International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 09 Issue: 04 | Apr 2022 www.irjet.net p-ISSN: 2395-0072

A Review: The Success of Tesla from 2003 to 2022

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Abstract - *Tesla is a American based company in Austin manufacturing Electric vehicles. It is one of the most world's reputed company in making clean energy electric cars. This Paper displays of Tesla's journey from its early stage to present scenario and how its founder Elon Musk led the company to success, What Technology Tesla uses for automated cars, how safety the Tesla vehicles, market rate across the globe.*

Key Words: Tesla, electric cars, automated cars, market rate.

1. INTRODUCTION

Tesla, headquartered in Austin, Texas, is an American electric car and renewable energy startup. Tesla designs and produces electric vehicles, battery energy storage systems ranging from residential to grid-scale, solar panels and solar roof tiles, as well as associated goods and services. With a market valuation of over US$ 1 trillion, Tesla is the world's most valuable automaker. Tesla had the highest worldwide sales of battery electric vehicles and plug-in electric vehicles in 2020, accounting for 23 percent of the battery-electric (purely electric) market and 16 percent of the plug-in market (which includes plug-in hybrids). Tesla Energy, the company's subsidiary, designs and builds photo voltaic systems in the United States. Tesla Energy is also one of the top global suppliers of battery energy storage systems, with 3.99 gigawatt-hours (GWh) deployed in 2021.

Tesla Motors was founded in July 2003 by Martin Eberhard and Marc Tarpenning as an homage to inventor and electrical engineer Nikola Tesla. Elon Musk, co-founder of X.com, became the company's largest shareholder and chairman in February 2004 with a $6.5 million investment. He has been CEO since 2008.Tesla's mission, according to Musk, is to assist accelerate the transition to sustainable transportation and energy, which can be attained through electric vehicles and solar power. [1]In 2009, Tesla began manufacturing of its first automobile model, the Roadster sports car. The Model S sedan debuted in 2012, followed by the Model X SUV in 2015, the Model 3 sedan in 2017, and the Model Y crossover in 2020.

Tesla has been involved in a number of lawsuits and disputes stemming from CEO Elon Musk's remarks and actions, as well as charges of creative accounting, whistle blower retribution, labour rights abuses, and unsolved and hazardous technical flaws with their cars. [1] The National Highway Traffic Safety Administration (NHTSA) required Tesla to provide statistics on all marketed Autopilot vehicles in the United States in September 2021.

This Review Paper on Tesla is patterned initially with abstract and Introduction followed by section 2 involving History of Tesla, continuing with section 3 displaying the market of Tesla, section 4 includes the technology that Tesla is using and concluding with section 5 with conclusion and references.

2. HISTORY OF TESLA

2.2 Founding Stage

Tesla was formed in 2003 by a community of developers who decided to show that piloting electric vehicles doesn't have to be a compromise - that they can be better, faster, and more maneuverable than gasoline vehicles. Tesla now manufactures not only all-electric automobiles, but also sustainable energy production and storage systems that are infinitely scalable. The quicker the world moves away from fossil fuels and toward a zero-emission future, Tesla thinks, the better. The firm was founded by Martin Eberhard and Marc Tarpenning on July 1, 2003, as Tesla Motors, Inc. CEO and CFO positions were held by Eberhard and Tarpenning, respectively.

Tesla automobiles are assembled in the company's factories in Fremont, California, and Shanghai's Gigafactory. Tesla is adopting a proactive approach to safety, requiring production personnel to complete a multi-day training programme before ever setting foot on the factory floor, in order to realise our aim of having the safest plants in the world. Tesla then continues to conduct on-the-job training and monitor performance on a daily basis in order to make rapid changes. As a consequence, Tesla's safety record continues to improve as manufacturing ramps up.

The Roadster debuted Tesla's cutting-edge battery technology and electric motor in 2008. From and then, Tesla created the Model S, the world's first upscale all-electric sedan, which has become the finest car in its class in every category. With the greatest range of any electric vehicle, over-the-air software upgrades that improve it over time, and a record 0-60 mph

Fig. 1. CEO of Tesla: Elon Musk

Fig. 3. Tesla Roadster Sport 2.5

Fig. 2. Tesla symbol

Fig. 4. Tzero: The proof of concept of Tesla

acceleration time of 2.28 seconds as tested by Motor Trend, the Model S has reset the world's expectations for the automobile of the twenty-first century. Figure 1 displays the image of CEO of Tesla. [2].

