Green Cars

Title: DO OPEN INNOVATION AND PARTNERSHIPS HELP TESLA MOTORS TO IMPROVE BATTERY PERFORMANCE AND COST REDUCTION

Course: ETM549 Managing Technological Innovation

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Abstract

Electric Vehicles existed over a century ago, but they were put into extinction because of invention of the internal combustion engine and its use in automobiles. Today, as gasoline prices rise and the overall supply of oil decreases globally, alternative fuel sources are sought after. With the advent of the computer and advancements in battery technology, the electric car has a bright future ahead. Furthermore, Tesla Motors is taking steps in the legitimate leadership of the world revolution by Gigafactory that Tesla Motors is in the process of aggregating a huge battery factory. This huge facility may be perspective to decrease the cost of batteries by 30% as well as car's cost reduction to be affordable to middle- income.

1. Introduction

Today with millions of gas cars and other transportations around the world, the CO2 emissions is the big problem that causes air pollution. According to the World Health Organization (WHO), air pollution is a leading environmental health hazard and is estimated to cause approximately two million premature deaths per year worldwide. The World Health Organization (WHO) identified that ozone, fine dust, NO2, and SO2 are the most dangerous kinds that are mainly, or to a large extent, traffic-derived. Traffic could be accountable for nearly half of quantified this pollution that caused health problem. On a global scale, 26% of the primary energy is for transportation purposes, and 23% of greenhouse gas emissions is related to energy. The traffic in the streets shares 74% in the transport sector worldwide. This sector includes planes, ships, trains, and all types of vehicles in the streets (for example, trucks, buses, cars and two-wheelers). Cars play a special role for three reasons: First, the vehicles are dominated by the traffic in the streets in most countries. Second, vehicles sales show the largest growth rates in global. Third, alternative technologies are drivetrain available unlike, for example, the trucks. While small trucks could be electrically operated within a limited range, large trucks rely on diesel fuel, which can be converted to a mixture of 80% of the methane (either fossil or biogenic) in the future. Electrical buses also can be driven on a limited distances; and used buses driven by compressed natural gas (methane) routinely. The bus is driven by fuel cells are already in the streets, and small trucks are driven by fuel cells and H2[12]. In this paper we concentrated on electric cars and especially on the electric cars company “TESLA MOTORS”. We also discussed the problems that are faced by the company and how Tesla Motors builds up the strategies to overcome these problems. Furthermore, we applied the open innovation to identify the most important partnerships to Tesla Motors. We also discussed the partnerships of the company, the future goals, and the planning of future productions.

2. Lecturer review

For over 100 years, numerous inventors in Europe and North America have attempted to perfect the electric vehicle, or EV. These self-propelled automobiles were first developed as a replacement for the horse and buggy. The cars were silent, clean and easy to operate. During this time period, the cars were used most often for short trips around town. Therefore, the lack of advanced battery technology, which increases the distance the vehicle can go before recharging, did not pose any issues [9].

Several men have been given credit for the invention of the EV because the term "electric vehicle" can be applied to multiple inventions of the time period. Between the years of 1832 and 1839, the Scottish inventor Robert Anderson created the first electric-powered carriage. In 1835, Thomas Davenport, a blacksmith from America designed and built a small electric car. More so, Dutch inventor Sibrandus Stratingh designed an electromagnetic car. In 1891, William Morrison built what is considered the first successful EV in the United States. Morrison's car was equipped with a 4 horsepower motor, and a power supply which consisted of a 24-cell battery. The car was capable of traveling at approximately 22 km per hour or 13 miles per hour. The Pope Manufacturing Company of Hartford, Connecticut was the first large scale U.S. manufacturer of Electric Cars. Its car also topped out at 22 km per hour, and had a range of 48 km per charge [9].

At the turn of the century, 28 percent of all cars produced in the United States were electric. These cars were more attractive than gas-powered vehicles because they were more reliable, did not backfire, and did not need to be hand-cranked to start. During this time period, Thomas Edison began working on a more efficient battery that would produce more power for a longer period of time, and also weigh less. His nickel-iron-alkaline battery was said to be at least 200% better than the existing lead-acid batteries. This advancement increased range from approximately 50 km with lead-acid batteries to approximately 160 km [10].

