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IP STRATEGY IN COMPLEX PRODUCT SYSTEMS: THE TESLA CASE

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ABSTRACT

IP Strategy and Management is a fundamental tool a company can exploit in order to establish market dominance and a long lasting and sustainable competitive advantage. Over the years, the tendency has been to construct a scaled and diversified patent portfolio so that the rights' owners would be able to conduct their commercial activities without fearing attacks form competitors, profit from the conditions arising from the creation of a legal monopoly over its patented technology, and possibly reinvest some of the revenues into the further development of improved and new technologies.

Lately a new phenomenon has been seen to spread among big corporations: companies have started to release their intellectual property for the public use in name of the Patent Open Source Movement. The first big name of the high tech industry that has pledged its patents has been Tesla Motors Inc., the Californian electric cars developer and producers, that on June 12th 2014 has irrevocably pledged the entirety of its patent portfolio for the public use by anyone who wishes to do so, in good faith.

The official motive for this steer in the canonical patent strategy has been to promote the development of the electric vehicle technology in order to address the pressing environmental issue. Nevertheless, Tesla is highly dependent on its intellectual property, since its core and only business are electric cars and since the company lacks productive capacity and funds and its value almost entirely lies in the brand and in the technology. Hence, this thesis focuses on trying to individuate the possible real reasons that might have pushed the management of Tesla into such a drastic move.

In order to do so the analysis has been carried out on two different levels: first, the qualitative analysis on the characteristics of the company and the entire market for electric vehicles has been conducted, and secondly the quantitative analysis on Tesla's patent, and the comparison of the data and the portfolio characteristics with those of the competitors. Through the information retrieved from the analysis it has been possible to draw some conclusions on the alleged reasons that brought Tesla to the patents' factual release: the main motive might be the hope in the setting of an industry standard utilizing Tesla technology on the batteries and recharging systems, as Tesla possesses the most advanced technology on those matters. Furthermore, the company might have hoped in an establishment of a tacit non-belligerence agreement among market players to avoid costly and risky patent invalidation and infringement lawsuits. Last, the freeing of the technology might have hoped to lead to the creation of collaborative environments for the fastest development and improvement of electric vehicles with lower individual investments by the single firms.

The long term results of the release are yet to be seen, but as of today it seems that Tesla has failed in trying to convince its competitors to use its technology, competitors who seemed at all uninterested by the change in patent strategy by Tesla, despite the market welcomed the company decision enthusiastically and with positive repercussions also on the stock market.

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1 INTRODUCTION

Innovation is understood as the process by which existing knowledge and inputs are creatively and efficiently recombined to create new and valuable outputs. Innovative firms, through the creation and the effective management of a valuable patent portfolio, are able to establish a relevant and sustainable competitive advantage. Intangible assets, like patents and trademarks, often constitute a relevant contribution to the overall firms' value. Furthermore, a company which is able to innovate and anticipate the market needs effectively and to develop and ensure the ownership of valuable patents are a most likely to lead in the sector, capitalizing over the inventions.

Aside from the industry's related reasons for the innovative processes lading to the granting of a patent, social interests are to be mentioned. According to the WIPO multiple compelling reasons exist for the necessity of intellectual property protection: "First, the progress and well-being of humanity rest on its capacity to create and invent new works in the areas of technology and culture. Second, the legal protection of new creations encourages the commitment of additional resources for further innovation. Third, the promotion and protection of intellectual property spurs economic growth, creates new jobs and industries, and enhances the quality and enjoyment of life." [1]

Customarily, inventions are created with the sole purpose of monetizing through the application for the granting of a patent, consistently with the purpose of the patent system itself. Inventors are appointed a legal monopoly over the patented technology as a reward for the economical efforts employed in the innovative process leading to the patented invention, provided the publication of the invention itself which, in this way, is rendered available to the general public for the spreading of the knowledge and the further advancement of it.

The innovative process is fundamental for the development of patentable inventions, nevertheless, for the purpose of this study the focus is shifted from the creation and use of invention to the governance and the management, encompassing the analysis of the inputs, the recombination of inputs, and the output. In fact, this study is aimed at analysing the strategic management of a patent portfolio. Specifically, this paper will be concerning the shift that has been happening to an open sourcing management of patents from the canonical defensive strategies of IP management.

Everyone is aware of the open sourcing in the filed of computer software and codes, but nowadays more and more highly innovative firms are shifting towards an open approach towards Intellectual Property rights, even in hardware fields. This practice was unknown to the most, until the 12th June 2014, when Tesla Motors' CEO, Elon Musk, published a statement on the company's blog stating that from that moment onwards Tesla would release all its patents for the public use in name of the Patent Open Source Movement.

This statement immediately caught the attention of all the media exposing to the public one other example of open sourcing in patents involving a highly innovative firm in the niche field of electric car development. Nevertheless, the reasons that brought a

company like Tesla, whose market value largely depends on the intangible assets, to factually release all its IP are unknown.

The patent Open Source Movement argues that the principles of the traditional patent protection and the reasons behind it are fallible, as it believes that the current protection system might not be the best solution to protect the inventors, incentivize innovation and lead to benefit of the citizens. The supporters of the Open Source Movement believe that in opening the patents for public use in good faith will not only allow faster and more efficient technological developments, but also, will result in economic benefits and in the creation of a strong market position and competitive advantage, despite the traditional reasoning stating the exact opposite [2].

The scope of this investigation is to understand the reasons behind the choice by Tesla of factually releasing their patents, in order to do so, Tesla's and Tesla's competitors' patent portfolios will be analysed statistically and research will be carried out. In doing so, the value of the patent portfolios will be assessed, and an assessment of the technology status will be possible. The position of Tesla's portfolio in the landscape of the technologies is investigated.

Initially the event has been researched in order to understand the significance of Tesla's Pledge and the market segment has been analysed in order to understand the market dynamics including demand, forecast, market shares and status of the technology. Afterwards, the possible implications, consequences and reasons behind this decision by Tesla will be studied through the analysis of the company's patent portfolio and the competitors' ones, on both quantitative and qualitative levels.

The paper will be divided in five main sections. The first section will be a theoretical recapitulation of Intellectual Property management and Intellectual Property strategy in highly complex product systems. Secondly will follow a chapter on the electric vehicles market, including the identification of the characteristics of the market demand and supply, the major market players and the development of the market around the world. The third chapter will be focused on Tesla Motors, including a short introduction of the company, its positioning strategy on the market and the characteristics of the company's intellectual property, including Tesla's Patent Pledge statement possible motives and implications. The fourth section will be the quantitative analysis of the patent portfolios of the electric vehicles producers, firstly with the analysis of Tesla's portfolio. Will follow, as the fifth part of the paper, the specular analysis of the competitors' portfolios. Lastly the result of the quantitative analysis will be interpreted and the conclusions of the study will be stated.

2 IP STRATEGY AND MANAGEMENT

Intellectual property rights can help a company gain competitive advantage in number of ways: they can provide a temporary technological lead rendering the owning firm the incumbent in the market, they can protect brand names and can help form an industry standard. Combinations of patents and trademarks can help to sustain IP-based competitive advantages.

The development of an effective patent strategy is an effort involving, not only the legal or the R&D departments, but rather it is a combined effort towards an integrated approach of Intellectual Property Strategy development and Management of a Patent Portfolio.

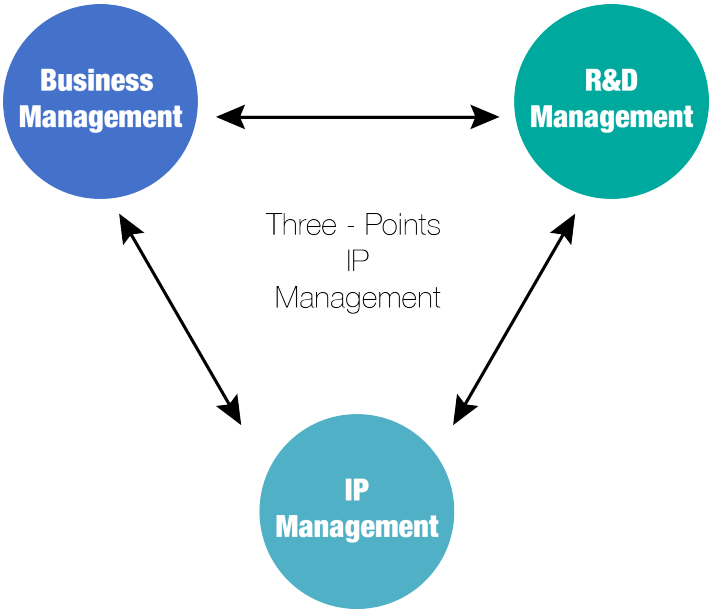

Figure 1 – Three - Points IP Management

Every major dimension of the company management shall be involved in the definition of the most appropriate and, hence, successful patent strategy.

Patent strategies in fact are successfully developed when a number of factors are taken into consideration. Among those the company market focus, the short term and long term objectives, the position occupied in the market, the competitors' situation, the investment in R&D and the current returns on said investments and the lifecycle of the technology.

Furthermore, as will be later discussed in details, the development of an IP strategy of an adequate and consistent patent portfolio is not a one-time effort, but rather a continuous process that is required to be reviewed and re-discussed periodically according to the changes that might occur, both internal and external to the company.

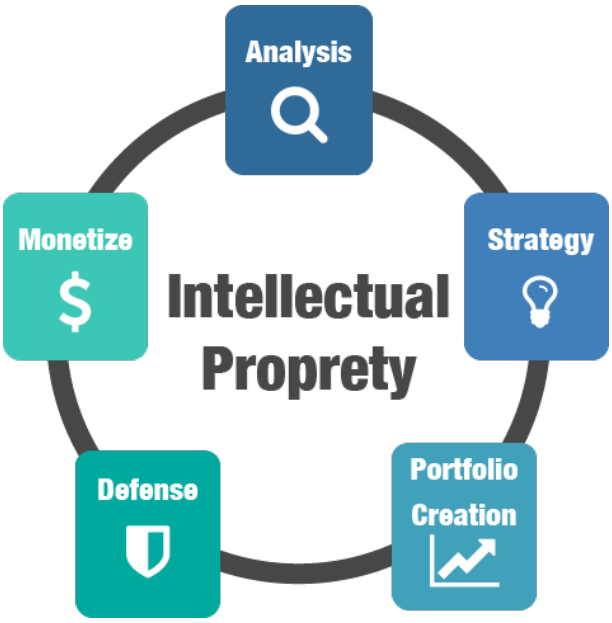

Figure 2 – IP Features

2.1 PATENT STRATEGIES

Patents are now less important than ever as a source of information for innovation, rather they provide information about patenting behavior [3].

Figure 3 – IP Strategy

The use of patents to enjoy a short-term technological lead is the best-known way to create competitive advantage through the ownership of IP rights, but it is becoming less and less important due to the fast pace of technological development that causes patents and technologies to become obsolete in a shorter time span. Certainly more appealing to a company owning relevant patents in a specific technology, is to impose one's technology as an industry standard, and hence render one's patent indispensable.

Of course, timing on matters of IP decisions is probably the most relevant among the decisions that shall be taken in IP management: the key trade-off lies between the disclosure of technical knowledge and the assurance of early protection through patents. Products characterized by short life cycles might generate most of their returns before the granting of the patent, additionally, if such products are copied and their intellectual property infringed, patent holders struggle when attempting to claim their real economic loss in courts. Hence, secrecy in those cases might be more effectives in short-cycled products [4].

From the general knowledge of market strategy, it is known that incumbency advantages can result form economies of scale, cumulative investment in a technology, consumer loyalty and switching costs. What is perhaps less known is that companies might resort to IP rights to obtain incumbency advantages: increasing the level and concentration of incumbents' patenting has the effect of discouraging the founding of new businesses and to enhance incumbency advantages, particularly in human application sectors of the industry where development and approval processes are more expensive and time-consuming. Furthermore, companies can employ IP rights to increase switching costs. One effect of established standards is that subsequently developed complementary technology is often designed to be standard-compatible; hence the raise in switching costs. Furthermore, on an optimal case scenario, incumbency advantages might be translated into entry barriers for possible new entrants [4].

One must also remember the power that might arise from the proper management of a strong distinctive and protected trademark. Hence patenting is not only to be seen as a matter of technical dominance but also of marketing and brand promotion.

The original purpose behind the establishment of the patent system was the temporary protection of a company's technological knowledge base, for that purpose a patent was simply understood as a legal mean to prevent imitation by competitors, and to ensure returns from the R&D investments employed in the development of the technology itself, and hence provide an incentive to increase the efforts in developing new and innovative technologies. Under a strategy related point of view, patents are an instrument for securing the company's technological space against competitors and prevent their future expansions by securing one's ownership over the technology. Patents have also started to be used as an asset in the establishment of collaborations, to generate licensing revenues or to gain improved access over capital markets, as an indicator of a sound technological basis, particularly when considering start-up companies, or as a performance indicator.

Companies need to be taking a subtler and strategically aligned approach to their IP. Yet given the fragmented governance structure for IP in most organizations, with responsibilities spread across legal, R&D, operations, and individual divisions, consistency of IP strategic intent is hard to achieve.

Inconsistencies in IP strategies can pose a significant risk. Consider Kodak: the company turned to aggressive licensing to stem losses and help finance its digital transformation away from film. While that value-extraction strategy provided short-term relief, between 2003 and 2010, Kodak generated more than $3 billion in IP revenue, it may have

undermined its long-term strategy, which depended on forging partnerships with the very companies it was accusing of patent infringement. In the language of our strategic-intent framework, Kodak's desire to create long-term relationships was out of sync with its short-term value-extracting activities. Then-CEO Antonio Perez acknowledged this contradiction in the Wall Street Journal in 2010. In 2012, Kodak sought bankruptcy protection.

Given the growing strategic importance of IP, it is essential that business leaders rethink their approach, seeking to avoid the perils of inconsistency and chart a subtler course to enhanced competitive advantage between the extremes of sue and share.

However, multiple additional reasons for patenting can be found. Arundel and Patel individuated two main classifications for strategic patenting reasons, dividing them into defensive and offensive strategies [5].

Defensive patenting strategy dictates that patents be taken out so that others do not use their patents to prevent working in an area. The greater the patenting of others, the greater the perceived need for defensive patents.

Defensive patent strategies with the purpose of stopping competitors from patenting one of its products and then in turn suing them for infringement, even in case the company does not necessarily required to patent the invention to earn investment returns. Defensive strategies might be chosen with the purpose of generating revenues from licensing and trading with other firms, as stated by Hall and Ziendonis the use of patents for negotiations is one of the main reasons for patenting [6].

Under the defensive patent theory competing firms use patents as a bargaining chip to negotiate with competitors an, most importantly to secure determined technology niches in the market.

The defensive patent strategy is based on the assumption that strong patent rights to make the threat of patent litigation significant and therefore a sufficient deterrent for infringement. In this way, even though patents themselves have not become any more valuable, in the sense of appropriating returns to research and development, they have somehow become more valuable as the subject matter of potential litigation. Thus, the defensive patenting theory holds that firms acquire patents to ward off possible lawsuits by using the patents as bargaining chips with potential plaintiffs.

Despite having logical grounds the defensive patent strategy can be criticized on two grounds. First, this theory focuses on only the defensive uses of patents, while ignoring the important offensive uses conferred with patent rights, as it does not consider patents as an effective means for return from the inventive activity. Second, the defensive patenting theory does not consider the variability associated to the patent portfolio composition, and this is a fundamental omission as the defensive force of patents critically depends not simply on the number of patents, but also on the design of the patentee's portfolio.

Offensive strategies are those aimed at preventing others from patenting in the same technical filed or competing products similar to the patented one; this is accomplished by

filing a considerable amount of applications, even in cases where the patented inventions are not aimed at commercialization or licensing, it is in fact often the case that some patents are filed regardless of their value and are in fact exclusively used to build a fence around the more valuable invention.

2.2 PATENT PORTFOLIO MANAGEMENT

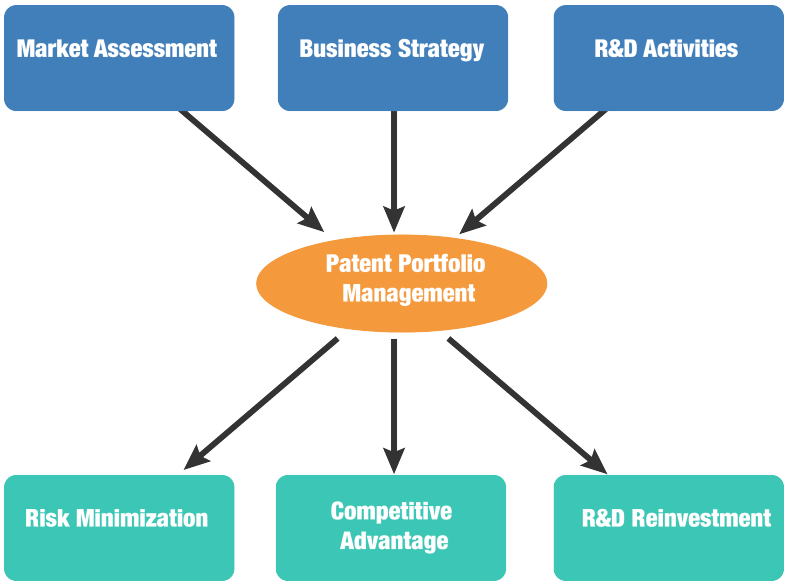

Figure 4 – Patent Portfolio Management

How to construct an optimal patent portfolio is a task that requires for large efforts, as many considerations are to be made in determining the optimal size of a company's portfolio and its composition, and will therefore vary depending on the company. The size of the portfolio shall vary according to the size and scope of the firm, that means that not every idea is worth patenting or should be patented and might be better to be kept as trade secret. Obviously, as size increases, each patent and patent decision will become growingly less and less important.

Portfolio size can be roughly assessed through the amount of R&D spending. Firstly considering the patent intensity per R&D expenditure, it can be estimated that for every $1.3 million in R&D expenditure, U.S. companies file one patent application [7]. Secondly, considering R&D spending, it can be estimated that the smaller the company is the greater will be R&D spending as a proportion of revenue, meaning that the more a small company invests in R&D the greater should the amount of filings.

The size of the portfolio will of course depend on the size of the company, the industry and the commercialised products. Noel and Schankerman [8] stated that a larger portfolio translates into an enhanced bargaining power of the company, as it is often the case that companied assess the value of the company in situations of negotiations about mergers, license contracts, or research co-operations also through the evaluation of the research efforts and results of their counterparts, which is mainly measured in the number of patents in the companies' portfolio.

Once reaching an adequate risk minimizing size of the patent portfolio, the remaining risks will primarily consist in broader industry risks depending on external factors such as economy, demand, consumer confidence and unforeseeable shifts in technologies.

Two additional factors in determining the company's optimal patent portfolio are scale and diversity.

In a patent portfolio, scale is the effective total filing over a subject matter, which includes applications and issued patents in all countries [7]. The aggregation of a number of related patents allows the scale-feature of patent portfolios and provides patent portfolios' holders to realize true "patent power" in the modern marketplace, which would be impossible through the ownership of individual patents alone.* The scale-features of portfolios spring from the observation that a well-conceived patent portfolio is in many ways a form of "super-patent," sharing many of the marketplace advantages conventionally attributed to individual patents, which can be summarised in the ability to exclude others from marketplace.

Scale enables market and category leadership, which in turn is a driver of profitability by providing the possibility of excluding others on several related patents. Furthermore, a well constructed and scaled patent portfolio, operates as a defensive tool against the risk litigations: a company holding multiple and strong patents in a technological filed, possesses the possibility of counterclaiming when one of its patents it attached, hence discouraging holders of a patent portfolio of a modest quality to attach it in the first place. Closely connected to the matter, a properly scaled portfolio is to be thought as an offensive weapon, as well as a defensive one, as it works as an entrance deterrent.

The broader protection conferred by patent portfolios offers a range of benefits to the holder different in kind as well as size from a simple collection of unrelated individual patents. Among those, the following can be found:

- Eases Subsequent In-House Innovation, as a broad patent portfolio allows a company to proceed along their chosen innovation path more confidently. The broad protection provided by the portfolio, the wider the technological possibilities that can be explored by subsequent R&D from the company without fearing third parties' patents infringement. This freedom is growingly seen as a crucial advantage, in a marketplace where speed and flexibility are imperative conditions for the survival of a company [9].
- Attracts Related External Innovations, a strong patent portfolio is a signalling tool for the market and can allow the company to hold a relevant position in their characterizing field, which in turns attracts possible collaborations of other market players, hence widening the effective accessible pool of patents available to the company [9].
- Avoids Costly Litigation, as a scaled portfolio with a broad sweep of exclusivity in a particular field reduces the probability of an involvement in a patent litigation. This is a double feature, both in case the portfolio holder is the infringer or the defender. In case where the portfolio holder is the alleged infringer, it is likely that he will have a cognizable counterclaim based on one or more of its own patents is relevantly higher, especially if the patent portfolio in

question covers a significant portion of the technological landscape, which encourages settlement rather than litigation. While in case the portfolio holder believes that another has infringed, the broader total scope of protection created by the portfolio will increase the chances that infringement will ultimately be proven, thus encouraging settlement likewise the previous case. Furthermore, where multiple portfolio holders operate in a particular field, the greatly increased stakes, and increased chances that both parties would be found liable, will diminish the appeal of litigation as a method of dispute resolution [9].

- Improves Bargaining Position. It is immediately understandable how holding a significant patent portfolio can improve the holder's bargaining position along several dimensions. Firstly, the high number of possibly successful claims, offer a powerful leveraging tool that can improve the holder's position with respect to competitors, particularly when this allows the establishment of a competitive advantage over the marketplace [9].
- Improves Defensive Positions, as patent portfolios serve to dissuade litigation and threats by others in the field, because of the threat, real or implied, of retaliatory litigation [9].

As previously mentioned, an all-in patent strategy might not necessarily be the most effective in order to construct a strong and strategically powerful patent portfolio: while the scale-features of patent portfolios abstract away from their underlying structure, the diversity-features embrace it, meaning that the diversity-features of patent portfolios reflect their status as the purposeful combination of distinct-but-related individual patents. The inherent diversity created by the aggregation of many different patents offers holders a range of benefits, such as the ability to address the risk and uncertainty fundamental to innovation, that cannot be easily achieved absent the creation of such structures.

Diversification over a number of diverse areas might prove useful to the extent it is able to reduce the risk associated to the different patents. Similarly to financial assets, a diversified patent portfolio should be composed of patents that will have different reactions form the same event, such as a change in demand or the introduction of a disruptive technology in the product area. This is of course not necessarily ensure a warranty against losses, but overall it might be a way to minimize long-term risks. Nevertheless, focus must be kept on the core business of the company even when attempting to diversify the patent portfolio, as too much diversification might lead to losing scale and power over the technical field. However, a properly diversified and scaled portfolio can be a powerful tool to achieve corporate success and market power. The categories represented in the patent portfolio shall align with the company's core businesses and the long term corporate strategy of the company. As such, executives and senior management shall be involved in the decisional process towards the shaping of the diversification strategy, as not only current technologies, but also future developments shall be considered for the profitability of the company.

The diversity-effects of patent portfolios mean that, among other benefits, holders can effectively address future uncertainties related to technological development, market

conditions, and competitor moves by offering a much broader array of protected subject matter; expand the scope of the research and development inquiry into areas adjacent to the main path of research, thus maximizing technological opportunity; and increase the long-term predictability of and confidence in holders' exclusionary rights by minimizing the consequences of many of the current uncertainties inherent in the patent law itself.

- Diversity-effects can be listed in the followings, among others:
- Addresses Ex Ante Uncertainty Related to Technology. Patent portfolios can help ameliorate some of the uncertainty related to the development of new technologies by allowing holders to secure protections along a broader swath of the technological-development path than would be possible with individual patents alone [9].
- Expands the Freedom of Research Inquiry. Diversified patent portfolios allow holders to expand the scope of their research and development efforts, while protected by the patent fence created through the portfolio. That is, the diverse nature of a patent portfolio allows researchers can freely move into distinct-but-related fields of inquiry with the assurance that patent protection is available [9].
- Addresses Uncertainty Related to Future Competitors and Uncertain Future Market Conditions. Uncertainty about the future can be offset by a well constructed patent portfolio, as it can reduce the variability of the market and can also hedge against future moves by one's competitors in the marketplace. [9]

Once an optimal portfolio has been created it must be periodically reviewed and rebalanced: the patent portfolio must accommodate the company's needs and the expected useful life of a certain technology or patent. At a certain point in time some patents that at the beginning of their life were of pivotal importance with respect to the company's needs and technical advancement of the technology might become obsolete and their renewal might be useless and a wasteful employment of money that might be redirected to other purposes: a patent life might be cut short of the 20 years life span possibility provided by the law. A patent will be maintained by investing resources in paying the renewal fees only if it is in the best interest of the portfolio, particularly if the patent covers a product in the early or middle stages of its lifecycle. New technologies often require multiple filing of applications in order to keep up with the changes and subsequent developments of said technology, in order to also track market changes.

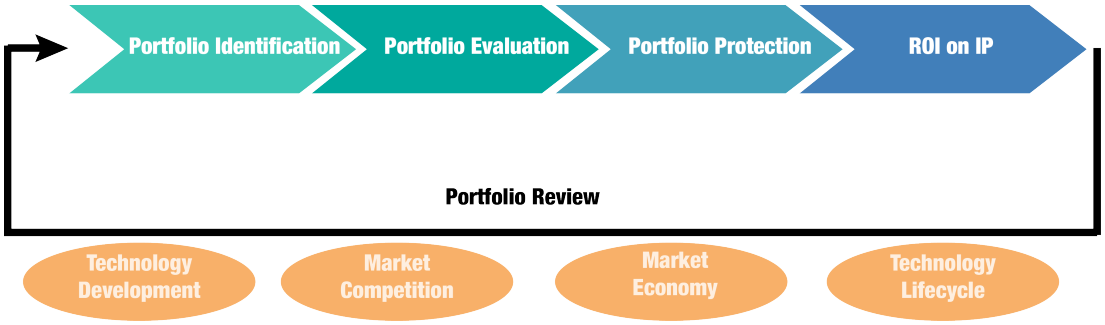

Figure 5 – Patent Portfolio Lifecycle

Furthermore, to review and rebalance the portfolio's composition, the company should assess its competitive position on the industries' segments and categories in order to

identify its strengths and current and potential market leadership areas, and those where it does not possess market power and leadership. The portfolio shall be analysed in order to understand which patents and their combinations provide the most scale in terms of additional value or investments' return. The portfolio shall be also analysed in view of assessing the extent of the competitive use of the patents composing it and their sub-combinations. Through the collected information, the technological areas with larger growth potential and competitiveness over the market shall be identified and the possible strategies to achieve said potential and category leadership developed. All this shall the carried out whilst keeping in mind scale and diversity, that must be maintained even when re-shaping the portfolio's characteristics.

Timing is of foremost importance when managing patent fling and patent management. Late entry might signify significant devaluation of the patent due to the limited coverage subsequent to the already widely exploited prior art; while early entry might provide the applicant with legal monopoly situations, capable of translating into large gains both of a monetary level and on the competitive advantage over competitors in the same technological field. Nevertheless, timing is crucial also in assessing when to quit sustaining patents and when deciding when to cease to maintain said patent.

2.3 PATENT PORTFOLIO VALUE

A well constructed and managed patent portfolio could signify relevant returns and a large contribution over a corporation's overall value, one famous example is the case of Motorola's acquisition and their patents by Google for 12.5$ billion. In some relevant cases the comparison might be drawn between the patent portfolios and other investment portfolios, and as such the canonical rules of investing can be applicable: asset allocation, scale, diversification, and so on and so forth.

The value a single patent has for its patentee is not observable. The actual true value of patent ownerships derives from their aggregation into a patent portfolio, meaning the collective value deriving form the aggregation of those patents and not merely the value brought by the individual patents. This consideration can be explained through the principle of risk spreading, that, much like for risk spreading in investment portfolios, is distributed among many patents and therefore the decrease of dependency on the single inventions.

Obviously, holding several patents in one technology provides the company with control over the market and allows a direct influence over the markets relying on said technology. It can therefore be said that a good patent portfolio is a tool for technology development and innovation, while also enabling market power and minimising risk.

It is therefore obvious how a strong portfolio empowers the company on an industry-wide level, as it allows the company to have influence on the industry decisions and the possibility of setting standards. Broad protection of a subject matter, a derivative of scale, increases bargaining power in licensing and monetization of the patent portfolio and will enable a company to wield significant market influence.

Patent value is reflected in the number of times the patent is cited, the length of its renewal, or the number of countries where it is extended.
As already stated, the most significant indication of the value of a patent is the quantity and distribution of citations: patents with high economic value are cited more than those, which are considered to be low-valued.
There are multiple algorithms to assess the value of a patent; a possible one is based upon three parameters:

1. Costs reduction associated to the patent [R]:1 stands for 10% cost reduction, 2 for 20%, 3 for 30%, and so on and so forth;

2. Competitors interest in the invention described in the patent [I]: 1 for low interest, 5 for medium interest in case the technology is also used by the competitors, and 9 for high interest in case the patent would prevent the competitor from improve their own patents;

3. Validity of a patent [V]: this parameter values 1 if the Search Report is negative, 3 in the Search Report is positive, 5 in the patent has been granted in the US or in Europe, 9 if the patent has been granted both in the US and in Europe.

The value of the patent is then calculated multiplying those factors:

$$R * I * V = \text{Patent Value}$$

This assessment of the value of the patent has to be updated every time a parameter changes, which is likely to happen in case the procedure status of the patent changes, e.g. from application to granted, or after a competitor action, or when the disadvantages overcome the advantages in owning legal rights over an invention. Obviously the applicant needs to fix a priori a minimum value below which it will be necessary to decide whether to pursue with the payment of the fees to keep the patent valid, or not. The decision on the minimum value has to be made according to the economic resources of the applicant, and to the importance the patent might have on the profits of the firm.

Another relevant fact that it is possible to infer from this simple way to measure the value of a patent, is that the last is very likely to vary with time: a patent that was initially worth a lot of consideration, after just a couple of months from the publication may become irrelevant in the field, especially in fast expanding sector.

Citations can be used in assessing the value of a single patent. The patent applicant may suggest patents that should be included as references, but is the examiner that makes the ultimate decision on what patents will be included as references to the prior art related to the submitted application Hence, references to patents in the prior art marks the boundaries of patentability and the basis the invention builds on, as they function as reference for the assessment of patentability, according to the requirements of novelty and inventive activity. This implies that the number of citations received (forward citations) play a similar role to that of references in scientific publications as an indicator for the importance of the patent. However, citations can also point to further technological development and a possible depreciation of the invention.

In addition to the number of citations, incidence of oppositions is also a positive value indicator. Opposition is the first dispute about the validity of a granted patent. Any third party can file an opposition within 9 months after a patent has been granted when there are reasons such as doubts as to novelty, doubts over a sufficient inventive step or when there might be pre-granting use of the invention prior to the patent application. The procedure is relatively cheap compared to a litigation procedure. However, there is no direct communication between the patentee and the opponent. This is different to a litigation procedure at a civil court. The rationale behind opposition is that the expected value of the protected invention is so high that it is worthwhile for competitors to oppose the patent in order to prevent or restrict the patentee's intellectual property right. Expected innovation rents for patents that withstood opposition procedures either amended or unchanged are proved to be higher than for non-opposed patents [10]. "On the one hand, a higher expected value of a patent attracts more interest from those who would wish to exploit that value. On the other hand, a patent that has faced and survived opposition becomes more valuable because survival indicates a stronger patent right." [11]. Oppositions can be interpreted as a signal from potential or actual competitors, it indicates that the value of the patent has been perceived and recognized by the relevant actors. The result of those oppositions can be a rejection of the opposition or an amendment of the patent, both of which are considered to improve the quality of the patent, while amendments in the sense of restrictions to the original claims are also regarded as a quality check [12].

Additional indicators can be found in the literature for the assessment of the value of the patent, among those references, family size [13], number of claims and routes of patent protection can be found.

The fundamental argument is that the real value of patents lies not in their individual significance, but instead in their aggregation into a patent portfolio: a strategic collection of distinct-but-related individual patents that, when combined, confer an array of important advantages upon the portfolio holder. Patent portfolio's benefits are substantial enough to encourage patenting behavior irrespectively on the expected value of the underlying individual patents themselves; the marginal expected gain in value of adding an additional patent to a well-crafted patent portfolio will almost invariably exceed the marginal cost of acquisition.

3 MARKET ANALYSIS

This chapter will, first of all, attempt to provide a short introduction of the technology under consideration in this paper. Will follow a section on the consumer attitudes and the motivation for the adoption and purchasing intentions, together with a section picturing the current status of the market penetration and the market sales, providing some relevant figures for the major geographical markets and the higher-selling automakers. Lastly a short introduction will be given regarding the major market players in regard to the development and commercialization of electric vehicles.

