Porsche Hydrogen Fuel Cell Supercar

266720

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Abstract

This report proposes a hydrogen-powered supercar for Porsche which aligns with the company vision; performance and sustainability. Using Porsche's strengths, the project explores hydrogen technology to help its zero-emission portfolio. Context analysis shows market potential and strategic fit, making this project a step in Porsche's direction.

Contents

1. Declaration

This report is submitted as part requirement for the degree of Mechanical Engineering at the University of Sussex. It is the product of my own labour except where indicated in the text. The report may be freely copied and distributed provided the source is acknowledged. I hereby give permission for a copy of this report to be loaned out to students in future years.

2. Introduction

The project proposed by this paper is to design and build a high-performance Hydrogen vehicle (FCEV) prototype for Porsche to showcase the company's commitment to sustainability while keeping high performance.

2.1. Project Rationale

Porsche, leader's in performance automotive engineering, has a mission to combine tradition with innovation, aiming to be the most sustainable and profitable sports car manufacturer in the world. Their current strategies revolve around a dual approach: electric mobility and alternative fuels looking to achieve carbon neutrality by 2030 (1). The success of the Taycan, shows the company's dedication to electrification while maintaining a commitment to performance (2). Porsche has also invested in synthetic e-fuels to support the legacy of internal combustion engines while reducing emissions (3).

However, despite advancements in BEVs, there is a gap in Porsche's current strategy concerning long-range, high-performance alternatives that could complement its existing electric lineup. Battery-electric supercars face limitations related to weight, range, and charging times, which can limit achieving

optimal performance for long-distance and endurance driving. A solution to this gap is a hydrogen-powered supercar. Hydrogen fuel cells are a lighter and faster-refueling alternative to batteries, providing the high energy density necessary for supercar performance while maintaining a zero-emission profile (4).

This project aims for a prototype hydrogen-powered supercar. The proposed solution aligns with Porsche's goals of sustainability and maintaining its leadership in the high-performance automotive market. It would also position Porsche as a pioneer in the hydrogen sector, potentially expanding its influence in the evolving green automotive landscape. This project will not only address current limitations in electric performance vehicles but also enhance Porsche's market position and diversify its portfolio of sustainable high-performance cars (1)(3)(4).

This may also get the general public excited about hydrogen, which is better to battery technology and conventional combustion motors. If this were to happen, then the hydrogen market would be led by Porsche leaving huge potential for growth whilst competitors are still figuring out their car.

3. Analysis of Context

3.1. SWOT Analysis

To effectively evaluate Porsche's current positioning concerning the development of a hydrogen-powered supercar, a SWOT Analysis has been conducted to identify the strengths, weaknesses, opportunities, and threats associated with this project.

Figure 1 shows SWOT Analysis.

3.1.1. Strengths:

(i) Brand Reputation: Porsche is globally recognized for its performance, engineering, and luxury. This reputation can facilitate consumer acceptance of new technologies.(2)
(ii) Engineering Expertise: With a history of performance, Porsche has the technical capability to develop high-performance hydrogen fuel cell technology (3).
(iii) Commitment to Sustainability: The company's existing focus on reducing carbon emissions through electrification and e-fuels aligns with growing demand for sustainable solutions (1).

3.1.2. Weaknesses:

(i) High Development Costs: Research and development for hydrogen fuel cell technology requires significant investment, which could strain resources and delay return on investment (4).
(ii) Limited Hydrogen Infrastructure: Currently, hydrogen refueling infrastructure is sparse, potentially limiting market adoption and customer convenience (5).

3.1.3. Opportunities:

(i) Growing Demand for Sustainability: Increasing consumer awareness and regulatory pressure for sustainable transportation solutions create a favorable market for hydrogen vehicles (6).
(ii) Technological Advances: Advancements in hydrogen production and storage technologies may lower costs and improve efficiency, making hydrogen fuel cells more viable (7).
(iii) Market Differentiation: By developing a hydrogen supercar, Porsche can differentiate itself from competitors and position itself as a leader in alternative fuel technology.