Regardless of these improvements in battery design, the popularity of electric vehicles soon declined. With the mass production of Henry Fords' gas powered model T, along with Charles Kettering's electric automobile starter, which eliminated the need to hand crank, gas powered vehicles soon became the standard. Further research and development of electric vehicles became more prominent during the 1960s and 1970s due to the rise in fuel costs and fear of exhausting fuel supplies. General Motors began producing its EV1 in the late 1990's which was the first mass produced electric car of the modern era. Despite innovations in battery technology, this electric vehicle could still only travel a fraction of the distance gas powered vehicles traveled, which was not appealing to most consumers. The vehicle was also extremely expensive to produce. After the failure of the EV1, GM became commonly known as the company that killed the electric car [10].

In 1997, Toyota began production of its first electric vehicle, the Rav4 EV. This electric vehicle hit the market in 2001 and boasted a driving range of 80-110 miles on a single charge. The Tesla Roadster, manufactured by Tesla Motors in California, which first became available in 2006, brought shock to many consumers, with a sticker price starting at $90,000. This vehicle could travel 245 miles on its lithium-ion battery pack. The Tesla Roadster was the first high performance electric vehicle and is still being produced today [10].

Currently, all major automobile companies are working on plans for electric cars. The all electric Ford Focus will be available soon, and will be able to run for 100 miles on a single charge. For the most part however, research and development has been done on hybrid vehicles, such as the Chevy Volt, which supplements electric power with a gas-powered engine that works as a generator to recharge the vehicles battery [10].

The future of electric vehicles depends on advancements in *the* battery technology. For electric vehicles to become a complete success, the range, performance, price, reliability, and convenience factor must be at that of the gasoline-powered automobile, if not superior. As this technology advances, affordable all electric vehicles may become the standard.

http://www.plugincars.com/electric-cars

3. Tesla Overview

In the early 1890s, Tesla discovered "rotating magnetic field" that are produced by two or more of the alternating currents of step with each other. Based on this invention, Tesla created models of alternating current motors proceeded almost every process and system polyphase whole generating, transmitting and distributing electricity, too. The first Tesla polyphase system patents were granted on May 1, 1888 [11].

Tesla Motors, Inc. is an American company that was founded in 2003 by a group of brilliant and innovative Silicon Valley engineers. These engineers proved that electric vehicles could be awesome substitute of the gasoline powered cars. Tesla not only designs, produces and markets electric cars, but it also provides advance electric vehicle power train components to other automakers including Daimler and Toyota.

Tesla first gained widespread attention by producing the Tesla Roadster, a solely electric operated sports car. Tesla then expanded its technological advantage to the luxury sedan market. Model S, a zero emission and sustainable luxury sedan, was then introduced as their second vehicle to the electric vehicle in 2012. The third model named Tesla model X is scheduled to be delivered to the market in 2014. Thus, Tesla is the only automaker that sells zero-emission sports cars in serial production at present [11].

Tesla Motors is taking steps in the legitimate leadership of the world revolution, which is largely re-organization of the national infrastructure, the economy, as well as modernistic perceptions and concepts of transportation. Actually, it has been jolty for the manufacturer of the car, from 2008 when Tesla run out of money and had trouble to raise funds during the credit crisis of that year. Moreover, Tesla also faced technical problems with Roadster, which is the first car. The auto industry and the experience of the period fraught with other risks in 2012 when he was trying to raise the level of production of electric car Model S. However, the company's fortunes changed for the better when they were securing Further funding of investors. The company obtained a loan by the Department of Energy, and need public. Today, Tesla's stock is trading at an amount of $200 per share. By the end of 2013, Tesla has close to 6,000 employees, *it* also made 600 Model S cars per week, and has to raise its production capacity to 1,000 vehicles per week plan before the end of the year. However, achieving this is linked to the third-generation car of the year the company, which could cost no more than $ 40,000 and could reduce to $ 30,000, which is perspective to be ready by 2017. To achieve the company is in the process of aggregating a huge battery factory, which is perspective to decrease the cost of batteries by 30%. This huge facility, which dubbed the "Gigafactory" is decisive for Tesla future. The factory is the key that Tesla needs to so that it could enter the realm of major automakers, as it will enable the company to produce affordable long-term electric car [13].

4. Problem Definition

This paper focuses on Tesla Motors for many reasons. The first reason is that Tesla Motors targets just electric cars. the second reason is that many automobiles' companies use Tesla electric component for their electric car like Toyota and Mercedes. Moreover, this paper has examined the collaboration and Open Innovation. Thus, this study will focus in Tesla's partnerships, and how Tesla with Open Innovation and partnership will improve battery performance as well as making its car affordable to people.