This section will allow have a general idea on the market dynamics, picturing which are the overall strengths and weaknesses of the market, the resistances towards a wider consumer base and faster adoption rate and who are the contenders for the lead in the market.

Generally speaking, the development of electric vehicles' technology has always required substantial capital investments, in research and development, patent filing and management, prototyping and marketing operations. The market for electric vehicles has been existing for several years now, yet cannot be considered a secure and fully developed one: more and more car producers started the production of electric vehicles, but only few have heavily invested in the production of EVs to actually gain a relevant position on the market, the technology still not fully mature and the market penetration of the product is still too low, with not irrelevant resistance to the adoption by the largest consumers base, despite the appreciable benefits that might come from the purchase of electric cars, both economically and socially.

3.1 ELECTRIC VEHICLE TECHNOLOGY

Conventional internal combustion engines vehicles burn petroleum based fuels, with generally low inefficiencies and emit a significant amount of greenhouse gases. There are two basic categories of electric vehicles—electric vehicles (BEVs), which run solely on the electric energy stored in the battery, and plug-in hybrid electric vehicles (PHEVs), which operate on both a rechargeable battery and a gasoline-powered engine.

Despite the general understanding of electric vehicles technology as one of the newest technologies introduced in the attempt to reduce the world dependence on oil, BEVs have existed since the birth of the American automobile industry. In fact, at the dawn of the twentieth century, consumers could choose between three different propulsion technologies: a steam powered internal combustion engine, which was fast and inexpensive, but required a long time to start and had to be refilled with water every few miles; a gasoline powered engine, which was dirtier, even more difficult to start, but could travel long distances quickly and without refuelling; and a vehicle with an electric motor, which was quiet and clean, but slow and expensive.

A plug-in hybrid electric vehicle (PHEV), plug-in hybrid vehicle (PHV), or plug-in hybrid is a hybrid electric vehicle which utilizes rechargeable batteries, or another energy storage device, that can be restored to full charge by connecting a plug to an external electric

power source. A PHEV shares the characteristics of both a conventional hybrid electric vehicle, having an electric motor and an internal combustion engine; and of an all-electric vehicle, having a plug to connect to the electrical grid. Unlike BEVs, when its battery is depleted, a PHEV is capable of running on a small conventional motor. Hence, consumers' range anxiety is substantially reduced [14], and offer the higher fuel efficiency of EVs within the all-electric range, but also the flexibility of conventional fuels for extended trips. Electric Cars use the energy stored in a battery (or series of batteries) for vehicle propulsion.

Very briefly, a battery electric vehicle (BEV) is a type of electric vehicle (EV) that uses chemical energy stored in rechargeable battery packs. BEVs use electric motors and motor controllers instead of internal combustion engines for propulsion. A battery-only electric vehicle or all-electric vehicle derives all its power from its battery packs and thus has no internal combustion engine, fuel cell, or fuel tank. Electric cars have traditionally used series wound DC motors, a form of brushed DC electric motor. Separately excited and permanent magnet are just two of the types of DC motors available. More recent electric vehicles have made use of a variety of AC motor types, as these are simpler to build and have no brushes that can wear out. These are usually induction motors or brushless AC electric motors which use permanent magnets. There are several variations of the permanent magnet motor which offer simpler drive schemes and/or lower cost including the brushless DC electric motor.

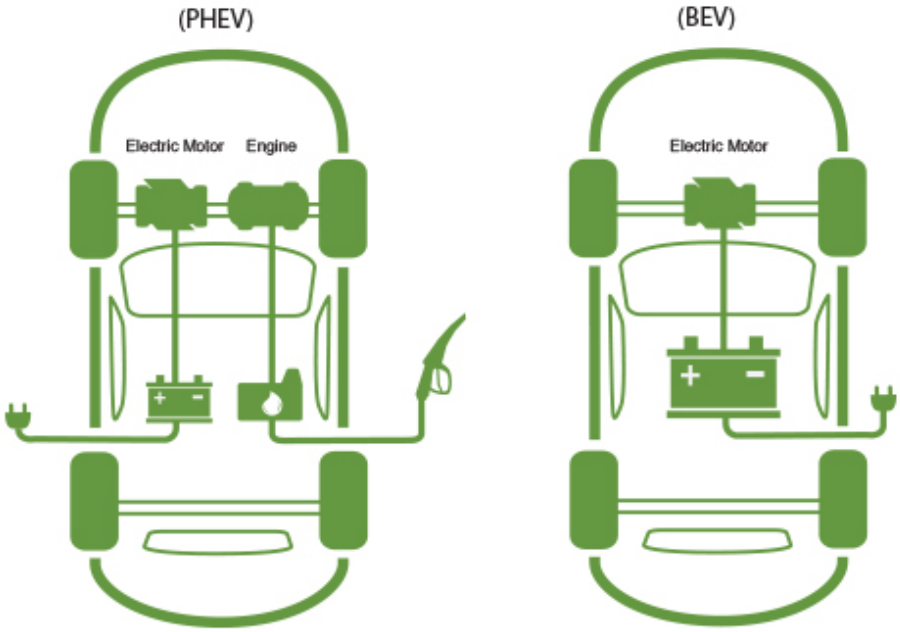

Figure 6 – Electric Vehicles (from https://www.sce.com)

Follow two brief schemes that summarize the advantages and disadvantages arising from the ownership of an electric vehicle, when compared to standard internal combustion engine cars, which might be considered when considering to switch from the conventional vehicles to a battery based car.

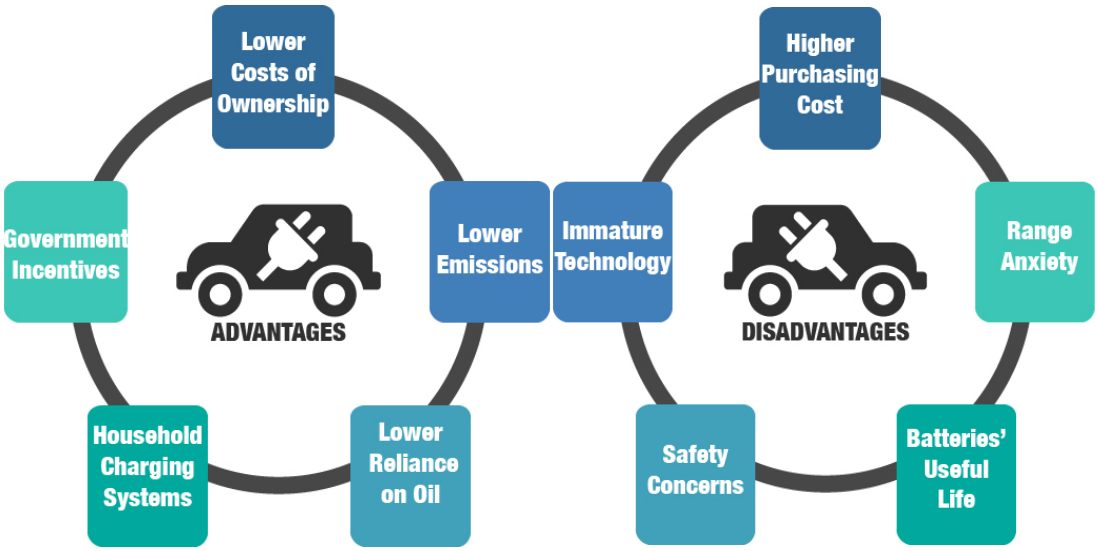

Figure 7 – Advantages and Disadvantages of Electric Vehicles

3.2 CONSUMER ATTITUDES

Consumers purchase cars based on how they value multiple attributes. They care about performance, aesthetics, reliability, and many other features: cost is an important consideration, but not the only one. Electric vehicle manufacturers have worked hard to ensure that electric cars are comparable over a wide range of attributes, but most BEVs are still plagued by relatively limited range, and consumers remain worried about the reliability of both BEVs and PHEVs with respect to conventional vehicles. The latter problem will gradually disappear as consumers become more accustomed to electric cars, but range anxiety is likely to remain until battery technology either substantially improve or until a capillary charging network exists, for all vehicles, regardless of the manufacturer. One can argue that such anxiety is irrational, since urban drivers, on average, drive less than 30 kilometres per day, but consumers do not solely base their car purchases on rational calculation: the bottom line is that the range issue will significantly affect consumer choice and is a major barrier to the penetration of electric vehicles [15].

Although electric cars meet the same needs as traditional cars from a marketing perspective, they should be considered a new market rather than the evolution of a mature product. This novelty is perceived by consumers due to the many innovative and unique features of electric cars. Consumers of these types of products are willing to accept the challenge of novelty, and they share the particular quality of "venturesomeness" (i.e. accepting hazard or risk) [16].

Electric vehicle perception, particularly because of the technical shortcomings when compared to traditional internal combustion engines, is fundamental in order to draw consumers to the purchase of a battery-powered car. Hence, public attitudes and preferences shall be considered when developing market preferences and increasing product and brand awareness. Consumer acceptance is obviously crucial for the continuous development of the EV technology and adoption, however consumers still tend to be resistant to the change towards battery powered vehicles due to the issues of

short battery life, low availability of charging stations and generally because of the scarce trust and willingness of consumers to switch to a new product.

Some of the most common barriers to the adoption of the new technology are the lack of knowledge by potential adopters, high initial costs and low risk tolerance [17].

One of the major deterrents for the consumers from purchasing an electric vehicle is the relatively low autonomy of the batteries powering the EVs. The battery range limits the distance an EV can travel on an all- electric range and on a single charge. The range issue has the greatest impact on EVs, which do not have the flexibility of fuel source like HEVs and PHEVs and therefore may require charging en route during long trips that exceed the range of the batteries. Consequently, there is also a need for EV charging infrastructure to charge EVs during trips, which is another major issue. To power an electric vehicle, consumers must have the ability to connect their vehicle to a source of electricity, the utility must have the capacity to transmit and distribute this additional power and sufficient electricity generation capacity must exist. If the private sector is unable to promptly provide charging equipment, distribution capacity, and electricity generation the adoption will be further slowed. Despite the domestic charging equipment might not be considered expensive, to construct a capillary and sufficient network of charging stations around the world, particularly in vast and desolated areas like the deserts across the United States, might become an excessive burden upon a single manufacturer, that might employ substantial resources in constructing an infrastructure that might not generate sufficient returns to justify the initial investment.

Furthermore, studies show that that consumer acceptance of EVs is limited partly due to perceived risks with new products and trade-offs between vehicle fuel efficiency, size and price [18]. Nevertheless, due to the high pace of technical development those shortcomings are gradually being reduced and, also thanks to governmental regulations and incentives, more and more consumers are contemplating the option of purchasing EV, or at least HEV.

Regarding financial benefits, consumers tend to maximise their utility based on their preferences, alternatives and budget: under this point of view a considerable deterrent for the purchase of EV is the relevantly higher purchasing cost, with respect to the cheaper gasoline powered option, which is mainly due to the significant costs for the battery. On the other hand, the cost associated to fuel, during the useful life of the car, are estimated to be considerably lower due to the lower cost for electricity and the relevant cost for gasoline, Gallagher and Muehlegger found that consumers usually make the decision to buy HEVs in response to increase in gas prices and government incentives [19]. Cost of ownership is estimated to be lower for BEVs and peaking with the cost of ownership for a convectional internal combustion engine cars, with PHEVs ranking second [20].

Non-financial reasons are those associated to environmental issues, hence those associated to the social benefits and externalities associated to the reduced emissions of EVs. Environmental awareness and values are powerful influence in the willingness of consumers to engage in actions protecting the environment, Heffner et al. (2007) found that, to this group of consumers, who show high levels of environmental awareness, choosing a HEV symbolizes ideas related to one's individuality and is used to

communicate interests and values [21]. Gallagher and Muehlegger found that social preferences for environmental quality and energy security were a major determinant for consumer adoption of HEVs [19]. Gallagher and Muehlegger concluded that social preferences increased HEV sales more than rising gas prices or tax incentives [19].

Historically, new technologies are attractive to few early adopters, like visionaries and technology enthusiast, while the majority of consumers will be hesitant to the adoption of said new technology. In recent times, however, there are increasing reasons to adopt EVs including rising and volatile gasoline prices, greenhouse gas emissions, increased dependence on imported petroleum, and the very high fuel economy of EVs [22].

3.3 MARKET PENETRATION

The EV sales results for 2014 in the U.S. show that 118,773 vehicles were sold as compared to 96,700 vehicles in 2013. This gives a one-year sales growth rate of 23%. The total cumulative number of EVs over the five-year sales period is now at 286,390 vehicles. Depending upon the escalation rate selected, the 10-year future U.S. sales (2024) are predicted to be from 200,000 to 2.4 million per year and the cumulative number of vehicles on the roads would be from 1.8 to 9.0 million. Comparing these results with predictions from other sources, a growth rate of 20% appears to be most appropriate. If a 20% growth rate is used, then the U.S. sales in 2024 will be 740,000 EVs per year with cumulative number of vehicles at 4.0 million [14].

Top 10 countries by PEV market share of total new car sales in 2014 and 2013			
Ranking	Country	PEV market share(%)	
		2014	2013
1	Norway	13.84%	6.10%
2	Netherlands	3.87%	5.55%
3	Iceland	2.71%	0.94%
4	Estonia	1.57%	0.73%
5	Sweden	1.53%	0.71%
6	Japan	1.06%	0.91%
7	Denmark	0.88%	0.29%
8	Switzerland	0.75%	0.44%
9	US	0.72%	0.60%
10	France	0.70%	0.83%

Table 1 – Market Penetration (from http://www.hybridcars.com)

Norway is the country with the highest market penetration per capita in the world, also the country with the largest plug-in electric segment market share of new car sales, and in March 2014 Norway became the first country where over 1 in every 100 passenger cars on the roads is a plug-in electric vehicle. According to forecasts made by Pike Research in January 2013, the United States will continue to be the largest market for PEVs in 2020, but the European market is anticipated to have a higher market penetration due to its higher gasoline prices and supportive government policies, while Japan is expected to become the largest market for hybrid electric vehicles [23].

As of December 2014, the United States has the largest fleet of highway legal plug-in electric vehicles in the world, with over 295,000 units delivered since the market launch of the Tesla Roadster in 2008, including passenger cars, utility vans and commercial trucks: American sales represented 41% of global PEV sales as of December 2014 [24].

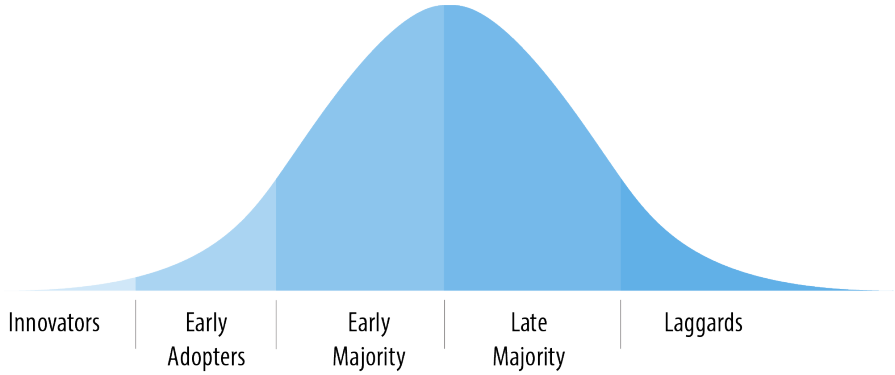

Figure 8 – Adoption Curve

When taking as reference the canonical adoption curve, it can be said that the electric vehicle market is now shifting from the "Innovators" to the "Early Adopter" stages, as awareness on the product is growing along the standard technology adoption S-curve: the average purchaser of electric vehicles is younger and wealthier than the average traditional vehicle purchaser, as is typical with all disruptive emerging innovative technologies. U.S. sales are led by California with 129,470 plug-in electric vehicles registered between December 2010 and December 2014, representing about 45% of all plug-in cars sold in the U.S. since 2010. During 2014 California's PEV market share reached 3.2% of total new car sales in the state, up from 2.5% in 2013.As of December 2014, California had more plug-in electric vehicles than any other country, and its market share is surpassed only by Norway and the Netherlands [25]. This data are symptomatic of the fervent economic and intellectual activity, and the presence of highly innovative companies, like Tesla Motors, and a great number of universities and incubators.

Early adopters are young, with high income, generally posses an electric car as second vehicle, and are concentrated where the recharging infrastructure are more readily available. Whilst the early majority, which is now purchasing the vehicles, have an higher-than-average income, weekly cover low distances by car, and are sensitive to the environmental issues, concerned about political issues and the dependence on foreign oil imports and are willing to pay a premium for convenience.

The demand for electric vehicles has been rising constantly since the introduction of EVs. The reasons shall be found in the high prices in fuels for combustion engines vehicles, and the request from consumers in the development of fuel-efficient vehicles.

On this matter, the US Department on energy has estimated that driving an electric car would lead to an average saving of 49.8% over the fuel cost [1]. Furthermore governmental incentives have certainly played a role into the reasons behind the demand.

One deterrent to the purchase of electric cars is the low kilometres range that an electric car can cover with one refuel. The chargers stations, despite being rapidly growing, still cannot guarantee long-range road trips.

Demand for electric vehicles may be affected by factors directly impacting automobile price or the cost of purchasing and operating automobiles, such as sales and financing incentives, prices of raw materials and parts and components, cost of fuel and governmental regulations, including tariffs, import regulation and other taxes. Volatility in demand may lead to lower vehicle unit sales and increased inventory, which may result in further downward price pressure and adversely affect the business, financial condition and operating results. These effects may have a more pronounced impact on a relatively smaller company like Tesla, particularly when compared to incumbents' cars manufacturers.

3.4 MARKET SALES

Different geographical markets have definite differences in the yearly sales of electric vehicles. In absolute terms the sales for the electric vehicle are still relatively low, if compared to the sales of traditional combustion engines vehicles. It is therefore obvious that electric cars' future heavily depend on a change of attitude of the average consumer looking for purchasing a new car.

Several factors may influence the adoption of electric vehicles, among those:

- Perceptions about electric vehicle quality, safety (in particular with respect to lithium-ion battery packs), design, performance and cost, especially in case adverse events or accidents occur that are linked to the quality or safety of electric vehicles;
- Negative perceptions of electric vehicles, such as that they are more expensive than non-electric vehicles and are only affordable with government subsidies;
- The limited range over which electric vehicles may be driven on a single battery charge and the effects of weather on this range, and the availability of service for electric vehicles. This is closely related to the access to charging facilities, standardization of electric vehicle charging systems and consumers' perceptions about convenience and cost to charge an electric vehicle; and the perceptions about and the actual cost of alternative fuel;
- The decline of an electric vehicle's range resulting from deterioration over time in the battery's ability to hold a charge, added to the varied calculations for driving ranges achievable by EVs, which is inherently difficult given numerous factors affecting battery range; further concerns of potential consumers are that if their

1 Data from http://energy.gov/articles/egallon-how-much-cheaper-it-drive-electricity

battery pack is not charged properly, it may become unusable and may need to be replaced;

- The consumers' desire and ability to purchase a luxury automobile or one;
- The environmental consciousness of consumer and the government regulations and economic incentives promoting fuel efficiency and alternate forms of energy as well as tax and other governmental incentives to purchase and operate electric vehicles.

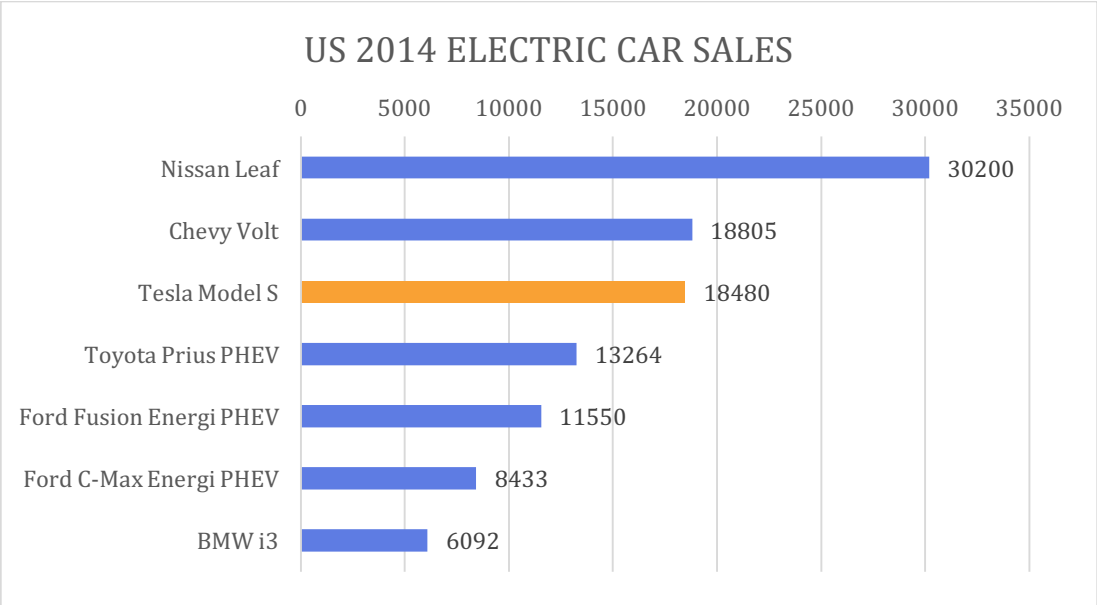

Chart 1 – US Sales for Electric Cars 2014(data from [26])

The United States is the largest electric car market in the world. Plug-in electric car sales during 2014 in the US rose above the 100,000 level, to total roughly 118,500, with an increase of approximately 27% over the previous year, it is a small percentage of the total U.S. market, and the impact of gasoline at $2.25 per gallon is yet to be determined. Moreover, 55 percent of the electric cars sold in the U.S. are plug-in hybrid electric vehicles, suggesting that consumers still do not trust the range of cars powered solely with electric [27].

In terms of winners in the U.S. market, the all-electric Nissan Leaf and range-extended Chevy Volt (which has gasoline engine back-up), are the top sellers this year, accounting for almost 50 percent of electric car sales. The Toyota Prius, Ford Fusion and Ford C-Max Energi, all PHEVs, round out the top five with another one-third of the market.

The leader in the US market is the Nissan Leaf model that substantially outmarches the second model for sales, Chevy Volt. Tesla's places in third position with almost 18,500 Model S sold in 2014.

Despite being third in the whole sales of electric cars, Tesla is the leader in the subsector of Luxury Electric Cars: Nissan Leaf and Chevy Volt are addressing a completely different consumer than Tesla. The former models sell at around 30,000US $ while Tesla's Model S' price start from 60,000 US$.

As such Tesla can be considered the leader in the subsector of the luxury electric vehicle, though feeling the pressure of the new entrants in the segment whose names recall reliability and luxury from decades, such as Volkswagen, Porsche, and Audi to name few.

Tesla is anyway witnessing growth in its sales of 19% with respect to the same data of the previous year.

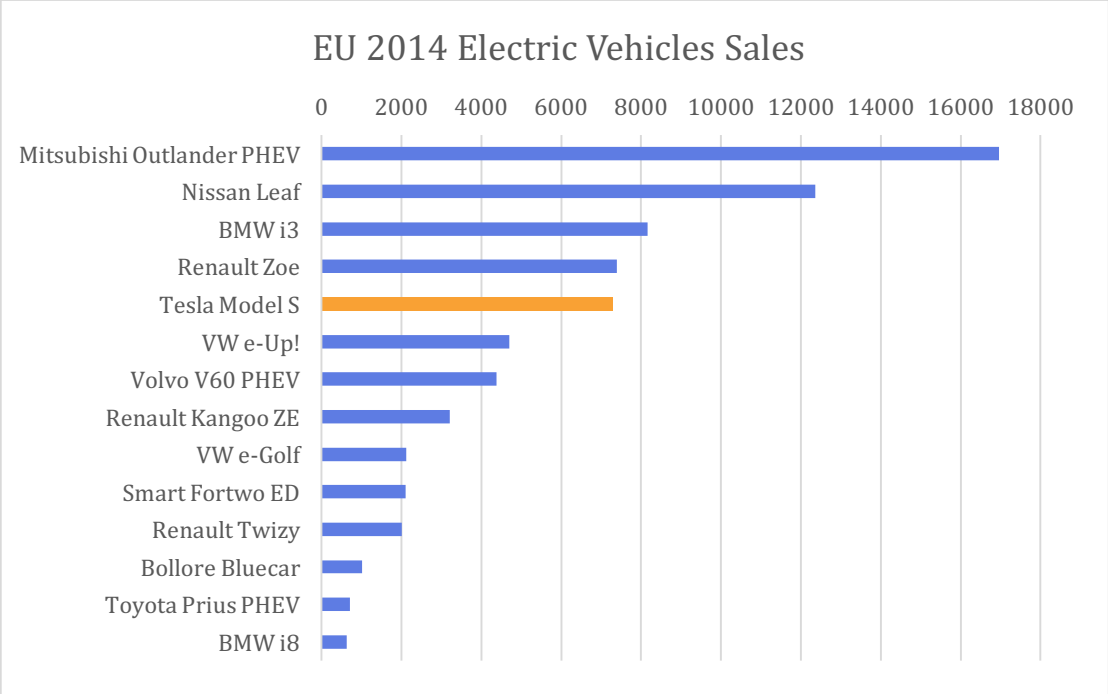

Chart 2 – European Sales for Electric Cars 2014 (data from [26])

Early adoption in Europe took off in 2013 and further expanded in 2014, hence with some lag with respect to what happened in the US or in Japan: the number of electric vehicles sold in Europe is still quite low, particularly when considering the staggering numbers of Norway setting the trend, but surely not representing the average European country in regard to the adoption of electric cars. In Europe, 72,419 electric cars were sold through October. The Mitsubishi Outlander, a PHEV, leads the way with a 23% market share, and the Nissan Leaf and BMW i3 follow with another 28 percent of the market. Currently, the uptake appears to be restricted to specific customer segments in selected countries in Europe. High costs, range anxiety, and low awareness are the most often cited barriers to EV adoption by the broader customer pool. Nevertheless, there is a sizable segment of early adopters who are willing to switch to EVs in spite of these barriers.

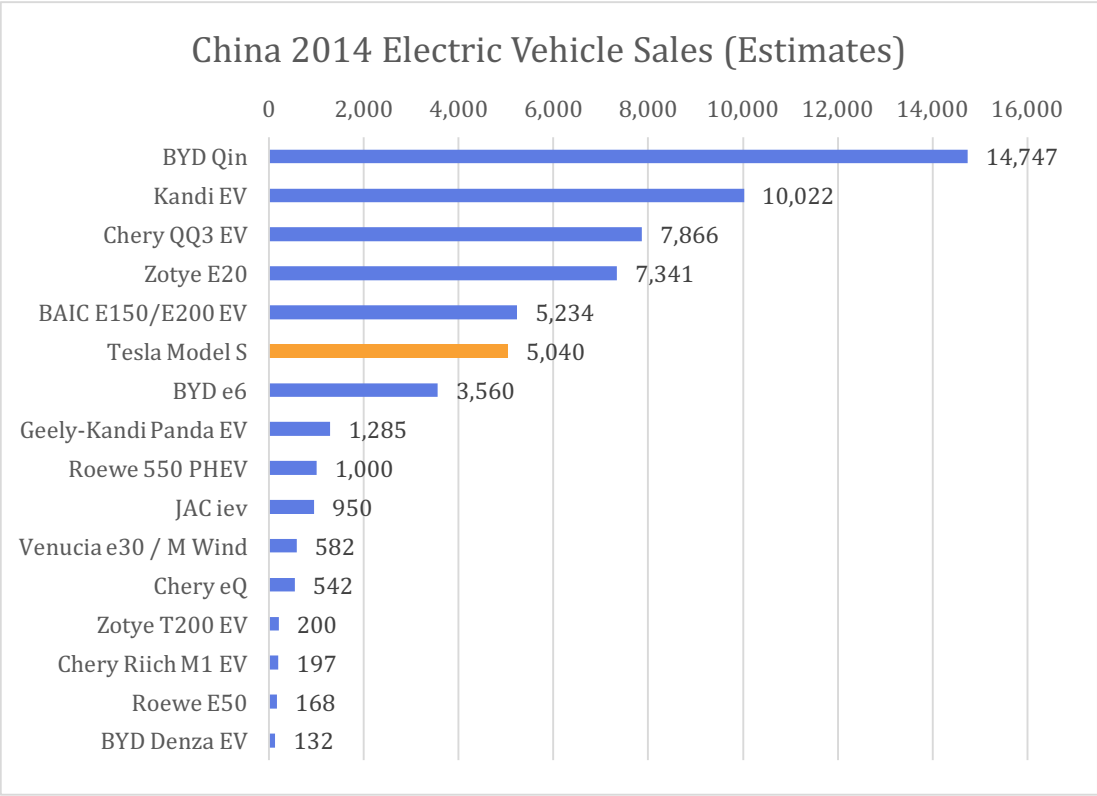

Chart 3 – Chinese Sales for Electric Cars 2014 (data from [26])

China has recently rolled out a set of measures, including tax exemptions, subsidies for car purchases, and requirements for government purchasing policies to promote the use of new energy vehicles. As a result, EV sales in September were 11,991 units and accounted for 28 percent of the total for the year. On an annualized basis, September's sales would indicate a yearly rate that is well above the sales rates in the United States and Europe [27]. Particularly relevant, in the Chinese case, is the speed of introduction of Tesla's, that entered the market in April 20014 and by the year was able to sell 5,040 vehicles. This result is even more impressive when considering that in China a Model S sedan cost start from around 680,000 RMB, approximately $110,000, according to the company's website, which is due to the heavy luxury taxes and import taxes imposed by the government. As norm in case of foreign enterprises in China, Tesla has faced significant difficulties in entry in the Chinese market, nevertheless is planning to increase the investments in the Chinese market, which is expected to be one of the largest markets in the coming years.

Of all the auto markets in the world, China may represent the single best potential opportunity for electric vehicles. China must continue to industrialize in order to provide prosperity for the hundreds of millions of its citizens that have yet to take part in the country's amazing economic development. Continued industrialization is creating an insatiable demand for energy in China, as well as high levels of air pollution in its major cities — two conditions that make a powerful case for new energy vehicles.

Nevertheless, the development of electric vehicles in China does not necessarily translate into opportunities for all producers because of the unique conditions that characterize Country may lead to the need of a different business model than those used in more

developed markets, and because of the different production and importing regulation and taxation system of the Country. As indicated by the recent success of Kandi, which sold almost 7,000 units or 56 percent of the total, in September, the China EV market appears to be developing differently than the other major auto markets in the world.

3.5 MAJOR MARKET PLAYERS

Despite being second for yearly sales, behind Nissan, it must be underlined that Tesla addresses a different consumer, producing a luxury electric car with prices starting from 70,000 US$, opposite to the significantly cheaper Nissan Leaf starting at 30,000 US$. For the purpose of the study, all the market players in the Electric Vehicles segment of the automotive industry have been included, regardless on the price segment.

The worldwide automotive market is extremely competitive and it is expected to further grow in the future. Tesla's markets luxury sedan models, and might be facing competition on his market segment from established brands in the automotive. Of those, many have declared to be about to enter the electric vehicle segment of the market. BMW, Daimler, Nissan, Fiat, Ford and Mitsubishi, among others, have electric vehicles available today. Moreover, Porsche, Lexus, Audi, Volkswagen and Volvo are also developing electric vehicles. On the side, several new start-ups have also entered or announced plans to enter the market for performance electric vehicles.

The main issue for Tesla would be that those current and potential competitors would have greater financial, technical, manufacturing, marketing and related resources compared to those available to Tesla, and as such would be able to dedicate greater resources to the design, development, manufacturing, distribution, promotion, sale and support of their products. This might mean also lower price for similar products to those offered by Tesla, and provide rapidly evolving products.

The resources are not the only advantage that Tesla's competitors might have: being well-known and globally recognised brands, they enjoy reputation and more extensive customer base and customer and industry relationships.

As demand is expected to grow within the next years, the competition is also expected to grow fiercer, and several factors will be playing in influencing the dominance on the market, such as product quality and features, innovation and development time, pricing, reliability, safety, fuel economy, customer service and financing terms. Furthermore, an increase in competition might lead to lover unit sales of the single players and in turn in an increase in inventory, which will in turn result in prices decrease, conversely affecting the already uncertain financial condition of Tesla, but affecting big and diversified brands the least.

