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Nissan Leaf: Navigating Turbulence on the Electric Road

Introduction to Nissan with a Focus on Nissan Leaf

Nissan, the big player in cars from Yokohama, Japan, has been making a real impact in the auto world. One gem in their collection is the Nissan Leaf – a ground-breaking electric ride that's all about being kind to the planet.

Going way back to 1911, Nissan kicked off as Kwaishinsha Motor Car Works. Fast forward to today, and they've become a big deal in the auto game. These guys are all about pushing the boundaries of tech and design, and the Nissan Leaf, hitting the streets in 2010, shows just how innovative they can be.

The Nissan Leaf is more than just a car; it's a symbol of Nissan's dedication to a cleaner, eco-friendlier way of driving. When they rolled it out, it wasn't just another car in their line up – it was a statement, a challenge even, saying, "Hey, we're not messing around when it comes to the environment, and we're here to change the game." [1]

With its elegant look and cutting-edge technology, the Nissan Leaf swiftly drew the attention of environmentally minded drivers across the world. Offering zero-emission driving without sacrificing performance, the Leaf became a symbol of sustainable mobility and a catalyst for change in the automotive industry.

But Nissan did not stop there. They continued to invent and enhance the Leaf, adding new features and improvements with each model year. Nissan has stayed dedicated to pushing the frontiers of electric car technology, from expanding range and charging capacities to incorporating sophisticated driver support technologies.

As Nissan continues to push for a greener, more sustainable future, the Nissan Leaf is at the forefront of their efforts. With its distinctive look and unrivaled eco-friendly performance, the Leaf continues to encourage drivers to make the move to electric and embrace a greener mode of transportation.

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Why did Nissan dive into the electric vehicle scene back in the early 2010s?

It's like a mix-tape of reasons: they care about the planet, want to stay on the right side of the rules, and have a smart plan for the future of how we all move around. They're not just making cars; they're leading the way towards a cleaner, greener driving experience.

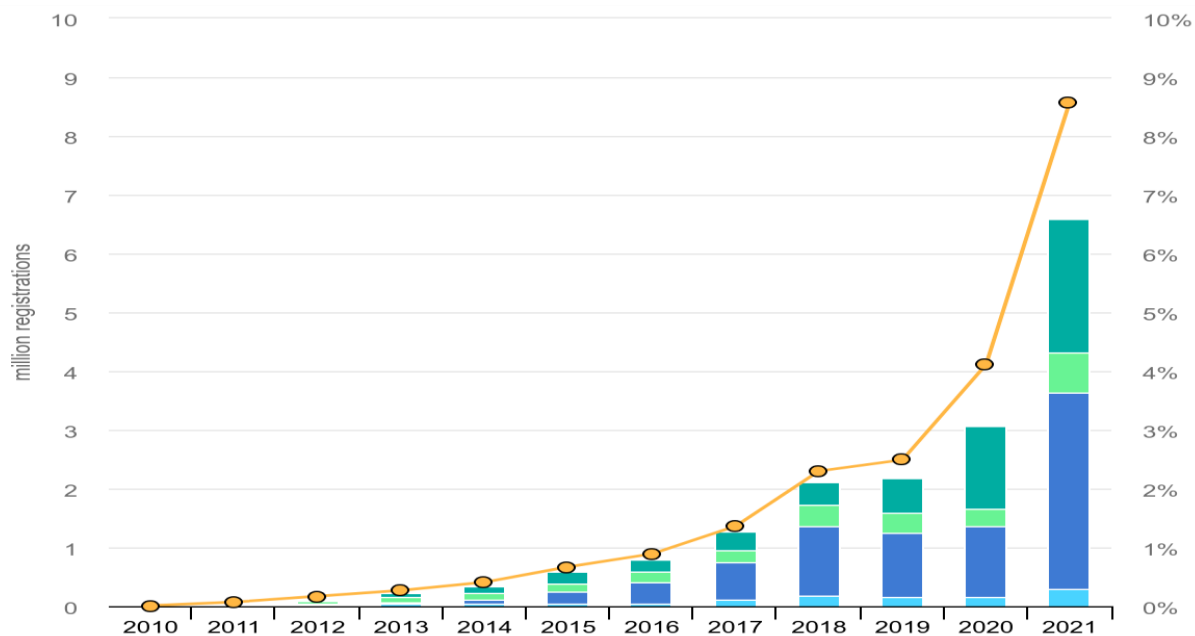
As the world started buzzing about environmental problems like air pollution and climate change, Nissan and other car makers felt the heat to find cleaner ways for us to get from A to B. Electric vehicles became the cool kids on the block, promising to kick traditional engines to the curb and slash those greenhouse gas emissions.

