, environmental degradation, and growing consumer demand for corporate responsibility, sustainability has become a business imperative. Companies across industries are being called upon to reduce their environmental impact while maintaining competitiveness and profitability [5]. Central to this shift is the convergence of green business strategies and digital transformation—a powerful combination that enables organizations to operate more efficiently, innovate responsibly, and drive long-term value creation.

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1. The Evolution of Green Business

Green business refers to the integration of environmentally and socially responsible practices into the core operations, strategy, and values of an organization. It encompasses a broad commitment to reducing environmental harm, conserving natural resources, and fostering long-term sustainability—not just for the benefit of the planet, but also for the health of economies and communities. Unlike traditional corporate strategies that may treat environmental initiatives as secondary or compliance-driven, green business strategies aim to embed sustainability at every level of decision-making [6]. Historically, early green business initiatives were limited in scope, often centered around isolated activities such as office recycling programs, energy-efficient lighting, or reduced paper usage. While these efforts were well-intentioned, they largely operated at the periphery of business operations. Over time, however, organizations began to recognize that sustainability could be a driver of innovation, risk mitigation, and value creation rather than just a regulatory requirement or public relations effort.

Today, green business strategies are far more sophisticated and systemic. They include ambitious efforts to lower carbon emissions through renewable energy adoption, reduce waste through circular economy principles, and design products with minimal environmental impact. Businesses are investing in sustainable supply chain management, ethical sourcing, carbon offsetting programs, and lifecycle assessments of products to measure and minimize their ecological footprints [7]. For instance, major brands are redesigning packaging to be biodegradable or recyclable, using eco-friendly materials, and optimizing logistics to reduce emissions.

This transformation is being accelerated not only by environmental imperatives but also by powerful market forces. Consumers are increasingly making purchasing decisions based on a brand's environmental and social track record, often favoring companies that demonstrate transparency and authenticity in their sustainability efforts. A growing segment of the workforce, particularly younger generations, also prefers to work for purpose-driven organizations that align with their values [8]. Meanwhile, investors are incorporating ESG (Environmental, Social, and Governance) criteria into portfolio decisions, redirecting capital toward businesses that demonstrate long-term sustainability and ethical governance.

Governments and regulatory bodies are playing a significant role as well. International agreements such as the Paris Climate Accord, along with national policies on emissions reductions, carbon pricing, and green subsidies, are encouraging companies to adopt more sustainable practices. Non-compliance is not only a reputational risk but also a financial one, as regulatory penalties and access to funding become increasingly tied to sustainability performance. In this dynamic context, the evolution of green business is no longer a peripheral trend—it is a core strategic shift [9]. Companies that view sustainability as a central pillar of their operations are better positioned to navigate risks, meet stakeholder expectations, unlock innovation, and build long-term resilience. Integrating green principles is now both a moral responsibility and a business imperative, laying the groundwork for a more equitable and environmentally stable future.



Fig 1: For sustainability leaders, navigating complex regulations while meeting environmental goals is challenging. Digital transformation offers a solution—streamlining data, improving reporting, and unlocking insights to drive lasting sustainability.

Source: <https://tracextech.com/digital-transformation-sustainability/>

2. Digital Transformation as a Catalyst for Sustainability

Digital transformation—the comprehensive integration of digital technologies across all facets of a business—has become a powerful enabler of sustainability. As organizations strive to reduce their environmental footprint and meet rising expectations for corporate responsibility, digital tools provide the means to operate more efficiently, transparently, and responsibly. Far from being separate initiatives, digitalization and sustainability are increasingly intertwined, with technology acting as a catalyst for greener, smarter business practices [10]. One of the most significant contributions of digital transformation to sustainability is its ability to support smarter resource management. With the help of advanced data analytics and real-time monitoring systems, companies can track resource consumption—such as water, electricity, fuel, and raw materials—with unprecedented accuracy. This visibility enables organizations to identify inefficiencies, eliminate waste, and optimize processes, ultimately leading to both cost savings and environmental benefits.

Cloud computing is a prime example. By migrating infrastructure to the cloud, businesses can reduce their dependence on energy-intensive on-premises data centers. Cloud providers often use highly efficient data centers powered by renewable energy sources and leverage economies of scale to minimize overall energy consumption [11]. This transition not only cuts emissions but also enables remote work, reducing the need for daily commuting and office space energy use.

The Internet of Things (IoT) plays a crucial role in monitoring and optimizing physical environments. IoT sensors can track energy usage in real time across office buildings, industrial sites, and transportation fleets. With this data, companies can automate systems to adjust lighting, heating, cooling, or machinery operations based on actual demand, significantly reducing unnecessary energy expenditure [12]. For example, smart thermostats and lighting systems in commercial buildings can lower electricity use while maintaining comfort and productivity.