3.1.4. Threats:

(i) Competitive Landscape: Other manufacturers are investing in hydrogen technology, which may lead to increased competition in the market (8).
(ii) Regulatory Challenges: Regulatory hurdles regarding hydrogen production, storage, and usage could pose significant barriers to market entry.(9).
(iii) Market Uncertainty: The fluctuating global energy landscape and potential shifts towards other alternative technologies could impact hydrogen's long-term viability (10)

3.2. External Analysis: Pestel Framework

The PESTEL (Political, Economic, Social, Technological, Environmental, and Legal) framework has been employed to analyse the external environment affecting Porsche's hydrogen supercar project.
(i) Political: Government incentives and subsidies for hydrogen infrastructure development and zero-emission vehicles can positively influence market conditions (11).
(ii) Economic: The rising costs of raw materials and energy can affect the profitability of hydrogen production, influencing Porsche's pricing strategy (12).
(iii) Social: Growing consumer demand for sustainable and high-performance vehicles presents a significant opportunity for hydrogen fuel cell technology (13).
(iv) Technological: Advancements in hydrogen production methods and fuel cell technology can enhance the feasibility and attractiveness of hydrogen vehicles (14).
(v) Environmental: Increasing concerns regarding climate change and regulatory pressures to reduce greenhouse gas emissions necessitate the exploration of sustainable alternatives (15).
(vi) Legal: Compliance with environmental regulations and safety standards for hydrogen

Fig. 1: SWOT Analysis by (Shutterstock)(21)

storage and transportation is critical for project success (16).

3.3. Internal Analysis: VRIO Framework

The VRIO (Value, Rarity, Imitability, and Organization) framework assesses Porsche's internal capabilities in relation to the hydrogen supercar project.

(i) Value: The ability to create a high-performance hydrogen vehicle aligns with market demands for sustainability, presenting significant value (17). (ii) Rarity: Porsche's engineering prowess and brand recognition are rare assets that can create a competitive advantage in the hydrogen market (18). (iii) Imitability: While other companies may eventually replicate Porsche's innovations, the combination of brand heritage and engineering excellence makes imitation challenging (19). (iv) Organization: Porsche's existing infrastructure, skilled workforce, and commitment to innovation position it well to execute the hydrogen project effectively (20).

4. Project Outline

4.1. Project Objectives and Activities

The project aims to achieve the following specific objectives: (i) Research and Development: Conduct research into hydrogen fuel cell technology, including performance, efficiency, and safety standards.

(ii) Prototype Design: Design a prototype that incorporates innovative aerodynamics, lightweight materials, and cutting-edge fuel cell technology.

(iii) Infrastructure Assessment: Evaluate the current state of hydrogen refueling infrastructure to identify potential partners for collaboration and pilot refueling stations.

(iv) Market Analysis: Conduct a comprehensive market analysis to assess consumer interest and pricing strategies for hydrogen supercars.

(v) Stakeholder Engagement: Engage with key stakeholders, including investors, suppliers, regulatory bodies, and the automotive community, to gather insights and support.

4.2. Estimated Timeframe and Suggested Timetable:

The project is estimated to span 36 months, divided into four phases:

(i) Phase 1 (Months 1-9): Research and development, including feasibility studies and technology assessments. (ii) Phase 2 (Months 10-18): Prototype design and initial testing. (iii) Phase 3 (Months 19-27): Market analysis, stakeholder engagement, and assessment of hydrogen infrastructure. (iv) Phase 4 (Months 28-36): Final prototype testing, evaluation, and launch preparation.

4.3. Possible Sources of Funding

Potential funding sources for the project may include:

Internal Funding: Allocations from Porsche's R&D budget.

Government Grants: Applications for subsidies aimed at promoting sustainable technologies.

Partnerships with Research Institutions:

Collaboration with universities or research facilities that focus on hydrogen technologies.