Governments threw down the gauntlet with strict emissions rules worldwide. That push got Nissan thinking, "Alright, time to put our money where our mouth is." And that's how they found themselves deep-diving into cleaner, greener technologies.

Many countries were implementing regulations to limit vehicle emissions and promote the adoption of electric vehicles as a means of meeting environmental targets.

Nissan aimed to position itself as an innovator and leader in the automotive industry. By embracing electric vehicle technology early on, the company sought to differentiate itself from competitors and establish a reputation for forward-thinking and environmentally conscious practices.

The volatility of oil prices and concerns about the long-term availability of fossil fuels also played a role in Nissan's decision to invest in electric vehicles. Electric vehicles offered a potential solution to reduce dependence on finite and polluting energy sources.



Global sales and sales market share of electric cars, 2010-2021[7]

Key Features and Background on Nissan Leaf

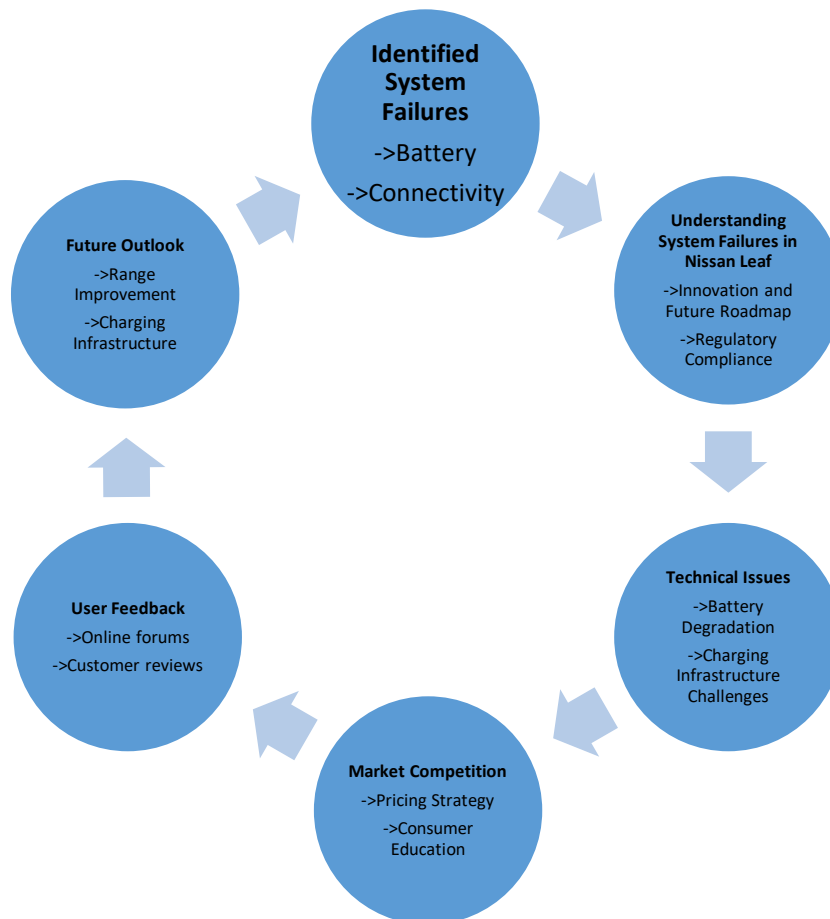
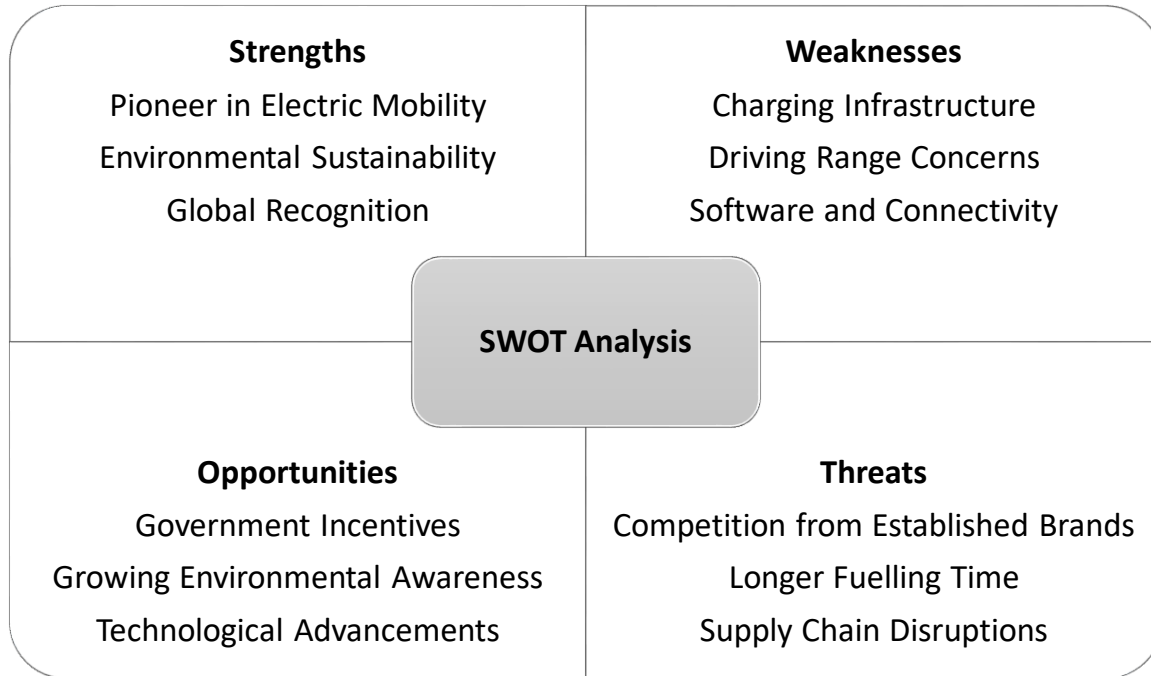
The Nissan Leaf comes with an all-electric powertrain, running on lithium-ion battery packs of different capacities in older models. It boasts an environmentally conscious design, providing both standard and fast charging options. Over the years, it has integrated various infotainment systems, elevating the driving experience. In its early models, the driving range usually falls between 70 to 100 miles on a full charge.

Factors Influencing the Nissan Leaf's Journey

Yet, even though it showed early potential, the Nissan Leaf ran into hurdles that resulted in unforeseen results. While it was meant to symbolize Nissan's dedication to eco-friendly technology, the Leaf faced problems that impeded its broad acceptance and triumph in specific markets. Issues like worries about driving range, concerns regarding charging infrastructure, and the competitive landscape in certain regions played a role in its reception falling short of expectations.

This deviation from the intended success of the Leaf calls for a closer look at the obstacles Nissan encountered in striving to establish the Leaf as a frontrunner in the electric vehicle market.

- Technical Issues
- Charging Infrastructure
- Range Anxiety
- Battery Degradation
- Software and Connectivity
- Regulatory and Standards Compliance
- Environmental Impact
- Customer Support and Service
- Market Competition
- User Experience



Technical Issues

The Nissan Leaf encountered notable technical challenges associated with its Automatic Emergency Braking (AEB) system. Designed to avert rear-end collisions, the AEB system depends on radar modules provided by Bosch. However, reports have surfaced indicating defects in these modules, resulting in various issues such as: [5]