Artificial Intelligence (AI) further enhances these efforts by enabling predictive and prescriptive analytics. AI algorithms can forecast equipment failures before they occur, allowing for predictive maintenance that reduces downtime and prolongs machinery life [13]. This not only saves resources but also avoids waste generated by premature replacement or breakdowns.

In supply chains, AI can optimize routes, forecast demand more accurately, and align production levels with market needs, thus avoiding overproduction and minimizing transportation emissions.

A particularly innovative technology in this space is the use of digital twins—virtual models of physical assets, systems, or processes. By simulating performance in a digital environment, businesses can test various scenarios without the need for physical prototypes. This leads to reductions in material use, production errors, and energy consumption [14]. In construction, for example, digital twins can help optimize building designs for energy efficiency before a single brick is laid, blockchain technology is being explored for enhancing supply chain transparency and verifying sustainability claims. It can securely track the origin and journey of raw materials, helping businesses ensure that their suppliers follow ethical and environmental standards, digital transformation is not only making businesses faster and more connected but also empowering them to be more environmentally conscious. It provides the tools to measure impact, innovate responsibly, and integrate sustainability into the core of business strategy [15]. By adopting these technologies, organizations can transition from reactive to proactive sustainability—shifting from compliance-focused efforts to leadership in environmental stewardship.



Fig 2: The UK's new Circular Economy Strategy focuses on enhancing material efficiency in construction and related sectors, aiming to reduce waste, lower emissions, and promote sustainable resource use.

Source: <https://www.energistik.co.uk/knowledge/the-new-uk-circular-economy-strategy-improving-material-efficiency-in-construction-and-beyond/>

3. Sustainable Technologies in Business Operations

As sustainability becomes a core priority across industries, businesses are turning to advanced technologies to embed environmentally responsible practices into their day-to-day operations. These sustainable technologies are helping companies reduce their environmental impact, enhance efficiency, and build resilience in the face of evolving regulatory and market pressures [16]. The adoption of these innovations is not limited to one sector; rather, it spans energy, manufacturing,

logistics, product design, and digital services—demonstrating the universal relevance of green transformation.

One of the most significant areas of innovation is the integration of renewable energy into business operations. Organizations are increasingly investing in clean energy solutions such as solar panels, wind turbines, and battery storage systems to power offices, manufacturing plants, and data centers [17]. By generating their own renewable electricity, businesses reduce dependence on fossil fuels, lower greenhouse gas emissions, and hedge against the volatility of energy prices. In some cases, companies are also entering into power purchase agreements (PPAs) with green energy providers, further contributing to the decarbonization of the grid. In the digital realm, green cloud services are becoming a critical part of sustainable IT strategies. Major cloud providers—such as Microsoft Azure, Google Cloud, and Amazon Web Services—have committed to powering their data centers with 100% renewable energy and are offering carbon-neutral or carbon-aware computing services. These platforms enable organizations to migrate workloads to more energy-efficient environments, reduce on-premise infrastructure needs, and achieve substantial energy savings while minimizing their digital carbon footprint.

The manufacturing sector is undergoing a transformation through sustainable production practices, often referred to as smart or Industry 4.0 manufacturing. Technologies such as automation, AI-driven process optimization, and real-time analytics are being deployed to monitor energy use, reduce material waste, and improve resource efficiency [18]. These systems can dynamically adjust production processes to reduce emissions and prevent overconsumption of inputs, enabling leaner, cleaner operations. Some factories are also adopting closed-loop systems that recycle waste materials back into production lines, reinforcing circular economy principles. In product design and logistics, sustainable packaging is emerging as another vital area of focus. Digital tools, including 3D modeling and lifecycle analysis software, are being used to develop packaging solutions that minimize waste, use recyclable or biodegradable materials, and reduce volume and weight for more efficient transportation [19]. These innovations not only reduce environmental impact but also align with growing consumer demand for eco-conscious products and packaging.

Finally, advancements in digital carbon tracking are empowering businesses to monitor, measure, and manage their environmental performance with greater accuracy. New platforms and software tools allow organizations to calculate their carbon footprint across multiple operations, including manufacturing, logistics, and supply chains. This data-driven approach enables companies to identify emissions hotspots, implement targeted reduction strategies, and transparently report progress toward net-zero or science-based targets. In some cases, blockchain technology is being used to verify carbon offsets and ensure the credibility of sustainability claims [20]. Incorporating these sustainable technologies into business operations not only supports environmental goals but also enhances brand reputation, regulatory compliance, and long-term profitability. As innovation continues to accelerate, companies that adopt and scale green technologies will be better positioned to lead in a climate-conscious global economy.

