

# Impact Of Corporate Green Technology Innovation from An ESG Perspective

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**Abstract.** This paper discusses the impact of green innovation on firms in the chemical, manufacturing, high-tech and power generation industries from an Environmental, Social, and Governance (ESG) perspective. Through case studies of representative firms in the industries, it summarizes the common features of the impacts in the industries by focusing on the impacts of green innovation on firms from an ESG perspective. By examining leading chemical companies, AkzoNobel, DuPont and The Dow Chemical Company, it demonstrates how green innovation can significantly improve economic performance. In the high-tech sector, Google, Intel and NVIDIA utilize technology to expand and streamline their businesses. In the manufacturing industry, Siemens, Apple and Tesla represent companies optimized across the board to reduce the CO<sub>2</sub> produced during manufacturing. Finally, in the energy sector, Tesla Energy, Vestas, and ANDRITZ Hydro are capitalizing on booming market opportunities for rapid expansion and growth. This paper provides a useful reference and outlook for understanding the growth strategies and profiles of these four industries.

**Keywords:** High-tech industry; energy; green innovation.

## 1. Introduction

Environmental, Social and Governance (ESG) factors have received a lot of attention as important factors in assessing the sustainability and ethical practices of businesses and organizations. ESG is a framework for assessing corporate performance and impact that goes beyond traditional financial metrics to take into account a company's environmental responsibility, social impact and governance practices [1]. With growing awareness of environmental challenges, social inequality and corporate responsibility, ESG has become a cutting-edge issue in the decision-making processes of investors, consumers, regulators and other stakeholders. Green innovation represents a range of technologies, strategies and practices designed to reduce negative environmental impacts and promote sustainable development [2]. There is a strong relationship between green innovation and ESG as they are intertwined and interdependent in many ways. Green innovation is often one of the keyways to achieve ESG objectives, and green innovation receives guidance and norms from ESG objectives [3]. This paper focuses on the significant impacts of these companies from an ESG perspective through case study research and then tries to summarize the commonalities of the impacts on different industries. In the chemical industry, AkzoNobel, DuPont, and The Dow Chemical Company are studied; in the manufacturing industry, Apple, Tesla, and Simons are studied; in the high-tech industry, Google, Intel, and NVIDIA are studied; and in the energy production industry, Tesla Energy, Andritz Hydro, and Vestas are studied. Conducted research. This research can help to understand the relationship between business and green innovation, provide insights into the experiences of representative companies, help companies to make more informed business decisions, and provide strong support for achieving the SDGs and building more sustainable business models.

## 2. Chemical Industry

The chemical industry is subject to significant environmental sustainability concerns. This section provides case studies of representative industry companies such as AkzoNobel, DuPont, and The Dow Chemical Company.

## 2.1. AkzoNobel

AkzoNobel, as an iconic paint and coatings company in the chemical industry, has been actively involved in developing eco-quality solutions, seeking to be more efficient and at the same time developing products that reduce their impact on the environment. They are constantly innovating and developing new eco-quality solutions, aiming to provide customers with sustainable options without compromising on performance. In 2020, AkzoNobel's eco-solutions products accounted for 21% of total revenues, and the trend is increasing year on year [4]. They have set an ambitious target: by 2030, more than 50% of their revenue will come from sustainable solutions [5].