2.2 Tesla's Symbol

Tesla Roadsters have an AC engine. This motor is based on a Tesla design that was first introduced in 1882. Tesla struggled to compete with other automobile makers despite contemporary technology and breakthroughs. That is, of course, why it need its own image and logo. The company's name is represented by a beautiful letter T on the badge. It also has an armour shield frame, which gives the badge a highly modern and appealing appearance. [2]The symbol's major purpose was to emphasize the brand's distinctive approach, which is focused on electric vehicles' breakthrough in comparison to any other car maker. Tesla logo is displayed in figure 2.

The Tesla Car logo is both simple and imaginative at the same time. The major purpose was to convey the concept of energy efficiency. In other words, engineers were keen to show that electric engines could be both powerful and long-lasting. The badge features a huge letter T after the company's name. It is designed in a fashionable and contemporary manner. It's above the armour shield, which represents a high level of dependability and safety when driving. The name of the company is laid on top of the letter T. The Tesla emblem is made up of black and silver colors. All of the letters are black and encased in a silver shield. Because these colors are connected with creativity, invention, and style, the log appears to be appealing and eye-catching.

2.3 Early Models of Tesla

The Tesla Roadster is a battery electric vehicle (BEV) sports car based on the Lotus Elise chassis that was manufactured in California by Tesla Motors from 2008 to 2012. The Roadster was the first highway-legal serial production all electric vehicle to employ lithium-ion battery cells, as well as

the first production all-electric vehicle to go more than 320

kilometers (200 miles) per charge. It is also the first production automobile to be propelled into deep space, on February 6, 2018, by a Falcon Heavy rocket in a test mission. Tesla sold around 2,450 Roadsters in over 30 countries, with the majority of the last Roadsters sold in Europe and Asia during the fourth quarter of 2012. Tesla began producing right-hand drive Roadsters in early 2010. The Roadster was eligible for government subsidies in a number of countries. Figure 3 is the first Roadster model of Tesla and Figure shows concept car of Tesla. [3].