Table 1: Impact of Digital Technologies on Sustainability Metrics

Digital Technology	Sustainability Benefit	Supporting Study/Source
IoT (Internet of Things)	15–20% reduction in energy consumption in smart buildings	McKinsey & Company (2020)
Cloud Computing	Up to 84% more energy-efficient than traditional data centers	Google Cloud Sustainability Report (2022)
AI & Machine Learning	10–30% reduction in supply chain waste	Capgemini Research Institute (2020)
Digital Twins	25% reduction in product development resource usage	Deloitte Insights (2021)
Blockchain for ESG Reporting	Improved transparency and reduced risk of greenwashing	World Economic Forum (2022)

Table 2: Barriers to Green-Digital Integration Among SMEs

Barrier	Description	Suggested Mitigation Strategy
High Initial Investment	Costs of new technologies and infrastructure	Government subsidies, phased implementation
Technical Skills Gap	Lack of digital expertise among staff	Training programs, partnerships with tech providers
Cybersecurity Concerns	Data vulnerability from digital systems	Strong IT policies, third-party audits
Cultural Resistance	Hesitation to change traditional processes	Change management and internal advocacy
Risk of Greenwashing	Misrepresentation of sustainability claims	Third-party verification and transparent reporting

Table 3: Comparative Analysis – Traditional vs. Green-Digital Business Models

Aspect	Traditional Model	Green-Digital Model
Energy Consumption	High due to inefficient systems	Reduced via smart systems and renewables
Supply Chain Management	Manual and linear	Digital, optimized, and circular
Reporting & Compliance	Paper-based, reactive	Real-time, digital, proactive
Customer Engagement	Transaction-focused	Value-driven and sustainability-oriented
Brand Perception	Neutral or inconsistent	Positive and trust-building

4. Benefits of Integrating Digital and Green Strategies

The convergence of digital transformation and green business strategies creates a powerful synergy that delivers value not only to the environment but also to the organizations that embrace it. By combining technological innovation with sustainability objectives, companies can unlock a wide range of strategic, financial, and reputational benefits that contribute to long-term success and resilience in a rapidly evolving global economy [21]. One of the most immediate and tangible benefits is cost reduction. Implementing energy-efficient technologies, optimizing operations through real-time data analytics, and using predictive maintenance tools all help lower utility bills, reduce resource consumption, and minimize waste. Over time, these efficiencies translate into significant savings across energy use, raw materials, logistics, and maintenance budgets. For example, smart energy management systems in manufacturing or office buildings can reduce electricity consumption by automatically adjusting lighting and HVAC settings based on occupancy and demand.

Regulatory compliance is another key advantage. As governments and international bodies tighten environmental regulations and enforce stricter reporting standards, digital tools enable businesses to accurately track emissions, monitor resource usage, and generate reliable sustainability reports [7]. This not only helps meet ESG (Environmental, Social, and Governance) requirements but also prepares organizations for future legislation and audits. The ability to demonstrate transparent and verifiable sustainability metrics can enhance access to green financing, subsidies, and investment capital.

Beyond compliance, the integration of green and digital strategies also fosters innovation and competitive advantage. Organizations that invest in sustainable product design, green logistics, and low-carbon technologies are better positioned to capture emerging market opportunities and differentiate themselves in crowded markets. Environmentally conscious consumers are increasingly favoring brands that align with their values, while investors are redirecting funds toward companies that demonstrate long-term sustainability and social responsibility.

This alignment with stakeholder expectations also boosts brand reputation and customer loyalty.

Transparent, eco-friendly business practices enhance consumer trust and contribute to a positive brand image. Customers are more likely to remain loyal to businesses that actively reduce their environmental impact, engage in ethical sourcing, and contribute to broader climate goals. In a digital age where public perception can rapidly shape a company's success, strong sustainability credentials can significantly influence purchasing and investment decisions.

Finally, integrating digital and green strategies strengthens a company's risk mitigation capabilities. Environmental risks—such as climate-related disruptions in supply chains, resource scarcity, and regulatory penalties—pose growing threats to business continuity. By using digital tools to map risks, monitor ecosystems, and forecast potential disruptions, companies can proactively develop mitigation strategies and build greater resilience [13]. This forward-thinking approach ensures that organizations are not only prepared for uncertainty but can also thrive in a world where sustainability is increasingly non-negotiable. In sum, the fusion of digital innovation with sustainable thinking equips businesses with the tools and frameworks to operate more efficiently, meet stakeholder expectations, and lead with purpose in the emerging green economy.