## 2.2. DuPont

DuPont, a global innovation leader, articulated a comprehensive sustainability strategy in its 2023 report. The company is focusing on four key impact areas to address the world's most pressing challenges: DuPont is committed to mitigating the effects of climate change through a variety of initiatives, conducting more than 1,000 product stewardship reviews and identifying opportunities to improve the sustainability of existing products. It includes recycling and reusing materials and designing safe and sustainable products. Ensuring that these products meet stringent safety and environmental standards. Manufacturing processes take into account efficient water conservation and treatment of reused water. Employee engagement is recognized as central to DuPont's sustainability efforts: the company's long-standing commitment to ensuring the safety and health of its employees, contractors, customers and communities. DuPont encourages employees to be actively involved in community development through key partnerships, work with nonprofit organizations, skills volunteering and board service. An inclusive environment delivers more results and impact for the company, and the steps they take improve the health and well-being of employees, communities and the world [6]. DuPont has been honored with nine Edison and research and development (R&D) 100 Innovation Excellence Awards. Eight of the nine innovations have delivered significant sustainability benefits, enabling customers to make progress toward their sustainability goals in climate, circular economy, chemicals management and water management. Sustainability innovations also provide significant benefits to DuPont, with 80 percent of top innovation programs delivering sustainability value to customers by 2022. More than 50 percent of these innovations are focused on climate [7].

## 2.3. The Dow Chemical Company

The Dow Chemical Company has taken a proactive stance on water conservation, especially in its Texas operations. First, Dow successfully implemented primary cooling water recycling at its chlorine plant and air compressor station. This innovative approach has resulted in significant water savings of 1,300 gallons per minute (gpm). Next, the company utilized seawater for cooling. The installation of seawater piping at Power Plant 6 marked another significant advancement. This initiative saved 200 gpm during startup and an even greater 200-600 gpm during shutdown, demonstrating the company's commitment to efficiency [8]. Dow's efforts also extended to product design. The company improved resin bed operations and enhanced the design of the Deming Water Plant tanks, saving 1,600 gpm. Green innovations have also given Dow expanded business. The company purifies water for many regions, helping the city of Lake Jackson, for example, save an impressive 2,500 gpm by reusing treated wastewater. Together, these strategic efforts propelled Dow's operations in Texas to exceed their goals, achieving a 10.6 percent reduction in water use [9].

## 2.4. Overall

All three companies recognize the need to address environmental issues. They are actively engaged in green innovation and sustainability activities to minimize their ecological footprint. AkzoNobel's emphasis on eco-quality solutions and DuPont's comprehensive sustainability strategy, which includes recycling, sustainable products and water conservation, underscore their commitment to environmental responsibility. Dow Chemical's water conservation strategy, which includes recycling cooling water and working with local governments to reuse wastewater, demonstrates the company's

concerted efforts to conserve valuable natural resources. These companies are at the forefront of innovation, incorporating sustainable practices into their products and processes. AkzoNobel's focus on eco-solutions products highlights its commitment to providing sustainable options without compromising performance. DuPont's dedication to sustainable innovation is exemplified by its award-winning commitment to providing products that meet sustainability goals. Dow Chemical has implemented innovative strategies such as seawater cooling and water recycling, demonstrating a proactive approach to resource management. Collaboration is a common theme among these companies. AkzoNobel's collaboration with various stakeholders exemplifies its approach to creating sustainable solutions through collective efforts. DuPont's focus on employee engagement and community development exemplifies its approach to holistic sustainability practices. Dow Chemical's collaboration with local governments on water conservation activities reinforces the importance of building alliances to drive positive change. Each company has set ambitious goals to drive sustainable change. AkzoNobel's high sustainability goals demonstrate the company's long-term commitment to the impact of change. DuPont's overall sustainability strategy spans multiple impact areas, including climate change, circular economy and chemicals management. Dow Chemical's tangible achievements, such as exceeding its water conservation goals, demonstrate its commitment to translating its long-term vision into actionable results. These companies recognize that sustainable practices are not only ethical, but also contribute to improved financial performance. AkzoNobel's growing revenue from eco-solutions products and Dow Chemical's fruitful water-saving strategy demonstrate how sustainability initiatives can produce positive financial results. DuPont's focus on innovation and sustainability also contributes to customer value and economic growth.

### **3. Manufacturing Industry**

Manufacturing is the cornerstone of the global economy and the frontier of green technology innovation practice. This section provides a comprehensive understanding of the impact of green technology innovation on the manufacturing industry through detailed analysis of representative corporate cases such as Siemens, Apple and Tesla.