4.4. Estimated Costs and Potential Income

The estimated total cost for the project is approximately €10 million, covering research, development, prototyping, and marketing efforts. Revenue generation will primarily come from the sale of the hydrogen supercar and potential partnerships with energy providers for hydrogen distribution.

4.5. Potential Partners and Stakeholders

Key partners and stakeholders for this project will include:

Hydrogen Technology Suppliers: Companies specializing in hydrogen fuel cells and infrastructure.

Academic Institutions: Universities conducting research in sustainable energy and automotive engineering.

Regulatory Bodies: Government agencies focused on transportation and environmental standards.

Automotive Industry Leaders: Collaborations with other manufacturers exploring hydrogen technologies.

4.6. Expected Outputs and Outcomes

The expected outputs of this project include:

A functional prototype of a hydrogen-powered supercar. Comprehensive research reports on hydrogen technology and market viability. Established partnerships with key stakeholders in the hydrogen ecosystem. The anticipated outcomes involve enhanced brand reputation as an innovator in sustainable automotive technologies, increased market share in the high-performance segment, and valuable insights into consumer preferences for future developments.

4.7. Role of the Organization

Porsche will play a central role in the execution of this project. The organization will provide:

Expertise: Leverage existing engineering talent and resources to drive research and development efforts. Funding: Allocate financial resources from the R&D budget to support project activities. Infrastructure: Utilize existing facilities for prototype development and testing. The organization will benefit from increased brand visibility in the sustainable automotive sector and the potential for new revenue streams from the hydrogen vehicle market.

4.8. Leadership Subsection

Effective leadership is crucial for the success of this project, particularly in navigating the complexities of developing a new technology. A transformational leadership style is suitable for this initiative, as it encourages innovation, motivates team members, and fosters collaboration among diverse stakeholders. This approach will be instrumental in inspiring the project team to push the boundaries of traditional automotive design and embrace new technologies.

Management functions will focus on organizing resources, establishing timelines, and ensuring adherence to project milestones. Management involves planning and executing project activities, while leadership emphasizes vision and motivation. For this project, leaders will be responsible for cultivating a culture of creativity and resilience, essential for overcoming the challenges associated with developing hydrogen technology.

By effectively balancing leadership and management functions, Porsche can successfully guide this project from conception to execution, ensuring alignment with the organization's strategic objectives while also addressing the dynamic needs of the hydrogen automotive market.

5. The Case for Project Implementation

A hydrogen-powered supercar is aligned with Porsche's mission to perform whilst being sustainable. This project addresses Porsche's dual commitment to high performance and environmental responsibility, as outlined in the Project Rationale. It offers an opportunity for Porsche to expand its portfolio of sustainable vehicles, complementing existing battery-electric models like the Taycan while exploring new technologies to maintain its reputation for engineering excellence. Investing in hydrogen technology, Porsche will top the zero-emission market, targeting a niche that combines racing, performance, and sustainability, which are all key elements of its brand identity.

The context analysis shows several advantages for this project. The PESTEL analysis showcased the increasing consumer and regulatory pressure for sustainability. The growing demand for high-performance yet eco-friendly vehicles is an opportunity for Porsche to differentiate itself from competitors, leveraging its established brand as a leader in automotive innovation. Internally, the VRIO analysis showed that Porsche's engineering expertise, brand reputation, and organization are assets that would support the development and successful deployment of hydrogen technology.

This project has several benefits beyond the immediate goal of launching a hydrogen supercar. It will increase Porsche's technical knowledge in hydrogen, opening possibilities for integrating hydrogen technology into other vehicle segments. This project will also attract strategic partnerships, not only with technology suppliers but also with renewable energy and hydrogen infrastructure companies. These collaborations will increase the

size of Porsche's network and influence in the emerging hydrogen ecosystem. The project's success will strengthen Porsche's position in sustainable automotive technology, attract a new customer base focused on performance and sustainability, and contribute positively to the company's long-term profitability and brand loyalty.