5. Challenges and Considerations

While the integration of digital transformation and green business strategies offers significant advantages, the journey toward sustainable digitalization is not without its complexities. Organizations—particularly small and medium-sized enterprises (SMEs)—often face a number of financial, operational, and cultural barriers that can slow or complicate implementation. One of the most common obstacles is the high upfront investment required for sustainable technologies and digital infrastructure. Transitioning to renewable energy systems, upgrading to smart manufacturing technologies, or deploying advanced digital platforms for carbon tracking can demand substantial capital. For SMEs with limited budgets, this cost can be prohibitive without external support such as government incentives, green financing, or partnerships with technology providers. While these investments often lead to long-term cost savings and efficiency gains, the initial expenditure may deter adoption without a clear return on

investment roadmap [19]. In parallel, the successful adoption of digital tools also demands workforce training and organizational readiness. Employees need to develop new skills to use data analytics, IoT systems, or sustainability reporting platforms effectively. Without proper training and change management, digital tools may be underutilized or improperly implemented, undermining their sustainability benefits. Additionally, the rise of interconnected systems and data collection introduces cybersecurity and data privacy concerns, which must be addressed through robust security protocols and compliance with relevant regulations.

A deeper challenge lies in the need for a cultural shift within the organization. Embracing digital sustainability requires moving beyond siloed environmental or IT departments to foster a holistic, cross-functional approach. Leadership must commit to embedding sustainability into the company's core values, decision-making processes, and performance metrics. This often means rethinking business models, stakeholder engagement, and long-term strategic planning. Another critical consideration is the growing concern over greenwashing—the practice of overstating or misrepresenting a company's environmental actions or impact. As sustainability becomes a key differentiator in the marketplace, the temptation to present superficial or misleading claims can damage credibility and stakeholder trust. To avoid this, organizations must ensure transparency and accountability in their sustainability efforts. This includes setting measurable goals, using credible third-party certifications, and publicly reporting progress with honesty and rigor. To navigate these challenges effectively, businesses should adopt a phased and strategic approach [12-14]. Starting with high-impact, low-barrier projects—such as energy audits, digital energy monitoring, or transitioning to cloud-based platforms—can deliver quick wins and build momentum. Establishing internal sustainability teams or cross-departmental task forces can help coordinate initiatives, monitor performance, and drive continuous improvement. Engaging employees at all levels, fostering innovation, and maintaining open communication about challenges and progress are also key to creating a resilient, future-ready organization, while the path to integrating digital and green strategies can be complex, a thoughtful, transparent, and incremental approach can help businesses overcome barriers and position themselves as leaders in the sustainable economy.

6. Future Outlook: The Green-Digital Synergy

The future of sustainable business will be shaped by the synergy between digital innovation and environmental responsibility. Emerging technologies such as blockchain, AI, and machine learning will continue to revolutionize the way businesses track, report, and reduce their environmental impact. For example, blockchain can enhance supply chain transparency, ensuring ethical and sustainable sourcing. AI can forecast demand more accurately, reducing waste and emissions associated with overproduction. Governments and international organizations are also promoting this convergence through green tech funding, tax incentives, and climate-tech partnerships. As global environmental targets become more ambitious, companies that align their operations with both digital transformation and sustainability will be best positioned to lead.

7. Conclusion

Green business strategies and digital transformation are no longer isolated initiatives; they are interdependent forces that together define the future of sustainable enterprise.

As environmental concerns intensify and technological innovation accelerates, the intersection of these two domains offers a unique opportunity for organizations to realign their operations with global sustainability goals. Businesses that embrace digital transformation not only improve operational efficiency but also gain powerful tools for reducing their environmental footprint and driving systemic change. Digital technologies—such as cloud computing, artificial intelligence, the Internet of Things, and blockchain—provide the infrastructure needed to monitor, measure, and optimize sustainability efforts across all areas of the value chain. From reducing energy consumption and minimizing waste in manufacturing to tracking carbon emissions and enhancing supply chain transparency, these tools empower companies to make data-driven decisions that align with both environmental responsibility and economic performance, the integration of green and digital strategies supports long-term innovation and competitiveness. Consumers, investors, and regulators are increasingly favoring businesses that demonstrate genuine commitment to environmental stewardship and ethical governance. Companies that lead in this space are not only better equipped to comply with evolving regulations and ESG standards, but also more likely to attract talent, secure investment, and build lasting brand loyalty, realizing the full potential of this convergence requires strategic planning, cross-functional collaboration, and cultural transformation. Organizations must move beyond short-term fixes and adopt a long-term vision that embeds sustainability into their digital agenda, the path to a sustainable future is inherently digital. Those organizations that act proactively—investing in the right technologies, cultivating transparent practices, and committing to continuous innovation—will not only contribute to the health of the planet but also thrive in the next generation of responsible business. The decisions made today will shape the environmental and economic outcomes of tomorrow.

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