- **False-Positives and Random Stops:**
Some radar modules, when supplied by Bosch, are believed to create false-positives, causing the AEB to activate and stop cars at random times.
Owners have reported sudden shaking, loud noises, and unexpected stops, even in optimal driving conditions
- **Deactivation of AEB Sensors:**
Frequent deactivation of front radar sensors resulted in the AEB and cruise control being disabled, compromising overall safety.
- **Reprogramming Attempts:**
Nissan attempted to address reported issues by instructing dealers to reprogram the driver assist system software, aiming to enhance AEB performance

Charging Infrastructure

From 2010 to 2018, the electric vehicle market was in its early phases, facing limitations in battery technology and charging infrastructure. Nissan's LEAF, being an electric vehicle, encountered difficulties related to range anxiety and the scarcity of charging options, affecting its market reach. [4]

The way the Nissan Leaf electric vehicle sold was heavily tied to how the charging setup looked during its early days. Back when the Leaf first hit the scene around 2010, there weren't too many places to charge it up. This scarcity of charging spots made people thinking about buying one wonder if having an electric car was really a practical move.

Charging stations were primarily clustered in city areas, making it tougher for folks in suburban and rural spots to hop on the electric car bandwagon. The uneven spread of charging spots put a cap on how appealing the Nissan Leaf was to a wider audience. In places where the charging infrastructure was still catching up, the Leaf had a hard time making headway in the market. It faced obstacles breaking into markets where the growth of charging spots was playing catch-up.

The underdeveloped charging infrastructure influenced urban planning and regulations, as local authorities were cautious about promoting electric vehicles without a robust charging network. Lack of supportive infrastructure slowed down policy initiatives promoting EV adoption.

The insufficient charging infrastructure placed electric vehicles, including the Nissan Leaf, at a competitive disadvantage against conventional vehicles with well-established refueling options.

During this time, Nissan Leaf owners experienced major issues owing to the scarcity of charging infrastructure. The limited availability of charging stations, particularly in suburban and rural regions,

hampered the broad adoption of electric cars. Prospective purchasers were hesitant to commit to electric car ownership, doubting the viability of depending on a vehicle with limited charging alternatives.

Range Anxiety

The early Nissan Leaf was equipped with an 80-kW AC synchronous electric motor powered by a 24-kWh lithium-ion battery pack. While this powertrain represented a significant step towards sustainable electric mobility, the 24-kWh capacity set a constraint on the vehicle's overall driving range. [2]

The Leaf's real-world driving range of 70 to 100 miles on a full charge contributed to range anxiety among customers. Customers were concerned about the number of miles the vehicle could cover on a single charge. The perceived limitation fueled anxiety, especially among those accustomed to the longer ranges offered by traditional gasoline-powered cars.

Nissan Leaf customers had to engage in strategic trip planning to ensure access to charging stations along their routes. This added complexity to travel planning and led to concerns about the inconvenience of having to alter routes or make unscheduled stops for charging. Daily commuting patterns were influenced by the perceived need for careful energy management, adding complexity to the overall driving experience.

Despite these problems, the early Nissan Leaf was a big step toward sustainable mobility. It spurred debate over electric vehicles' feasibility as practical alternatives to regular gasoline-powered automobiles, paving the way for advances in battery technology and charging infrastructure. Nissan proceeded to refine and improve the Leaf, and future versions addressed many of these original problems by increasing range and improving charging facilities to lessen range anxiety and improve the entire driving experience.

Battery Degradation

- **Dual Battery System in the Vehicle**
This vehicle has two types of batteries. The car uses two batteries: a 12-volt battery for internal combustion engines and a high-voltage battery for the traction motor. The high-voltage battery is enclosed in steel and installed beneath the car. [2]
- **Premature Battery Degradation**
Early model years suffered from premature battery degradation, primarily attributed to the absence of a thermal management system for the battery. The lack of liquid cooling, a technology using coolants to regulate battery temperature, resulted in suboptimal performance in terms of battery life and overall range.
- **Battery Degradation Rates Across Model Years**
2015 Redesign's reported a 6% battery degradation rate in the first year, escalating to 18% in the fifth year of ownership. 2014 Models experienced a substantial 23% battery degradation rate after six years. Newer Models Showed improvement, with battery degradation in the range of 1% to 3% during the first year for the 2016-2019 models.
- **Power Inverter Failure**

Instances were reported where the 2014 LEAF experienced complete shutdowns without warning. Nissan issued a recall (14V263000) for select model year vehicles, identifying the inverter as a common cause of the shutdown concern.