Do Open Innovation and partnerships help Tesla Motors to improve battery performance as well as cost reduction so that it could be affordable to middle class people?

5. Methodology

Because the term is limited to ten weeks only, we have carefully carried out literature review to gain extensive information of the analyzed subject. This paper focuses basically on articles related to the topic and Tesla Motors websites.

5.1 Close and Open Innovation Approach

Technological companies have a radical change in innovation ways, so they should transfer their innovation strategies from a Closed Innovation approach to an Open Innovation approach. Many researchers have devoted great interest to this radical transformation from a closed to an open innovation approach [2]. Figure 1.1 has demonstrated the Closed Innovation flowchart.

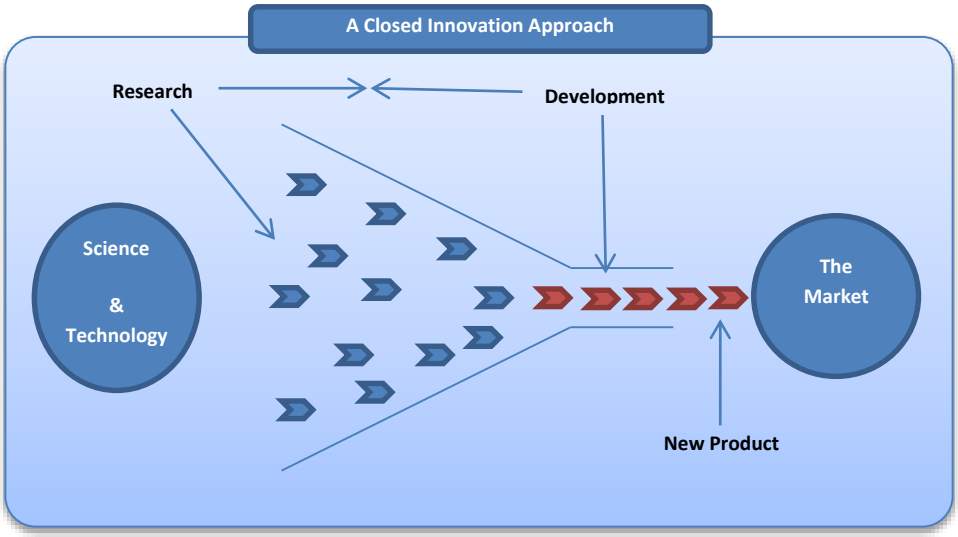


Figure 1.1 Closed Innovation flowchart **[6]**

5.2 Open Innovation

Open Innovation could be known as: **"***The use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively. Open innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology***"** [4]**.**

Open innovation is one of the most drivers of scientific innovation and technological innovation. It has an increasing connection among history that let people and companies to share and exchange ideas, knowledge, and information to develop a new thing. In fact, Open Innovation assumes that companies may use external ideas, at the same time use internal ideas to progress their technologies. It is possibility through new approaches to intellectual innovation management, incidental benefits, authorization, and other methods that might realize external ideas into the company. Business Open Innovation is much lucrative ways to innovate. It could reduce expenses, expand the differentiation within the market, and find new value sources for the firm. Moreover, firms should search for technologies and ideas that could be suitable for their business model. If internal technologies and ideas do not suit for firm, they should go to outside firm [5]. Figure 1.2 is shown the Open Innovation flow chart.