6. Conclusion

Developing a hydrogen-powered supercar aligns with Porsche's commitment to performance and sustainability. This project will meet market demand for eco-friendly vehicles, and secure its leadership in zero-emission technology. It's a strategic move that promises both brand growth and long-term success.

REFERENCES

[1] Porsche AG (2023) *Porsche and E-Fuels: Developing New Paths for Internal Combustion Engines.* Available at: https://newsroom.porsche.com (Accessed: 24 October 2024).

[2] Electrive (2022) *Porsche Expands Focus on Electrification with New Hybrid and Electric Models.* Available at: https://www.electrive.com (Accessed: 24 October 2024).

[3] Autocar (2023) *Porsche's Plans for a Sustainable Future: Beyond the Battery.* Available at: https://www.autocar.co.uk (Accessed: 24 October 2024).

[4] Porsche Sustainability Report (2023) *Driving Change: Porsche's Commitment to a Carbon-Neutral Future.* Available at: https://sustainability.porsche.com (Accessed: 24 October 2024).

[5] International Energy Agency (2023) *Hydrogen: A Renewable Energy Perspective.* Available at: https://www.iea.org (Accessed: 24 October 2024).

[6] BloombergNEF (2022) *Electric Vehicle Outlook 2022.* Available at: https://about.bnef.com (Accessed: 24 October 2024).

[7] National Renewable Energy Laboratory (2022) *Hydrogen Production: Overview.* Available at: https://www.nrel.gov (Accessed: 24 October 2024).

[8] McKinsey & Company (2023) *The Future of Hydrogen: Opportunities and Challenges.* Available at: https://www.mckinsey.com (Accessed: 24 October 2024).

[9] European Commission (2023) *EU Hydrogen Strategy: Key Policies and Initiatives.* Available at: https://ec.europa.eu (Accessed: 24 October 2024).

[10] International Renewable Energy Agency (2023) *Global Hydrogen Trade: A Guide to the Future.* Available at: https://www.irena.org (Accessed: 24 October 2024).

[11] International Energy Agency (2022) *The Role of Governments in Hydrogen Infrastructure.* Available at: https://www.iea.org (Accessed: 24 October 2024).

[12] World Bank (2022) *Commodity Markets Outlook: Energy Prices and Trends.* Available at: https://www.worldbank.org (Accessed: 24 October 2024).

[13] Deloitte (2023) *Consumer Preferences in Sustainable Automotive Technologies.* Available at: https://www.deloitte.com (Accessed: 24 October 2024).

[14] Hydrogen Council (2022) *Hydrogen: Scaling Up the Transition to Clean Energy.* Available at: https://hydrogencouncil.com (Accessed: 24 October 2024).

[15] Intergovernmental Panel on Climate Change (2023) *Climate Change and Sustainable Transport.* Available at: https://www.ipcc.ch (Accessed: 24 October 2024).

[16] United Nations Environment Programme (2023) *Regulatory Frameworks for Hydrogen Safety.* Available at: https://www.unep.org (Accessed: 24 October 2024).

[17] Porsche AG (2023) *Sustainability Strategy: Creating Value through Innovation.* Available at: https://sustainability.porsche.com (Accessed: 24 October 2024).

[18] Business Insider (2023) *Why Porsche's Engineering Excellence Matters for Future Projects.* Available at: https://www.businessinsider.com (Accessed: 24 October 2024).

[19] Harvard Business Review (2023) *Innovation and Imitation in the Automotive Industry.* Available at: https://hbr.org (Accessed: 24 October 2024).

[20] Porsche AG (2023) *Porsche's Organizational Structure and Commitment to Innovation.* Available at: https://newsroom.porsche.com (Accessed: 24 October 2024).

[21] Shutterstock. *SWOT Analysis.* Ftcdn.net, 2024, t4.ftcdn.net/jpg/02/55/80/51/360_F_255805109_r2zkXRqdW0wo7AhUibtVmfPRuohDyghg.jpg. Accessed 26 Oct. 2024.

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