4 TESLA MOTORS INC.

This chapter is aimed at introducing Tesla Motors. In order to picture a comprehensive image of the company several aspects will be touched, from the marketed technology to their market and financial performances, to then reach the section dedicated to the introduction of the company's statement of June 2014, when the CEO of the company, Elon Musk, officially declared that the company had decided to join the Open Source Movement by factually release their patents for the public use in good faith for the advancement of the electric vehicle technology. For the purposes clarity for the analysis it is important to try and understand what are the concrete implications for both the industry of electric cars as a whole and the same Tesla Motors in case the sought open use of the patents in good faith by developers, manufacturers and sellers.

Tesla Motors Inc. is an electric vehicle company located in Palo Alto, California. Founded in 2003 by Elon Musk, Tesla gradually grew and was able to impose itself as one of the leader companies in the design, development and manufacturing of high-performance fully electric vehicles advanced electric vehicle powertrain components and stationary energy storage systems.

Figure 9 – Tesla Motors Inc. [29]

From the US, Tesla has expanded worldwide through sales network and the Supercharger recharge stations in order to incentivise the introduction of electric vehicles in the market.

Different from traditional automobile manufacturers, Tesla is exclusively producing relatively high priced electric vehicles: currently the company provides only one model of electric car, the Tesla Model S.

Tesla's strategy has been to emulate typical technological-product life cycles and initially enter the automotive market with an expensive, high-end product targeted at affluent buyers, and as the company gains brands awareness and consumers' acceptance matured, has scaled down to increasingly more affordable products: the battery and electric powertrain technology for each new type is be developed thanks to the capital raised for through sales of the former types, starting with Tesla Roadster, which is currently no longer commercialized, and moving on to the Tesla Model S, positioning at mid-high price and corresponding expected volumes , Model X and Model 3, expected to hit high volumes at low prices vehicles.

One of Tesla's stated goals is to increase the number and variety of electric vehicles available to on the market by not only selling its own vehicles in company-owned showrooms and online, but also selling powertrain components to other automakers, and most importantly by building a strong brand image and positive product perception to foster the development of electric vehicles by other automakers and by stimulating consumers' awareness with the aim at considerably increasing the adoption of electric cars.

Since the beginning of the delivering of Model S sedans in June 2012, Tesla declared the delivering of almost 57,000 cars [28]. The company is furthermore planning to start shipments for the new Model X crossover in the third quarter of 2015. Both the models currently available for order are targeted to the high price segment of the market, with prices starting from 60,000 US$.

Being Tesla's only focus the design, engineering and development of electric vehicle, their vehicles enjoy benefits over the competitors' models. Tesla's cars offer ranges that are over double the range of any other commercially available electric vehicle, and incorporate a proprietary on-board charging system, permitting recharging from almost any available electrical outlet. Furthermore, Model S can be charged through the fast-charging system developed by Tesla itself: the Supercharger.

4.1 TESLA'S TECHNOLOGY

"Tesla's costs of maintenance and fuels are estimated to be substantially lower than the classic combustion engine cars. Cost of ownership is estimated to be lower to combustion-engines cars: assuming an average of 15,000 miles driven per year, an average electricity cost of 12.1 cents per kilowatt-hour and an average gasoline price of $2.83 per gallon over the full ownership of the vehicle which were the average electricity cost and premium gasoline price in the United States, respectively, for December 2014, and based on our estimate of the energy efficiency of Model S, we estimate that our Model S could save approximately $1,600 per year less in fuel costs than a comparable premium internal combustion engine sedan." [28]

Figure 10 – Tesla Motors Inc. Model S and Supercharger Station [29]

Tesla is a new company, that was born exclusively with the intention of producing and marketing electric vehicles, unlike the other electric cars producers which have approached this new market segment whilst having produced and commercialised ICE cars for years, and hence being well-known by consumers. Hence, to be able to impose their product as one of the best selling electric cars available, despite the high price, was a success that can be imputable to the superior technology and features embedded into their cars.

Tesla's core competencies are powertrain engineering, vehicle engineering and innovative manufacturing. Their focus is electric powertrain consists of battery pack, power

electronics, motor, gearbox and the control software which enables the components to operate as a system.

Tesla's features that allowed their products to gain a predominant position on the market is their batteries and charging systems. The unique battery architecture makes Model S P85D the fastest sedan currently available on the market: accelerating from 0 to 60 mph in 3.1 seconds [29], requiring a strong draw from the battery pack to power the front and rear motors. The connections, cell chemistry, and battery cooling system are all engineered to move significant power out of the battery pack during hard accelerations and uphill driving. And the Superchargers, the Tesla's dedicated charging systems, exploit the architecture of the battery itself allowing for the fastest charging system available currently. Driving and charging use the same systems to move energy out of and into the battery. Supercharging utilizes the car's discharge capacity to flow a similar amount of power back into the battery pack through dedicated high voltage cables. The car's on-board computer constantly monitors the battery during both driving and charging to ensure that Model S performs at its peak. Superchargers consist of multiple Model S chargers working in parallel to deliver up to 120 kW of direct current power directly to the battery. Typically, Model S uses its on-board charger to convert alternating current from a wall charger to DC that's stored in the battery. As the battery nears full charge, the car's on-board computer gradually reduces the current to the optimum level for topping off cells. Model S is currently the only EV capable of charging at up to 120 kW, which equates to 170 miles of range in about 30 minutes., although many factors are to be taken into account when considering the actual charge rate, such as ambient temperature, utility grid restrictions and charging traffic, amongst others; Tesla's Superchargers are the fastest charging systems existing at the time of the writing of this paper.

One of the latest Tesla's project consists in the construction of the so called Tesla Gigafactory, where the company intends to produce the battery packs for that will be mounted on Tesla's cars, in a joint production effort between Tesla and its suppliers to integrate battery precursor material, cell, module and battery pack. The latter is considered the highest application of Tesla's Intellectual Property, proprietary technology includes cooling systems, safety systems, charge balancing systems, battery engineering for vibration and environmental durability, robotic manufacturing processes, customized motor design and the software and electronics management systems necessary to manage battery and vehicle performance under demanding real-life driving conditions.

Additionally, Tesla designs, develops, manufactures and sells advanced electric vehicle powertrain components to other automotive manufacturers, like Daimler Smart fortwo, A-Class, and B-Class electric vehicles, and Toyota RAV4 EV.

4.1.1 TESLA'S SUPERCHARGER NETWORK

The Supercharger network is one of the most relevant features provided by the company, which is not only producing its own full electric powertrain systems and components, but also for other automobiles' manufacturers. Tesla is now in the process of building a network of up to 120 kW fast charging equipment, each called a Tesla Supercharger, throughout North America, Europe and Asia for fast charging of Model S and future Tesla vehicles. The development of said network has been a welcomed initiative, that had as principal aim to remove the barrier to the broader adoption of electric vehicles caused by the perception of limited vehicle range and to provide free charging access to Tesla's existing and potential customers. Furthermore, Tesla's Supercharger allows for fast charging (170 miles of range in the battery pack in approximately 30 minutes), when compared to traditional charging times.

Currently 380 Superchargers stations are operative in North America, Europe and Asia; one of the objectives is to continuously expand the network, which despite starting to be quite extensive, especially in the US, is definitely not sufficient to cover the territory and limits the adoption of Tesla's vehicles further. To further overcome this issue, Tesla has embarked in the setting up of additional charging options at hotels ad popular destinations. Nevertheless the cost for the construction of Supercharger stations is considerably high and it might undergo to delays due to a number of factors, including the inability to secure, or delays in securing, suitable locations and permits, problems negotiating leases with landowners or obtaining required permits for such locations, difficulties in interfacing with the infrastructures of various utility companies and greater than expected costs and difficulties of installing, maintaining and operating the network.

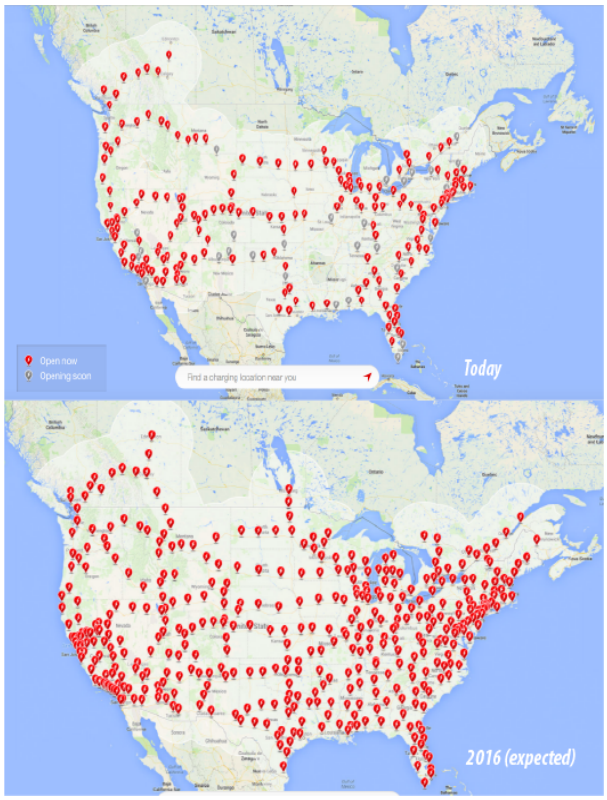

Figure 11 – USA Superchargers Network [29]

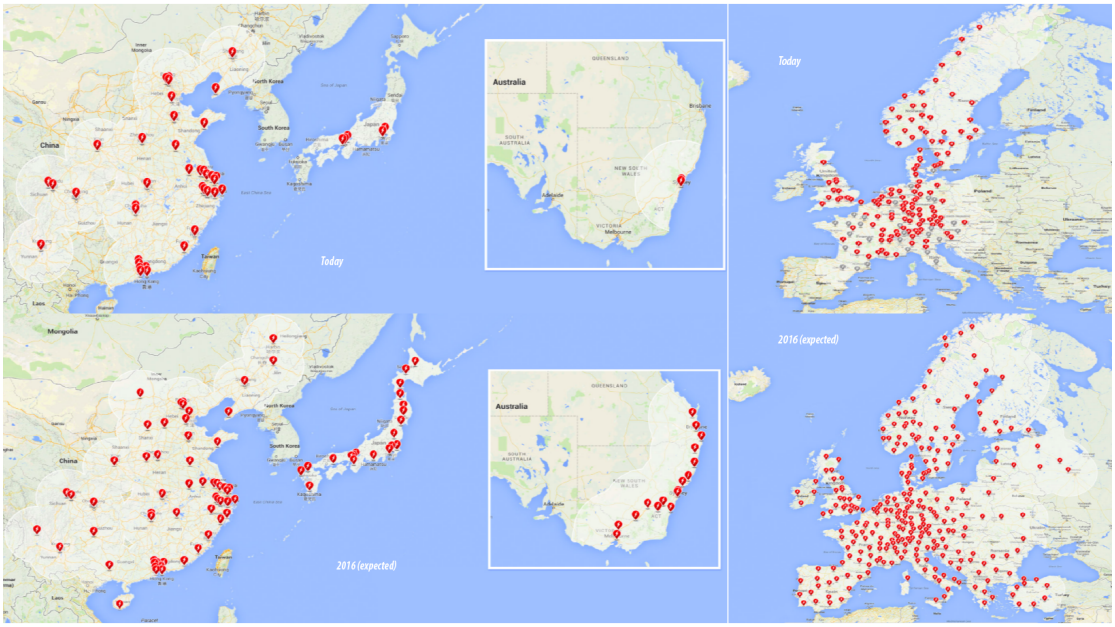

Figure 12 – Asia and Europe Superchargers Networks [29]

Furthermore, even where Superchargers exist, the increasing number of Model S vehicles as well as future vehicles such as Model X may saturate the available charging bays at such Superchargers, leading to increased wait times and dissatisfaction for customers.

Although our Supercharger network is intended to address customer concerns regarding long-distance travel, this network may not result in increased reservations or sales of Model S or future vehicles like Model X; as intended by the company.

4.1.2 TESLA'S GIGAFACTORY

As already stated, Tesla's Gigafactory is being build for the production of battery packs for the whole vehicles' production from 2016.

Figure 13 – Tesla's Gigafactory [29]

The Gigafactory is currently expected to attain full production capacity in 2020, which is anticipated to be sufficient for the production of approximately 500,000 vehicles annually as well as for the production of stationary storage applications. In the waiting for the full productive capacity of the Gigafactory, Tesla is planning on purchasing the necessary batteries from other manufactures (approximately 15GWh out of 50GWh). The total capital expenditures associated with the Gigafactory through 2020 are expected to be $4-$5 billion, of which approximately $2 billion is

expected to come from Tesla, and savings associated with the new production plant have been estimated to be 30% on a per kWh basis by the end of the first year of volume production. Panasonic has already agreed to partner with tesla in the construction of the Gigafactory, and other investors are expected to join in the project during its development. On this regard it is relevant to mention that on March 23th, 2015, also Panasonic has announced the pledging of its patents.2

4.2 TESLA'S RELATIONSHIPS

Tesla has strategic or commercial relationships with Panasonic, Daimler, and Toyota.
Panasonic supplies battery cells for our battery packs and has partnered with Tesla on the construction of the Gigafactory. In January 2010, it was announced that Tesla was collaborating with Panasonic on the development of next-generation electric vehicle cells based on the 18650 form factor and nickel-based lithium ion chemistry. In October 2011, a supply agreement was finalized for these battery cells. In October 2013, this supply agreement was amended to, among other things, provide for the long-term preferential prices and a minimum of 1.8 billion lithium-ion battery cells Tesla intend to purchase from Panasonic from 2014 through 2017. In July 2014, Panasonic agreed to partner on the Gigafactory. beginning in 2008, Tesla and Daimler AG we commenced efforts on a powertrain development arrangement: Tesla has developed and produced powertrain components for Daimler for the Smart fortwo electric drive program, the A-Class electric vehicle program and the B-Class electric vehicle program. The cooperation with Toyota Motor Corporation, started in 2010, has lead to the production of a validated powertrain system, including a battery, power electronics module, motor, gearbox and associated software, which was integrated into an electric vehicle version of the Toyota RAV4. The delivery of these systems to Toyota for installation into the Toyota RAV4 EV began in the first half of 2012. During the third quarter of 2014, the RAV4 EV program was completed. [28]

4.3 TESLA'S MARKET & FINANCIAL PERFORMANCES

Tesla markets their products directly to the consumers through an international network of company-owned stores and galleries.

Tesla generally carries extremely low inventory and vehicles are set in production once the consumer has entered the purchase agreement and paid an advance on the price due, which is utilized to finance the company's working capital requirements to align production with demand. Hence, it can be understood how, probably due to the high costs of production and the limited demand, Tesla has an overall pull production strategy.

2 "Panasonic will today formally pledge to provide royalty-free access to software, patents and experience from its product ecosystem to speed the development of the Internet of Things (IoT) software and services, at the Embedded Linux Conference in San Jose, Calif. Panasonic will also announce plans to increase its intellectual property contributions to the AllSeen Alliance, a cross-industry nonprofit open source consortium." [45]

According to the company's year end financial shareholders letter, the principal marketing goals are to generate demand for vehicles and drive leads to the sales teams, build long-term brand awareness and manage corporate reputation, manage the existing customer base to create loyalty and customer referrals; and enable customer input into the product development process.

Tesla's revenues for the year 2014 were recognised to $3.20 billion [28], a 37% increase compared to the previous years recorded revenues, primarily due to the growth of Model S deliveries worldwide. Sales of Tesla's Model S allowed the company to finally recognise revenues, the following graph allows a quick understanding of the evolution of the financial situation of the company.

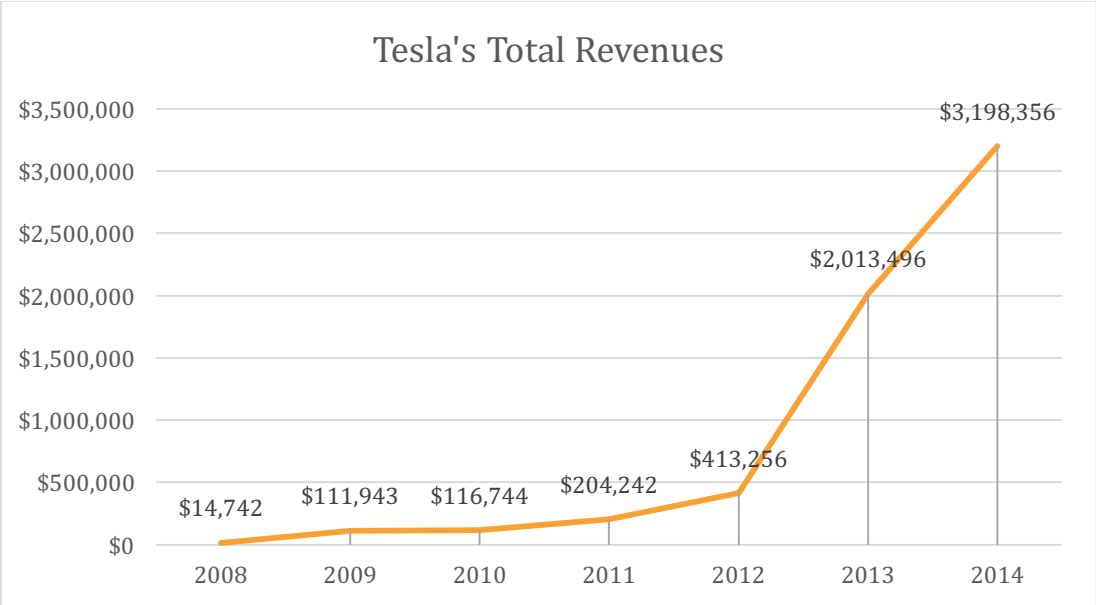

Chart 4 – Tesla's Total Revenues over Time (data from [28])

Despite being Tesla's business diversified and divided between the production and development of its own models of electric cars and the production of powertrain components for other automakers, it is immediate how the last portion of the business is only marginal and does not account for much of the company's revenues. Of course the number of partnerships for the production of powertrain components is limited, regardless, the problem lies on the quantity of vehicles sold by Tesla's partner, as if the current numbers were to remain stable and not grow over time, it is impossible to see revenues from collaborations grow substantially, even if more contracts were underwritten with other producers. This situation would definitely be changes in case the number of overall sales of electric cars were to increase, this way Tesla would proportionally not only increase the revenues from the production of its own vehicles, but also the revenues from the production of powertrain components for its competitors. Furthermore, increasing the production, Tesla might even hope to reach economies of scales numbers that would allow it to cut down on costs and further increase revenues. Similar reasoning is of course behind the idea of the Gigafactory for the batteries construction, to be used by Tesla's vehicles, but not only.

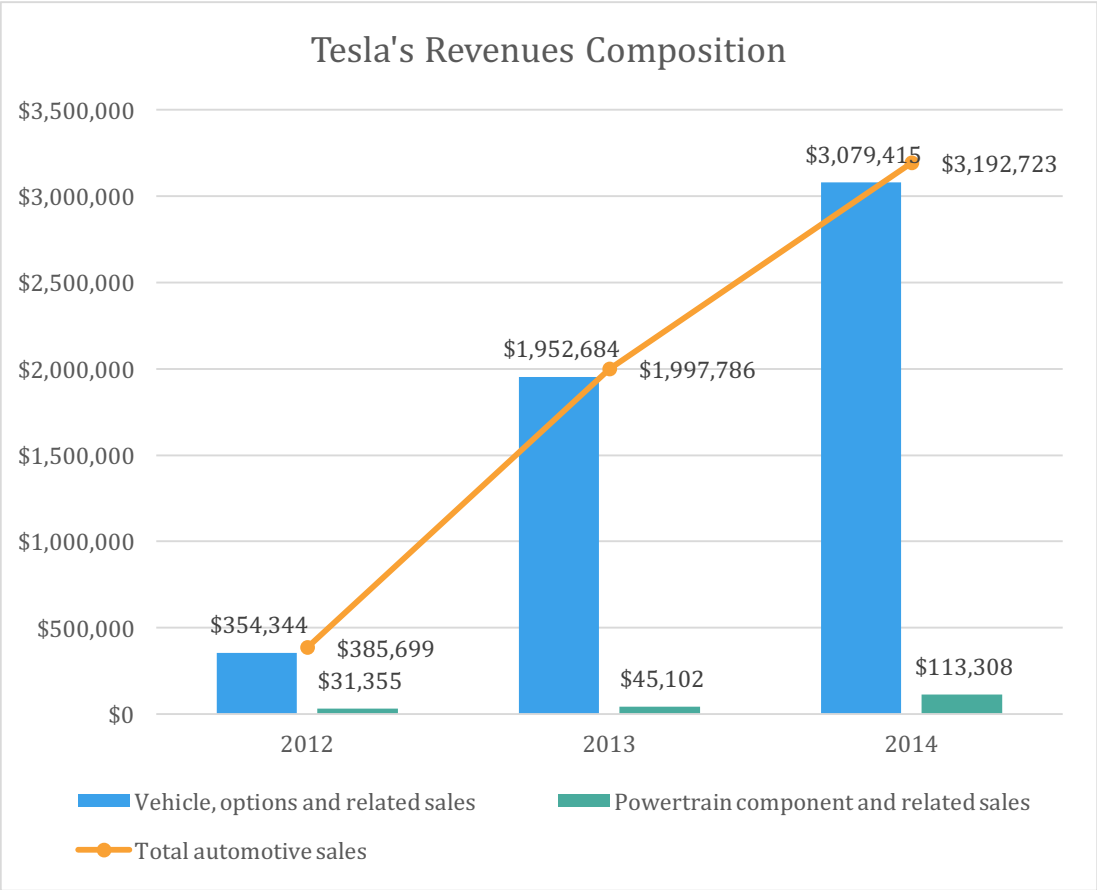

Chart 5 – Tesla's Yearly Revenue Composition (data from [28])

Research and Development expenses more than doubled in the last financial period, bringing the total investment in R&D to 464.7 million US$: the increase can be explained by the development of the new Tesla car Model X, the dual motor powertrain and other development programs. These investments in R&D can be transposed in a number of possibly patentable technologies, hence a growing number of patents, which, since their creation and application to the patent office, are free for public use.

Model S orders and sales have spiked in the last year, compared to the previous and are expected to continue growing within the following years, alongside the new orders for Model X (almost 20,000 reservations where received by end December 2014). This is translated in an expected steady revenue stream, which on the other hand might be influenced by the entrance in the market segment occupied by Tesla of other automobiles' producers like Porches, Lexus or Audi. Furthermore, the growth in demand has been influenced by the increased awareness of the brand and is expected to further gain market share in markets different from the US one. This is strictly linked to the perception of the company, marketing campaigns and the concerns for the environmental issue. To this purpose it is clear how the Pledging of Tesla's patents has contributed to both increase awareness of the brand and, as a marketing operation, providing a positive image of the company to the outside public. Demand for EVs is expected to grow; nevertheless, it is well known that the demand for automobile sales depends to a large extent on general, economic, political and social conditions in a given market and the introduction of new vehicles and technologies. As a low volume

producer, Tesla has less financial resources than more established automobile manufacturers to withstand changes in the market and disruptions in demand. The company growth is highly dependent upon the adoption by consumers of alternative fuel vehicles in general and electric vehicles in particular, and is subject to an elevated risk of any reduced demand for those. If the market for electric vehicles in North America, Europe and Asia does not develop as expected, or develops more slowly, Tesla business, prospects, financial condition and operating results will be heavily harmed.

The increase in demand needs to be accompanied by a parallel increase in the productive capacity of the company, which, as of now, is not yet sufficient to withstand the demand for the vehicles, as shown by the delays in deliveries of several orders from 2014 to 2015. Expected capacity by the end of 2015 has been forecasted to 2,000 units per week, this is expected thanks to the heavy investments Tesla made on the production capacity starting August 2014 that will last during the current year 2015. Tesla's sales have also been influence by the fact that the productive capacity of the company is limited, and it has been estimated that around 1500 car's deliveries have been postponed in 2015. Furthermore, the actual sales' capacity of the company might have adversely affected the willingness of consumers to purchase the cars when those were declared not available by the company, or because of the long waiting times that pass from the order of the car to the delivery, that could reach months.

Tesla's expected growth in annual production is over 50% for the following years, provided a corresponding increase in demand for their products. The increase in productive capacity and manufacturing efficiencies, has lead Tesla to expect, together with the forecasted increase in demand, a 30% gross margin on Model S by end 2015, assuming stable currency conditions. Those will be offset by inevitable production inefficiencies in the introduction of Model X. Expected deliveries for 2015 are estimated to 55,000 for both models worldwide.

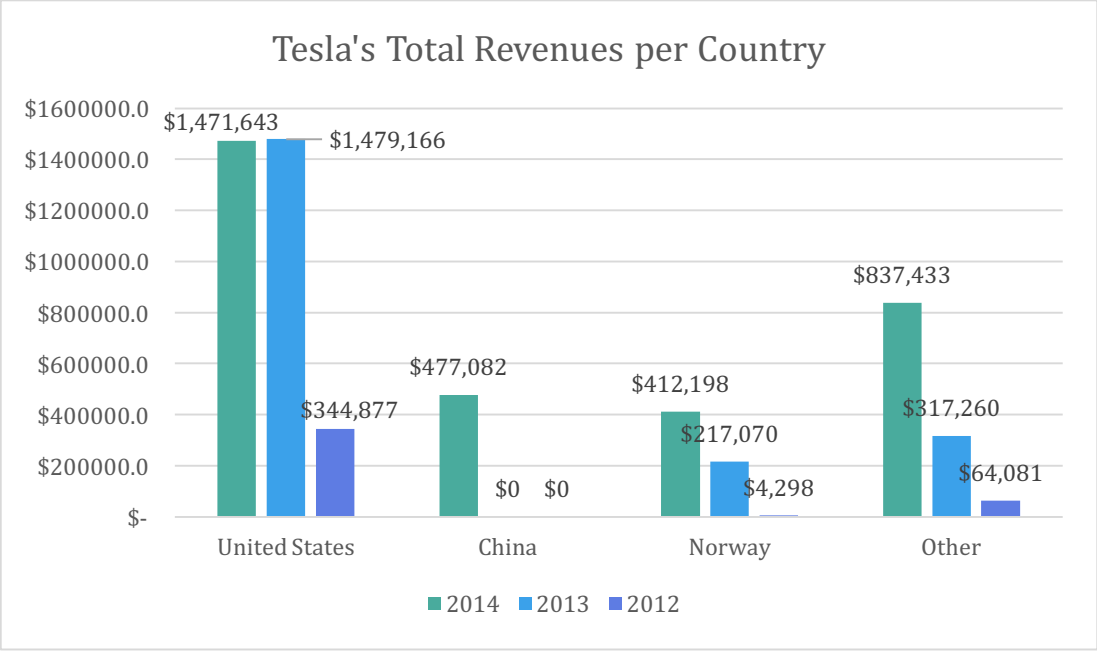

Chart 6 – Tesla's Major Markets Yearly Total Revenues (data from [28])

As already seen in the previous chapter, Tesla ranked among the first producers of BEVs in the three major market areas, 2nd in US, 5th in Europe and 6th in China. This places Tesla as one of the most important brands for electric cars production. Furthermore, Tesla Model S ranked as the second most sold luxury car in the United Stated, which is indicator on how Tesla does not only compete on the market for electric cars alone, but its Model S is among the options when consumers think about purchasing a vehicle in the luxury segment. Tesla's purchasers hence values not only the electric vehicle per se and its technical characteristics, but also the added value and the social status associated with the particular vehicle rather than the ownership of one, as they are perceived as luxurious solely because they play a role of status symbol, signifying the purchasing power of the purchaser.

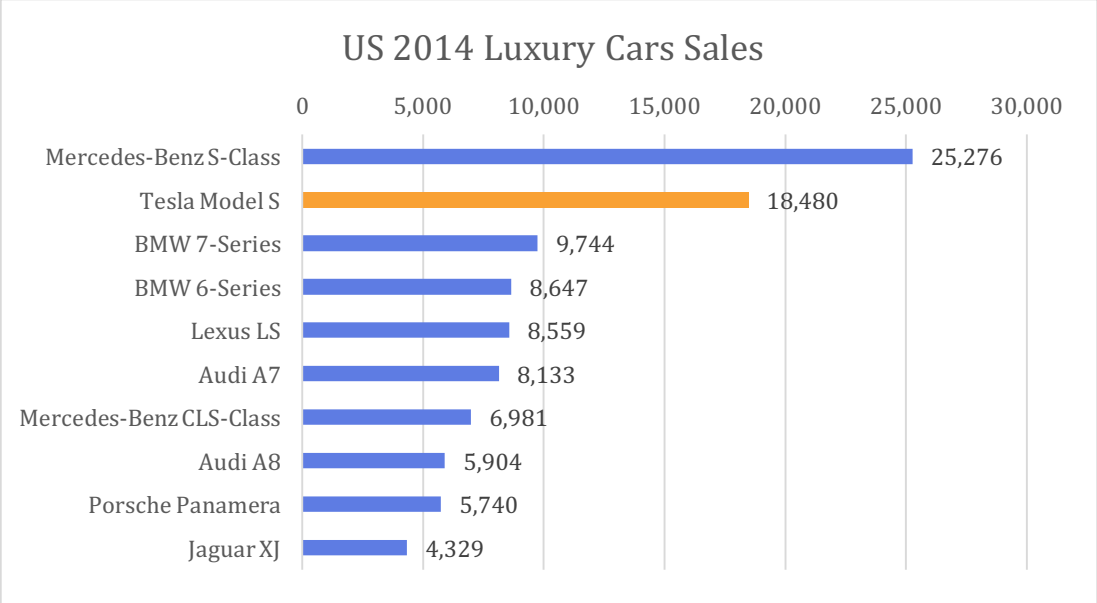

Chart 7 – US Luxury Cars Sales (data from [26])

Tesla is under the eyes of some still a start-up that, despite the hype and the considerable attention devoted to the company by the media and consumers, has limited resources, limited production capacity and has not been able to achieve relevant numbers both financially and for what concerns manufacturing rates.

Despite those reservations, some of which are understandable and also shared by the management of the company, Tesla is quoted on the financial stock and the numbers associated to the company are staggering.

The same company that struggles in meeting the demand of vehicles, due to the limited production capacity, that has limited capitals so much to prevent them to enlarge the production plants and assembly lines and that has been able to record revenues only in the last year, 10 years after the incorporation, has a market capitalization of almost 31 Billions US$. This impressive number, once compared to the overall company's characteristics, can be only traced back to the only distinguishing feature of the company that allows it to still be one of the dominant players in the market, that is Tesla's intangibles: its brand image and the company's trademark, and, obviously the company's technology, residing, protected in its patent portfolio.

Financial data 12 June 2014	
Market Capitalization	25.25 B $
EPS	0.5
52 Weeks High	265.00 $
52 Weeks Low	95.12 $
1Year Target	269.11$
Beta	1.44
2014 Revenues	3.198.356 $
Vehicles Sales 2014 - Worldwide	~ 30.000

Table 2 – Tesla's Financial Data (data from [30])

The above consideration on the company's financial performances is supported by the other financial data: EPS is negative at minus 3.18, with a Beta of 1.44.

Nevertheless, shares value has been increasing fairly steadily throughout the years, excluding some major setback in correspondence to particularly negative events, such as the catching fire of one of the first mass produced Model S. The following image, from Yahoo! Finance, shows the share price oscillation over the pas year.

Financial performances have been constantly positive, experiencing a steady increase in the value of the company's share throughout the years, since the first Model S have started to cruise the American streets. Some relevant but temporary decrease in value of the shares is periodically experienced on the financial market, but they have never been enough to hinder the growth of the company, as it can be seen in the he following graphs, which have been constructed through the data retrieved from the company's financial statements.

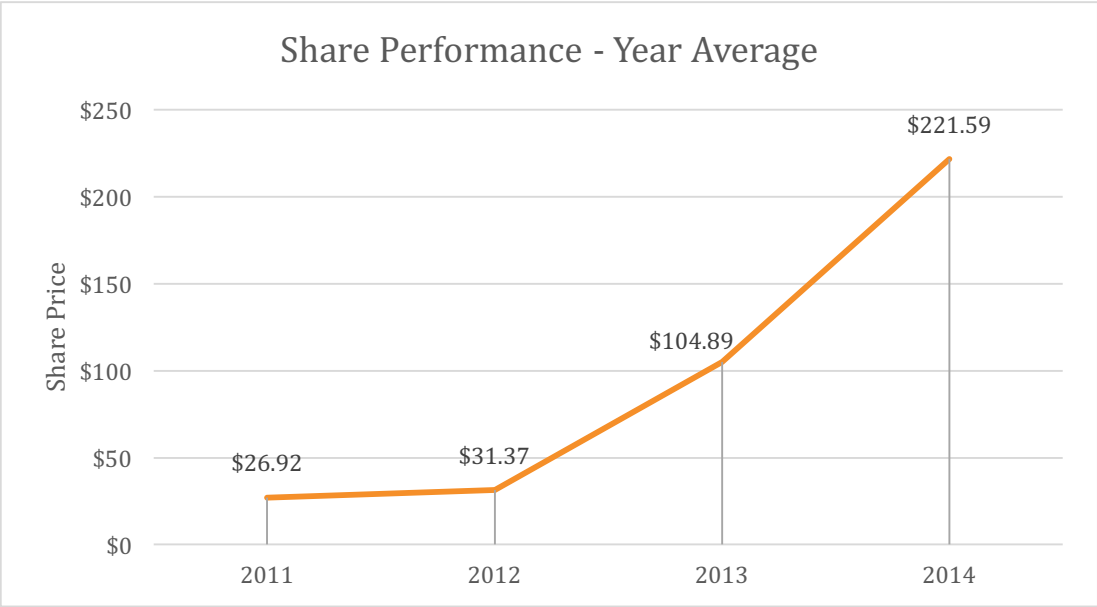

Chart 8 – Yearly Average Tesla's Share Performances (data from [28])

2014 has been a positive year for the company, that has seen the share price raising, at times, almost doubling the first quarter low of 139.34 US$/share.