- **Diminished Range in Low Temperatures**
Some 2013 LEAF models experienced a significant reduction in driving range, up to 47%, during low temperatures. The EV's driving range tends to diminish by approximately 20% in cold weather, according to a report by the Norwegian Automobile Federation
- **Effects of High Ambient Temperatures**
High ambient temperatures can accelerate battery depreciation in Nissan Leaf automobiles, particularly in hot locations. Elevated temperatures can speed up chemical processes within battery cells, leading them to breakdown more quickly. Without suitable thermal management technologies in place, extended exposure to high temperatures can affect the long-term health and efficiency of the battery pack, lowering its total capacity and driving distance.

Software and Connectivity

Users had a tough time when it came to software updates, causing potential headaches with certain apps or devices. The car's software not playing nice with external gadgets meant that features didn't work as they should.

Things got a bit messy when trying to hook up the Nissan Leaf with charging station networks. Finding charging spots, dealing with payment issues, or just getting a charging session started became more complicated than it needed to be.

Users also ran into problems with the user interface, messing with their overall experience. Navigating menus, adjusting settings, or using touchscreens and buttons didn't always go smoothly.

The Nissan fell behind in the safety game without those fancy AI-driven features like adaptive cruise control and automated emergency braking. Modern cars have those, and customers love it.

Looking back to the early 2000s, the infotainment and connectivity in cars, including Nissan's, weren't as top-notch. The struggle with syncing up with smartphones, voice commands, and other connected services made the overall driving experience less than stellar.

Addressing these software and connection issues is critical for Nissan to improve the user experience, increase convenience, and remain competitive in the quickly changing automotive market. Nissan can position the Leaf as a top choice for customers looking for a smooth and connected driving experience by investing in robust software development, prioritizing compatibility with external devices and mobile applications, and implementing sophisticated connection capabilities.

Nissan Leaf Recall Due to Unintended Acceleration

Nissan has issued a recall for over 80,000 Leaf electric vehicles (EVs) in the U.S., spanning model years 2018 through 2022, to address a software issue in the vehicle control module. [9]

The problem could lead to unintended acceleration or a sudden stop of the electric motor after exiting cruise control. While affecting nearly a million vehicles globally, the recall specifically impacts the Leaf model in the U.S. Nissan plans to install updated control module software to mitigate the issue.

The recall follows internal testing revealing the potential for unintended acceleration under specific post-cruise control actions. Despite no reported incidents, Nissan is taking proactive measures to address the concern and ensure the safety of affected Leaf EVs. Owners are required to bring their vehicles to dealerships for the installation of the updated software.

The National Highway Traffic Safety Administration (NHTSA) is expected to publish documentation on the recall, and owners can check the Nissan recall website or the NHTSA recall site for information on their specific vehicles.

Solutions

Empowering Your Drive:

- **Boosting Battery Brilliance:**

Pros: Improved energy storage and faster charging improve the Nissan Leaf's utility and convenience. Nissan's dedication to innovation and keeping ahead of the electric car industry is evident in its cutting-edge technologies.

Cons: Research and development costs for cutting-edge battery technology may be high, potentially increasing the cost of the vehicle for consumers. Implementation of new technology may take time, delaying its availability to consumers

- **Educating the Explorer:**

Pros: Transparent and accurate information regarding driving range decreases range anxiety and enhances the driving experience. Educational activities highlight Nissan's dedication to customer pleasure and assistance.

Cons: Educational projects demand resources for conception and execution, which may raise operating expenses. The campaign's effectiveness may vary based on Nissan's marketing reach and involvement.

Charging Made Easy:

- **Partnerships for Power:**

Pros: Collaboration with governments enhances the availability of charging stations, hence growing the market for electric vehicles. Increased availability of charging infrastructure enhances environmental sustainability and alleviates range anxiety.

Cons: Collaboration with governments may result in bureaucratic processes and delays in execution. Expansion of charging infrastructure necessitates major expenditure, which may strain financial resources.