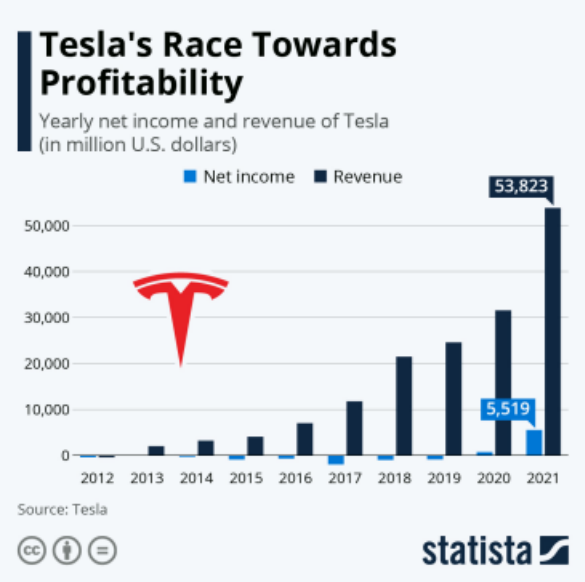

Fig. 5. Tesla Race towards Profit

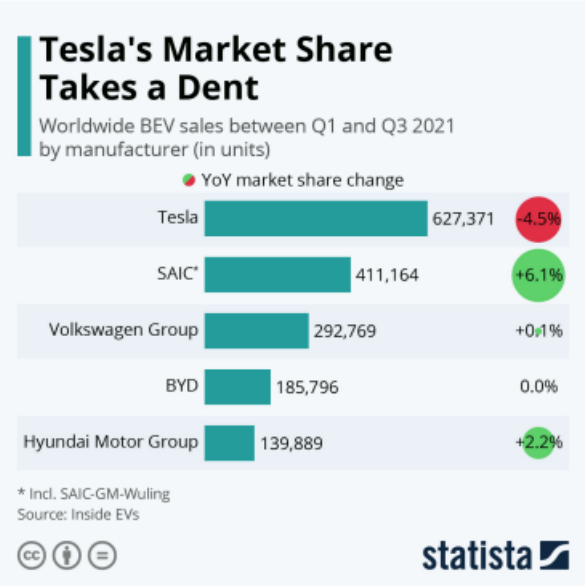

Fig. 6. Tesla Market Rate

3. Market Statistics of Tesla from early stages

Tesla has not only beaten analysts' projections with a net income attributable to shareholders of $2.3 billion this quarter and a total of $5.5 billion in 2021, but it has also reached the conclusion of a decade-long path towards true profitability and coming out of the red on its own terms. As our graph indicates, the path to this aim was not without challenges. For the first time, Elon Musk's firm, for example, generated net profits rather than a loss in 2020. This suggested a growing interest in battery electric vehicle adoption throughout the world, following the failure of the car manufacturer's models S and X, which were introduced in 2012 and 2015, respectively, to earn significant income. A deeper look at the $721 million in 2020 earnings indicates that the manufacturer still needed a boost to turn a profit. The corporation would have lost money again if regulatory credits worth $1.6 billion had not been sold. Figure 5 shows the Market rate increment of Tesla from 2012 to now. [4].

While Tesla accounted for more than a quarter of all BEV sales globally from Q1 to Q3 2020, its market share fell by about 5% in the same time in 2021. One of the reasons for this is the increased popularity and accessibility of automobiles manufactured by the SAIC□GM-Wuling conglomerate, which manufactures not just models with internal combustion engines (ICE), but also battery-powered and plug-in hybrid alternatives. According to the China Passenger Car Association, China's best-selling BEV, the Wuling Hongguang Mini EV, attracted 256,661 new owners from January to September 2021, for a total of more than 400,000 sales since its introduction in July of 2020.

It costs one-tenth the price of the lowest new Tesla vehicle, with a starting price of around $4,500. According to Inside EVs, the Tesla Model 3 Rear-Wheel Drive costs around $45,000 and has more than three times the range of the smaller and slower Hongguang Mini EV. Both models are aimed at different audiences, but they will almost certainly dominate the discourse when it comes to the number of BEVs sold in the coming months. This suggests that Tesla's primary focus should be on legacy vehicle manufacturers rather than BEV only manufacturers. Figure 6 involves the Market Dent of Tesla.

Martin Viecha, Tesla's Head of Investor Relations, appears to agree that the company is competing with established automobile manufacturers, albeit he sees the roles of hunter and prey inverted. "Over 90% of automobiles sold [in 2021] will be ICEs," he said on Twitter. "It is the ICEs that are losing market share to all comparable EVs." Despite the fact that ICE-powered vehicles continue to dominate sales, the same major automakers are continually growing their hybrid electric vehicles (phevs hybrid and battery electric fleets. Audi, for example, has said that from 2026, it would solely produce battery-powered vehicles, while Volvo and Nissan have set a 2030 deadline for the same.

Joining the ranks of Tesla and Rivian, Lucid is now the world's third most valuable automotive company, and it's only a matter of time before it surpasses GM and leaves the (old) "Big Three" in the dust. Despite the fact neither Lucid nor Rivian has delivered a significant number of cars to consumers, investors continue to rate them highly. The opportunity to ride in what may be the next Tesla appears to be too appealing for many to pass up, despite the fact that there is a significant amount of uncertainty and danger involved. Figure 7 shows

Fig. 7. Tesla's competition with Lucid and Rivian.

the market competition of Tesla with Lucid and Rivian.

4. Technologies used in Tesla

Tesla has gained a global brand as the industry leader and pioneer in electric vehicles, but it also develops and sells innovative battery and solar panel technologies. As a tech trailblazer with a big stake in the battle to produce and commercialise self-driving cars, it stands to reason that they are now profoundly interested in artificial intelligence. However, it was just this month that the company's billionaire founder and CEO, Elon Musk, openly said that it is developing its own AI hardware. He is also a co-founder of OpenAI, a research organisation devoted to ensuring that ai systems is created and implemented in a safe and controlled manner, reducing any existential threat that robots may offer to mankind in the future. Tesla has been chastised by some for looking overly anxious to be the first to introduce self-driving vehicles on the road, following what is thought to be the first tragic accident involving a self-driving car. With internal and exterior sensors that may pick up information about a driver's hand placement on the gauges and how they are working them, Tesla effectively crowd sources its data from all of its vehicles as well as their drivers. This data has significant worth in and of itself, in addition to assisting Tesla in the refinement of its systems. According to McKinsey Co., the market for vehicle-collected data will be worth $750 billion per year by 2030.