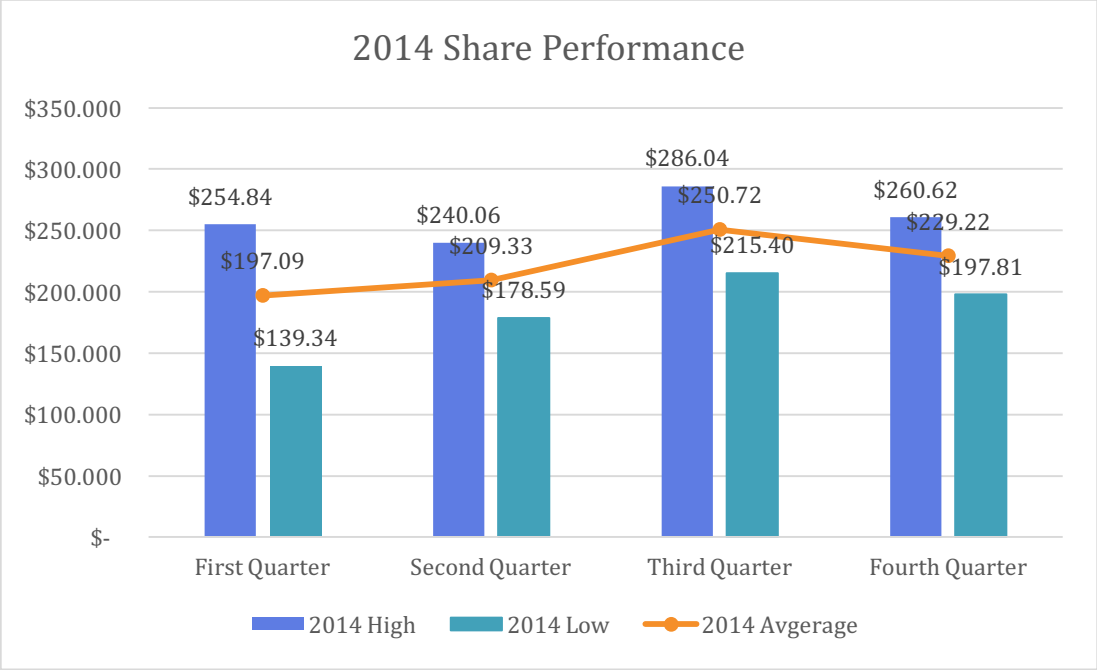

Chart 9 – Tesla's Quarterly Shares' Price Performances (data from [28])

The peaking values have been registered during the third quarter of 2014. To be notice that in the first two quarters of the year, the company was facing a critical situation when considering the value of its outstanding shares, as their value was close to a zero-growth situation. The management of the company was then able to revert the situation, during the third quarter with the announcement of the construction, but also with the announcement of the factual release of the company's patents at the end of the second quarter, which had helped in increasing the company's value, rather than diminishing it despite the company's IP is considered the asset with the greatest value.

As it can be seen by in the following picture, once again from Yahoo! Finance, which depicts the share performances of the company over the last years, right before Musk's announcement, the share value has been experiencing major decreases in value.

Figure 14 – Tesla's Share Trend (from [30])

4.4 TESLA'S PATENT PLEDGE: A NEW PATENT STRATEGY

On June 12th, 2014 Elon Musk, Tesla's Founder and CEO, posted a press release on the company's blog that caught the attention of the press and the automotive industry.

> *"All Our Patent Are Belong To You - Elon Musk, CEO June 12, 2014*
>
> *Yesterday, there was a wall of Tesla patents in the lobby of our Palo Alto headquarters. That is no longer the case. They have been removed, in the spirit of the open source movement, for the advancement of electric vehicle technology.*
>
> *Tesla Motors was created to accelerate the advent of sustainable transport. If we clear a path to the creation of compelling electric vehicles, but then lay intellectual property landmines behind us to inhibit others, we are acting in a manner contrary to that goal. Tesla will not initiate patent lawsuits against anyone who, in good faith, wants to use our technology.*
>
> *When I started out with my first company, Zip2, I thought patents were a good thing and worked hard to obtain them. And maybe they were good long ago, but too often these days they serve merely to stifle progress, entrench the positions of giant corporations and enrich those in the legal profession, rather than the actual inventors. After Zip2, when I realized that receiving a patent really just meant that you bought a lottery ticket to a lawsuit, I avoided them whenever possible.*
>
> *At Tesla, however, we felt compelled to create patents out of concern that the big car companies would copy our technology and then use their massive manufacturing, sales and marketing power to overwhelm Tesla. We couldn't have been more wrong. The unfortunate reality is the opposite: electric car programs (or programs for any vehicle that doesn't burn hydrocarbons) at the major manufacturers are small to non-existent, constituting an average of far less than 1% of their total vehicle sales.*

At best, the large automakers are producing electric cars with limited range in limited volume. Some produce no zero emission cars at all.

Given that annual new vehicle production is approaching 100 million per year and the global fleet is approximately 2 billion cars, it is impossible for Tesla to build electric cars fast enough to address the carbon crisis. By the same token, it means the market is enormous. Our true competition is not the small trickle of non-Tesla electric cars being produced, but rather the enormous flood of gasoline cars pouring out of the world's factories every day.

We believe that Tesla, other companies making electric cars, and the world would all benefit from a common, rapidly-evolving technology platform.

Technology leadership is not defined by patents, which history has repeatedly shown to be small protection indeed against a determined competitor, but rather by the ability of a company to attract and motivate the world's most talented engineers. We believe that applying the open source philosophy to our patents will strengthen rather than diminish Tesla's position in this regard." [31]

The last corporate annual statement reads: *"As part of our business, we seek to protect our intellectual property rights in various ways, including through trademarks, copyrights, trade secrets, including know-how, patents, patent applications, employee and third party nondisclosure agreements, intellectual property licenses and other contractual rights. Additionally, consistent with our mission to accelerate the advent of sustainable transport, we announced a patent policy in which we irrevocably pledged that we will not initiate a lawsuit against any party for infringing our patents through activity relating to electric vehicles or related equipment for so long as such party is acting in good faith. We made this pledge in order to encourage the advancement of a common, rapidly-evolving platform for electric vehicles, thereby benefiting ourselves, other companies making electric vehicles, and the world."* [28]

This new approach completely reverses the customary understanding of patent protection and strategic patent management. Not only the software can be opened to the public use and modification through Open Sourcing, but also highly technological and hardware components are released for the public use with the main purpose of the development of the technology itself [32].

The standard justification for the existence of patent protection is that patents are necessary to solve an appropriability problem that would otherwise plague the production of innovative products and process [33]. The appropriability problem stems from the "public good" characteristics of intellectual goods. Unlike tangible goods, public goods share two distinctive characteristics: non-rivalry of consumption and non-excludability of benefits. The non- excludability property of public goods gives rise to two related problems. First, public goods are likely to be under-produced if left to the private market. Second, markets for public goods will not form. Since inventions are essentially information goods, they too are susceptible to the twin problems of under-production and lack of market exchange. Absent patent protection, copiers would be able to appropriate much of the value embodied in inventions without incurring the considerable costs of research and development. In such a world, however, inventors would likely put their creative skills to rest and too few inventions would be produced. Patents remedy the appropriability problem that attends the production of information goods by bestowing upon inventors exclusive rights in the inventions they divined.

The field's experts have had different reactions, some welcomed Tesla's move with enthusiasm believing it would lead to enhanced innovation and to a new era where patents are effectively developed for the sole purpose of scientific innovation and no more as a legal weapon or as a threat. Other scholars have doubts on the effectiveness of the reverse use of patents, as they demonstrated highly sceptical in regard to the Tesla's true intentions considering the press release more as a market and publicity move rather than an effective statement of intentions of the company change of strategy. On this regard, it is of foremost importance to underline what said by Mr. Musk: "Tesla will not initiate patent lawsuits against anyone who, in good faith, wants to use our technology." [31]

Good faith is an abstract and comprehensive term that encompasses a sincere belief or motive without any malice or the desire to defraud others [34]. As such, no objective and absolute definition can be given, the extent and definition of an action in good faith will vary according to the context, the person interpreting the facts and according, most importantly, to a case specific discriminatory analysis.

This subjectivity will of course lead to different interpretations on different cases on whether a player has been acting in good faith or not. In the words of Rimmer: "It should also be noted that Tesla Motors has not abandoned its intellectual property entirely. [T]he company has only offered access for 'good faith' uses of its patents — which still leaves open the prospect of the company taking action against 'bad faith' uses of its patents." [35]

Furthermore, Tesla has not ceased to pay the renewal fees for their patents, as they plan on renewing and keeping alive all their patents since the expiration the duration prescribed by law and will continue on patenting new technologies that will be developed by the firm. According to the Patent Pledge: "A party is "acting in good faith" for so long as such party and its related or affiliated companies have not:

- asserted, helped others assert or had a financial stake in any assertion of (i) any patent or other intellectual property right against Tesla or (ii) any patent right against a third party for its use of technologies relating to electric vehicles or related equipment;
- challenged, helped others challenge, or had a financial stake in any challenge to any Tesla patent; or
- marketed or sold any knock-off product (e.g., a product created by imitating or copying the design or appearance of a Tesla product or which suggests an association with or endorsement by Tesla) or provided any material assistance to another party doing so." [36]

Nevertheless, easy ways against this short and concise definition can be found. It will be entirely up to Tesla's Lawyers and Management to discriminate whether competitor and other industry players are utilizing their patents in good faith or whether they are exploiting Tesla's patents in a manner which is not consistent with the encrypt or of the concepts of good faith used by Musk's management and law team. In fact, Tesla has not committed their patents explicitly under an agreement like the Defensive Patent License, which sets a clear standard that patents are to be both shared and used for good. Similar

doubts have been brought by Greenberg, who questioned the legal enforceability of Tesla's statement, even in case of promissory estoppel, and the possible scenario when Tesla's patents where sold [37]. From a legal perspective, nothing has changed: regardless the form the statement, competitors and industry players would never knowingly infringe on Tesla's patents without legal documentation allowing them the use of Tesla's Patent from the patent owner.

According to Tesla's declaration, the Pledge is irrevocable and legally binding on Tesla and its successors, is a "standstill," meaning that it is a forbearance of enforcement of Tesla's remedies against any party for claims of infringement for so long as such party is acting in good faith. In order for Tesla to preserve its ability to enforce the Tesla Patents against any party not acting in good faith, the Pledge is not a waiver of any patent claims (including claims for damages for past acts of infringement) and is not a license, covenant not to sue, or authorization to engage in patented activities or a limitation on remedies, damages or claims. Except as expressly stated in the Pledge, no rights shall be deemed granted, waived or received by implication, exhaustion, estoppel or otherwise. Finally, the Pledge is not an indication of the value of an arms-length, negotiated license or a reasonable royalty [31].

"What this pledge means is that as long as someone uses our patents for electric vehicles and doesn't do bad things, such as knocking off our products or using our patents and then suing us for intellectual property infringement, they should have no fear of Tesla asserting its patents against them." [31]. Yet again, despite the attempts on clarifying the behaviours that shall or shall not be considered good faith, the statement is very vague and leaves large space for interpretation.

Musk asserted that owning large patent portfolios does not necessarily translate in a long lasting success, as opposite to the traditional concept where a well managed intellectual property will result in the creation of a strong lead in the industry and the creation of a competitive advantage; and he is certainly acting upon his believes.

Among the publications supporting Musk's idea that intellectual property protection does not always result in better market positioning and increased innovation is Gallini's publication of 2002 'Prior research has shown that at low levels of intellectual property rights protection, an increase in the level of protection encourages innovation because it provides incentives to research and to disclose information. However, at high levels of intellectual property protection, stronger intellectual property rights may discourage subsequent research on valuable, but potentially infringing, inventions." [38]. Tucker's study (2104) on 'The Effect of Patent Litigation and Patent Assertion Entities on Entrepreneurial Activity' has empirically found that higher granting percentages lead to higher litigation occurrence, hence the innovating activity would be considerably higher if it were not for the scare of litigations and courts' costs and expenditures [39]. In the publication, 'Why do firms give away their patents for free?' Ziegler, Gassmann and Friesike tried to understand what are the factors leading firms to release their patent, action which seems contradictory to the original scope of patent protection. The main motives behind the open IP-strategies are based upon economical, technological and social reasons, eventually resulting in value creation through the release of a patent, this is

due to cost cutting, profit increasing and catalysing phenomenon innovative activity of third parties benefiting from the freed technology. Overall, according to Ziegler, Gassmann and Friesike, firms have high incentives and high returns in freeing their patents, as they keep on benefiting from the effects of an open source approach [40]. Moreover, from the study of Gambardella and Panico (2014) 'On the management of open innovation' it can be evinced that the potential of open innovation is under exploited, under the assumption that open innovation is a profit-maximizing strategy targeting both value creation and value appropriation (Chesbrough and Rosenbloom, 2002) [41].

Opposite to this view Totaro argued, ""Open sourcing" one's patent portfolio reduces the ability to obtain value in return for that investment in innovation." [42]. Furthermore the aforementioned writer also stated that "Tesla's move does address one of Mr. Musk's pain points in that it will lower the commercial barriers to competition in the EV market, rather than using proprietary rights to "stifle progress" in the industry. However, giving away key aspects of your technology without a license fee inherently diminishes your investment and makes it easier for your competition to leapfrog you. So, when the EV market does take off, Tesla's competitors will be in a better position to gain commercial advantage and more market share than Tesla. Tesla will still be a takeover target, given their entrenched position commercially and technologically, but with a significantly lowered valuation resulting from this move." [42].

On one hand Musk's move has brought significant attention to the firm, that was experiencing financial setbacks during the previous months, in May the firms' shares experience a minimum quotation of just above 175 US $/share., which can be identified as a marketing move, bringing under the general public eye the involvement of Tesla in the call to fight the urging problem of environment crisis and carbon emissions.

From Musk's statement it might also seem that Tesla is hoping for a tacit understanding among the industry players with the aim of reducing the lawsuits for patent infringing, as his understanding of patent ownership might might as well be a "ticket to a lawsuit". In simple terms, the implicit message of Elon Musk might be that Tesla will not sue for patent infringement or invalidations as long as it will not be sued. The major industry players for the most part seemed uninterested in utilizing Tesla's patents and none upheld the new approach to patent strategic management.

The change in the technology strategy by Tesla can be considered rather unusual, particularly when considering the size of the company, when compared to the competitors means and technology availability. The move surprised observers who view the startup's patents as a competitive advantage, particularly since the offer included access to Tesla's patents on rapidly recharging batteries, a core component of the company's electric vehicles.

The traditional argument for patents is that startups can protect their technology against imitation by large incumbents. Existing firms have the advantage of controlling complementary assets, like manufacturing plants operating at high-scale economies or widespread distribution networks, that are used alongside an innovation to compete in the marketplace. Against this formidable obstacle, the standard strategy for a tech startup

is to build a patent portfolio as an offsetting basis of competition. The patent-based strategy makes sense in many industries. No biotech startup would make its drug patents freely available. Big pharmaceutical companies and generic drug makers would simply copy those drugs and use their better sales forces to defeat the startups in the marketplace.

Nevertheless, different from the above mentioned bio-tech companies, Tesla does not just have to win against competing automobile companies, but most importantly, Tesla's management must get the market to adopt electric-vehicle technology. This will only happen once complementary technologies will be available, such as a widespread battery recharging station network. The release of Tesla's technology to multiple automakers could incentivize them to embrace the electric vehicles' market, and spur the development of recharging stations, which would lead more customers to switch to electric vehicles.

Tesla is facing increased competition by decreasing the market advantage but the management hopes the broader customer adoption of electric vehicles will offset the greater competition.

Tesla's move can be seen as a clever and new patent strategy, as the company could have used its strong patent portfolio to discourage rivals. Instead, by removing the threat that it will assert its patents, Tesla is trying to shape and accelerate the growth of the industry. The nascent electric-car industry is subject to network effects: the more charging stations and related infrastructure are in place, the more electric cars will be sold, driving manufacturing costs down. Lower costs will increase sales and encourage infrastructure investment. Tesla understands that it cannot build the industry single-handedly.

Electric cars today have a 1% market share. By making its patents available to competitors, Tesla is trying to expand the size of the pie over the long term rather than insisting on taking the largest helping today, as patent trolls try to do. As the technological leader, Tesla will presumably profit handsomely through market expansion.

Much speculation has been done on the reasons behind this move by Musk. As many scholars have sided against the effectiveness and the factual feasibility of the statement, and others, at the same time, showed enthusiastic reactions to the change in approach by the American electric vehicle manufacturer.

The company patent portfolio, which has been released on its entirety, is not an extremely strong portfolio, as will be later show in the course of the analysis. Tesla is aware of the possibility of being sued: companies holding patents or other intellectual property rights may bring suits alleging infringement of such rights or otherwise assert their rights and urge Tesla to take licenses. In addition, in case of infringement upon a third party's intellectual property rights, the company might be required to cease selling, incorporating or using vehicles or offering goods or services that incorporate or use the challenged intellectual property; pay substantial damages and possibly obtain a license from the holder of the infringed intellectual property right, which license may not be available on reasonable terms. This might have even greater consequences, as the redesign of vehicle or other goods and services might be required. In case of a successful

claim of infringing, and a failure to obtain the desired license for the questioned industrial property right, Tesla might face the entire disruption of the company's activities.

Furthermore, given the general uncertainty for the grant of a patent when filing for an application, Tesla's position is further uncertain as their primary focus was the US and now are trying to extend patents also abroad, with no certainty of granting.

5 METHODOLOGY

In order to understand the possible reasons behind tesla's decision both a quantitative analysis on the company's patents and its competitors' ones, and a qualitative assessment on the market situation have been deemed necessary. The combination of the information form the two different levels of analysis will allow to understand whether the alleged reasons are pertinent to the legal status and composition of their portfolio, or lie more in the current situation of the market.

After the first theoretical analysis on Tesla's market and characteristics and the introduction of the topic of Strategic Patent Management according to the literature, the research question will now be answered through the quantitative research of Tesla's patent portfolio and the competitors one.

The introductory chapters on the characteristics of the market of electric vehicles and the position occupied by Tesla specifically are of foremost importance because, in combination with the quantitative information retrieved from the quantitative analysis of the patent portfolios. The market features are of help in finding the reasons for the specific patenting behaviours of the various companies and the alleged reasons behind the shift in patent strategy by Tesla. A comprehensive picture would be impossible to draw basing the study solely on the data retrieved from the patent databases.

The quantitative data collected through the us of patent databases can give punctual and specific information on the patenting behaviours of firms, technological position of the firms with respect to the market undertakings and the strategy adopted by the company, and the value embedded in the industrial property.

The data retrieval has been possible through the use of Thomson Innovation Database. Thomson Innovation is one of the largest and most exploited patent databases, belongs to the Thomson Reuters Corporation, and provides patent information and cataloguing to some other important databases, see DWPI. Its coverage includes all the main publications: WIPO applications, US granted and applications, Europe granted and applications and those pertaining to the UK, France and Germany; Chinese, Japanese and Korean grants and applications; plus a further addition of abstracts of patents and applications from several other worldwide countries. Specifically Thomson Innovation Database, allows for identify key competitors, technologies and trends with robust analysis and visualization, charting and mapping tools. It provides one of the highest coverage among the available patent databases and for analysis purposes it provides particular features, such as citation mapping, the creation of charts and graphs, et alia.

The quantitative research has been carried out on two different levels: first Tesla Motors' patent portfolio has been studied, and secondly, from the information collected from said analysis, the patent portfolios of Tesla's competitors have been retrieved and then analysed both quantitatively and qualitatively, following the same procedures as those utilised for the study of Musk's company.

For the retrieval of the patent portfolios and the data of interest some queries have been developed according to the information that were required for the purposes of the analysis.

On a first instance, Tesla's Portfolio has been downloaded from Thomson Innovation Database, by utilizing the research by applicant: CMP=("Tesla OR Tesla Motors"). No other fields were required as the totality of the company's portfolio was required for the purposes of the research and no time limitation where needed, as the entirety of the company's patent portfolio has been release and therefore all results will be relevant for the study Furthermore, the company was founded in 2003, hence all patents can be deemed as recent enough to be part of the study, both under a technical point of view and when considering the life of a patent, that if renewed could last up to 20 years. The research resulted in 197 INPADOC Families and 746 patents. The list of patent has been then downloaded in order to access the main information about the patents. The export is dated 18 February 2015.

Through the analysis of the most occurring terms in the title of Tesla's patents, the keywords for the subsequent research in the portfolios' of Tesla's competitors have been found. It is important to underline that all the players in the market of electric vehicles, except from Tesla, and have as main productive activity the production of traditional internal combustion engines. For this reason, a wide research on their portfolio, like what has been done for Tesla's, would have resulted in the inclusion of an excessive number of patents encompassing all fields and applications. Therefore, in order to narrow the database search, the queries have been developed in order to limit the patents to those strictly related to the ones release by Tesla, that is Tesla's portfolio.

This has been done taking into consideration the most recurring terms in the titles of Tesla's released patents and the highest occurring IPC codes (4 Characters), once again from Tesla's portfolio analysis.

For what concerns the identification of the main competitors, all the companies currently producing and marketing electric or hybrid vehicle have been included. Furthermore, the main players have been identified, through the market shares and market sales in the European and United States markets for electric and hybrid vehicles. The competitors' list and relative retrieval queries can be found in the following table. Once again, the preliminary market analysis has been fundamental in determining the applicants that have been included in the study. The major market players have been included as the direct competitors of Tesla, as well as collaborating companies.

1	IC=(H01M OR H02J OR B62D OR B60L OR H02K) AND CTB=((electr* ADJ vehicle*) OR (electr* ADJ batter*) OR (batter* ADJ charg*) OR (charg* ADJ system*) OR (electr* ADJ batter* ADJ pack*) OR (charg* ADJ station*) OR (charg* ADJ method*)) AND CMP=("NISSAN" OR "AICHIMACHINE" OR "JATCO");	Nissan
2	IC=(H01M OR H02J OR B62D OR B60L OR H02K) AND CTB=((electr* ADJ vehicle*) OR (electr* ADJ batter*) OR (batter* ADJ charg*) OR (charg* ADJ system*) OR (electr* ADJ batter* ADJ pack*) OR (charg* ADJ station*) OR (charg* ADJ method*)) AND CMP=("GM");	General Motors – Chevrolet – Cadillac

3	IC=(H01M OR H02J OR B62D OR B60L OR H02K) AND CTB=((electr* ADJ vehicle*) OR (electr* ADJ batter*) OR (batter* ADJ charg*) OR (charg* ADJ system*) OR (electr* ADJ batter* ADJ pack*) OR (charg* ADJ station*) OR (charg* ADJ method*)) AND CMP=("TOYOTA" OR "CATALERCORP" OR "DIAHATSUMOTOR" OR "HINOMOTORS");	Toyota - Lexus
4	IC=(H01M OR H02J OR B62D OR B60L OR H02K) AND CTB=((electr* ADJ vehicle*) OR (electr* ADJ batter*) OR (batter* ADJ charg*) OR (charg* ADJ system*) OR (electr* ADJ batter* ADJ pack*) OR (charg* ADJ station*) OR (charg* ADJ method*)) AND CMP=("FORD");	Ford
5	IC=(H01M OR H02J OR B62D OR B60L OR H02K) AND CTB=((electr* ADJ vehicle*) OR (electr* ADJ batter*) OR (batter* ADJ charg*) OR (charg* ADJ system*) OR (electr* ADJ batter* ADJ pack*) OR (charg* ADJ station*) OR (charg* ADJ method*)) AND CMP=("BMW");	BMW
6	IC=(H01M OR H02J OR B62D OR B60L OR H02K) AND CTB=((electr* ADJ vehicle*) OR (electr* ADJ batter*) OR (batter* ADJ charg*) OR (charg* ADJ system*) OR (electr* ADJ batter* ADJ pack*) OR (charg* ADJ station*) OR (charg* ADJ method*)) AND CMP=("DAIMCHRY" OR "DETROITDIES" OR "MITSFUSO" OR "NUCELLSYS");	Daimler – Smart
7	IC=(H01M OR H02J OR B62D OR B60L OR H02K) AND CTB=((electr* ADJ vehicle*) OR (electr* ADJ batter*) OR (batter* ADJ charg*) OR (charg* ADJ system*) OR (electr* ADJ batter* ADJ pack*) OR (charg* ADJ station*) OR (charg* ADJ method*)) AND CMP=("HYUNDAIMOTOR");	Hyundai Motor
8	IC=(H01M OR H02J OR B62D OR B60L OR H02K) AND CTB=((electr* ADJ vehicle*) OR (electr* ADJ batter*) OR (batter* ADJ charg*) OR (charg* ADJ system*) OR (electr* ADJ batter* ADJ pack*) OR (charg* ADJ station*) OR (charg* ADJ method*)) AND CMP=("FIATSPA" OR "CHRYSLER" OR "COMAU" OR "FIATAUTO" OR "FIATCENTRES" OR "MAGNETIMARELLI");	FCA
9	IC=(H01M OR H02J OR B62D OR B60L OR H02K) AND CTB=((electr* ADJ vehicle*) OR (electr* ADJ batter*) OR (batter* ADJ charg*) OR (charg* ADJ system*) OR (electr* ADJ batter* ADJ pack*) OR (charg* ADJ station*) OR (charg* ADJ method*)) AND CMP=("PORSCHEHOLD" OR "VW" OR "KARMANN" OR "MANAG" OR "PORSCHE" OR "SCANIAAB");	Porsche – Audi – Volkswagen
10	IC=(H01M OR H02J OR B62D OR B60L OR H02K) AND CTB=((electr* ADJ vehicle*) OR (electr* ADJ batter*) OR (batter* ADJ charg*) OR (charg* ADJ system*) OR (electr* ADJ batter* ADJ pack*) OR (charg* ADJ station*) OR (charg* ADJ method*)) AND CMP=("RENAULT");	Renault
11	IC=(H01M OR H02J OR B62D OR B60L OR H02K) AND CTB=((electr* ADJ vehicle*) OR (electr* ADJ batter*) OR (batter* ADJ charg*) OR (charg* ADJ system*) OR (electr* ADJ batter* ADJ pack*) OR (charg* ADJ station*) OR (charg* ADJ method*)) AND CMP=("KIAMOTORS");	Kia Motors
12	IC=(H01M OR H02J OR B62D OR B60L OR H02K) AND CTB=((electr* ADJ vehicle*) OR (electr* ADJ batter*) OR (batter* ADJ charg*) OR (charg* ADJ system*) OR (electr* ADJ batter* ADJ pack*) OR (charg* ADJ station*) OR (charg* ADJ method*)) AND CMP=("VOLVOAB");	Volvo
13	IC=(H01M OR H02J OR B62D OR B60L OR H02K) AND CTB=((electr* ADJ vehicle*) OR (electr* ADJ batter*) OR (batter* ADJ charg*) OR (charg* ADJ system*) OR (electr* ADJ batter* ADJ pack*) OR (charg* ADJ station*) OR (charg* ADJ method*)) AND CMP=("MAZDA");	Mazda
14	IC=(H01M OR H02J OR B62D OR B60L OR H02K) AND CTB=((electr* ADJ vehicle*) OR (electr* ADJ batter*) OR (batter* ADJ charg*) OR (charg* ADJ system*) OR (electr* ADJ batter* ADJ pack*) OR (charg* ADJ station*) OR (charg* ADJ method*)) AND CMP=("PEUGEOT" OR "FAURECIA" OR "EMCONTECH");	Peugeot

Table 3 – Competitors Patents Queries

For the sake of a comprehensive analysis, aside form downloading the single company's portfolio, an overall export has been created including all the above selected automakers. This has been done for the purpose of conducting a comprehensive analysis: on a fist instance, the general export including all the applicants is studied and only afterwards

some selected companies are chosen to undergo a deeper analysis according to the information found in the overall patent export.

No limitations other than the IPC and the keywords have been imposed, in the retrieval of the patent lists. Later in the study it will be indicated that for data processing only the patents with earliest priority year after the year 2000 will be taken into consideration for a number of reasons, nonetheless all patents concerning the researched technology have been included in the download in order to have all the data readily available and only later define subsequent restrictions when deemed necessary.

As the information on patents are updated daily, as each date the status of a patent may vary and new applications and grants can be published, the following prospectus reports the date of download of each set of data utilised in throughout this paper, and the information retrieved are to be considered consistently with the download date. Some modification to the number of patent applications, granted patents and their status are to be expected at the time of the publication of the study, nevertheless, no relevant modifications to the patent portfolios of the various undertakings are to be expected so to change the findings of this paper.

The retrieved information on the various undertakings patent portfolios have been exported from Thomson Innovation Database through the export tool available in excel format, and data processing has been mainly done by the tools provided by said software. After the preliminary research, the data have been statistically analysed on order to identify the main trends in the portfolios, through Excel tools. Specifically, given the large amount of data exported from the patent database, Pivot Table functions have been mostly exploited, in order to visualize the most significant data and data combination, also through the subsequent use of visual aids such as charts and graphs when appropriate.

Out of the number of graphs and table that will be retrieved from the analysis, particularly for what concerns the analysis of the competitors' portfolio, only the most relevant ones will be inserted in the paper.

Moreover, being the patent situation an evolving manner on a daily basis, as well as the company market situation, the market and company's updated have been monitored everyday during the whole duration of the study.

The data will be analysed taking into consideration a variety of criteria, such as the trends over time of the development of the technology, the geographical distribution of the patents, and an estimation of the quality and the value of the patent portfolio will be given through the various methods listed previously in this paper. Once quantitative conclusions will be drawn it will be possible to state some hypothesis on the reasons behind the factual release and the possible short term and long-term consequences both on the company itself and on the market of electric vehicles.

Briefly, the analysis method has been the following: once the raw data have been downloaded and the file ordered and the relevant filters applied, a number of pivot tables have been created in order to easily filter the data and to understand the possible paths and trends in the application behaviours and patents characteristics of the various

applicants, to this purpose visual aid has been provided by the plots of appropriate charts and graphs to allow a first-sight-understanding. The data downloaded from the database interested both Tesla and its competitors, whose patent portfolio has been analysed under a more generic level to be able to compare Musk's company to the whole industry, and then specifically, the portfolio of the four major players have been considered to deepen the analysis. The choice of the four automakers to analyse has been based both upon market information and information retrieved from the analysis of the industry's portfolio of patent in the relevant technology, for example through the assessment of the companies owning the largest number of patents, who are owners of the more valuable patents or who has shown the more intense patenting activity in correspondence of the fields researched by Tesla and during Tesla's patenting activity, time-wise.

Through the combination of the data analysis and the theoretical knowledge it has been possible to give a sought and reasoned interpretation of the facts and figures, and to reach sound and logical conclusions.

6 TESLA'S PORTFOLIO ANALYSIS

This chapter will be concerning the quantitative analysis of the whole of Tesla's patent portfolio. As already mentioned, the company's portfolio has been exported from Thomson Innovation database and analysed through the tools available on Microsoft Excel. The method utilized for the selection of the patents coming to compose the export is illustrated in the "Methodology" chapter of this paper.

Tesla's Patent Portfolio consists in 746 (database retrieved from Thomson Innovation Patent Database 18th February 2015) among granted patents patent applications. According to the company's website, the factually released can be found in Appendix A. Tesla's decision to factually releasing all their patents involves all their active patents that are for the most part concerning the electric vehicle technology on batteries and the technologies related. It is important to recall that the Pledge is irrevocable and legally binding both on Tesla and on its possible successors owning the company's patents, despite this the company has not relinquished any rights on its patents, in order to to preserve its ability to enforce the Tesla Patents against any party not acting in good faith, hence practically the inherent value of the patents remains unchanged.

