



TESLA'S ROLE IN DRIVING CLEANER PRODUCTION IN THE AUTOMOTIVE INDUSTRY: A REVIEW

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ABSTRACT:

Tesla, a pioneer in the electric vehicle industry, has consistently demonstrated a strong commitment to sustainability. Central to its environmental efforts is the implementation of cleaner production strategies. Cleaner production involves optimizing processes and technologies to minimize waste, pollution, and resource consumption throughout the entire production lifecycle. By adopting this approach, Tesla aims to reduce its environmental footprint, enhance operational efficiency, and contribute to a more sustainable future. This review paper will delve into the specific cleaner production strategies employed by Tesla. It will explore how these strategies have been integrated into various aspects of the company's operations, from manufacturing processes to supply chain management. Additionally, the paper will assess the effectiveness of these initiatives in achieving Tesla's sustainability goals and contributing to a more sustainable electric vehicle industry.

Keywords: cleaner production, Electrical vehicle, circular economy, sustainability, hybrid fuel vehicle.

INTRODUCTION:

Cleaner production is considered as a paradigm shift in manufacturing it aims to minimize environmental pollution and waste throughout the product lifecycle. Cleaner production is essential for sustainable development. By integrating environmental, social, and economic aspects, enterprises can create competitive advantages, promote decent work, and contribute to economic growth while addressing environmental challenges[1].

Tesla, founded in 2003, has revolutionized the automotive industry with its electric vehicles. It is a pioneer in the electric vehicle industry, has demonstrated a strong commitment to cleaner production. This company has consistently pushed the boundaries of technological advancement, focusing on both modular and architectural innovation to create groundbreaking products[2]. They initially focused on high-end models Tesla expanded its market reach with the Model 3 in 2016. The company has also ventured into solar car design and self-driving technology, demonstrating its commitment to innovation and sustainability[3]. It notes that while many automakers have invested in EVs for decades, Tesla has emerged as a pioneer, particularly in battery electric vehicles (BEVs), which accounted for a significant portion of EV sales in recent years[4].

STRENGTH	WEAKNESSES	OPPORTUNITIES	THREATS
<ul style="list-style-type: none"> •Brand and marketing power •Innovation •Design of cars and customer experience 	<ul style="list-style-type: none"> •Numerous Manufacturing problems •Small target group 	<ul style="list-style-type: none"> •Increasing in EV charging infrastructure •Government Incentives for the electric automobiles •Increasing in the clean energy preference 	<ul style="list-style-type: none"> •The self-driving regulation in some countries •The competitors

Fig 1: Tesla's SWOT analysis towards sustainability[5].

CLEANER PRODUCTION STRATERGEIES OF TESLA:

1)Electric Vehicle:

Tesla played a crucial role in popularizing electric cars and demonstrating their viability as a practical transportation option[6]. As EVs continue to gain popularity, there is a growing need for innovations that can enhance their efficiency, affordability, and sustainability. Tesla has invented battery swapping, which involves quickly replacing a depleted battery pack with a fully charged one. This technology has the potential to reduce the need for frequent charging, which can strain battery management systems and increase charging times. As battery technology becomes more standardized, battery swapping is likely to become more feasible and widespread.[7]

Key Factors Driving the EV Market:

1. Environmental Concerns: Growing consumer awareness of climate change and emissions.
2. Regulatory Push: Bans on new petrol and diesel cars in the EU by 2035.
3. Government Incentives: Financial support for EV adoption (e.g., Inflation Reduction Act).
4. Climate Activism: Influential figures like Greta Thunberg advocating for sustainable transportation.[3]

Tesla's introduction of advanced EV technology in China sparked a major transformation in the automotive industry. It demonstrated the viability of electric vehicles and inspired local companies to shift from traditional engines to electric mobility. This led to a surge in demand for electric components, batteries, and infrastructure, fostering a vibrant ecosystem of startups and established players. As a result, the industry experienced a profound shift in vehicle design and manufacturing[8].

2) Li-ion batteries:

Despite significant and unpredictable periodic disruption, from 1999 to 2023 global automobile production increased at an average annual rate of approximately 2.1 percent. In 2023, auto companies around the world produced 94 million vehicles, with China (32 percent), the United States (11 percent), and Japan (10 percent) representing the majority of global output. Commercial production of Li-ion batteries began in 1991, with Japan-based Sony producing Li-ion batteries to power its Handycam camcorder. Li-ion batteries had superior energy density and cycle life compared to the alternative NiMh (nickel metal hydride) or lead-acid batteries available[4].