Tesla's Model S is pricey (ranging from $70,000 to over $100,000), but it has a 265-mile range, which is more than three times that of Nissan's Leaf (75 miles). Tesla intends

Fig. 8. Battery packing: The battery pack in the Model S is flat and part of the frame that supports the car—the metal case provides structural support

to develop considerably more cheap vehicles, such as one that costs $30,000 to $35,000 and has a range equivalent to the Model S, within a few years. Tesla also intends to make electric cars more practical by constructing a statewide network of charging stations capable of delivering 200 miles of charge in approximately half an hour, as opposed to the many hours it takes to charge an electric car at a regular station today.

Tesla's decision to use tiny lithium-ion batteries is undoubtedly one of the company's most significant strategic bets. Larger battery cells have been chosen by established automakers because they simplify battery pack engineering because fewer of them are required. Larger cells, on the other hand, are more harmful since they carry more energy. As a result, manufacturers utilise less energy-dense battery materials that are more fire-resistant. To compensate for the reduced energy density, manufacturers selected flat cells, which pack together more tightly but cost more to produce. Figure 8 shows the battery packing in Tesla Model S.

Induction motors were employed in the Model S and X. A spinning magnetic field is created in an induction motor by running alternating current via windings in the rotor (the motor's stationary section). This magnetic field creates electric currents in the rotor's windings, which generate an opposing magnetic field, forcing the rotor to spin in the same direction as the magnetic field.The Model 3 launched with an alternate motor technology known as a permanent magnet synchronous reluctance motor, which Tesla calls a permanent magnet synchronous reluctance motor. The rotor of a synchronous reluctance motor is surrounded by electromagnets, but the rotor lacks windings or permanent magnets. Instead, the rotor is made up of veins of magnetic material interspersed with non-magnetic material, organized in such a way that it has a preferred orientation in the rotor's magnetic field.

The motor turns the rotor by sequentially activating electromagnets, resulting in a revolving magnetic field that pushes the rotor along. Because the activation of the electromagnets is synchronised with the rotation speed of the rotor—something that isn't true for an induction motor—this design is known as a synchronised motor.The

Model 3 with two motors has a front-mounted induction motor and a rear-mounted permanent magnet synchronous reluctance motor. This is reversed in

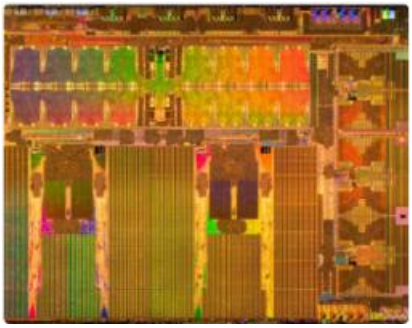

Fig. 9. FSD Chip

the Model S and Model X, with an induction motor in the back and a PMSRM in the front.Because the two motor types have differing performance characteristics, combining an induction motor with a PMSRM makes sense. "One is tuned for power one is optimised for range," Elon Musk said last year. Induction motors provide a lot of torque at low speeds, but they use a lot of energy. When instant, rapid acceleration is required, dual-motor cars can supply power to the induction motor, then change power to the PMSRM as the vehicle accelerates.

Tesla claims that the efficiency improvements in the Model S and X haven't come at the sacrifice of torque. On the contrary, the firm claims that the most recent models have improved by 0-60 speeds over previous versions.

4.1 Artificial Intelligence and Auto Pilot

Build AI inference processors to run the Full Self-Driving software, taking into account every single architectural and micro-architectural enhancement while squeezing the most performance-per-watt out of silicon. Floor-planning, scheduling, and power assessments should all be done on the design. To ensure functionality and performance, provide thorough tests and scoreboards. Drivers are used to programme and interact with the chip, with a focus on performance and redundancy. Finally, test the silicon chip before mass-producing it in our automobiles-FSD Chip in Figure 9.. [3]

To power the Dojo system, they need to build AI training chips. From the tiniest training nodes to multi-die training tiles, use cutting-edge technologies. At every granularity, design and architect for optimal speed, throughput, and bandwidth. Dictate the chip's physical approach, floor design, and other physical features. To assure functional accuracy, develop pre‐silicon verification and post-silicon validation tools. Throughout the Dojo system, write compilers and drivers to maximise power and performance for our neural networks. Figure 10 and Figure 11shows the DOJO chip and DOJO system.