On a very superficial analysis of the Pledged patents list available on the company's legal section of the website, it can be noticed how the most recurring terms are those referring to the electric vehicles' batteries, charging systems and the related technologies, already evidencing a strong focus on the development of a battery with solid performances and an efficient charging system, to address the issues concerning most potential buyers. Also, it seems that powertrain development is not a strong part of the patent investments, despite its commercial collaboration with other automakers are in fact for the provision of powertrain components rather than the batteries and systems thereof.

The entirety of Tesla's portfolio has been taken into consideration for the purposes of the analysis. No limitations have peen imposed on the regards of the Earliest Priority Year: since Tesla was founded in 2003 all their patents can be considered relatively new and relevant for the technological field. Furthermore, in order to individuate the fields of major interest for the subsequent research, the whole portfolio has been searched so to understand the fields of major interest of the company, data which will then be used on order to appropriately select the competitors patent pool, as no company focusing exclusively on electric car development and commercialization exists, aside from Tesla itself.

Several computation and counts have been performed on the information provided by the database, but particular attention has been given onto the analysis of the IPC in order to understand the technical field of higher interest for the company and the various time and geographical trends that characterise the portfolio. Also, the citation analysis has been carried out in order to understand whether Tesla is possessing some particularly valuable patents.

6.1 IPC OCCURRENCES

In order to further identify the focus of the R&D efforts of Tesla's the most recurring IPC Codes have been identified.3 As an instrument for investigating the state of the art in given fields of technology, the occurrences of determined IPC codes shape the characteristics of a portfolio.

Tesla's portfolio can be considered quite narrow: the majority of patents fall under the following section H – Electricity, with focus on the three subclasses H01M, H02J; and to the subclass B60L with in the group B – Transportation.

This clearly limits the scope of the Company's R&D to the development of electric vehicles technologies and of the batteries and electric apparatus to be used in said vehicles.

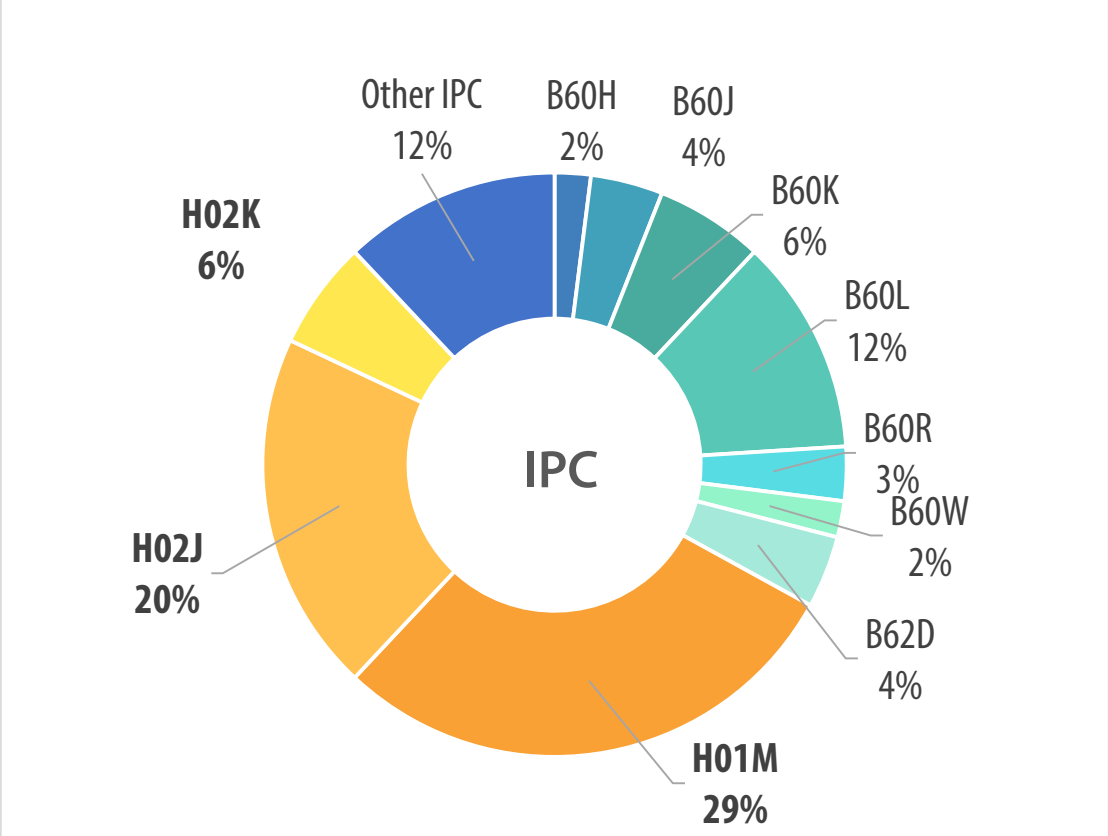

Chart 10 – Tesla's IPC Subclass Occurrence in Percentages

3 "The IPC is a hierarchical system which, in its fifth edition (1990), subdivides technology into 8 sections, 118 classes, 620 sub-classes and approximately 60,000 groups ("main" groups and "sub"-groups), each having a symbol. The symbol or symbols representing the invention described in any patent document are usually indicated on the patent document by the industrial property office which issued it. Thus, the document will be retrievable, according to its subject matter, with the help of the IPC. The IPC is now applied by about 70 industrial property offices which, taken together, issue over 90% of the patent documents of the world." [46]

IPC Full	Description	#	%
B60H	Arrangements or adaptations of heating, cooling, ventilating, or other air-treating devices specially for passenger or goods spaces of vehicles	19	2%
B60J	Windows, windscreens, non-fixed roofs, doors, or similar devices for vehicles; removable external protective coverings specially adapted for vehicles	30	4%
B60K	Arrangement or mounting of propulsion units or of transmissions in vehicles; arrangement or mounting of plural diverse prime-movers in vehicles; auxiliary drives for vehicles; instrumentation or dashboards for vehicles; arrangements in connection with cooling, air intake, gas exhaust or fuel supply of propulsion units in vehicles	48	6%
B60L	Propulsion of Electrically powered vehicles; supplying electrical power for auxiliary equipment of electrically propelled vehicles; electro-dynamic brake system for vehicles in general; Magnetic suspension or levitation for vehicles; Monitoring operating variables of electrically propelled vehicles; Electric safety devices for electrically propelled vehicles	102	12%
B60R	Vehicles, Vehicle Fittings, Or Vehicle Parts, Not Otherwise Provided For	26	3%
B60W	Conjoint control of vehicle sub-units of different type or different function; control systems specially adapted for hybrid vehicles; road vehicle drive control systems for purposes not related to the control of a particular sub-unit	17	2%
B62D	Motor vehicles; trailers	36	4%
G01R	Measuring electric variables; measuring magnetic variables	22	3%
G06F	Electric digital data processing	62	7%
H01M	Process or means, e.g. batteries, for the direct conversion of chemical energy into electrical energy	242	29%
H02J	Circuit arrangements or systems for supplying or distributing electric power; systems for storing electric energy	169	20%
H02K	Dynamo-electric machines	54	6%

Table 4 – Tesla's IPC Subclass Occurrences (definition from [43])

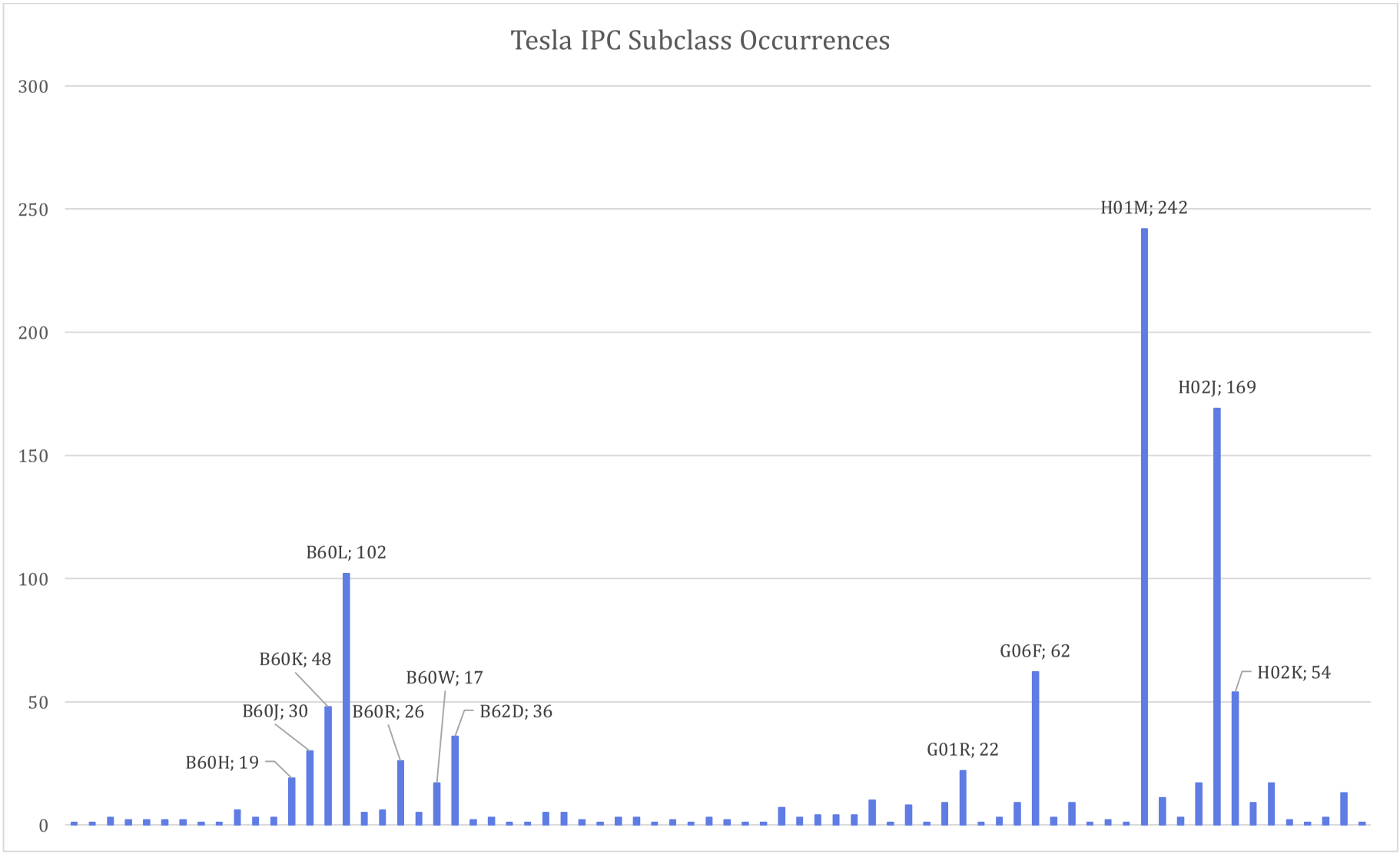

Chart 11 – Tesla's IPC Subclass Occurrence

Already from this preliminary analysis of the most recurrent IPC, which at four digits can only give a rough idea of the field of highest activity of the R&D department of the company, the most recurrent IPC is that referring to the batteries, followed by the systems of storing electrical energy. Hence the strengths of Tesla seem to be confirmed to be on the development of batteries and systems thereof. The other classifications are those related to the other and the auxiliary system for the production of an electric vehicle.

This first analysis on the portfolio's first level IPC allows to grasp the general fields of interest of the company, and the major field where Tesla is more active with regard in the patenting activity. Furthermore, this first level analysis of the IPC has been useful in order to define the search fields for the subsequent competitors' analysis.

Furthermore, it is can be notices how determined IPC stand out over the entire pool: B60L, H01M, H02J and H02K, the only ones with occurrences over 50.

In order to increase the level of details of the analysis, a further count has been performed on the IPC, this time at 8 digits.

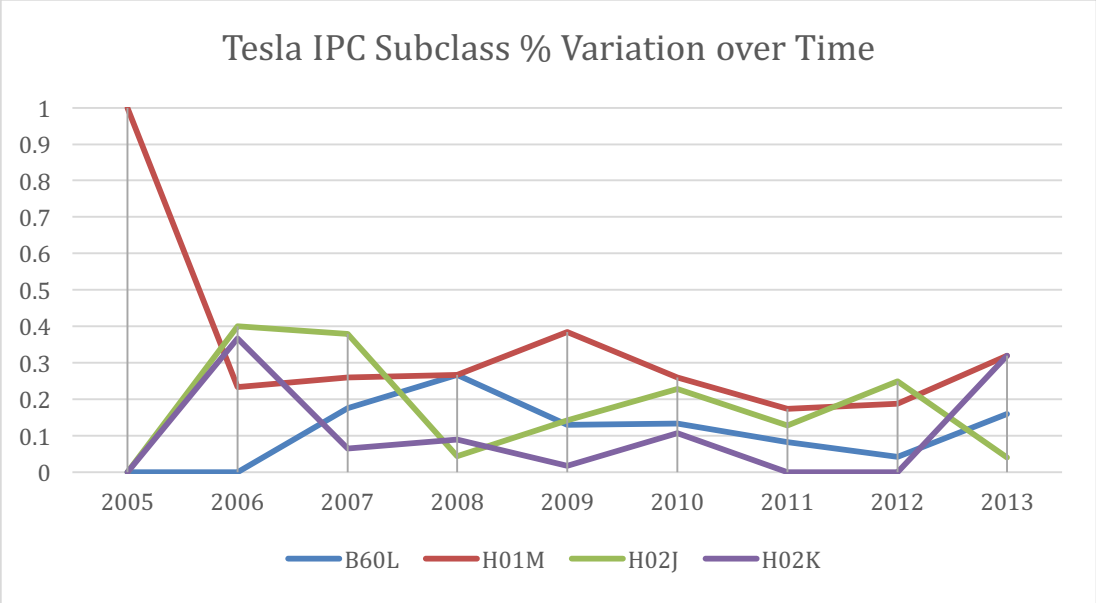

Chart 12 – Tesla's IPC Subclass Percentage Variation over Time

B60L	Propulsion of Electrically powered vehicles […]
H01M	Process or means, e.g. batteries, for the direct conversion of chemical energy into electrical energy
H02J	Circuit arrangements or systems for supplying or distributing electric power; systems for storing electric energy
H02K	Dynamo-electric machines

Table 5 – IPC Explanation (definition from [43])

The above chart, plots the four more occurring IPC percentage over the total IPC occurrences in the considered year in order to understand the changes in R&D over time of the company[4].

It is immediate how the company focus has always been on the batteries and related and auxiliary technologies. Powertrain-related patents have been steadily patented throughout the years but with a decreasing trend.

In order to deepen the level of details of the analysis, a further count has been performed on the IPC, this time at 8 digits.

The following histogram clearly the occurrences of all the 8-digit IPCs present in the company's portfolio. For the sake of reporting only the most relevant codes, only those with occurrences greater than 10 have been considered.

4 The reported percentages do not sum up to 1 due to the missing IPCs, as only the most important have been considered in the analysis.

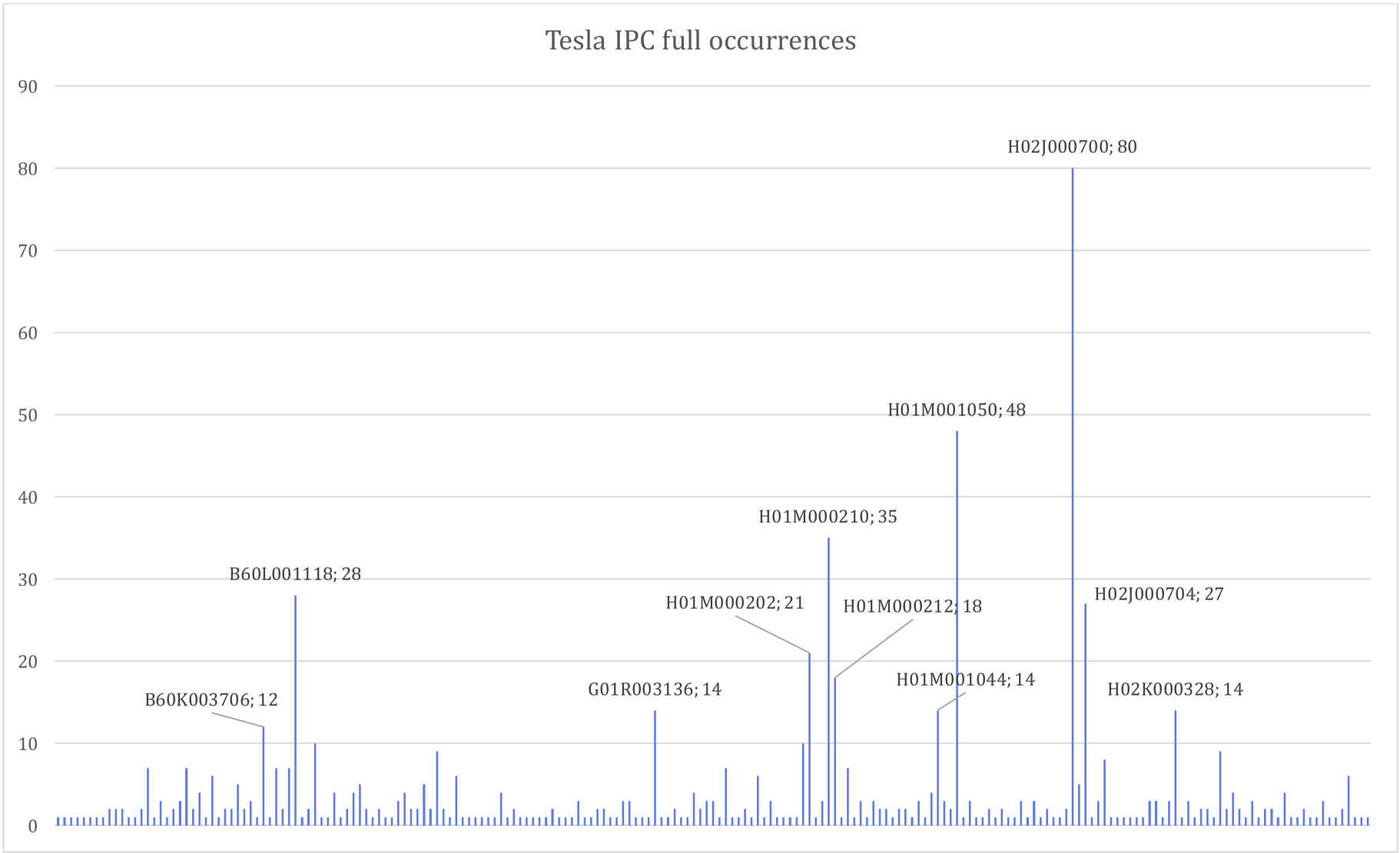

Chart 13 – Tesla's IPC Full Occurrences

IPC Full	Description	#	%
B60L001118	Electric propulsion with power supplied within the vehicle using power supplied from primary cells, secondary cells, or fuel cells	66	18%
H01M000210	Process or means, e.g. batteries, for the direct conversion of chemical energy into electrical energy. Constructional details, or processes of manufacture, of the non-active parts Mountings; Suspension devices; Shock absorbers; Transport or carrying devices; Holders	52	14%
H01M001050	Primary cells; Manufacture thereof	93	25%
H02J000700	Circuit arrangements for charging or depolarising batteries or for supplying loads from batteries	116	31%
H02J000704	Circuit arrangements for charging or depolarising batteries or for supplying loads from batteries for charging batteries from ac mains by converters Regulation of the charging current or voltage	44	12%

Table 6 – Tesla's IPC Full Occurrences (definition from [43])

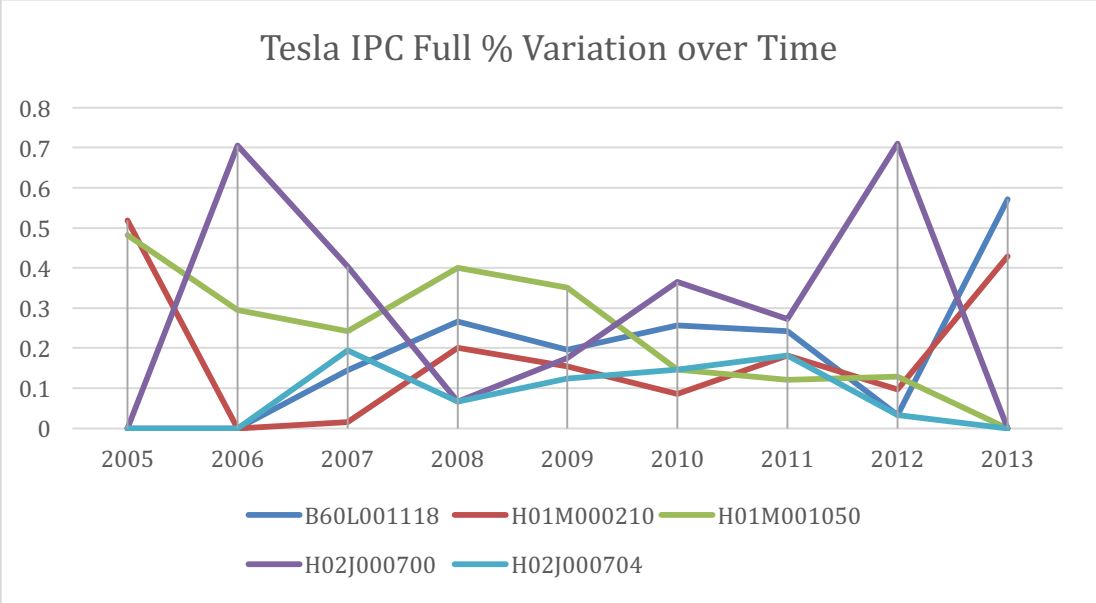

Chart 14 – Tesla's IPC Full Percentage Variation over Time

With the further deepening of the level in detail related to the technical field of the company. Most of the patents are concerning the development of the batteries needed to generate electrical power, charging methods of the vehicles batteries and the circuit arrangement necessary, follows a relevant portion of patents the structural elements to be

employed in combination of said charging systems. Another relevant section comprises the testing system for said batteries and the dashboard controls.

Here it is apparent how the propulsion-related filings cover a relatively lower percentage of the filings, however, when considering this class of patents, the most recurring one is B60L 11/18, as can be seen from the above table.

This further stresses the importance that patents related to the batteries powering the vehicle cover in the company's portfolio. Tesla has been able to stand out in the market, not just because its company proposition and philosophy, and the relative low number of producers of luxury cars in the market, but mainly because of the superiority of their technology in the matter of batteries and charging systems thereof. The company's Supercharger technology and the long range autonomy batteries are one of the stand-out characteristics when compared to the other market players, regardless on the price segment where they market their products.

When considering the time evolution of the patents IPCs along the filing history of the company, it can be seen how Tesla has been gradually focusing lesser and lesser attention on the development of the actual batteries, and has shifted more resources onto the developing of patents on the transmission of the power generated by the battery and the propulsion system. Patents regarding charging systems have been the replacing those concerning batteries as for occurrences, since 2009.

6.2 GEOGRAPHICAL TRENDS

In order to identify the geographical scope of a company, the count of application country and priority country can be a good indication of the addressed market.

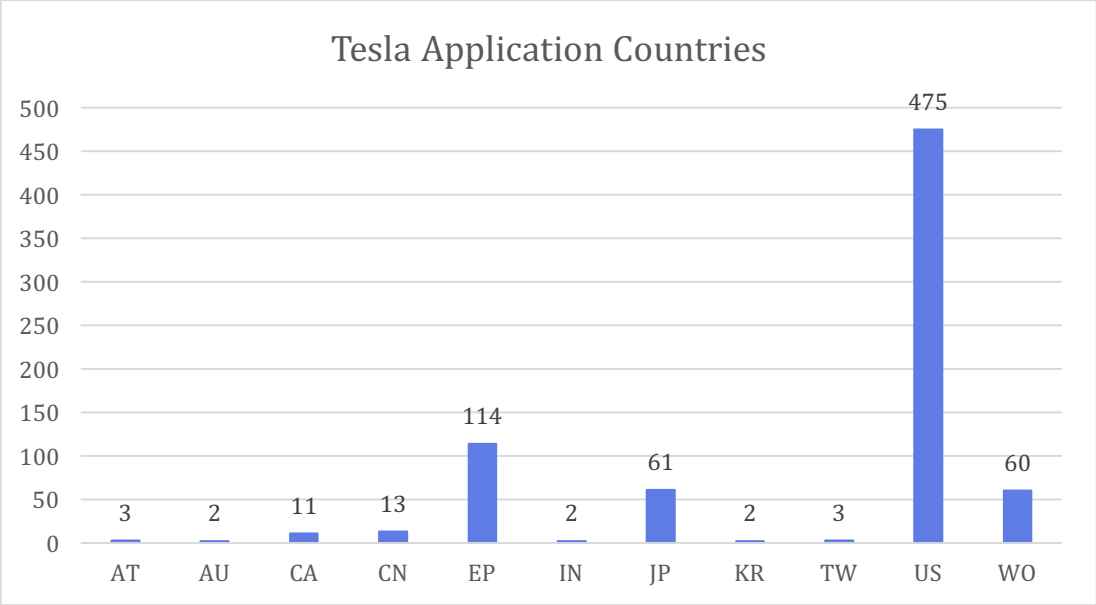

Chart 15 – Tesla's Application Country

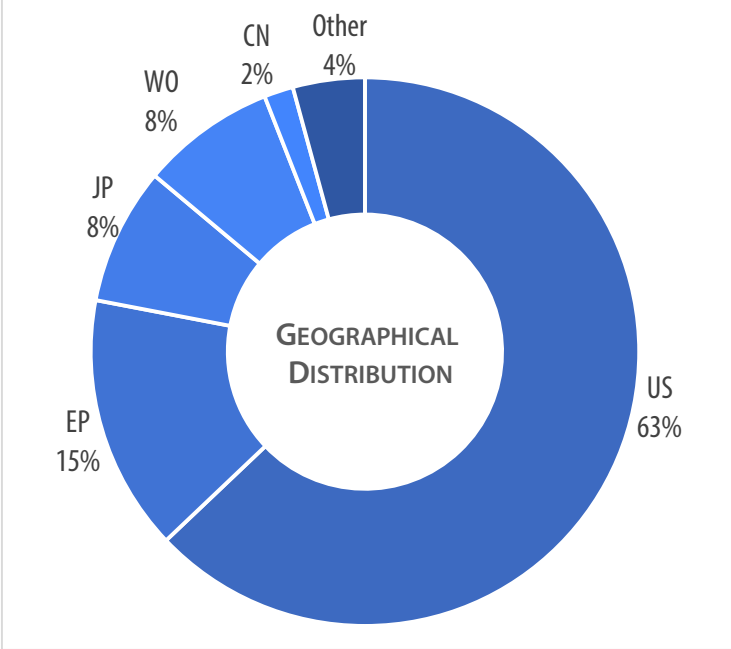

Chart 16 – Tesla's Percentage Geographical Distribution

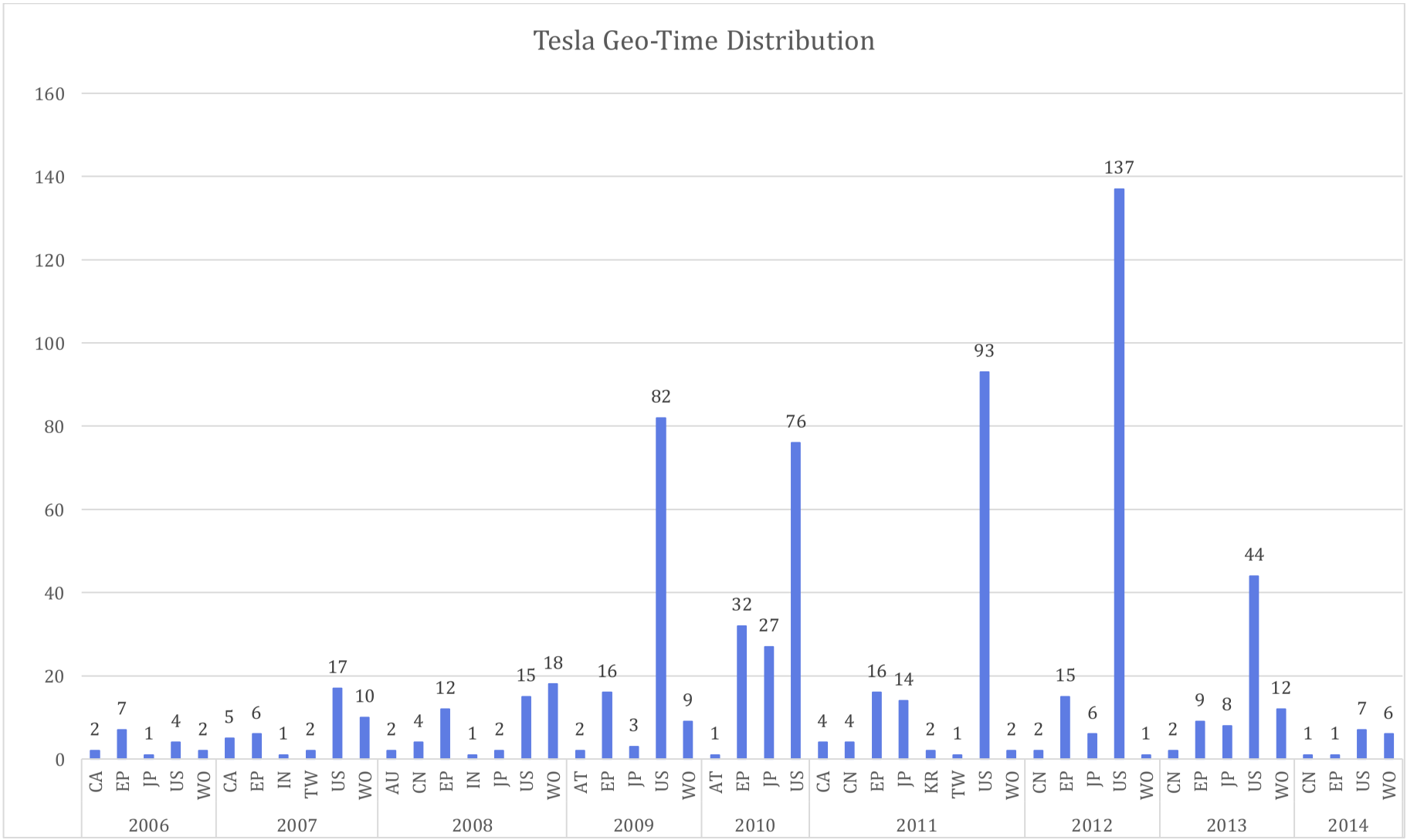

Chart 17 – Tesla's Geo-Time Distribution

Tesla, as an American company, up to the later years has limited its geographical scope to the United States market. The majority of patents have been processed by the USPTO. Specifically, the Company based in Palo Alto has been benefiting from the dynamic and innovative environment of the Silicon Valley. Their geographical focus is specifically the US market, and hence their patents have been filed mostly at the USPTO, with some extension to the European Patent Office and Japan, both markets where Tesla has entered and where the adoption of electric vehicles is increasing. Furthermore, as already stated the issuance office contributes to the patents' value: a patent granted by the Chinese SIPO is considered of far lesser value than a patent granted by the EPO, and even more by the USPTO. This is due to various factors, one is of course concerning the market characteristics and potential consumer base in the different countries: for what concerns electric vehicles, as already seen, the US market is the one that shows immediate higher potential, this is due to the consumers propensity to the adoption of electric vehicles, the government incentives (e.g. by 2020 all vehicle in California will have to be either BEV or PHEV), the presence of complementary assets, such as the capillary and growing network of Supercharging stations. Despite the Chinese market would seem attractive as for consumer base it must be remembered the overcharged price for Tesla's Model S (mainly due to the luxury and import taxes imposed by the Beijing) and the numerous domestic alternative for electric vehicles. Generally speaking then a patent granted by the SIPO is not considered a strong patent due to the over patenting tendency, and the Those might be some of the strategic reasons for which the majority of patents are US-granted.