- **Fast Lane Charging:**

Pros: Fast-charging stations shorten charging times, making electric travel more convenient and tempting to customers. Quick and hassle-free charging improves the whole driving experience, especially on extended trips.

Cons: Installation and maintenance expenses for fast-charging stations may be greater than for traditional charging infrastructure. During peak hours, a lack of fast-charging stations may cause congestion and increased wait times.

Battery Bliss:

- **Cooling for Endurance:**

Pros: Advanced temperature management enhances battery performance and lifetime, reducing premature aging. Enhanced battery endurance lowers maintenance costs and boosts consumer confidence in the Leaf.

Cons: Implementing thermal management systems can increase vehicle weight and complexity, thereby impacting performance and dependability.

The use of new technologies may necessitate additional training for maintenance workers.

- **Warranty with a Promise:**

Pros: Consumers benefit from robust warranties that safeguard against any battery difficulties. Replacement programs for outdated batteries highlight Nissan's dedication to customer satisfaction and support.

Cons: Extended warranties and replacement programs may raise Nissan's operational costs, affecting profitability. Warranty terms and conditions may vary, causing consumer misunderstanding and unhappiness.

Smooth Software Sailing:

- **User-Friendly Updates:**

Pros: Simplified software update procedure improves user comfort and lowers frustration during system maintenance. Updates that provide intuitive navigation increase the overall user experience and pleasure with the Leaf.

Cons: Developing and testing user-friendly software upgrades takes resources and might delay the delivery of new features. Compatibility difficulties with current hardware and software may occur, necessitating further troubleshooting and assistance.

- **Tech Harmony:**

Pros: Seamless connection with external devices promotes connectivity and driving experience for customers. Collaboration with tech partners illustrates Nissan's dedication to innovation and remaining current with technology breakthroughs.

Cons: Integrating other devices may lead to increased cybersecurity risks and privacy issues. Compatibility concerns with third-party devices might result in customer unhappiness and support issues.

Green and Clean Commitment:

- **Regulations in Check:**

Pros: Ensures compliance with worldwide rules, lowering the likelihood of penalties or fines. demonstrates environmental concern and enhances brand reputation.

Cons: It takes a large amount of resources to monitor and keep up with developing legislation. Compliance with tight standards may limit flexibility in product creation or corporate operations.

- **Eco-Friendly Battery Goodbye:**

Pros: Addresses environmental problems around battery disposal and waste management. Nissan positions itself as a pioneer in sustainable practices, attracting environmentally sensitive customers.

Cons: Implementing recycling systems may result in higher expenditures for research, development, and infrastructure. The success of the initiative is dependent on customer engagement and desire to recycle batteries.

Customer Care Redefined:

- **Support with Heart:**

Pros: Improves client satisfaction and loyalty via individualized and empathic care. Increases brand awareness and encourages good word-of-mouth marketing.

Cons: Customer support personnel must get training and growth. May raise operating expenses involved with delivering high-quality support services.

- **Drive Smart Programs:**

Pros: Addresses particular difficulties for Nissan Leaf customers, improving their entire ownership experience. A complete strategy is achieved by integrating technical improvements, community participation, and educational activities.

Cons: Creating and executing such programs may necessitate substantial effort and money. Success is dependent on good execution and involvement by Leaf owners, which may vary.

Revolutionizing the Ride:

- **Innovation Overdrive:**

Pros: Positions the Nissan Leaf as a trailblazer in modern mobility, enticing tech-savvy buyers. Offering innovative driver assistance technologies and reinventing the driving experience gives you a competitive advantage.

Cons: Significant investment in research and development is required for the integration of innovative features. Potential difficulties in combining innovation, affordability, and mass-market appeal.

- **User-Focused Evolution:**

Pros: Uses user feedback to constantly enhance the Nissan Leaf's interface and experience. Prioritizes consumer preferences and wants, which increases customer happiness and loyalty.

Cons: User input must be monitored and analyzed on a continuous basis, which can be resource costly. Changes may cause compatibility difficulties or pushback from existing users.