#### **3.1. Siemens**

Siemens has demonstrated a comprehensive and diversified strategy in environmental sustainability with a wide range of programs. The company has launched the EcoTransparency program, which aims to make energy use more environmentally friendly by offering transparent products, systems and solutions [10]. This includes innovative "blue" products that not only reduce F-gas emissions, but also do so without compromising performance [11]. In terms of its sustainability strategy, Siemens has implemented the DEGREE framework to comprehensively monitor all aspects of its efficiency [12]. The company has also made breakthroughs in the field of hydrogen production, developing advanced green electrolysis systems and establishing joint ventures in the renewable electrolytic hydrogen market. Siemens has reduced its CO<sub>2</sub> footprint by more than half and has set a goal of achieving carbon-neutral operations by 2030, with energy savings also providing significant economic benefits [13].

#### **3.2. Apple**

As the world's largest technology company by market capitalization, Apple has greatly enhanced its corporate reputation by continually touting the strides they have made in environmental sustainability. Apple's green initiatives cover a wide range of areas from material sourcing to energy use and transportation. Apple is committed to using 100 percent renewable electricity in its manufacturing processes from more than 250 suppliers who account for more than 85 percent of Apple's direct manufacturing spend [14]. In addition, the company prioritizes low-carbon, efficient modes of transportation, such as rail, sea and electric vehicles, to minimize its environmental impact. In addition, Apple has reduced the average energy consumption of its products by 70 percent since

2008. Notably, Apple pioneered the production of low-carbon aluminum and invested in clean energy projects. These efforts have resulted in a significant 70 percent reduction in aluminum-related carbon emissions since 2015. Through advances in green chemistry and recycling, Apple is committed to making products without depleting the earth's resources, moving the company closer to fully sustainable operations. Apple has set an ambitious goal of making all of its products carbon neutral by 2030 [15]. In short, Apple's multi-pronged approach to green technology not only mitigates its impact on the environment, but also sets the standard for the entire tech industry.

### 3.3. Tesla

Tesla, a pioneer in electric vehicles and renewable energy products, has made significant achievements in environmental sustainability. According to 2022 data, Tesla's products and services have helped customers avoid 13.4 million tons of Carbon Dioxide (CO<sub>2</sub>) emissions. The company has also demonstrated a high level of resource efficiency in its manufacturing processes, with 90 percent of production waste recycled and reused. In addition, Tesla has made efforts to collect and reuse rainwater and condensate, and its Supercharger stations rely on 100% renewable energy. However, despite these achievements in environmental protection, Tesla still faces a number of challenges. These include issues related to labor practices and the potential environmental impact of battery production [16]. These issues will require Tesla to pay sufficient attention and address them on the road to sustainability in the future.

### 3.4. Overall

Siemens, Apple and Tesla, although representing completely different sectors of the manufacturing industry, have all demonstrated a deep-rooted commitment to environmental sustainability, targeting carbon neutrality by 2030 as an integral part of their respective corporate strategies. They are all focusing on energy use and efficiency in the manufacturing chain processes, raising standards and aiming for lean production, thus increasing competitiveness, reducing resource consumption and creating customer value without increasing pollution and waste [6]. For example, Siemens' EcoTransparency and DEGREE frameworks optimize and disclose all aspects of the company, Apple focuses on renewable electricity, low-carbon transportation modes, and waste minimization through its comprehensive green initiatives, and Tesla, a pioneer in electric vehicles and renewable energy, emphasizes the cumulative reduction of CO<sub>2</sub> emissions from its products. Such innovations not only mitigate environmental impacts, but also hold the promise of economic value through operational efficiencies or market differentiation. Each of these companies also takes a multifaceted approach to environmental, social, and governance (ESG) factors, whether in the form of transparent reporting, sustainable supply chain management, or investment in clean technology. As such, their collective efforts serve as both a model and a catalyst for industry-wide progress on environmental sustainability. However, the path to green innovation is not without its challenges, including high initial investment costs, technological barriers, and resistance to change within organizations. Overcoming these barriers requires strategic investment in green technology research and development, technology transfer in collaboration with external partners.