Furthermore, it can be noticed also that in the last years, Tesla started to file patents in Asiatic countries aside from Japan where the electric vehicles technology was first developed by Toyota. As understandable and as stated by Tesla's itself in their last letter to shareholders, blooming economies, like the Chinese market, in Asia could signify high sells and rapid diffusion of Tesla's products. This is due to growing wealth of said areas, and the search for luxury products, particularly in places like Beijing and Shanghai. Furthermore, the environmental issues that characterise developing countries might lead to a greater number of consumers willing to switch to electric vehicles and possible governmental incentives, both for the consumers that would be lead to a more convenient purchase, but also for manufacturers of greener means of transportation. This might lead to high incentives in establishing productions or, at least, increase the market presence in such countries, hence the need of expanding the patent protections to their intellectual property state offices as well. over-granting tendency, that has been characterizing the Chinese patent office in the latest years. Nevertheless, there still is reluctance in filing patents in the Chinese market, for the fear of infringements and made-in-china copies of the technologies, which though now should not be any longer an issue given the proposition of Tesla of factually releasing their patents. On the other hand, protection on the Chinese market shall be sought due to the possibility of re-engineering of the technology or even, filing of said patent on the Chinese market. Of course, now that also the SIPO has introduced absolute novelty as requirement, the filing of an existing patent elsewhere outside the US should be unfeasible, nevertheless as mentioned previously, the quality of the review process is not outstanding and often

patents are granted regardless. Hence a possible scenario could be a wholly domestic Chinese producer filing and obtaining a patent belonging to Tesla, but for which the company has not though to extend the protection at the SIPO. The consequent step would then be the domestic producer suing Tesla for patent infringing in the commercialized vehicles on the Chinese market, which would in turn precluded any further expansion on the People's Republic of China's territory of Tesla, or at least, possibly, high licensing costs to be bore by Tesla to the domestic patent owner in order to be allowed to still sell its Model S, and soon X. of course, Tesla might attempt to invalidate the patent on the basis of failing the requirement of absolute novelty, but the Chinese courts have been often found to be leaning more towards the domestic party in similar IP disputes, and even so the costs associated to such an event would be relevant both on an economic and on a time level. This might seem as an intricate reasoning, but it is already common practice when company fail to appropriately and timely protect their trademark in China, so it can be expected to be expanded to the patents, particularly when concerning the practice of factually releasing the patents, and highly technical and costly technologies to be developed. Tesla should thus be on the look-out when concerning a growing market such as the Chinese one, where domestic firms still have relatively limited costs of production and a potentially enormous consumer base, give the latest car-purchasing frenzy, particularly in the first and second tiers cities, such as Beijing, Shanghai, Guangzhou, and Shenzhen; Chongqing, Chengdu, Wuhan and Xiamen.

6.3 TIME EVOLUTION

The temporal trends are important in assessing the characteristics of a company's portfolio. It gives an indication of the efforts in Research and Development of a company over the years and their inventive activity and quality.

It can be seen that Tesla's portfolio has been growing steadily until 2012, when the inventive activity of the company has experienced an abrupt decrease.

The decrease in inventive activity is coincident with the release and the beginning of the production of the first Model S. Hence, it seems that the company's R&D has been focused on the development of the first technology for their leading product, and that the same technology will be utilised in the making of the following products for the company, Model X and Model 3, of course provided small adjustments. This means that Tesla's product development and research efforts have been focused on developing the basic technology characterising their products, namely the long-range batteries and the fast charging related systems.

Another reason for the decrease in patent applications filing form 2012, aside from the reduced need of innovating, could be the cut in the financial resources devoted to the R&D departments. Given the lack of revenues from the foundation of the company until 2012, and the start of production of the first Model S cars in 2012, it might be that funds were moved from the research department in order to finance the actual production of the commercialized vehicles.

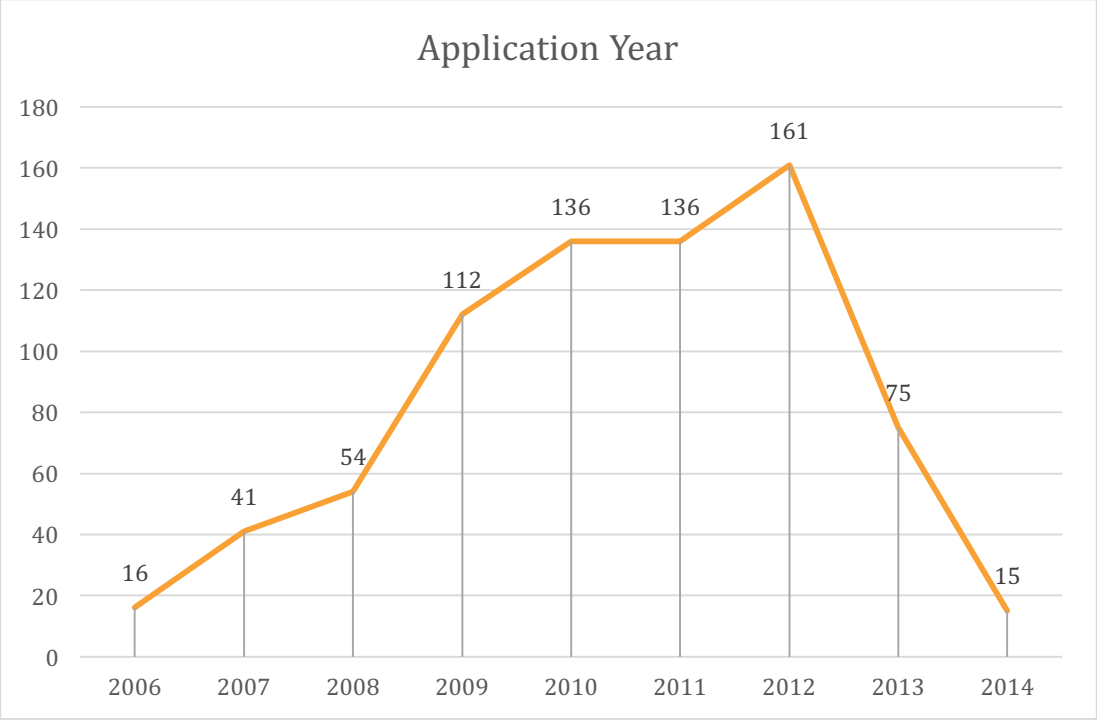

Chart 18 – Tesla's Application Years

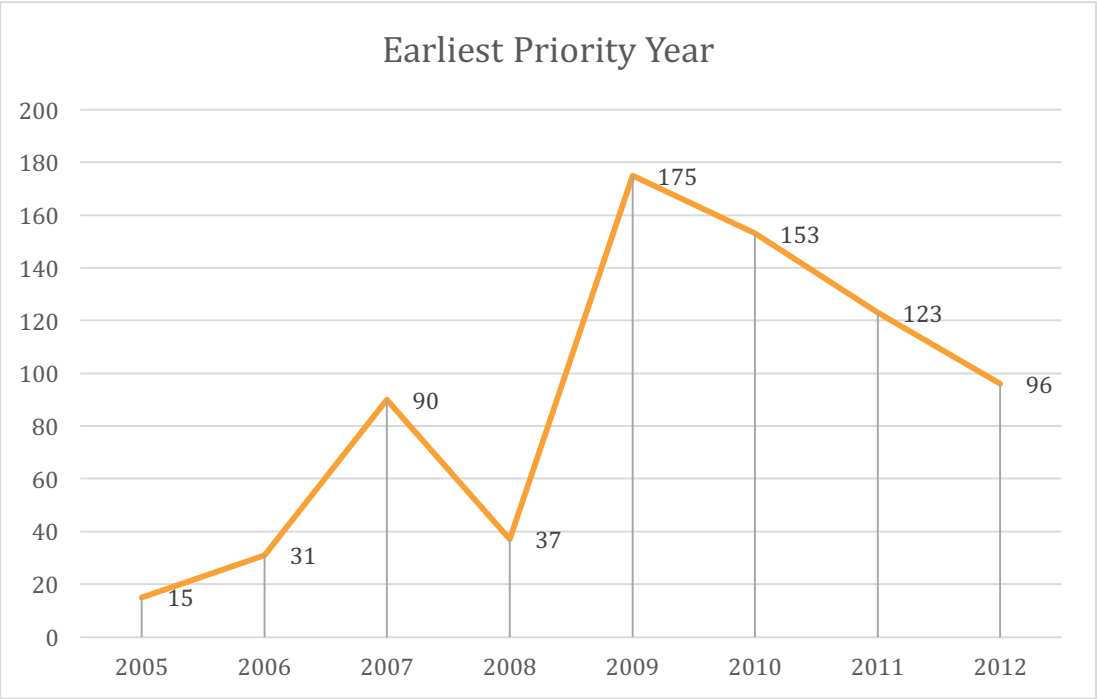

Chart 19 – Tesla's Earliest Priority Yeas Distribution

Furthermore, it can be shown that since the foundation of the company, it took two year to start developing some patentable technologies, and the years of highest activity followed the first world financial crisis in 2008. Data that are consistent with the assumption that in years of economic difficulties the corporations' inventive activity is spurred and more patents are developed.

Also, great capital investments have been made for the establishment and development of the company's Gigafactory, and hence lower effort has been directed towards, partly unnecessary given the recency of the new Model X market release, further and impellent R&D investments.

Additionally, a spin off of the company, Tesla Electric has been incorporated for the production of household batteries, solar-powered with high capacitive and storage power. This might have caused a shift in the company's original R&D efforts into the new corporation and product.

6.4 CITATIONS ANALYSIS

Citations can be an indication of a patent's value: when submitting an application for an invention patent, the applicant is required to provide the relevant reference to the prior art related to his work, and from which his work differentiates. Citations to antecedent patents can be made both by the patent applicants, or added later during the search report by the examiner.

Citations are particularly relevant, not exclusively in relation to the intellectual property field as an indication of the state of the art and the technical development, but also by the R&D departments of the firms as citations are indication of the patent's value. In turn, a patent portfolio constituted of highly cited patents indicates high values of intangible property of the company. Furthermore, citations can be used as a tool to develop strategic behaviours of a firm and o knowledge spillovers and innovative performances.

Hence, citations can be seen as a measure of the quality of a patent, the higher the number of forward citations, citations received by a patent, the higher is the value of the patent. *"During the examination process, the examiner searches the pertinent portion of the "classified" patent file. His purpose is to identify any prior disclosure of technology [...] which might anticipate the claimed invention and preclude the issuance of a patent; which might be similar to the claimed invention and limit the scope of patent protection [...]; or which, generally, reveal the state of the technology to which the invention is directed [...]. If such documents are found they are made known to the inventor and are cited in any patent which matures from the application [...]. Thus, the number of times a patent document is cited may be a measure of its technological significance."* [44]

A patent which is highly cited over a long period of time, is a patent that has substantially contributed to the development of the technology and that has been the base upon which a specific technology has been developed. In turn, it can be understood that a patent application with significant number of backward citations, is either a very weak patent, in case the citations are subsequent to the actual filing of the patent and made during the review of said patent, or a very specific patent, with its scope limited and narrow claims. Generally, whilst highly cited patents are highly valued, patents with a great number of citations are not considered to be very important in the technology scenario.

For the purpose of the analysis only the first patents both for number of forward and backwards citations have been reported in the following tables.

Title	Publication Number	Earliest Priority Year	IPC 4 digits	Count of Citing Patents
Electric Vehicle Communication Interface	US20090021385A1	2007	G08B	36
Morphing Vehicle User Interface	US20110082627A1	2009	B60W, G06F	25
Sealed Battery Enclosure	US20100136402A1	2009	H01M	25
Electric Vehicle Communication Interface	US7698078B2	2007	G01R, G06F	23
Dual Motor Drive And Control	US20100222953A1	2009	G06F	23

System For An Electric Vehicle				
Multi-Mode Charging System For An Electric Vehicle	US20090143929A1	2007	B60W, G06F	23
System For Optimizing Battery Pack Cut-Off Voltage	US20100188043A1	2009	H02J, G06Q	22
Battery Pack Thermal Management System	US20090023056A1	2007	H01M, B23P, B60H	21
Battery Charging Based On Cost And Life	WO2009012018A2	2007	B60L, H02J	20
Battery Charging Time Optimization System	US20100138092A1	2009	G06F, H02J	19
Control System For An All-Wheel Drive Electric Vehicle	US7739005B1	2009	B60L, G06F	19
Mitigation Of Propagation Of Thermal Runaway In A Multi-Cell Battery Pack	US7433794B1	2007	G06F, H02J	19
Adaptive Audible Feedback Cues For A Vehicle User Interface	US20110082618A1	2009	G06F, B60Q	17
Multi-Mode Charging System For An Electric Vehicle	US20090140698A1	2007	H02J	17
Method And Apparatus For Mounting, Cooling, Connecting And Protecting Batteries	WO2006124663A2	2005	H01M	16
Traction Control System For An Electric Vehicle	US7747363B1	2009	B60L, G06F	16

Table 7 – Tesla's Most Cited Patents

Tesla's situation is worth considering, as the number of highly cited patents is very limited, and with a relatively limited number of citations, and all those patents are older patents with publication years[5] ranging from 2005 and 2009. On the other side, the weakest patent applications are those with the more recent earliest priority years. Of course partly this trends must be related to the lesser time the newest patents have been published, but when limiting the analysis to patents published the latest in 2013, and given the rapid pace of the technology evolution, two years are more than sufficient for other technology developers to become aware of the new patent and acknowledge its relevancy, if the case.

Consistently with the IPC analysis, it can be seen that most of the highly cited patents are those belonging to the H01, H02 and B60 IPC classes. In turn the patents with the highest number of backward citations belong to a variety of classes, which do not belong to the strongest IPC classes for numerosity of application in Tesla's portfolio. Those weaker patents are concerning mainly user interfaces, and thermal control of the battery packs. On the other hand, among the most cited patents from Tesla's portfolio we can find patents related to the charging systems of batteries. Specifically, the patents on "Multi-mode charging system for an electric vehicle" are the most valuable patents in Tesla's portfolio as they are those concerning with the Superchargers technology.

5 Publication year is considered and not Priority year as it gives a more precise indication on the trend in citations from the moment the technology has actually been disclosed.

This would underline the superiority of Tesla's chargers, which is widely recognised, and indicate the clear intention of the company to release the patents with the aim of the automatic standard imposition.

Deepening the analysis, it can be noticed how the move by Tesla's management of the factual release of the patents, happened at a time when the company has slowed its innovative activity with respect to the previous years and when it appears that the quality of the patents has substantially decreased: Tesla is conscious of the declining quality of their Intellectual Property and by releasing its patents is hoping to contain the possibility of lawsuits by other patents rights' holders with the implicit slogan "I will not sue, as long as I will not be sued"[6]. In fact, Tesla's patent cannot count on a very high number of citations, especially when compared to the competitors portfolios and single patents. Hence, if taking into consideration the number of forward citations as the major criterion for assessing the quality of a single patent, and to a larger extent of the portfolio as a whole, Tesla seems to hold a relatively weak position over the filed. This supposition is further strengthened by the incidence of backward citation of the patents composing the portfolio.

Title	Publication Number	Earliest Priority Year	IPC 4 digits	Count of Cited Patent
Vehicle battery pack thermal barrier	US8875828B2	2010	B60R, B60K, B62D, F41H	89
Integration system for a vehicle battery pack	US8833499B2	2010	B60R, B62D, F41H	89
Vehicle Battery Pack Thermal Barrier	US20130153317A1	2010	B60K	89
Integration System for a Vehicle Battery Pack	US20120160583A1	2010	B60K	89
Vehicle user interface with proximity activation	US8892299B2	2009	G06F	88
System for absorbing and distributing side impact energy utilizing an integrated battery pack and side sill assembly	US8702161B2	2010	B62D	88
System for Absorbing and Distributing Side Impact Energy Utilizing an Integrated Battery Pack and Side Sill Assembly	US20130088044A1	2010	B62D	88

6 "A party is "acting in good faith" for so long as such party and its related or affiliated companies have not:
• asserted, helped others assert or had a financial stake in any assertion of (i) any patent or other intellectual property right against Tesla or (ii) any patent right against a third party for its use of technologies relating to electric vehicles or related equipment;
• challenged, helped others challenge, or had a financial stake in any challenge to any Tesla patent; or
• marketed or sold any knock-off product (e.g., a product created by imitating or copying the design or appearance of a Tesla product or which suggests an association with or endorsement by Tesla) or provided any material assistance to another party doing so" [36]

Vehicle User Interface with Proximity Activation	US20110082616A1	2009	B60W, G01C, G06F	88
System for absorbing and distributing side impact energy utilizing a side sill assembly with a collapsible sill insert	US8696051B2	2010	B62D	86
System for Absorbing and Distributing Side Impact Energy Utilizing a Side Sill Assembly with a Collapsible Sill Insert	US20130088045A1	2010	B62D	86
Adaptive soft buttons for a vehicle user interface	US8818624B2	2009	G06F, B60K, G01C	79
Adaptive Soft Buttons for a Vehicle User Interface	US20110082619A1	2009	G06F, B62D	79
Coolant de-aeration reservoir	US8448696B2	2010	F28D	77
Coolant De-Aeration Reservoir	US20120180997A1	2010	F28D	77
Rotor temperature estimation and motor control torque limiting for vector-controlled AC induction motors	US8773058B2	2010	H02P, H02H	76
Rotor Temperature Estimation and Motor Control Torque Limiting for Vector-Controlled AC Induction Motors	US20120007532A1	2010	H02H	76

Table 8 – Tesla's Most Citing Patents

Despite covering different technological fields than those characterizing the company the incidence of backward citations is considerably higher than that of forward ones, and even more, given the patents over which Tesla is not most advanced in the market are the same which seem the weaker citation-wise and the latest filed over time, it is likely that Tesla might be incurring in possible infringing activity and possible competitors' request for invalidation. This argument is strengthening the alleged reason for which Tesla is hoping to achieve some sort of tacit non-belligerence agreement market-wise.

The last prospectus shows also a decreasing trend in the value of Musk's patents, when considered against time. The most powerful patents date back to the beginning of the company's life, whilst the weakest patents are all filed in the last 5 years, this is a feature of, not only the reported patents in the above tables, but of the whole portfolio, when comparing citations against time.

7 COMPETITORS' PORTFOLIO ANALYSIS

Another tool that can be used to assess the reasons behind the decision of releasing the company's patent portfolio is the analysis of the Competitors' patents on the related fields. The assessment of Tesla's competitors' patent portfolios on the electric vehicles' technologies, and in particular on battery charging systems that has been shown to be main technology developed by Musk's company.

The major competitors have been identified through the market analysis that has been carried out previously in the study. Furthermore, to the existing market players present on the market with electric vehicles, potential entrants' portfolios have been identified.

According to the results of the resulting portfolio investigation, it will be possible to identify the players with higher patent quality and quantity and those that might be interested in using Tesla's released patents.

For convenience, the overall analysis of the technology has been carried out considering the entirety of the patents regarding the electric vehicle technology, regardless on the applicant. To this purpose all producers of electric and hybrid vehicles have been included in a search on Thomson Innovation Database, according to the search keywords and IPCs that have been individuated during Tesla's portfolio analysis. In fact for the comparison on the patent quality, value and technology available to the various market players, only the segment of the technology of highest relevancy to Tesla have been taken into consideration.

Once the most important patents among the competitors' ones have been identified, specific investigations on the single player have been carried out.

The main competitors have been identified through the market analysis, according to the electric cars available on the market and to be released in the coming year.

The queries run on Thomson Innovation Patent Database have been identified after the analysis of Tesla's Portfolio, according to the most occurring data and

For what concerns limitation on the priority years, in order to retrieve only relevant patents from the Thomson Innovation Database, all the provided data refer to the patent pool with limitation to the earliest priority year to the year 2000. This has been done for multiple reasons, first of all in order to obtain only patents that is granted and maintained for the entirety of their possible life, secondly give the rapid development of the technology it would be illogical to keep in the analysis obsolete patents, no longer used in today's cars and lastly, in order to give comparable figures with respect to Tesla's portfolio. Understandably this limitation was not necessary for Tesla's portfolio, which has been retrieve in its entirety due to the foundation date of the company, 2003.

7.1 PORTFOLIO COMPOSITION

As already stated, the choice of the competitors has been made according to the market data regarding the currently available electric vehicles and hybrid vehicles on the market for purchase or pre-order, and the announced vehicles for the upcoming two years.

Some possess a wide range of patents and some only few. Some producers might be outsourcing the production of particular components of the produced vehicles, which is the case of the Toyota and Daimler partnerships with Tesla for the production of the batteries for their electric cars.

The following table shows the number of patents owned by each producer and their relative presence in the patent database created for the research.

Immediately these figures can give an indication on the main competitors, technology wise of Musk's company.

Electric Car Producer	Number of Patents Found[7]	Relative presence
BMW	42	2%
Fiat	63	3%
Ford	238	11%
GM	251	11%
Hyundai	68	3%
Daimler	95	4%
Nissan	371	17%
Toyota	746	34%
Porsche - VW	59	3%
Renault	122	6%
Kia	16	1%
Volvo	34	2%
Mazda	14	1%
Peugeot	81	4%

Table 9 – Considered Competitors

Technologically speaking when comparing the quantity only of the patents on the same field as the majority of Tesla's patents, Toyota, Nissan, Ford and General Motors are the patents' holder with the largest portfolios.

7 No limitation on the Earliest Priority Year have been set at this time, filers will be later used when appropriate.

This, together to the patent quality that will be later investigated on a more specific level, might already sets apart those producers that might be willing to exploit Tesla's factually released patent from those that might be challenging Tesla's patent validity for competition hindering purposes.

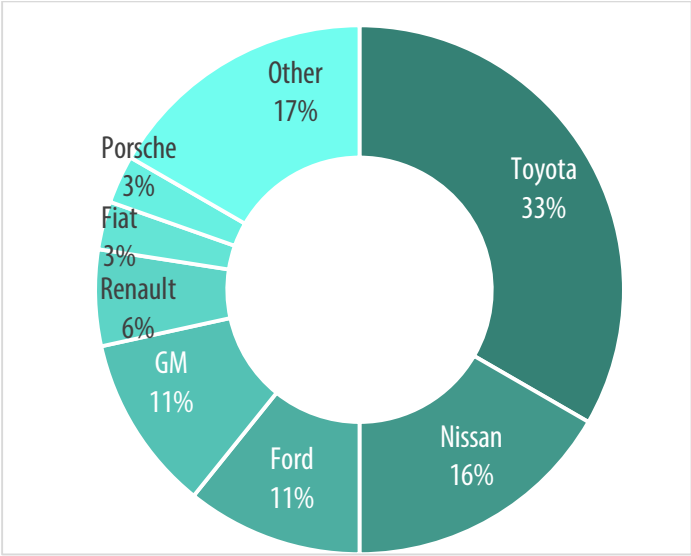

Chart 20 – Competitors Percentage Portfolio Presence

7.2 IPC OCCURRENCES

The composition of the IPC codes of the patent portfolio created by the inputted queries is of course limited to the chosen IPC. Nevertheless, the actual composition of the IPCs' occurrences shall be further investigated, in order to better understand whether Tesla's most valuable patent and technology development efforts are concentrate in the same areas as those of the competitors. This particular comparison will be able to give an indication on whether some collaboration and patent sharing through the strategic move of patent factual release it is possible or whether all major technology developers focus their R&D efforts in one specific segment, giving rise to possible invalidation lawsuits.

Furthermore, this investigation can be relevant also under a strategic point of view, in order to see which are the saturated segments of the market and which are the less crowed ones, possibly, to give an indication on which technologies are the ones with highest development rate and which are those where more room of improvement is left.

IPC Full	Description	#	%
B60K	Arrangement or mounting of propulsion units or of transmissions in vehicles; arrangement or mounting of plural diverse prime-movers in vehicles; auxiliary drives for vehicles; instrumentation or dashboards for vehicles; arrangements in connection with cooling, air intake, gas exhaust or fuel supply of propulsion units in vehicles	531	11.98%
B60L	Propulsion of electrically-propelled vehicles supplying electric power for auxiliary equipment of electrically-propelled vehicles; electro-dynamic brake systems for vehicles in general; magnetic suspension or levitation for vehicles; monitoring operating variables of electrically-propelled vehicles; electric safety devices for electrically-propelled vehicles	1189	26.83%
B60W	Conjoint control of vehicle sub-units of different type or different function; control systems specially adapted for hybrid vehicles; road vehicle drive control systems for purposes not related to the control of a particular sub-unit	425	9.59%
F02D	Controlling Combustion Engines	114	2.57%
F16H	Gearing	96	2.17%
G01R	Measuring electric variables; measuring magnetic variables	93	2.10%
H01M	Processes or means, e.g. batteries, for the direct conversion of chemical energy into electrical energy	483	10.90%
H02J	Circuit arrangements or systems for supplying or distributing electric power; systems for storing electric energy	646	14.58%

Table 10 – Competitors' IPC Subclass Occurrences (definition from [43])

Despite the setting some limits on the possible IPC present the created patent pool, it is immediate a shift in the reach focus: the 4-digits IPC with highest occurrence among the

competitors patent pool on EVs is B60L, with the 27% of occurrences, followed by B60K and B60W which together account for more than 20%

Hence, it is already possible to state that rather than focusing on the development of the batteries and the related systems automakers have preferred to keep the focus upon the propulsion systems for BEVs and PHEVs leaving aside the development of batteries, by outsourcing the development of the technology, purchasing the battery from third parties, or even, such as the case of Daimler and Toyota directly stipulating contracts with Tesla itself.

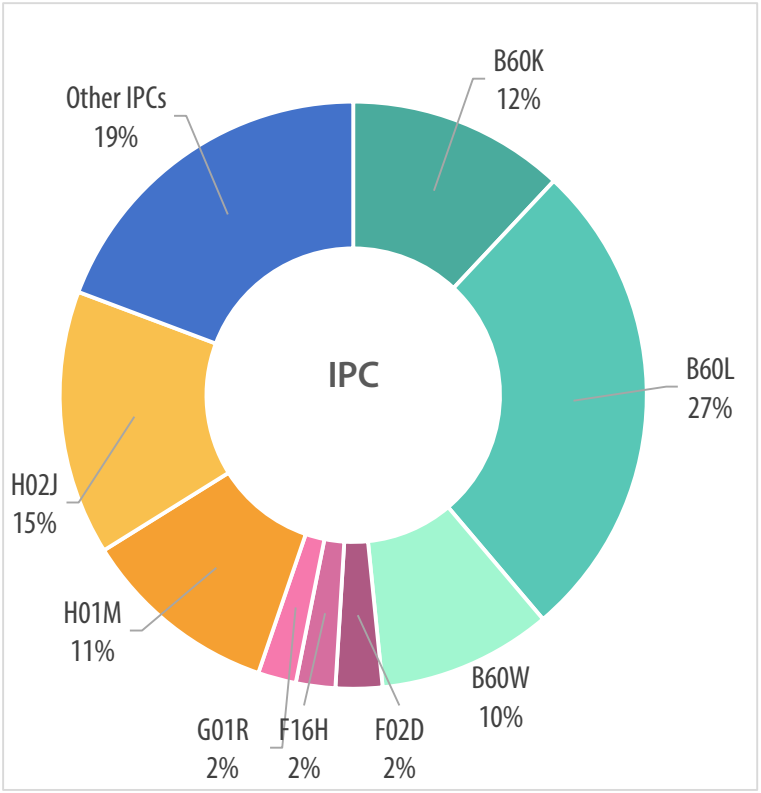

Chart 21 – Competitors' IPC Subclass Percentage Occurrences

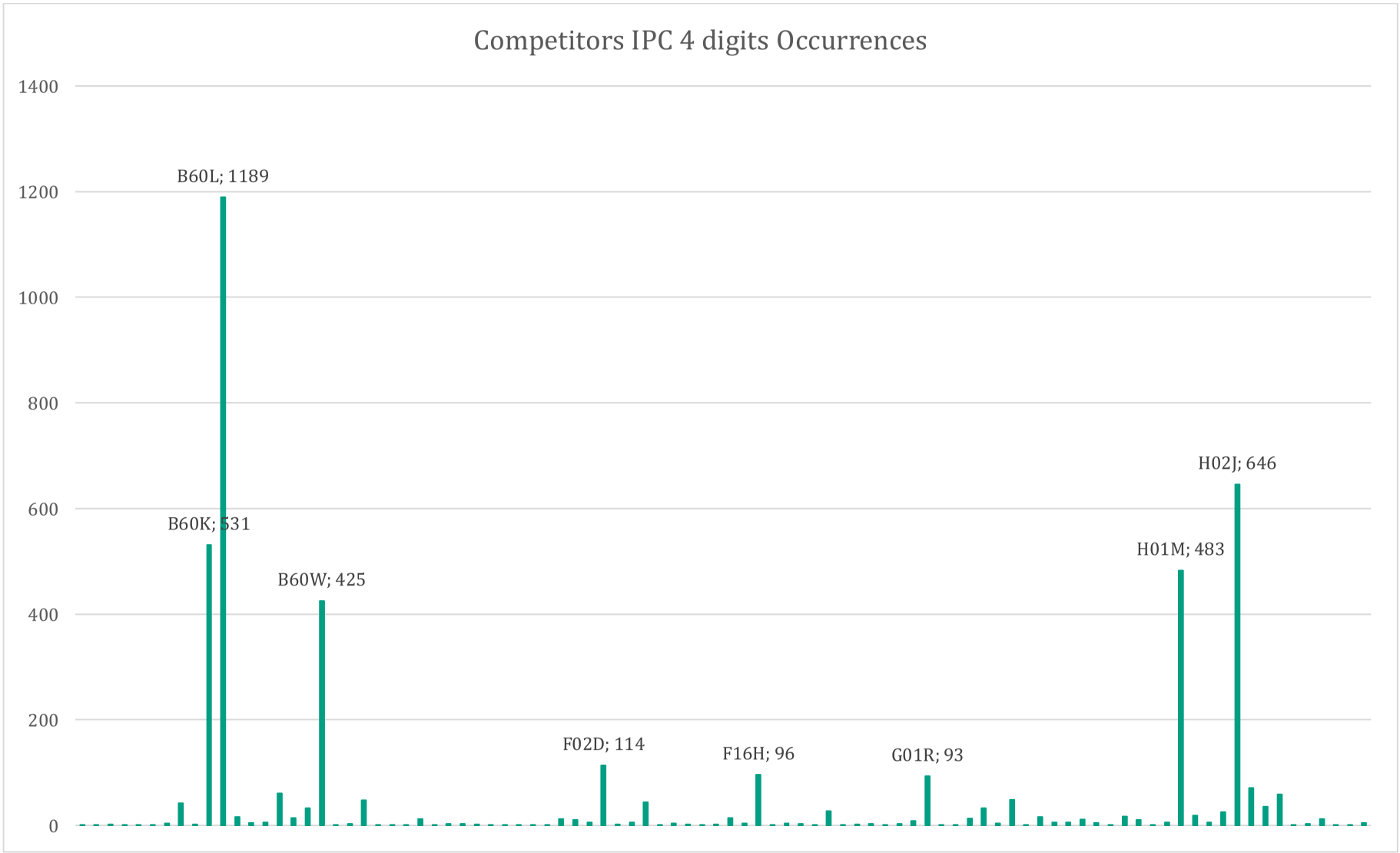

Chart 22 – Competitors' IPC Subclass Occurrences

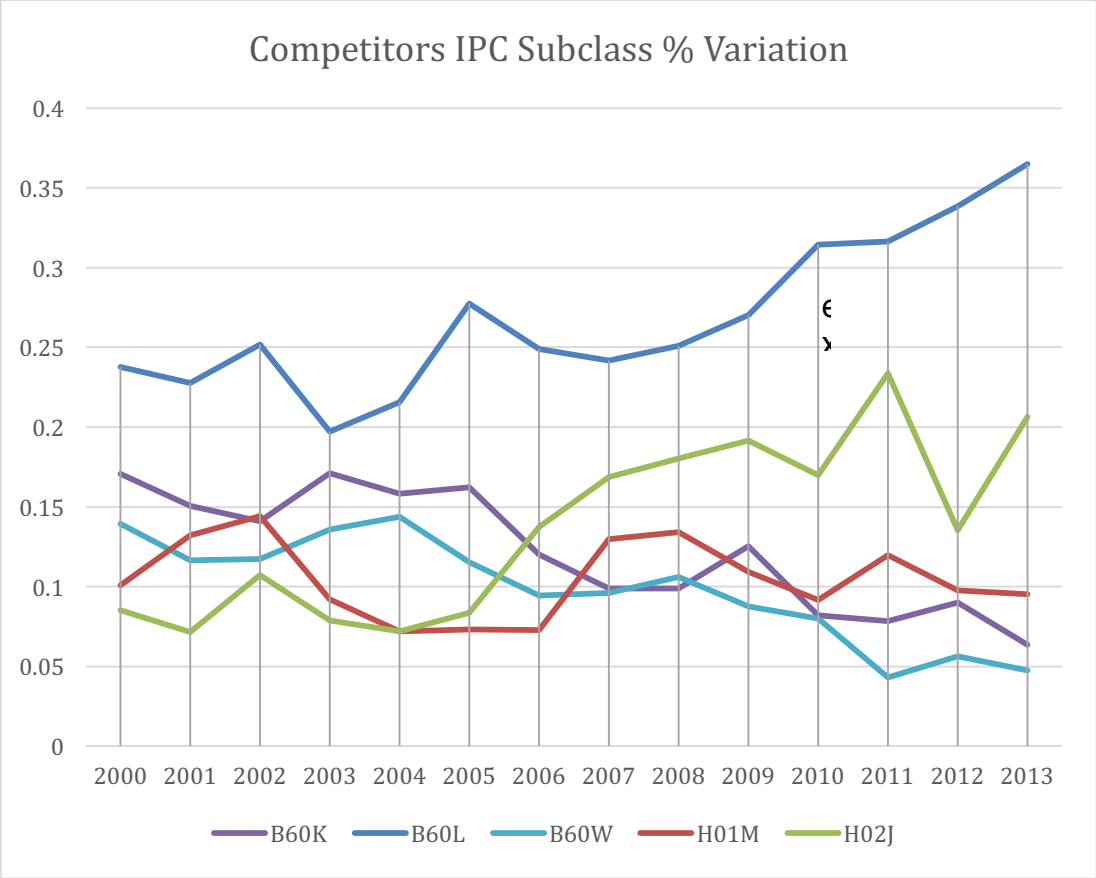

Chart 23 – Competitors' IPC Subclass percentage Variation Over Time

B60K	Arrangement or mounting of propulsion units or of transmissions in vehicles; arrangement or mounting of plural diverse prime-movers in vehicles […]
B60L	Propulsion of electrically-propelled vehicles supplying electric power for auxiliary equipment of electrically-propelled vehicles […]
B60W	Conjoint control of vehicle sub-units of different type or different function; control systems specially adapted for hybrid vehicles […]
H01M	Processes or means, e.g. batteries, for the direct conversion of chemical energy into electrical energy
H02J	Circuit arrangements or systems for supplying or distributing electric power; systems for storing electric energy

Table 11 – IPC Meaning (definition from [43])

Trend-wise, B60L has constantly been the most relevant IPC subclass, not only, it has been showing an increasing trend ever since. Similar trend has been shown by the patents on charging systems for batteries, even if with a significantly lover number of patents.