From the semiconductor firmware interfaces to the high level software APIs that manage the Dojo system, design and develop it. Solve difficult challenges with cutting-edge technology for high-power supply and cooling, as well as

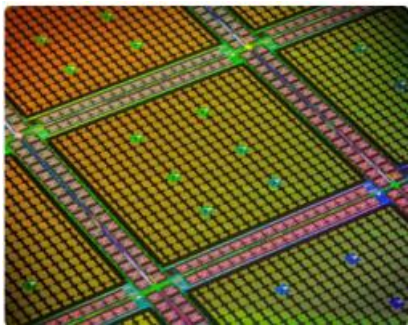

Fig. 10. DOJO Chip

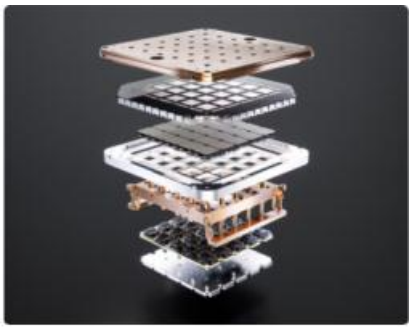

Fig. 11. DOJO System

scalable control loops and monitoring software. Work on every part of system design, with only your creativity as a limit, combining the talents of our mechanical, thermal, and electrical engineering teams to develop the next-generation of machine learning computing for Tesla datacenters. Collaborate with Tesla fleet learning to deploy training workloads based on our enormous datasets, and create a public facing API that will make Dojo accessible to the whole public. [3].

Training deep neural networks on challenges ranging from perception to control using cutting-edge research. To conduct semantic segmentation, object identification, and monocular depth estimation, our per-camera networks evaluate raw pictures. Our birds-eye-view networks use footage from all cameras to produce a top-down image of the road layout, static infrastructure, and 3D objects. Our networks learn from the world's most complex and diverse scenarios, which are iteratively generated in real time from our fleet of roughly 1 million cars. Autopilot neural networks require 48 networks to complete and 70,000 GPU hours to train. At each timestep, they generate 1,000 different tensors (predictions).Relative information regarding neural network in Figure 12. [5]

Create a high-fidelity picture of the world and design trajectories in that space to develop the key algorithms that move the automobile. Algorithmically construct accurate and

Fig. 12. Tesla Predicts either to stop or go

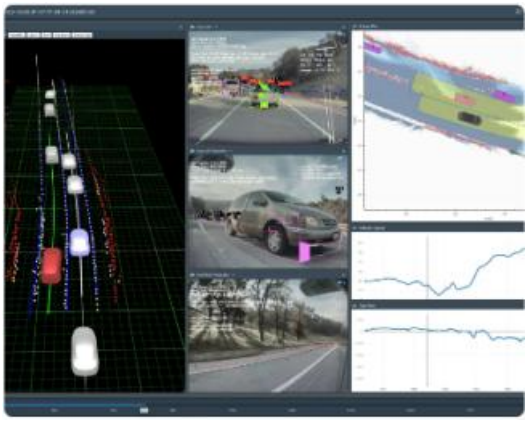

Fig. 13. Autonomy Algorithms

large-scale ground truth data by merging input from the car's sensors across space and time in order to train neural networks to anticipate such representations. Build a powerful planning and decision-making system that can work in complex real-world circumstances under uncertainty using cutting-edge methodologies. Evaluate your algorithms on a larger scale than the Tesla fleet. Figure 13 shows the interface of Autonomy Algorithms. [6]

5. Conclusion

This Review Paper on Tesla Motors presented main aspects of Tesla includes foundation, history in which we showed Early stages, first car, etc... We presented the market study of Tesla from past decade till now, how Tesla is competing with its comparable companies, we demonstrated the technologies used in Tesla such that making it innovative. We gave a clear description on automated cars technology.

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