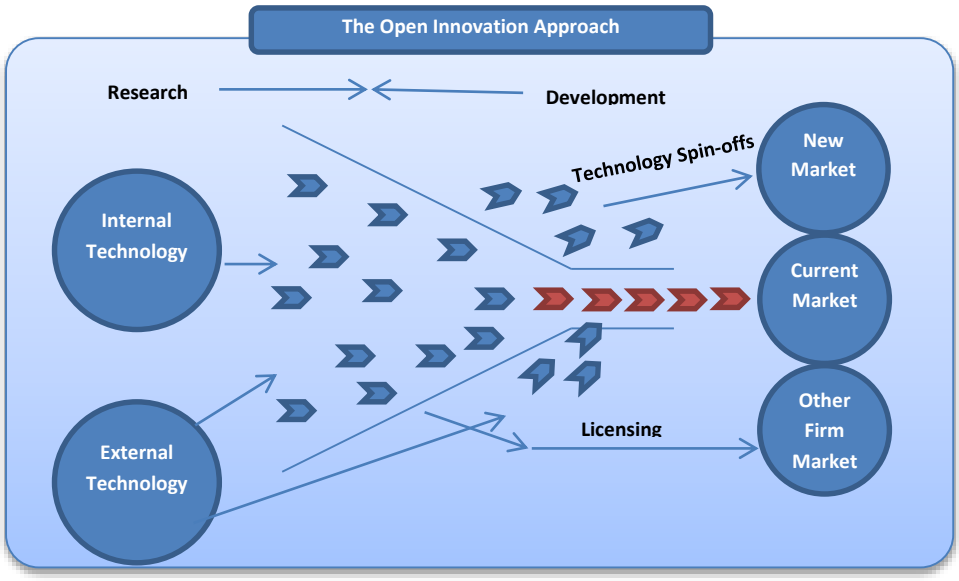


Figure 1.2 Open Innovation flowchart **[6]**

Contrasting principles of Closed to Open innovation	
Closed innovation principles	**Open innovation principles**
The smart people in the fieldwork for us.	Not all the smart people in the fieldwork for us. We need to work with smart people inside and outside the company
To profit from R&D, we must discover it, develop it, and ship it ourselves	External R&D can create significant value: internal R&D is needed to claim some portion of that value
If we discover it ourselves, we will get it to the market first.	We don't have to originate the research to profit from it.
The company that gets an innovation to the market first will win.	Building a better business model is better than getting to the market first.
If we create the most and the best ideas in the industry, we will win.	If we make the best use of internal and external ideas, we will win

Table 1.1 Contrasting principles of Closed to open innovation **[2]**

6. Partnerships and collaboration

One objective of this paper is to focus on the collaborations and partnerships with Tesla Motors. Lotus is the closest partner to Tesla Motors, and the most significant partnership to Tesla is battery partnership. However, Toyota is producer partnership who is also providing engineering support. Before you are planning a partnership, you have to define the objective of the partnership co-development (co-dev) [1]. The table in down obviously indicates of various objectives with Tesla's partnerships.

Different Business Objectives of Co-development		
Objective	**Business requirement**	**Implication for co-dev design**
Increase profitability	Lower cost	Increase volume to spread fixed costs; partner for less-critical components
Shorten time to market	Incorporate already-developed components or subsystems	Seek partners with proven capabilities
Enhance innovation capability	Increase the number and variety of front-end technologies	Create strategic research partnerships with universities, research labs
Create greater flexibility in R&D	Share risks with partners	Develop research partnerships in bottleneck areas
Expand market access	Broaden the pathways to market for products and services	Leverage partner's complementary R&D to tailor offerings for new markets

Source: [1]

6.1 The Lotus Partnership

Tesla made a design competition that Lotus team won in that competition. After that, Tesla made a close partnership with Lotus who has manufactured the body of Tesla in the UK. The result of this competition was Tesla Roadster similar to the Lotus Elise. There is a significant number of the reasons why this partnership might be required for both partners that became a success partnership. The main reason is that Tesla Motors would need to enter to the EV market. This market might have high obstructions to Tesla especially with creating production facilities, storage, supply chain etc [1]. It might be greatly exorbitant for them. Other reason is that Tesla may need to open innovation. It also needs to continue in the market, open innovation process is necessary.

	
Lotus Elise	Tesla Roadster

6.2 The battery partnership

The battery is the most significant component in electric car, so the partnership with the battery cell manufacturer probably one of the most important ones. Initially, the battery that Tesla provides is the core innovation for Tesla Motors. Thus, the battery partnership has been kept obscure, but many indicate that the partner is either Sanyo or Sony [1]. However, In 2009, Tesla and Panasonic have agreement that Panasonic is a supplier for Tesla. In 2010, in order to be closer partnership, Panasonic has invested $30 million in Tesla Motors. By 2011, they agreed that Panasonic provides a grade lithium ion battery cells to Tesla. Tesla used the battery cells for Model S. This agreement continues to cover R&D collaboration to develop a next-generation of grade battery cells that could be based on nickel chemistry [2]. This new technology of battery cells could create one of the most effective cars.

6.3 The production partnership

Tesla is considered the smallest automobile manufacturer, so it is necessary for Tesla learning and developing from other automobile manufacturers like production and experience. In 2010, Tesla motors agreed that a partnership with Toyota to develop production electric cars as well as provide engineering support. Tesla would choose a factory side, expertise of manufacture, and technological resources, as for Toyota would get supplies and equipment for electric vehicles like electric motor, power electronics, battery, gearbox and software [3]. They have both benefited from this agreement. Tesla benefited from Toyota experience as well as Toyota benefited. Toyota *wants to* be ready when electric cars dominate in the market share.