Conclusion

Nissan is at a crossroads that necessitates a proactive approach that promotes innovation, sustainability, and customer pleasure above all else. With the electric vehicle environment constantly shifting, Nissan must grasp the opportunity to preserve its leading position by strategically investing in cutting-edge battery technology, increasing charging infrastructure, and refining software upgrades. These collaborative efforts not only increase the attractiveness of Nissan's flagship model, the Leaf, but also maintain its long-term relevance and competitiveness in an increasingly crowded market.

Moreover, by demonstrating unwavering commitment to environmental stewardship through initiatives such as green battery recycling programs and providing exceptional customer service, Nissan can exceed customer expectations, foster long-term brand loyalty, and drive positive transformative change in the automotive industry.

In light of the ever-changing nature of the electric vehicle industry, Nissan finds itself at a crossroads, needing a proactive approach that prioritizes innovation, sustainability, and customer pleasure. As the

automotive industry undergoes a significant change toward electrification, Nissan must take the chance to not only adapt but also lead the way in crafting the future of mobility.

Among these initiatives, the 'Empowering Your Drive' campaign stands out as a symbol of innovation and customer-centricity. Nissan develops a sense of empowerment and confidence in its customers by offering them with real-time information regarding their vehicle's operating range as well as actionable data to help them improve their driving habits. Furthermore, efforts like green battery recycling programs demonstrate Nissan's dedication to sustainability and environmental care, ensuring that the advantages of electric mobility extend beyond the road and into the larger ecosystem.

To do this, Nissan must devote resources to significant advances in battery technology, such as solid-state batteries, which promise higher energy density and longer life. Furthermore, investment in charging infrastructure should be increased to make electric car ownership more accessible and easy for customers. Nissan can relieve range anxiety and further encourage electric car adoption by strategically placing charging stations in metropolitan locations, along roads, and in residential neighborhoods.

This case study highlights the importance of Nissan's proactive strategy in defining the future of electric transportation. Nissan not only confirms its position as a pioneer in the electric car market, but also sets a pattern for the whole automotive industry, by prioritizing innovation, sustainability, and customer pleasure. Nissan is not only changing the driving experience with programs like 'Empowering Your Drive,' but it is also laying the road for future generations to enjoy a greener, more sustainable future.

References

- [1] Nissanusa.com. NISSAN HISTORY AND HERITAGE
<https://www.nissanusa.com/about/heritage.html>
- [2] Riniboo. (2020, November 16). 2018 Leaf Error "Service EV System No Power" DIY Fix.
<https://mynissanleaf.com/threads/2018-leaf-error-service-ev-system-no-power-diy-fix.31620/>
- [3] Jennifer Sensiba(CleanTechnica). (2020). Nissan LEAF Is Falling Apart at 66,000 Miles.
<https://cleantechnica.com/2020/12/05/my-2018-nissan-leaf-is-falling-apart-at-66k-miles/>
- [4] LAURA SKY BROWN. (2023, July 8). 80,000 Nissan Leaf EVs Recalled over Risk of Unintended Acceleration
<https://www.caranddriver.com/news/a44575583/80000-nissan-leaf-evs-recall/>
- [5] CarParts.com Research Team. (2023, August 30). Nissan LEAF: Battery Degradation and Other Common Problems
<https://www.carparts.com/blog/nissan-leaf-battery-degradation-and-other-common-problems/>
- [6] nissanproblems.com. (2019, March 21). Nissan's AEB is Suddenly Stopping Vehicles for No Reason
<http://www.nissanproblems.com/aeb/>
- [7] International Energy Agency. (n.d.). Global sales and sales market share of electric cars, 2010-2021 [Data visualization]. Retrieved from
<https://www.iea.org/data-and-statistics/charts/global-sales-and-sales-market-share-of-electric-cars-2010-2021>
- [8] Flickr. (n.d.). [Photographs]. Retrieved from
<https://www.flickr.com/photos/157634822@N04/page3>
- [9] Car and Driver. (2022, October 13). 80,000 Nissan Leaf EVs Recalled. Retrieved from
<https://www.caranddriver.com/news/a44575583/80000-nissan-leaf-evs-recall/>