Overall the entire patent portfolio the tendency is dictated by those patent having IPC belonging to the two major group B60L and H02J, indicating the years, of major filing within those category, between 2009 and 2011. Notably the H02J and H01M follow

comparable trend over time, as the technologies are complementary, their development shall be somehow contemporary to ensure a proper functioning and successful technology implementation.

Once the general trend in the subclass has been found, the full IPC are investigated in order to understand whether than within the specific classes the competitors of Tesla move on its same patenting direction or Musk's company is further able to diversify.

On this second level, deeper analysis, only the IPC with more than 150 occurrences have been taken into consideration.

As previously depicted by the previous trend on the IPC subclass the highest trending IPC are those belonging to the powertrain subclass, notably the one with highest frequency is B60L 011/18 which is the only one belonging to the B60 class among the highly utilized ones by Tesla, hence it can be seen that in the last years both Tesla and the other market undertakings have been focused on this IPC patents, within the propulsion system technology.

Contrary to Tesla's situation, the battery related patents cover approximately the 8% of the entirety of the utilized IPC in the selected patent pool, with only H02J 07/00 in common with the most utilized by Tesla.

IPC Full	Description	#	%
B60K0006445	Arrangement or mounting of plural diverse prime-movers for mutual or common propulsion, e.g. hybrid propulsion systems comprising electric motors and internal combustion engines with differential gearing distribution type	170	2%
B60L000300	Electric devices on electrically-propelled vehicles for safety purposes; Monitoring operating variables, e.g. speed, deceleration, power consumption	211	2%
B60L001114	Electric propulsion with power supplied within the vehicle take precedence; arrangements or mounting of prime-movers consisting of electric motors and internal combustion engines for mutual or common propulsion using engine-driven generators with provision for direct mechanical propulsion	258	3%
B60L001118	Electric propulsion with power supplied within the vehicle (B60L 8/00, B60L 13/00 take precedence; arrangements or mounting of prime-movers consisting of electric motors and internal combustion engines for mutual or common propulsion using power supplied from primary cells, secondary cells, or fuel cells	671	8%
B60W001006	Conjoint control of vehicle sub-units of different type or different function (for propulsion of purely electrically-propelled vehicles with power supplied within the vehicle including control of combustion engines	188	2%
B60W001008	Conjoint control of vehicle sub-units of different type or different function (for propulsion of purely electrically-propelled vehicles with power supplied within the vehicle including control of electric propulsion units, e.g. motors or generators	258	3%
B60W001026	Conjoint control of vehicle sub-units of different type or different function (for propulsion of purely electrically-propelled vehicles with power supplied within the vehicle for electrical energy, e.g. batteries or capacitors	187	2%
B60W002000	Control systems specially adapted for hybrid vehicles, i.e. vehicles having two or more prime movers of more than one type, e.g. electrical and internal combustion motors, all used for propulsion of the vehicle	363	4%
H01M001044	Secondary cells; Manufacture thereof methods for charging or discharging	198	2%
H02J000700	Circuit arrangements for charging or depolarising batteries or for supplying loads from batteries	479	6%

Table 12 – Competitors' IPC Full Occurrences (definitions from [43])

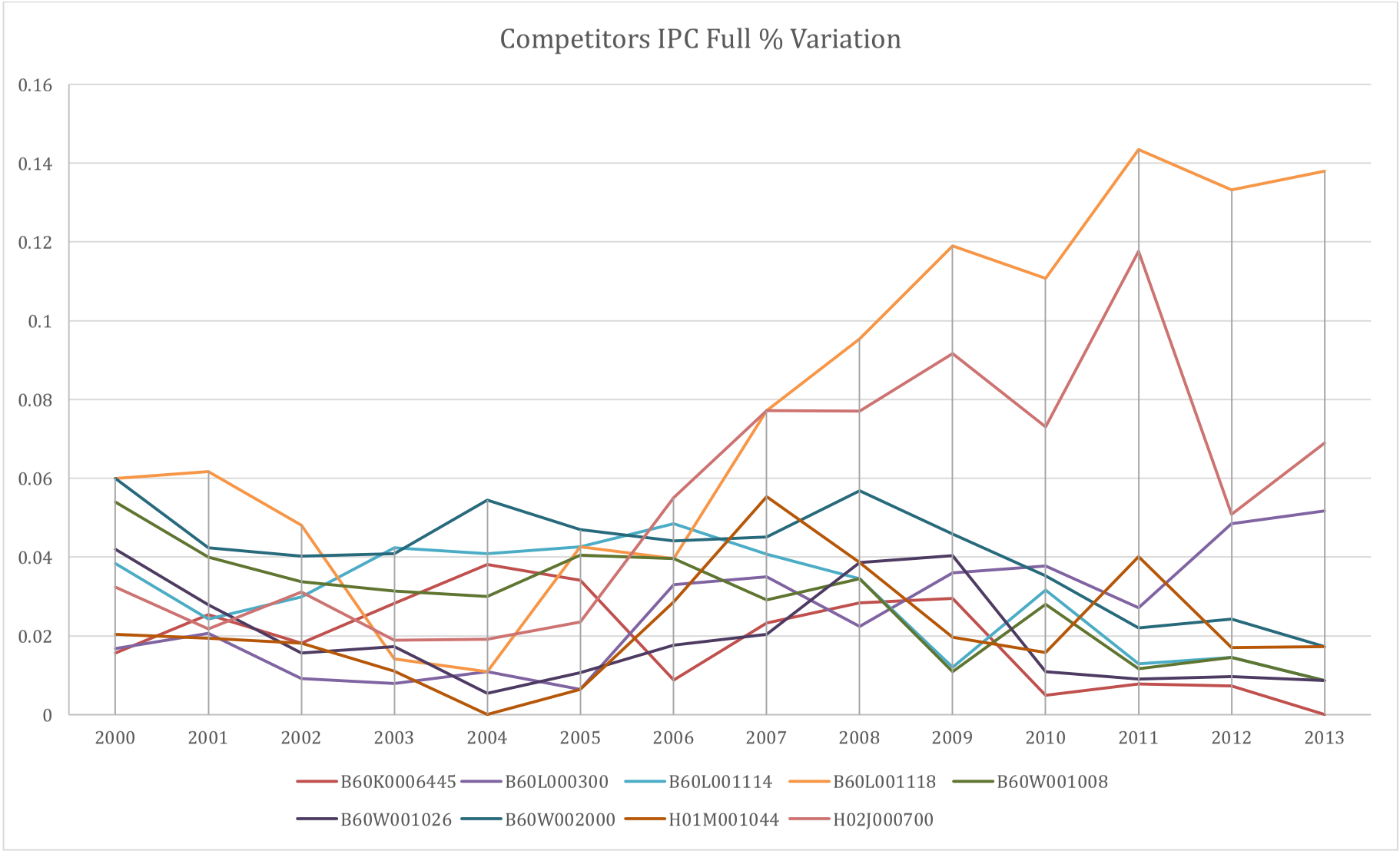

Chart 24 – Competitors' IPC Full Percentage Variation Over Time

B60L 11/80 has clearly been more and more the best preferred field under which develop new technology among automakers' EV R&D departments, since the dawn of the electric cars' technology boom. A similar trend can be found in those patents related to the batteries circuits exactly parallel to Tesla's strategy.

7.3 GEOGRAPHICAL TRENDS

Contrary to Tesla's portfolio geographical protection, the investigated competitors have different geographical scopes depending on a multiplicity of factors.

Of course it is undeniable the particular focus that is still kept on the US market, also for strategic reasons, as it is one of the most remunerative market for the sale of electric vehicles. As previously found, the acquisition rate in the US is steadily growing, like in Japan or in Nord European Countries, where the number show high adoption percentages for what concerns electric vehicles, nevertheless it is important to underline the difference in potential customer base that might come from the US , where the population is considerably higher than other geographical areas where electric vehicles are appreciated and where public transportation is not everywhere readily available , particularly outside the largest cities, and where the ownership of a car is a need for transportation purposes for most of the population.

The consideration on the importance of a patent issued by the USPTO are the same as those already made for Tesla, hence the strategy seems consistent market wise.

Furthermore, when looking at the chosen priority country from a pool of such diverse companies, with different places of incorporation and different geographical market scopes, it is necessary to go deeper and understanding the different presence in the different continents.

Hence, the producers that might be more likely to challenge Tesla's patents are those having more interest in the US market, simply because of the fact that the majority of Tesla's patents are valid in the US primarily.

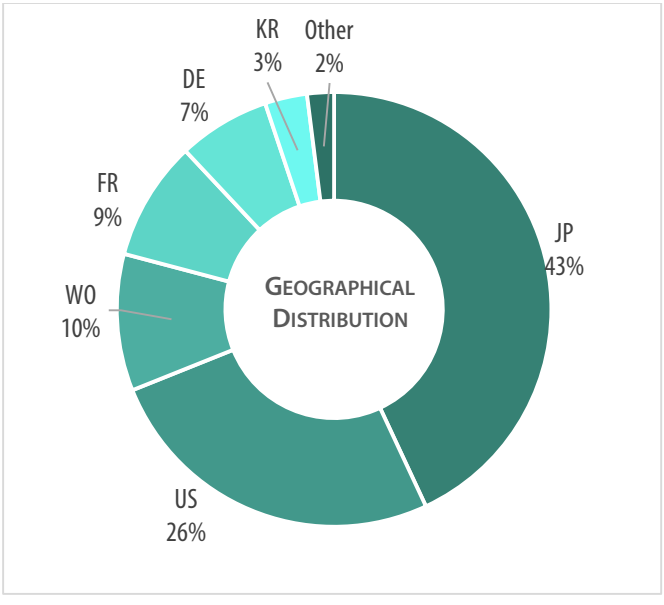

Chart 25 – Competitors' Percentage Geographical Distribution

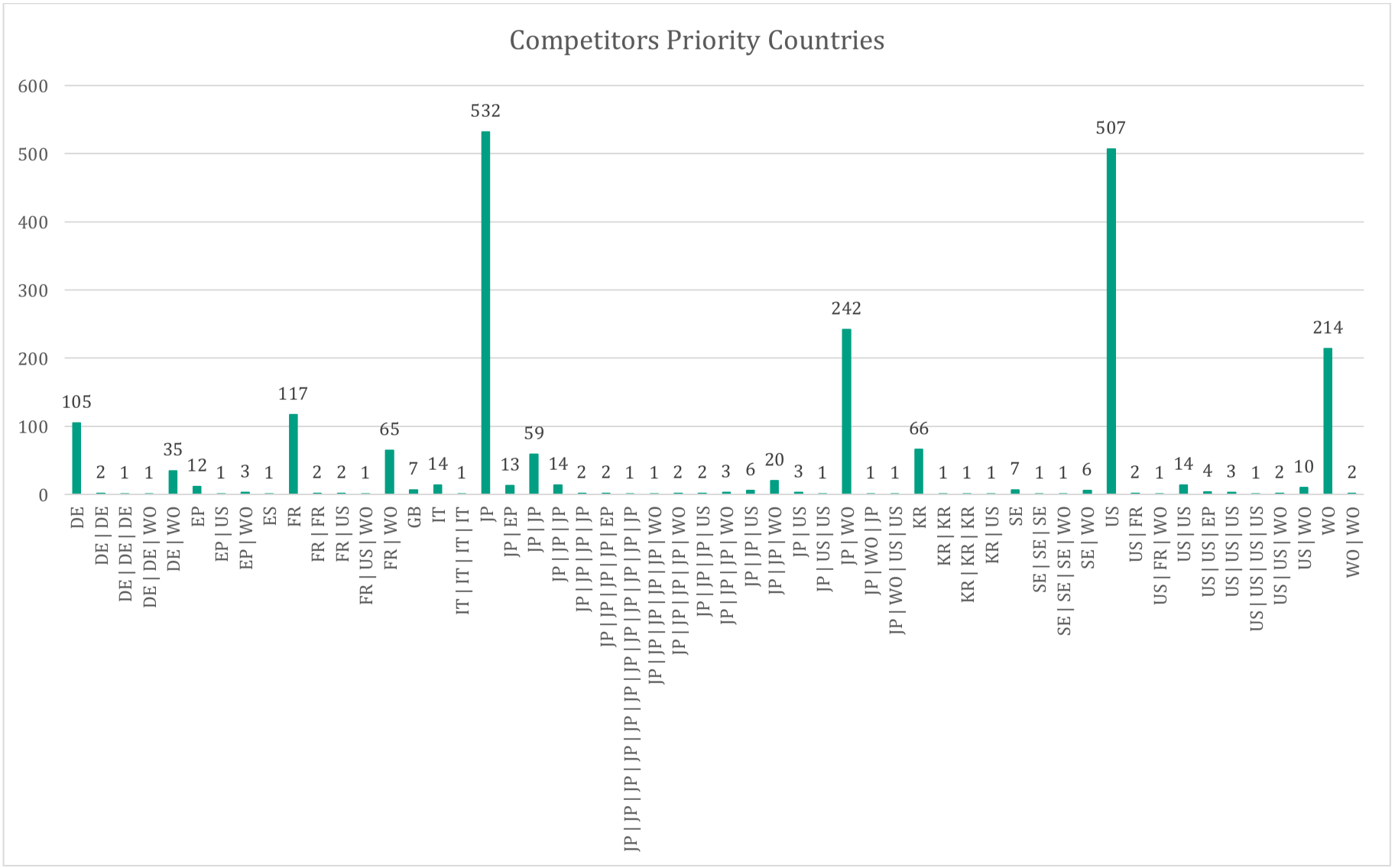

Chart 26 – Competitors' Priority Countries

Priority Countries are obviously trending diversely, being affected by the place of incorporation and of R&D of the various companies: the first in commercializing a PHEV was Toyota and it has been one of the major players ever since, together with Nissan. Korea is present due to Hyundai. Once again US appears as a highly occurring priority country, together with of course the WIPO applications, with growing interest in the later years.

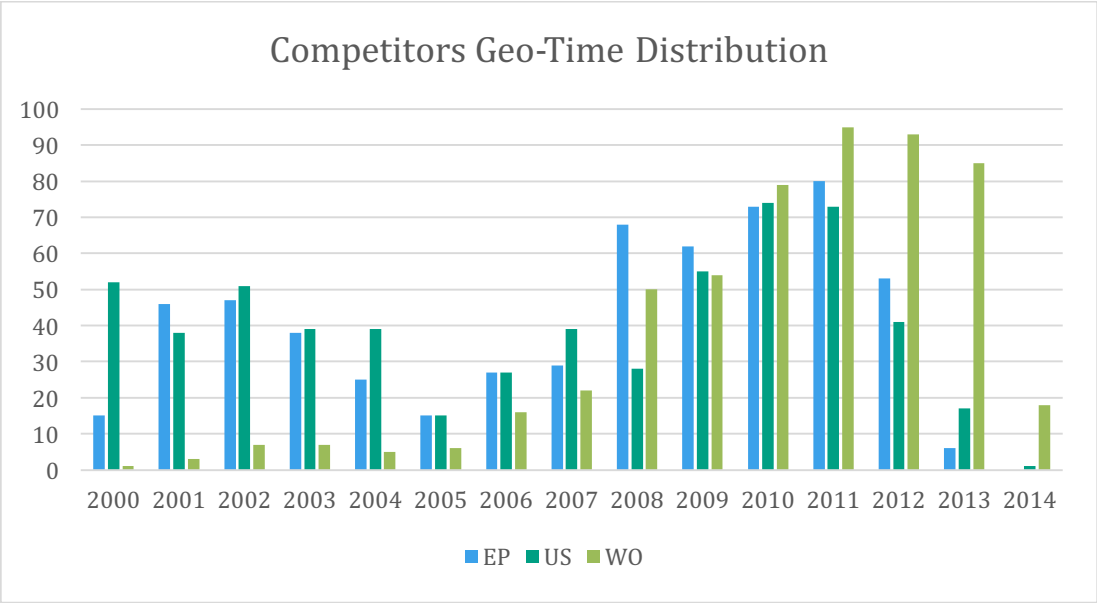

Chart 27 – Competitors' Geo-Time Distribution

7.4 TIME EVOLUTION

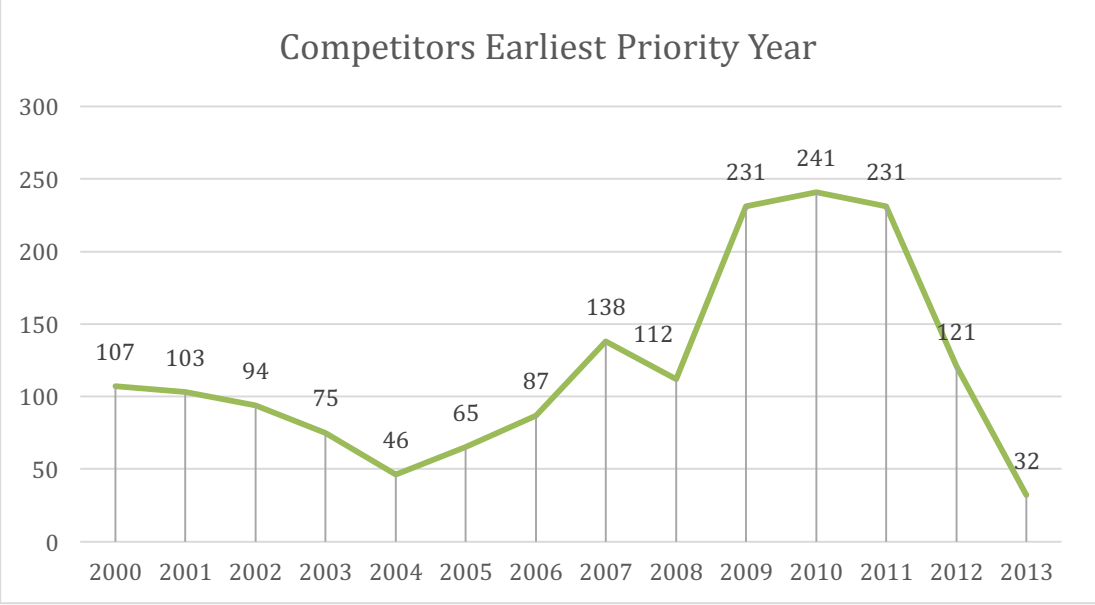

Chart 28 – Competitors' earliest Priority Years

Contrary to the previous two sections, the time evolution will have a deeper meaning if done according to the specific undertaking.

Generally speaking, the trend reflects Tesla's, which might be due to the external factors affecting the investment in R&D, or the status of the art of ancillary technologies necessary for the development of patents specific for the use in electric vehicles.

Nevertheless, it is important to understand the trends in investment on a company based scale hence this section will be further divided to illustrate the major competitors, according to the information retrieved in the previous parts.

For what concerns limitation on the priority years, in order to retrieve only relevant patents from the Thomson Innovation Database, all the provided data refer to the patent pool with limitation to the earliest priority year to the year 2000. This has been done for multiple reasons, first of all in order to obtain only patents that is granted and maintained for the entirety of their possible life, secondly give the rapid development of the technology it would be illogical to keep in the analysis obsolete patents, no longer used in today's cars and lastly, in order to give comparable figures with respect to Tesla's portfolio. Understandably this limitation was not necessary for Tesla's portfolio, which has been retrieve in its entirety due to the foundation date of the company, 2003.

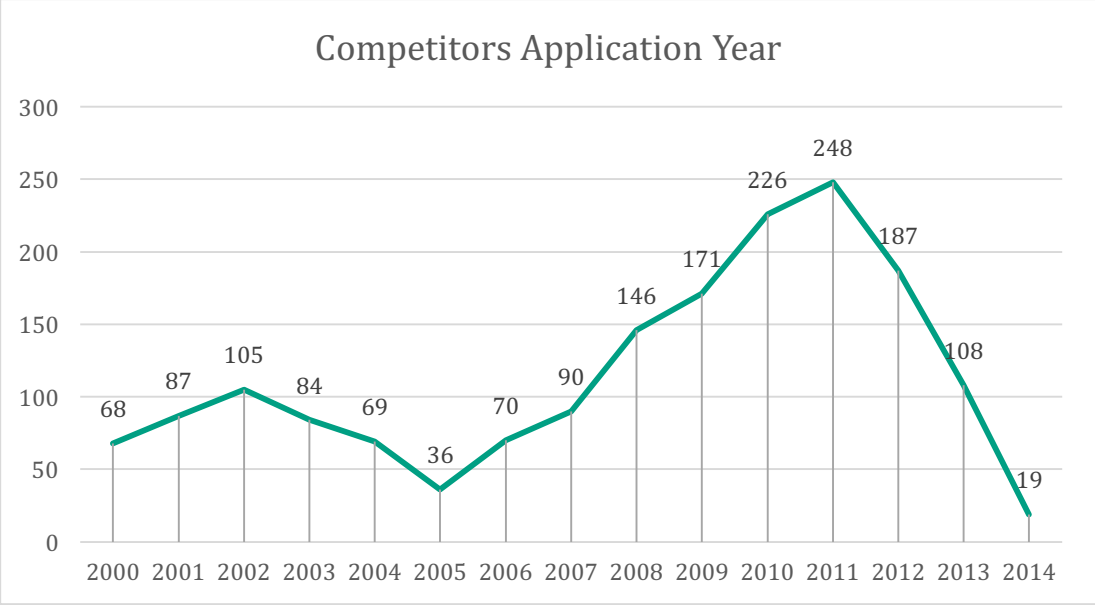

Chart 29 – Competitors' Application Years

Applications years among competitors peaked in 2011, after the 2005's low. This is of course due to the growing interest shown by companies in the technological filed, but an additional explanation is found in the theory supporting the hypothesis that in periods following economic crisis the patent activity increases: during the economic recession resources are diverted towards the development of new technology, both for the lack of diverse investment of such resources and also for the hope of a successful discovery that might help the company's situation over a not so florid market. Hence the years following the major economic crisis are among those more active patenting wise, generally speaking. This hypothesis is supported by the Earliest Priority Years claimed reached their maximum in the years between 2009 and 2011, with a steady increase over the inventive activity from 2008.

7.5 CITATIONS ANALYSIS

Citation analysis is particularly important in this section of the study in order to understand which are the most valuable patents in the field, what they protect and who are owner by.

Not only, but also, it will be interesting to see whether those patents have been receiving citations from any of Tesla's patents, and whether they themselves cited any of Tesla's technology.

Once again this will delineate some possible scenarios, particularly in light of the possible means of free exploitation of Tesla's patents by other electric vehicles producers, also considering the possibility of reengineering practices, based upon said released patents. Furthermore, citation occurrences can also give an indication on the possible invalidation suits that might be brought over, and therefore possibly avoided through the factual release of the infringed or infringing patents, by invigorating the hypothesis of the mutual tacit non-suing agreement as an alleged reason for the factual release.

Title	**Publication Number**	**Assignee - Standardized**	**Earliest Priority Year**	**Publication Year**	**IPC Current**	**Count of Citing Patents**
Method for adjusting battery power limits in a hybrid electric vehicle to provide consistent launch characteristics	US6868318B1	Gen Motors Corp	2003	2005	B60K, B60W	158
Strategy to use an on-board navigation system for electric and hybrid electric vehicle energy management	US6487477B1	Ford Global Tech Inc	2001	2002	B60W, B60K, B60L, F02D	104
State of charge prediction method and apparatus for a battery	US6441586B1	Gen Motors Corp	2001	2002	H01M, B60L, G01R	88
Hybrid electric vehicle energy management	EP1256476A2	Ford Global Tech Inc	2001	2002	B60W, B60K, B60L, F02D	72

Power electronics cooling for a hybrid electric vehicle	US6450275B1	Ford Motor Co	2000	2002	F01P, B60H, B60K, B60L, B60W	71
Engine on idle arbitration for a hybrid electric vehicle	US6664651B1	Ford Motor Co	2000	2003	F02M, B60K, B60L, B60W, F02D	69
Thermal management of fuel cell powered vehicles	US6394207B1	Gen Motors Corp	2000	2002	B60K, B60H, B60L, H01M	67
Battery having an integral cooling system	US6512347B1	Gen Motors Corp	2001	2003	H01M	66
Electric Vehicle and Power Feeding Apparatus For The Vehicle	WO2009054221A1	Toyota Motor Co	2007	2009	B60L, B60M, H01F, H02J	65
HEV charger/generator unit	US6724100B1	Ford Motor Co	2000	2004	H02J, B60K, B60L	63
System and method for optimizing grid charging of an electric/hybrid vehicle	US7402978B2	GM Global Tech Operations Inc.	2006	2008	H01M	56
Torque-based monitor in a hybrid electric vehicle	US6490511B1	Ford Motor Co	2000	2002	B60K, B60W	53

Table 13 – Competitors' Most Cited Patents

Strongest patents belong to General Motors and Ford Motors, and all are in the mostly focused on the propulsion technology, with some patents recalling as secondary classification the field of batteries. Hence, it can be seen how not only among competitors the activity is more intense under the B60L, but also they are more successful in development innovative and solid patents.

Most of the strongest patents date back to the beginning years for the development of the technology, exception made for a 2006's patent on charging optimization by GM, to be remarked as this is a patent of interest under Musk's point of view; and a 2007's

patent by Toyota on the feeding apparatus for EVs, which is concerning propulsion so not in the same area covered by Tesla.

Notably, Tesla's citation figures would are significantly lower than those, indication that Tesla's patents are not considered among the more relevant in the field, or, arguably, that their patents are so advanced that no improvements or further implementation on their technology is felt needed.

7.6 MAJOR COMPETITORS

Given the results on the most relevant patents in the field of major interest for Tesla, the most valuable patents and the market performances of the various producers and the speculations on the market a deeper analysis on the patent portfolio of the following companies has been sought necessary:

- General Motors
- Ford
- Toyota
- Nissan

The choice has been taken into consideration two main factors: on one hand the most valuable patents in the selected patent pool have been found and the largest patent portfolio on the according to the selected search criterions; on the other hand, market values and strategic partnerships have been taken into account. Much speculation has been done on the whose companies Tesla was hoping to attract by releasing their patents, Nissan and Toyota (the last already has contractual agreements with Musk's company).

7.6.1 GENERAL MOTORS

GM accounts for 164 among patents and patent applications from 2000 to 2014, with a maximum in patenting activity in 2009, but showing steady decreasing in interest in patents in the EV field since then. GM activity, like Tesla, and similarly to most American based companies has been focused almost entirely at the USPTO, with only some patents extended to Europe.

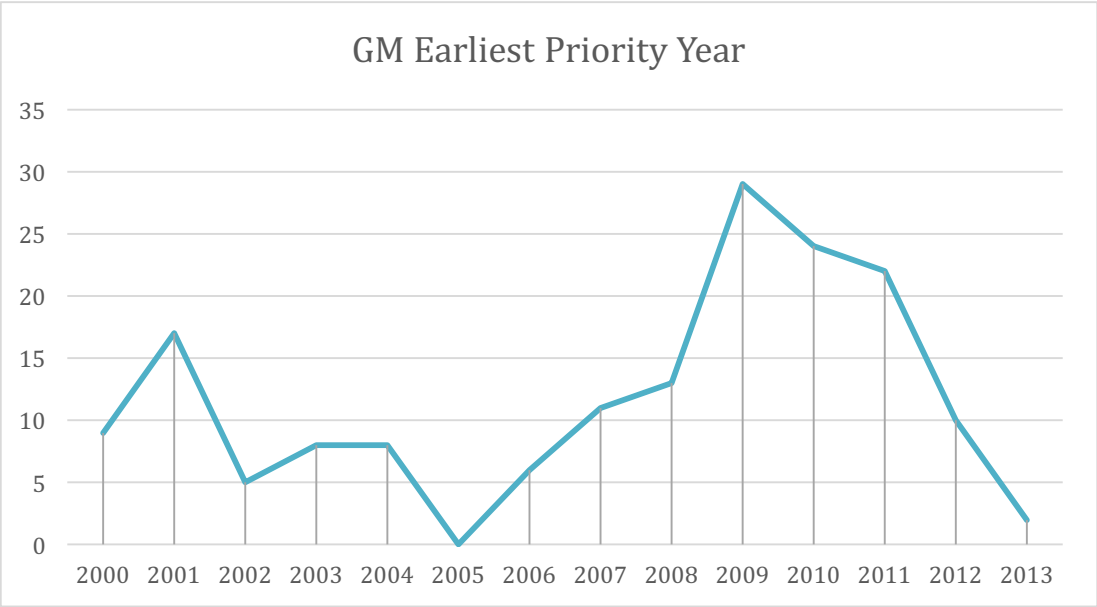

Chart 30 – GM Earliest Priority Year

The fields of technology development are comparable among the two individuated major classes, the propulsion-related patents and the batteries and auxiliary systems, with IPCs specular to Tesla's, even if with different percentages of occurrences.

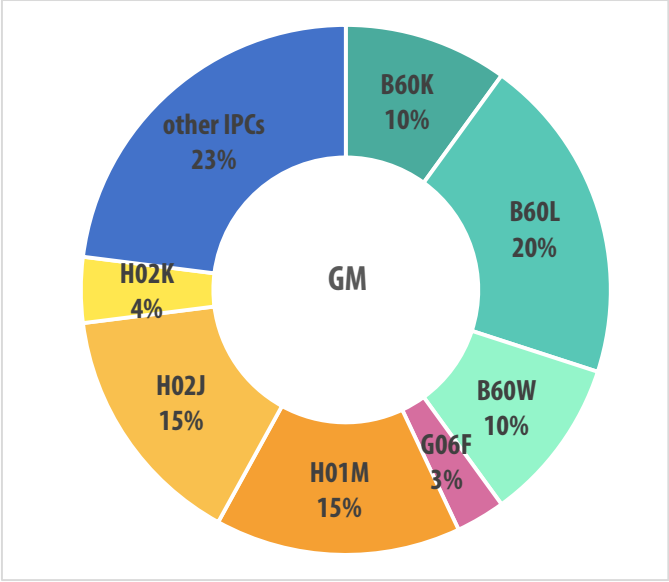

Chart 31 – GM IPC Percentage Occurrences

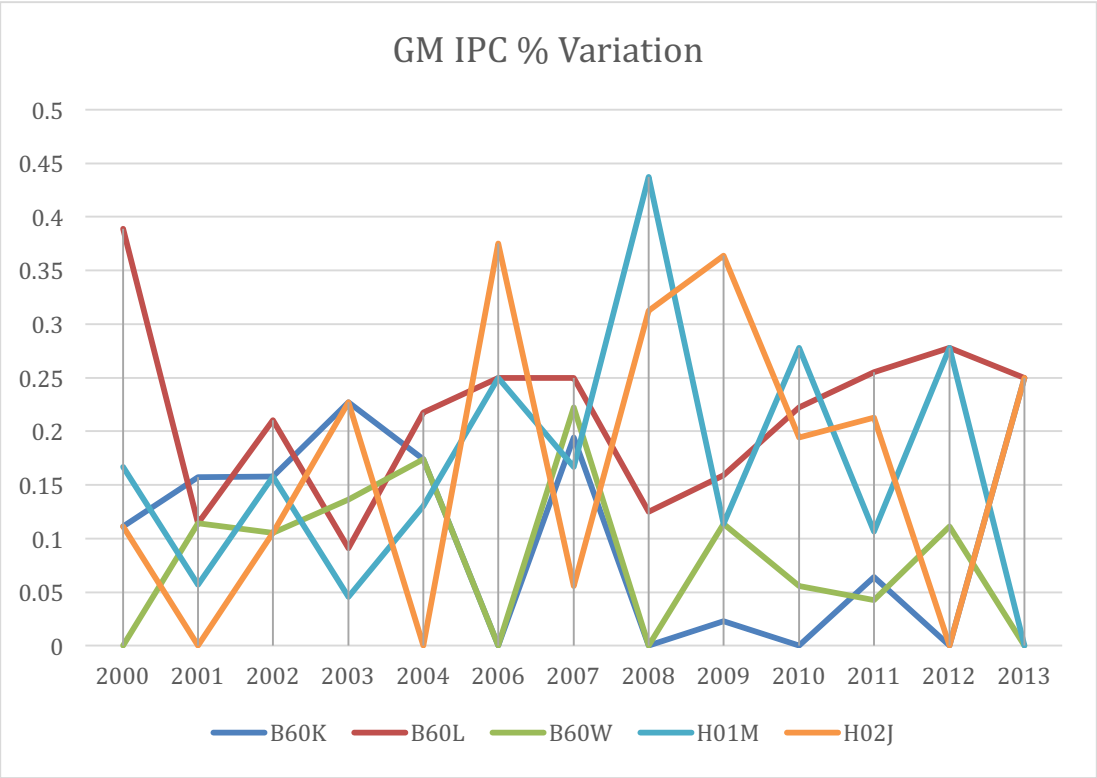

Chart 32 – GM IPC Percentage Variation over Time

Once again, also GM Shows similar patterns, with a steady effort on the propulsion systems and oscillating interest, along the years, on the development of batteries and charging systems thereof.