7. Discussion

Tesla Motors is the first company that just focuses on applying product innovation by manufacturing only electric cars in the market. In addition, Tesla Motors uses open innovation to cooperate with many companies that have produced and exchanged some components as well as provided engineering supports with Tesla Motors.

The idea of open innovation is very wide and there are several ways to classify it. There are two main types of open innovation in the innovation process of the company. Open innovation contained which is based on an external process, and outbound open innovation which is based on the process from the inside-out. The aim of the process abroad is increasing knowledge of combining customers, suppliers and knowledge are coming from external sources Company. Otherwise, the inside-out process seeks to make the company more profitable throughout innovative ideas and marketing of intellectual property rights (IP) and the expansion of technology through interaction with the external environment. This combination of the processes that mentioned above is the process of innovation which has the application processes of incoming as well as outgoing at the same time. This could be achieved generally by supplementary cooperation partners [2].

Associated innovation indicates the innovation in complementary partners. These partnerships could be identified as projects and joint partnerships. Through innovation processes as well as companies get the relations among companies. Thereby, R&D departments collaborate to develop supplementary technology. The cooperation between organization’s departments of their R&D, companies are eligible to scout new technologies. Collaborative networks and alliances R&D technology are an important factor for companies in an attempt to achieve the best results in product innovation. Moreover, depending to a recent study that was based on extensive review of empirical studies quantity alliances and R&D appears to be a more efficient strategy than merging and acquisitions which improves the company's innovative performance [2]. By using this strategy, Tesla Motors is able to manage and combine its employees' ideas with other companies. There are many benefits from these alliances. For example, Lotus and Toyota

provide significant design and manufacturing processes innovations, and Panasonic provides an innovative battery technology.

Going back to the research question, "Do Open Innovation and partnerships help Tesla Motors to improve battery performance as well as cost reduction so that it could be affordable to middle class people?"

Greater cells give less mechanical complication; however, they oblige a safety framework in every cell to prevent fire in case of accident. This makes the cells more costly and organizations to avoid a cost increment of their vehicles ordinarily diminish the battery thickness keeping in mind the end goal to reduction the danger of fire, which lamentably lessen the vehicle Cost too[8]. Battery technology and performance need to be improved their reliability and capacity, and increasing the performance of battery will increase the mileage. Tesla Motors knows that thermal management of batteries is necessary to improve battery performance. Thus, Tesla has created R&D partnerships with Dana Holding Corporation. This R&D Corporation has helped override a technological obstacle by designing a new technology that can control heat buildup in the electric cars batteries [7].

Another corporation could help Tesla Motors to reduce the cost of car to be affordable to people. Tesla Motors and its partners will invest $4-5 billion in the Gigafactory through to 2020. By 2017, Tesla Motors will start manufacturing batteries, and by 2020, Tesla Motors aims to produce more than 500,000 batteries as Figure 1.3.