## 4. High-tech Industry

The high-tech industry, as direction takers in the sustainability process, utilizes research to change the current state and direction of sustainability. This section provides case studies of Google, NVIDIA and Intel.

### 4.1. Google

Google reduces long-term energy costs by using renewable energy. The company has created more accurate and efficient greenhouse gas accounting, utilizing technology to accelerate climate action. Since 2007, Google has championed the adoption of renewable energy, and by 2017, the company

achieved a remarkable feat-100 percent of its global electricity use came from renewable sources [17]. Google's green strategy and practices have attracted additional partners, including governments, NGOs, and other businesses, to advance global sustainability. They have set a goal to help individuals, cities, and other partners reduce emissions by 1 gigaton of carbon dioxide equivalent per year by 2030. These results not only demonstrate Google's commitment to a greener future, but also position it as a trailblazer in the industry [18].

#### **4.2. NVIDIA**

NVIDIA, renowned for its revolutionary GPU technology, has harnessed innovation as a driving force. A deep commitment to research and development (R&D) has enabled NVIDIA to continuously push technological boundaries. This commitment is underscored by their strategic collaborations with tech giants, research institutions, and startups, fostering a culture of collective innovation. A remarkable facet of NVIDIA's green strategy lies in its dedication to energy efficiency. Their GPUs, designed for peak performance, have been engineered with an acute focus on reducing energy consumption. The company's ethos of responsible innovation is further exemplified by their sustainable product design, contributing to a reduction in their overall carbon footprint [19].

#### **4.3. Intel**

As a giant in semiconductor technology, Intel has made environmental responsibility a centerpiece of its operations. Pat Gelsinger, the company's CEO, said, “ Intel was built for these kinds of challenges” [20]. Intel designs more energy-efficient products and improves product competitiveness. Intel is seriously committed to reducing greenhouse gas emissions throughout the value chain, investing in many environmentally friendly programs. Their ambitious goal of achieving 100% global renewable energy utilization by 2030 underscores their strong commitment to sustainability. This commitment extends to their supply chain, where collaboration with various suppliers not only fosters innovation, but also demonstrates their dedication to ethical practices [21].

#### **4.4. Overall**

The high-tech industry, led by influential companies such as Google, NVIDIA and Intel, is playing a significant role in promoting environmental sustainability through green innovation. While the key products and services of these companies are different, they are united in integrating environmental, social and governance (ESG) principles into their operations and strategic frameworks. Google has achieved the milestone of using 100 percent renewable energy for its global electricity consumption, a milestone that underscores its commitment to sustainability and influences stakeholders from government to business. NVIDIA and Intel also place a high priority on the energy efficiency of their chips when developing their chip products. The tech industry they have used their technology as, in collaboration with other industries, expanded their business. Google uses technology to provide more accurate accounting of carbon emissions, partnering with governments, NGOs and businesses to provide technical support. NVIDIA has formed strategic alliances with tech giants, research organizations and startups to foster a culture of green innovation. Intel extends its sustainability commitment to its supply chain, working with suppliers to implement ethical sustainability practices. These companies don't view sustainability as just a corporate social responsibility, but as an economic responsibility and competitive advantage. Their ambitious goals of achieving carbon neutrality and renewable energy use, combined with advances in energy-efficient technologies and responsible supply chain management, are not only in their business interest, but also enhance their corporate image, making them a benchmark for ESG practices in the high-tech industry.

### **5. Energy Production**

Driven by the urgent need to combat climate change and achieve sustainable development, the transformation of the energy production industry plays a key role. Because green innovation is

directly affecting their product performance, their financial reports should reflect the impact of green innovation. In this section, three representative case studies are selected from the fields of hydroelectric power, wind power, and solar power, including Tesla Energy, Vestas, and Andritz Hydro.