Tesla is adopting a vertical integration strategy, which involves controlling various stages of the supply chain, from material extraction to battery production. This approach allows Tesla to manage the quality and sustainability of the materials used in its batteries, thereby enhancing cleaner production practices. For instance, Tesla has announced plans to develop its own lithium mine in Nevada, which reflects its commitment to securing sustainable sources of battery materials[9].

3) AI Towards production:

Digital technologies are transforming mature industries like automotive, particularly within the electric vehicle (EV) sector, where a significant paradigm shift is occurring. Tesla Inc. has been a leader in this digital transformation, utilizing modular components and the Internet of Things (IoT) to manage complexity and enhance flexibility in its platform architecture[6]. The deployment of advanced technologies such as Big Data analytics and artificial intelligence is mentioned as a means to improve production and distribution efficiency. These technologies can help in identifying inefficiencies and optimizing resource use, which is essential for cleaner production practices[10].

4) Advancement In Fuel:

Tesla's reliance on solar panels for electricity generation is a prime example of cleaner production[11]. The development of fuel-efficient, low-emission vehicles has surged in response to environmental concerns and shrinking fuel resources. Hybrid vehicles, which combine combustion engines with electric motors, lead this trend, offering better fuel efficiency and lower emissions than traditional internal combustion engines (ICEs). However, their complex drive systems, involving both electric and combustion components, make them expensive and still dependent on fossil fuels.[2]

CHALLENGES:

1. Mechanical Complications and Innovation Risks: The high level of innovation at Tesla leads to increased mechanical complexities and risks in production. The launch of the Model X highlighted these challenges, causing significant distribution delays and difficulties with the manufacturing process at Gigafactory 1.
2. Supply Shortages: Tesla's brand value can be affected by its inability to meet demand due to the sophisticated and testing manufacturing processes that sometimes fail to satisfy production needs. Major hurdles of circular supply chains: Costs of disposals as a common good, Incentive complications, Cost of recovery vs. cost of new procurement, High level of inter-departmental and inter-organizational coordination and complexity, Political hindrances, Stakeholder acceptability and standardization[12].
3. Inadequate Production Capacity: While Tesla is a leader in electric vehicles, it struggles to produce a large volume of its models. The company is currently facing challenges at Gigafactory 1 related to production costs, workforce management, and facility expansion, especially as it ramps up Model 3 production. As the popularity of electric vehicles (EVs) continues to rise, so does the demand for battery recycling. EV batteries are a valuable resource but also pose environmental concerns if not disposed of properly. This passage highlights the importance of developing effective recycling schemes to ensure the sustainability of the EV industry and minimize the environmental impact of used batteries[13].
4. Battery Shortage: CEO Elon Musk indicated at the annual shareholders' conference that overall production has been hindered by a lack of available rechargeable batteries, affecting both electric vehicle demand and power storage solutions[14]. China faced challenges in building EV charging infrastructure due to rapid EV growth, lack of standardization, and uneven geographic distribution. Overwhelmed stations, fragmented charging technologies, limited access in urban homes, and grid strain complicated efforts. To address these issues, the government incentivized charging station construction and worked to standardize technologies for better compatibility and convenience[8]
5. Relatively high cost structure due to lack of significant economies of scale[15]
6. Threads related to Electrical vehicle: Privately owned, autonomously driving and perceived "zero-emission" EVs may increase total traffic and resource use Culture/mindset and social status symbol[16]

MEASURES TAKEN BY TESLA:

1. Focus on Innovative Ecological Environment: Tesla emphasizes the importance of creating a conducive environment for innovation. This involves leveraging global resources and collaborating with universities, research institutions, and other enterprises to advance core technologies, particularly in batteries, motors, and electric control systems.
2. Disruptive Innovation: Tesla employs a strategy of disruptive innovation to differentiate itself in the market. This approach allows the company to challenge traditional automotive standards and practices, positioning itself as a leader in the new energy vehicle sector.
3. Market Awareness and Education: While the passage does not explicitly mention Tesla's initiatives for market positioning, Tesla's broader strategy involves increasing public awareness and understanding of electric vehicles. By promoting the benefits of its vehicles, Tesla aims to facilitate market acceptance and transition consumers towards new energy vehicles.
4. Development of a Robust Business Model: Tesla recognizes that business model innovation is crucial for the growth of the new energy automotive industry. By establishing a mature business model that aligns with the broader industry chain, Tesla can ensure sustainable operations and support infrastructure development.
5. Collaboration with External Partners: Implicitly, Tesla's engagement with external partners aligns with the need for companies in the NEV sector to master sufficient technology. Collaborating with specialized suppliers and research entities helps Tesla enhance its technological capabilities.
6. Long-Term Strategy for Technological Mastery: By focusing on mastering the technology of new energy vehicles, Tesla positions itself for long-term success, ensuring it can adapt and thrive as industry standards evolve.[17]
7. The circular economy aims to reduce waste and preserve resources by emphasizing recycling, reducing, reusing, repurposing, and recovering materials. Electric vehicles are a key component of this transition, as they reduce greenhouse gas emissions and promote sustainable transportation. Tesla has played a significant role in leading the transition to electric vehicles, with a focus on recycling battery materials and promoting sustainable energy solutions. [18]
8. Tesla has adopted an open-source strategy to foster collaboration and innovation within the electric vehicle industry. It has made a significant number of its patents publicly available, encouraging other companies to utilize and build upon this knowledge[19].
9. To accelerate sustainable transport by bringing mass-market electric cars to market. Tesla applied Green-Lean Production principles to the development of the Model 3. A team of experts conducted a comprehensive assessment of the direct, secondary, and tertiary effects of the Model 3. Which Prioritized environmental and social effects over business considerations by adopting a selective approach, focusing on Green and Lean effects[20].
10. Theory of the diffusion of innovations: The theory identifies different groups of consumers, including "innovators" who are early adopters of new technologies. Tesla's marketing strategy focused on targeting these innovators, who are often wealthy and influential, to drive the diffusion of their electric cars. By designing a car that appealed to this group, Tesla was able to create a desire for the product and encourage its adoption by other market segments[21].

WAY FORWARD:

Tesla can contribute to the development of hydrogen fuel cell vehicles by adopting a dual-fuel strategy, combining hydrogen with hydrocarbon fuels to enhance efficiency and reduce emissions. However, significant research and development investments are needed to make hydrogen cars more practical and affordable.[3]

Tesla's reliance on external suppliers for battery packs presents challenges in terms of supply chain stability and charging speed. To overcome it Tesla has to diversify Suppliers, a chieve Battery Self-Production and expand Charging Network[22].

Artificial intelligence (AI) has the potential to revolutionize sustainable manufacturing by improving efficiency, reducing waste, and developing new eco-friendly materials. However, ethical and legal concerns, such as data privacy and job displacement, must be addressed to ensure AI's positive impact. By integrating AI with sustainable materials, businesses can enhance their environmental performance and gain a competitive advantage in the market.[23] Conduct in-depth market research in different regions to understand local preferences, regulations, and competitive landscapes. This will enable Tesla to tailor its strategies and products to specific markets.[24]

Green Operations Strategy as a long-term plan focused on responding to environmental pressures while creating socio-economic value. It involves considering resource availability, environmental impact, and social ethics for both products and production processes. The main drivers for green operations are similar to those in corporate sustainability, including legislation, customers, internal policy, competitors, performance gains, and corporate image.[25]

While sustainable innovations offer benefits like enhanced reputation and higher revenues, they also face challenges such as resource commitment, delayed returns, and the "value-action" gap. The "value-action" gap refers to the discrepancy between consumers' pro-environmental attitudes and their actual product choices. Three factors contribute to this gap: difficulty in judging credibility and environmental performance, habitual routines, and perceived functional compromises. To close the attitude-behaviour gap, companies need to address these factors. Blame avoidance is crucial to maintain reputation and trustworthiness. Institutional entrepreneurship can help to shape consumer preferences and overcome habitual routines. Product design plays a critical role in ensuring that sustainable innovations meet consumer expectations for functional performance.[26]

The scaling of sustainable technologies faces challenges in cost, efficiency, and infrastructure compatibility. It also has psychological detachment and economic concerns hindering the adoption of cleaner production .Therefore, government policies and incentives are crucial for promoting sustainable practices[27].

To future expanded its share and profit in the global market Tesla has to collaborate on areas like battery technology to enhance competitive advantages, develop clear strategies to distinguish themselves in the market and seek government support and partnerships to promote electric vehicle adoption[28].

CONCLUSION:

The world is entering a resource revolution fuelled by advances in technology that will boost resource productivity and drive economic growth with reduced environmental impact. Although the cleantech sector has faced setbacks, such as poor investment performance and company bankruptcies, it is not failing. Instead, it is following a common pattern seen in emerging technologies: initial excitement, inflated expectations, disillusionment, and consolidation, after which stronger players emerge[29]. Tesla Motors' success can be attributed to their strategic choices in these areas, including their innovative distribution channels, marketing approach, and manufacturing investments[30]. Through Tesla focus on sustainable materials, energy efficiency, and battery recycling, Tesla has demonstrated the potential for businesses to adopt cleaner practices and contribute to a more sustainable future. As the world continues to address environmental challenges, Tesla's approach can serve as a model for other industries to follow.

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