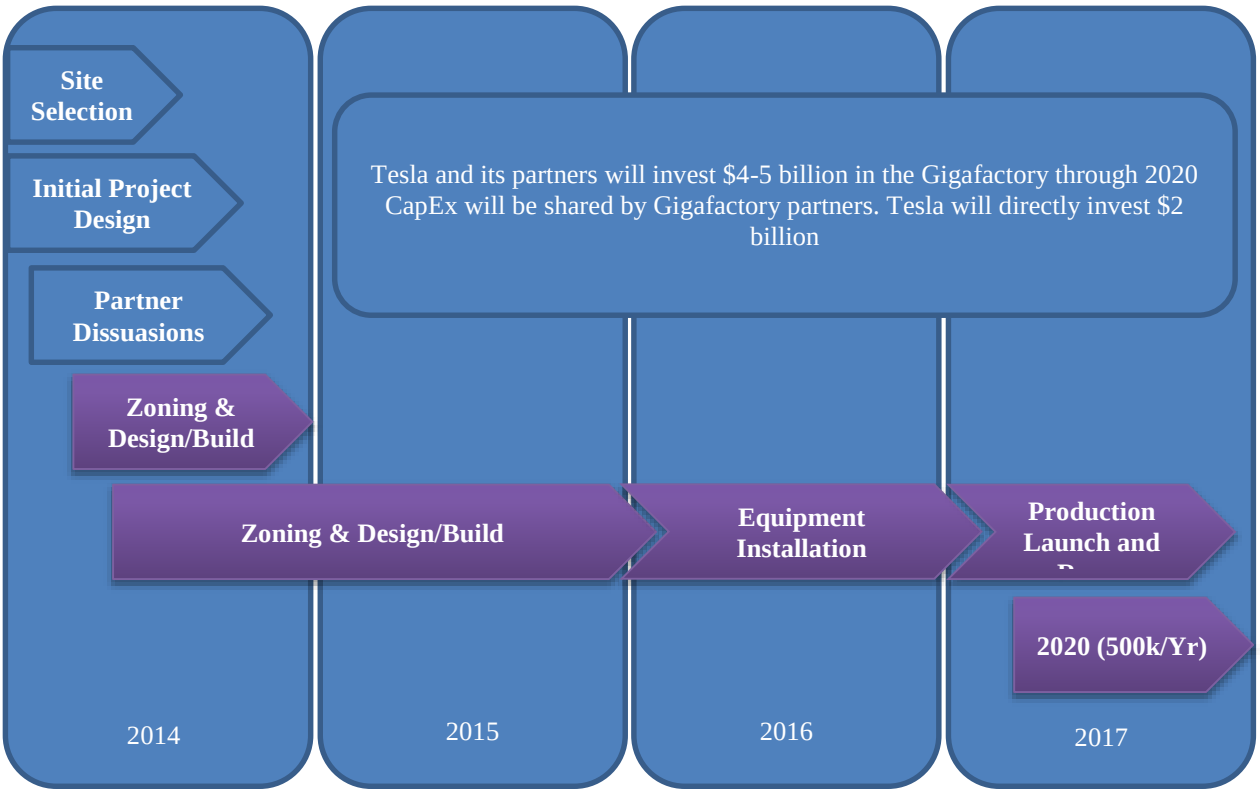
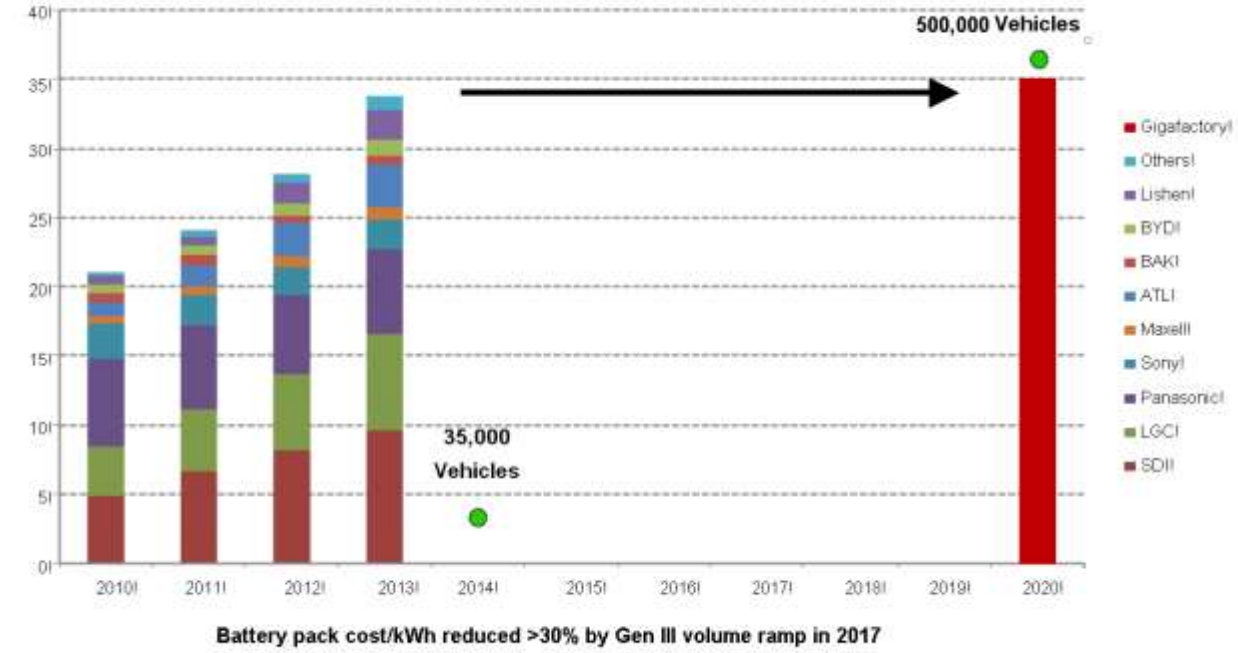


Figure 1.3 Gigafactory projected timeline (Source: Tesla Motors Blog) [14]

In 2020, Gigafactory Production planned to exceed what was produced in Global Production in 2013.