### 5.1. Tesla Energy

Tesla Energy has tapped into the solar energy market with its highly efficient and aesthetically pleasing solar roof tiles and Powerwall batteries. The integration of these technologies has led to a fundamental improvement in the efficiency of power generation in home energy systems [22]. Tesla's innovations have lowered the barrier to entry for solar adoption, as it offers systems that are not only easier to operate, but also competitively priced and aesthetically pleasing. These advantages have facilitated the widespread adoption of solar energy in the average home.

### 5.2. Vestas

Vestas is a leader in the wind energy sector with advanced turbine designs that increase efficiency and competitiveness in the wind energy sector. On the financial front, the company expects full-year revenues in 2023 to reach between €14 billion and €15.5 billion, realizing significant growth. This forecast includes service revenues, which are expected to grow by around 10% [23]. Vestas ambitiously plans for its service revenues to outpace market growth rates over the long term in a market that is expected to grow in the high single digits. In addition, taking into account the integration of the offshore and onshore businesses, the latter of which currently enjoys higher margins, the company aims to maintain an EBIT margin of around 25% over the long term [24].

### 5.3. Andritz Hydro

Andritz Hydro focuses on optimizing the energy output of hydroelectric power through highly efficient turbines and generators. Financially, approximately 45 percent of the company's total sales come from renewable energy technologies, including hydroelectric power plant equipment and biomass power generation systems [25]. The division's main products include electromechanical equipment for hydroelectric plants and biomass boilers and recovery systems for the pulp and paper industry. The company hopes to increase the share of revenues from sustainable solutions and products to more than 50 percent by the end of 2025 [26].

### 5.4. Overall

Tesla Energy, Vestas and ANDRITZ HYDRO have used innovative power generation technologies to significantly increase the efficiency of green energy production systems and broaden their markets. From an economic perspective, the innovations of these companies have helped to significantly increase revenue growth and market competitiveness. Vestas, for example, expects revenues of between €14 billion and €15.5 billion in 2023, with service revenues expected to grow by 10 percent. Tesla's innovations have the potential to appeal to a broader consumer base due to lower costs and easier operation. ANDRITZ HYDRO aims to increase the share of its sustainable solutions in total revenue to more than 50% by the end of 2025. On the environmental front, these innovations are directly aligned with the goal of reducing greenhouse gas emissions. Tesla's high-efficiency solar solutions have the potential to significantly offset residential demand for electricity from fossil fuels. Vestas' high-efficiency wind turbines contribute to the decarbonization of the energy sector. Andritz Hydro's energy-efficient turbines similarly promote clean, renewable power generation.

## 6. Conclusion

Based on the case studies in this paper, it can be summarized that through green innovation, companies in the chemical industry have been able to significantly increase their economic

performance, companies manufacturing industry can largely minimize CO<sub>2</sub> emissions during production, companies in the high-tech industry have utilized innovative technologies to increase their business, and companies in the energy production industry have been able to ride on the wave of momentum, with a rapid expansion of their markets and rapid growth. On the environmental front, the concept of green innovation has given these companies the opportunity to save energy, recycle energy and materials, and put green innovation into their growth strategies. On the social front, these companies are using their ESG achievements to publicize and increase their social impact and become industry benchmarks. On the governance side, the all-encompassing pursuit of green greatly improves efficiency, puts the physical and mental health of employees into consideration, and realizes long-term cooperation with employees. However, the research subjects in this paper are large companies and it is difficult to find data for small companies. It is difficult to directly compare the direct impact of companies due to green innovation because of the intervention of various factors such as the growth of the business and changes in the economic environment. ESG is at a critical juncture, torn between transformative potential and critical skepticism. While ESG offers promising avenues for sustainable innovation and financial performance, its implementation and impact are not consistent across industries or regions. Moreover, there is an urgent need for a transparent national dialog to establish effective legislative and regulatory frameworks. Only within such a framework can businesses refocus on maximizing shareholder value while taking into account environmental and social considerations.

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