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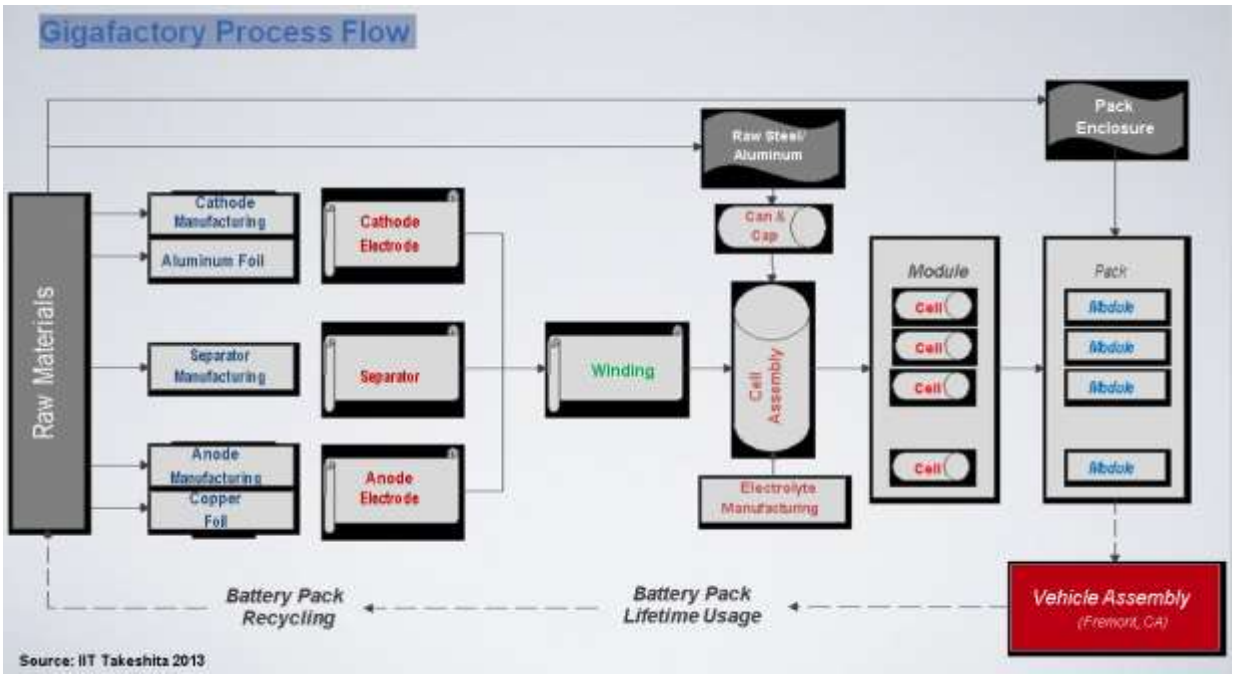

[14]

Many researches indicate that the most expensive component in electric car is battery, and with this number of batteries that Tesla Motors will produce in Gigafactory by 2020, will make the price of electric car down to be affordable to people with average incomes. Tesla is mainly aiming to produce the electric cars such that they compete with the usage of conventional cars. From the data collected and based on the future strategies of Tesla motors I think that other electrical companies may collaborate with Tesla in the battery production and also in the production of some of the electric parts.

8. Conclusion:

Throughout the study, some specific tools and/or frameworks were utilized during each stage of the open innovation process. Lot of partnership investments were done so the open innovation for investments has been used so that they have a clear view of how to handle the partners. In order to maintain sustainability in today's diverse and competitive automobile market, it's imperative for Tesla Motors to design, develop, and integrate Open innovation as strategic tool to harmonization their technological strategies with business strategies. Finally, Tesla should plan for a development stage, which is the continuous integration and implementation of open innovation into an ongoing strategic planning process. Additional research can be conducted on how Tesla can effectively integrate this open innovation into its business process and organizational changes are required.

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