7.6.2 FORD MOTOR

238 patents and patent application retrieved from Thomson Innovation Database, from 2000 to 2014, referring to Ford Motor as current company owning the IP rights.

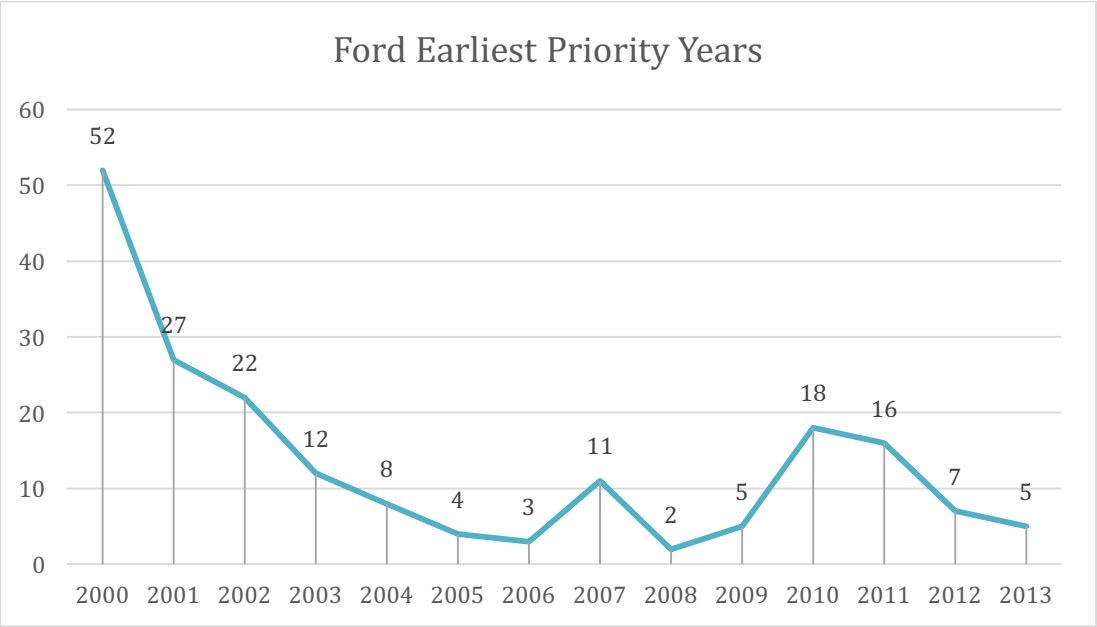

Chart 33 – Ford Earliest Priority Years

Despite being one of the companies with the largest patent portfolio, Ford has been continuously abandoning the development of EV related patents in the latest years. Making it a marginal undertaking threat and technology wise, for Tesla.

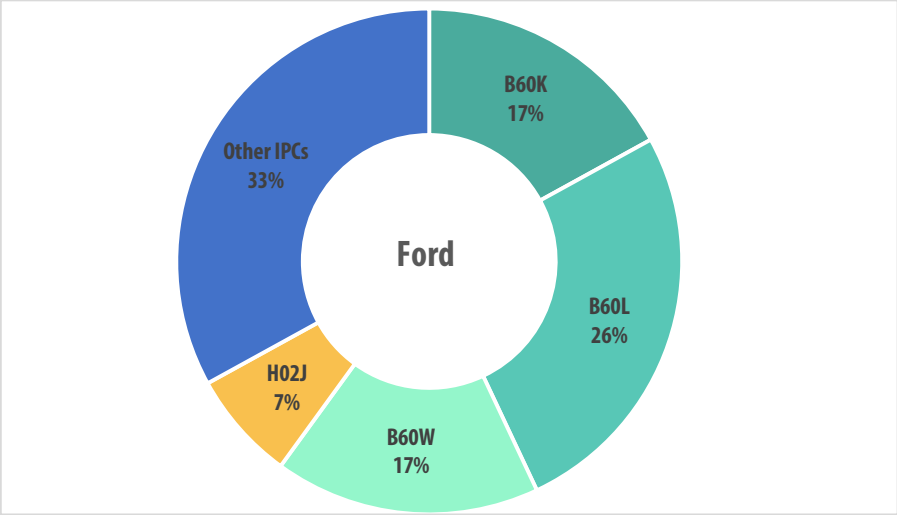

Chart 34 – Ford IPC Percentage Occurrences

The marginal competitiveness of Ford with Tesla is further stressed by the low importance conferred by the company to the development of batteries and systems thereof, which aside from being low in absolute terms has been almost abandoned in the latest years.

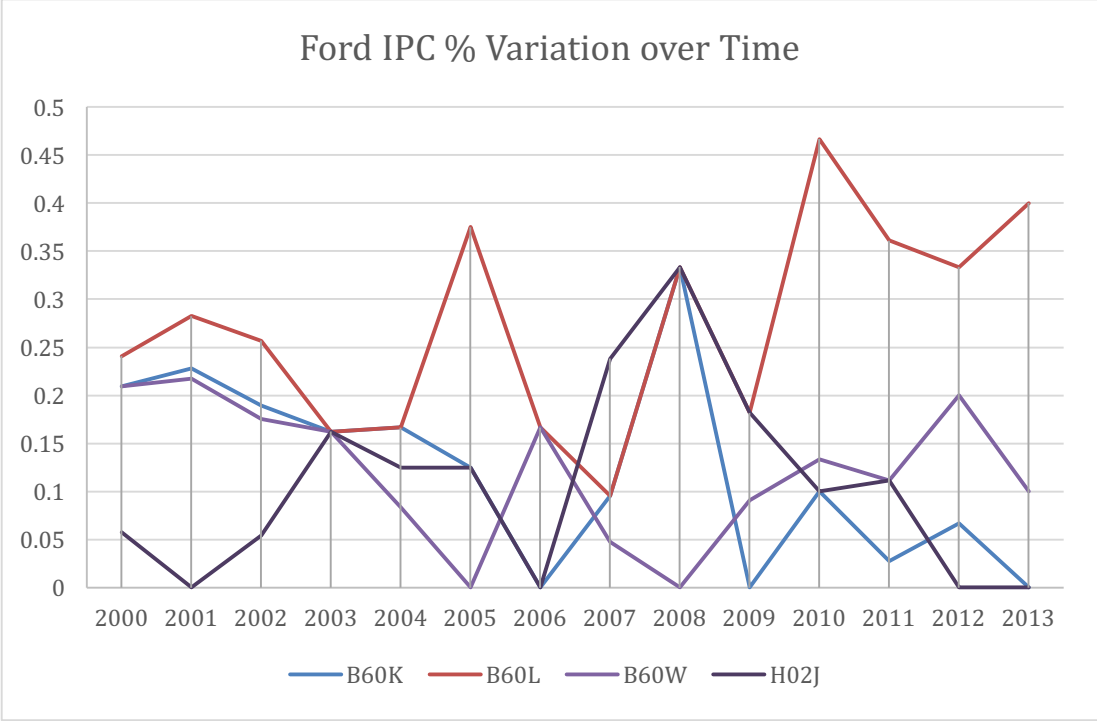

Chart 35 – Ford IPC Percentage Variation Over Time

7.6.3 TOYOTA

The Japan innovative company that introduced to the market the first hybrid vehicle and opened the path to the technology of electric vehicles, presents the largest portfolio on

the technology. Portfolio which show comparable characteristic to the other analysed, time-wise, whilst when considering the IPC trends, the trends are comparable to those of GM, with a 360° approach to the R&D efforts for the development of patents necessary to the development of the entire vehicle. Making Toyota, as well as GM, the two more fearsome competitors, IP-wise for Tesla, not only due to the amount and distribution over the classes of their patents but also because of the inherent quality of their inventions. Notably, growing interest on patents regarding the battery related technology can be noticed in the last years, even if the overall number of patent decreased.

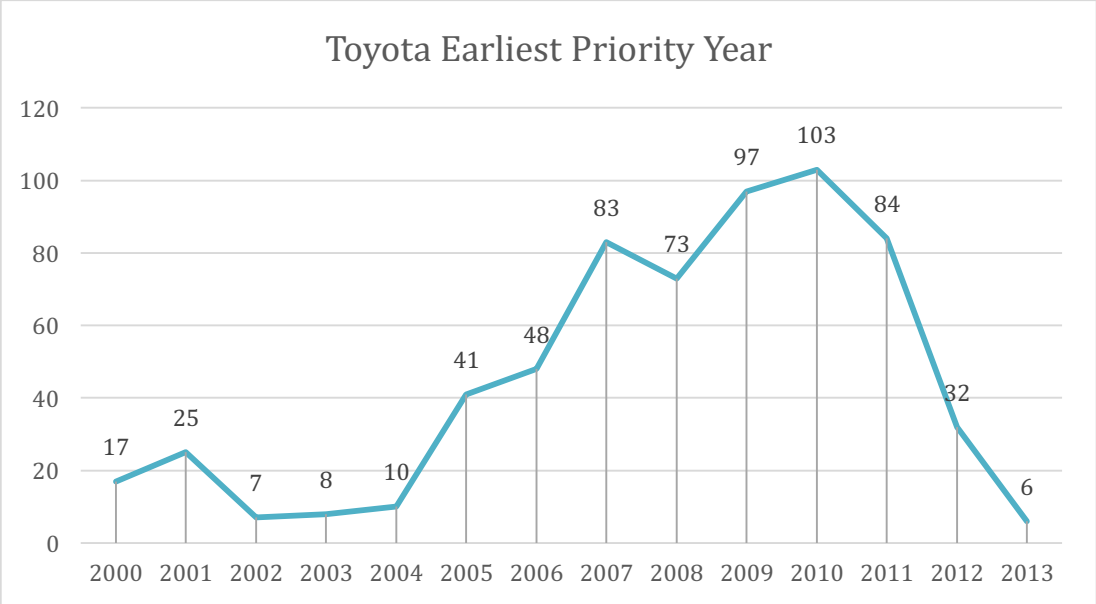

Chart 36 – Toyota Earliest Priority Years

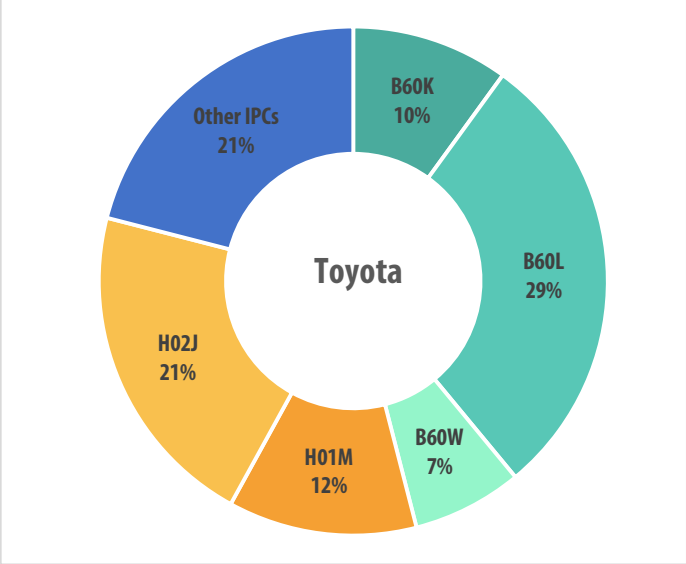

Chart 37 – Toyota IPC Percentage Occurrences

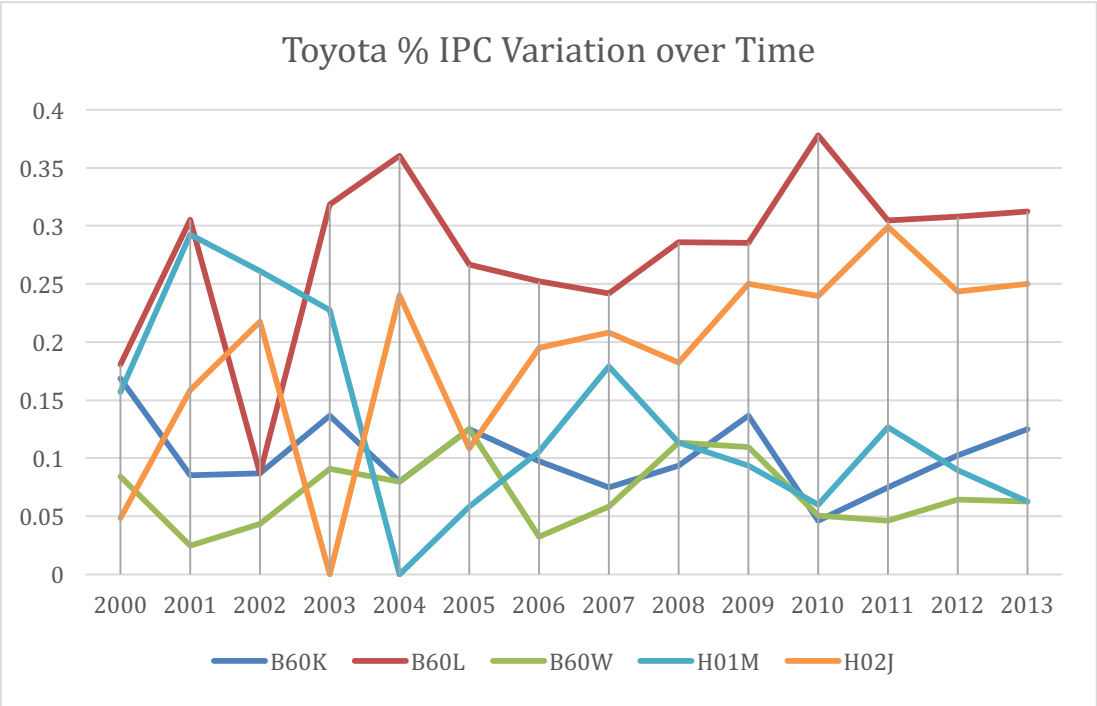

Chart 38 – Toyota IPC Percentage Variation over Time

7.6.4 NISSAN

Nissan, the current market leader in vehicles sold in the US, possess ownership over 324 among patents and applications, in the period ranging from 2000 to 2014.

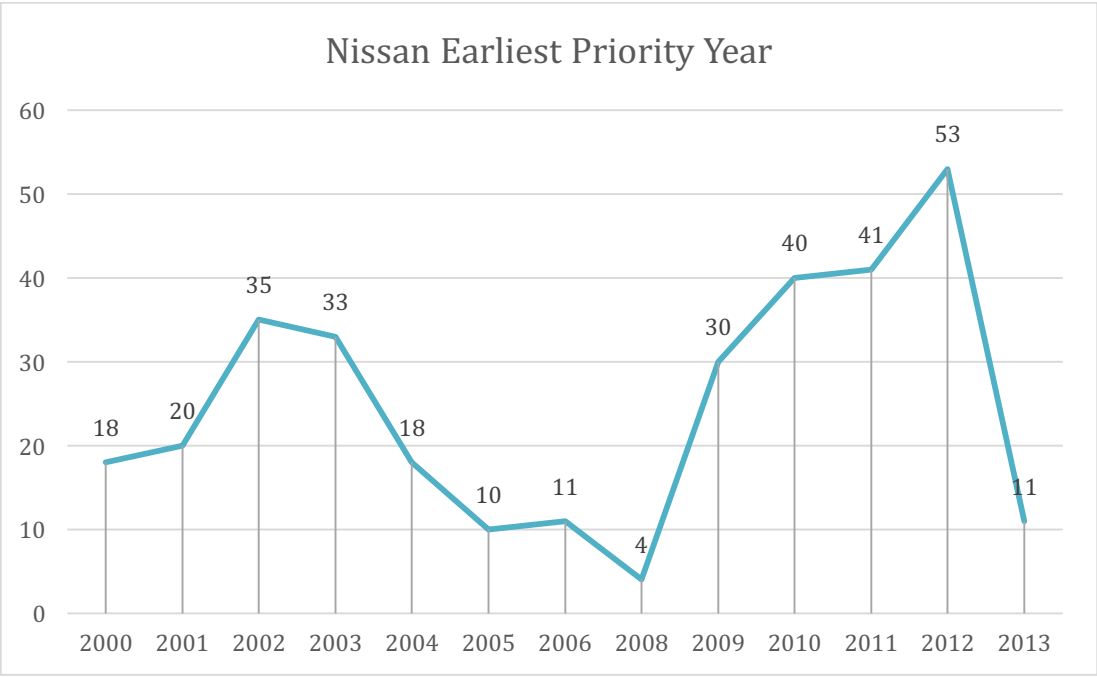

Chart 39 – Nissan Earliest Priority Years

Opposite to the other companies considered above, the Japanese company has reached the highest level of inventive activity in 2012, a trend possibly continuing for the

following years. When considering the focus of their developing activity, despite having as major focus the B60 patents, the company has been showing growing interest in the later years, which are also those of major activity, in the battery-related patents. This is consistent with the market success and the intentions of the company in devoting a larger amount of resources to the development of EVs, and their involvement in the ChaDeMo movement for the specific charging stations' standard.

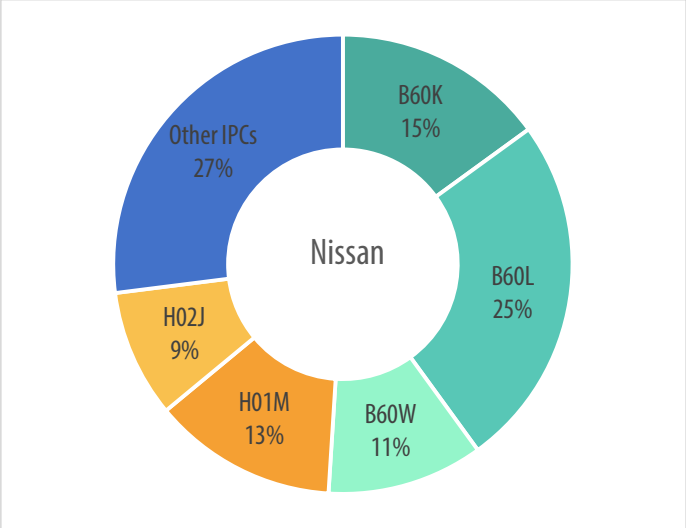

Chart 40 – Nissan IPC Percentage Occurrences

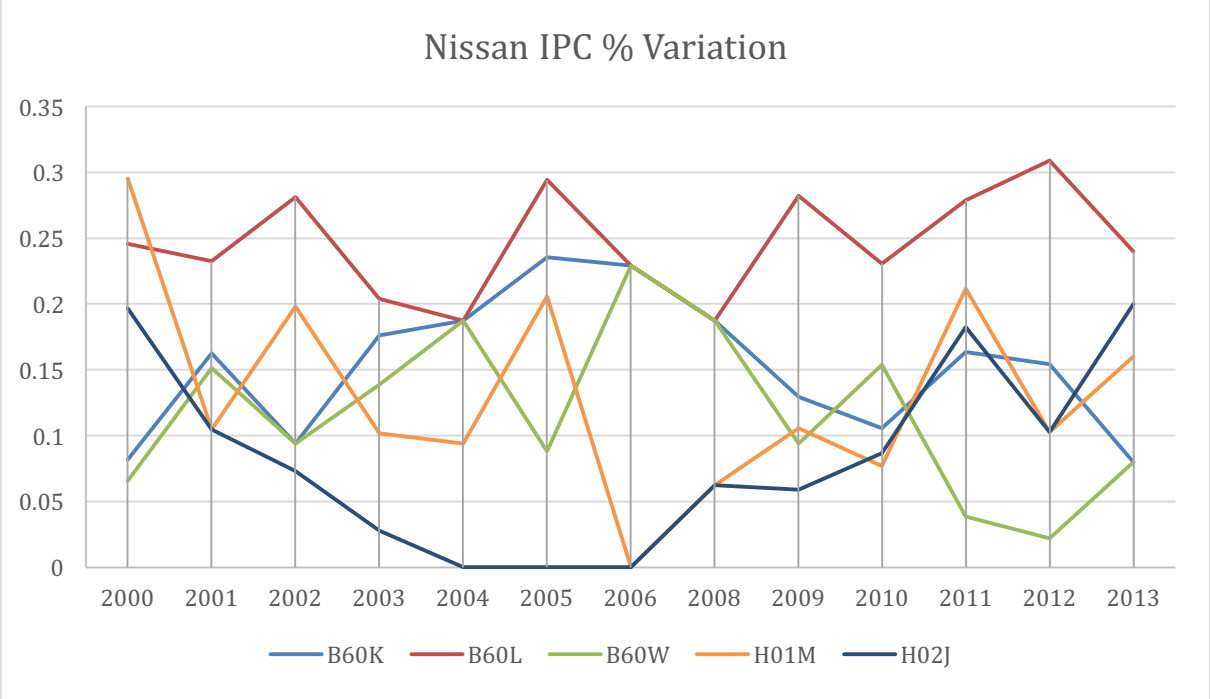

Chart 41 – Nissan IPC Percentage Variation over TIme

8 ANALYSIS' RESULTS AND OUTCOMES

8.1 ANALYSIS' FINDINGS

In order to recapitulate and better identify the sensible information retrieved from the study of the data, this chapter is aimed at setting the comparisons among the various, relevant, trend among Tesla and the market competitors, with timely relevant insight on specific relevant information identified from the 4 major competitors, GM, Nissan, Ford and Toyota,

As the aim of this paper is to find some reasons behind the decision by Tesla to factually release their patents, the patent analysis was focused at individuating the patenting trends of the technology and specifically to understand Tesla's position and relate it to the competitors. The results from the database analysis are taken into consideration and interpreted in light of the market characteristics, this way it will be possible to make reasoned and informed allegations on the motives that brought Tesla to this important steer in patent strategy.

Tesla shows higher focus on the research fields regarding the batteries and related control and auxiliary systems, as expected by the identification of its core business in the electric batteries, while, seems to devote lesser efforts in the development of technologies related to the propulsion systems of EV.

The opposite can be said when considering the competitors' pooled patents, which instead focus more on the latter technology category, which composes the majority of the filed patents taken into consideration. Nevertheless, it can be noted how increasing awareness is spreading through the producers on the EVs on the importance if the quality of the battery and auxiliary systems for the successful commercialization of their products. An increasing trend in the occurrences of battery-related IPCs can be seen, particularly from 2006 with a steady increase over time in the filing of patents in said fields. One practical example can be found in Nissan's patent portfolio on EV, which, despite being constructed on a solid base of patents belonging to the B60L and B60K subclasses, shows a clear shift in the development efforts towards the development of batteries and even more, the development of the auxiliary systems; whilst at the same time showing a steady decrease in the B60K patents. Similar behaviour is depicted by the portfolios of patents belonging to another great giant in the automotive field: General Motors. The American company has been steadily patenting inventions on the B60x fields along the years, but once again is showing periodical interest in batteries related inventions. The same behaviour can be noted by Ford, even if considering the constant decrease in their overall patenting activity in the field. Toyota, instead, probably due to the longer R&D focus over the years on the analysed technology has been steadily patenting on both technology fields, even if with decreasing attention on the development on the batteries per se, probably due to the collaboration with Tesla and the advent of the Gigafactory for the development and production of Tesla's patents at lower prices and with better technology than any available on the market as of today.

All those consideration lead to a very important remark: Tesla can rightfully be considered today on of the leaders on the technology for batteries, which other automakers lack. But on the other hand Tesla is lacking those technologies that its competitors possess. Further evidence is found the valuable patents hold by Musk's company: the more valuable ones fall under the battery technologies hat, the weakest are concerning other technologies for the developing of EVs.

Nevertheless, as already stated Tesla could not spare any of its patents, as those are fundamental for the lawful manufacturing of its vehicles: as protected it can be when dealing with batteries, the same cannot be said for the other patents that could be challenged and possibly invalidated. This would be catastrophe for the future of the company, that would incur in either enormous expenditures, such as fees, fines, royalties and so on; but also in possible stops in productions, delays in deliveries, which would altogether probably lead to a serious financial setbacks and reputation disruption.

The obvious superiority of Tesla's batteries and overall technology focus, when compared to the competitors, might make the standard-creation aim a actual reason and hope of the company's management. As more companies have been starting to invest more and more on the battery and battery related technologies, would not it just be easier to exploit a successful technology, with the benefit of having a large section of the infrastructure of the superchargers network already present or in construction? If that would eventually be the case it is yet to be understood and anyway seems unlikely (as Tesla started to commercialise the ChaDeMo adapter to exploit the competitors' charging systems as well as the Supercharger network, further enlarging their charging station network and possibly convincing more and more consumer to purchase their products), but evidence from the patenting activities of the competitors suggest that it has been very likely on of the main arguments for the decision of factually releasing the patent portfolio.

Under another point of view, the hope in a tacit non-belligerence understanding among undertakings could be understood as a possibility. This hypothesis could be supported by the fact that where Tesla's excels and where lacks in solid patents, and those of the competitors. Tesla is willing to let go on part of its technology as long as it will not have to leave in fear of an overly expensive lawsuit, with the constant remainder, though, that as weak are some of their patents, others are extremely strong and can be use in a court war against anyone that will challenge them.

Similarly, it might be possible that Tesla would benefit from the use of others' patents, both for further developments and for present use, without having to incur in licensing costs and contractual engagements, and is willing to give up some of its protection to gain some more flexibility. Thus, Tesla's might have hope to open the way for more EV developers in joining the patent open source movement.

Another important consideration can be made on the pace of patenting activity by the automakers, and hence the level of development in the EV technology related fields. All the analysed market players show a decrease in the number of filed patents in the EV fields.

Not only the pace of filing has been decreasing throughout the years but also the quality of the filed patents overall seem lower, once again this seems to be common among all the market player. Specifically Tesla can be brought as the leading example: a company that only develops and produces electric vehicles has been experiencing a strong setbacks in the volume of technologies developed, whilst having few very powerful patents, particularly when compared to other automakers that can count on diversified business and a far more scaled and diversified patent portfolio.

Hence the overall R&D efforts on the development of more and more sustainable vehicles has been slowing down, since after the peak activity years between 2009 and 2011. It is impossible then not to think about Musk's statement, and the reasons that brought to the release of the company's patents: "Yesterday, there was a wall of Tesla patents in the lobby of our Palo Alto headquarters. That is no longer the case. They have been removed, in the spirit of the open source movement, for the advancement of electric vehicle technology" [31].

Perhaps one other motive leading to the factual release lies in the slower pace in development experience by the market, and hence a hope that sharing some key, basic, patents would inspire other and resolve this stalling situation moving towards new technologies. As much as this sounds reasonable, it would probably be overly altruistic from the part of Tesla, that would only benefit in terms of image, rather than actual economic returns, and that could even lose in case some disruptive technologies were to emerge and leave them behind. Nevertheless, this scenario would still probably be more preferable to Tesla than that where electric vehicles were no longer present, replaced by hydrogen-powered cars or by the traditional combustion engines vehicles, which are becoming more and more efficient and decreasing their lifecycle impact on the environment on a daily basis, to the point that some consider the next generations combustion engines cars to be overall more sustainable than electric vehicles.

A further reason for which Tesla might have decided to steer from the canonical patent strategic path could be to attract new and fruitful industry collaborations among automakers. It is a well known fact that Tesla disposes of limited capital, and has been facing substantial expenditures to expand their productive capacity, the creation of the Gigafactory and the continuously expanding Supercharger network, could use some slack. Collaborative partnerships, not only directly in the production and commercial relationship side, but also in the R&D department. Collaborations might cut the costs for the R&D and speed up the developing process for new technologies.

Either ways, for he sake of the technological development per se, Tesla's move might be incentivising and hopefully correct.

Of course under a purely marketing point of view, all leads to believe that this has been a calculated move by Musk and its management. Consistent with the no-advertisement policy, Tesla has been able to generate massive information spreading and publicity increase due to the echo on every national press agency. This cannot be the main reason that caused the factual release, but surely has been a carefully considered factor in determining the final decision on whether to pursue the action or not: the company's value relies almost entirely on its intangibles, and even when considering Tesla's brand to

be one of the most valuable worldwide, it does not even remotely justify the value conferred to the company on the market stock. In order to take this relevant risk, the returns shall be expected to be proportionally high. In fact the market, positively reacted at the statement with an increase of several points on the value of the shares, and, after one year no catastrophic consequences have been experienced by Tesla's share value: the value has been steadily increasing, regardless of some temporary and never major losses in value, which is to be attributed to a number of events and actions taken by the company, but which is at the same time symptomatic of the fact that no major damage has been suffered by releasing the patents for the public use in good faith.

When considering timing one has to take into consideration also the timing of the statement: the company's share value was stalling and experiencing a decreasing trend, if even so slight. Musk's statement was certainly not an impulsive one and the releasing time was certainly carefully chosen in order to have the largest attention from the consumers, competitors, shareholders, and most importantly by the markets.

However, timing was not perfect, few days after the release several EV producers joined the ChaDeMo association, among them Nissan and Toyota, factually rejecting the proposal implicitly made by Tesla of using the same charging technology and adhering to the other main charging stations technology. It might have been the case that if Tesla had rendered available their the earlier in the year, the proposition could have raised more interest in the other players and actually have accomplished larger positive feedback. Of course those are suppositions as there is no way to confirm them.

Marketwise the electric vehicles adoption is expected to be growing steadily in the coming years, nevertheless, pushing towards a greater supply and improved vehicles might help in further increasing the consumer base. By giving up its technology might allow more producers to erode some of its market share, but if this would lead to an overall increase in the sales of electric vehicles, the absolute increase in revenues might be relevant when compared to the relative loss in market share, particularly when thinking that Tesla is not running to establish market dominance, as they market luxury products with upscale features, not accessible to every consumer interested in purchasing an electric vehicle. This reasoning might be likely, also due to the decision of starting commercialize a cheaper and more affordable vehicle in the future, which is not consistent with the pricing strategy of the company, but might be an attempt of actually increasing the company's consumers. In short Tesla might be hoping in increasing overall demand by pushing the supply and the diversity of the offer by keeping the prices constant, or possible decreasing them according to the market laws.

When considering the geographic market, the majority of the inventions are valid on the US, Europe and Japan. The main factor for the geographical extension of a patent seems to be two. On one hand the location of the R&D labs of the company and its place of incorporation. On the other, the possibilities of growth and market share that lie in the various places. The largest potential market, due both to the potential consumer base and to the consumer preferences and readiness to accept the technology, is the USA market. Other Countries, such as Norway in Europe and Japan in Asia, have already good penetration of EVs, and at the same time low prospective customer base.

It is then clear why most patents are filed in the US: development and production of most of the major automakers is in the US, as will be their customers. This must be also added to the intrinsic higher value of a patent issues by the USPTO, rather than other smaller state offices around the globe.

As already stated in the course of the paper, another huge potential market would be the Chinese one, nevertheless companies, excluded the domestic ones, seem to still be reluctant in extending their patents at the Sino Intellectual Property Office. Protection in nevertheless fundamental in a country where the economy is booming and every single citizen is ready to set up a company with another's person idea.

For what concerns the factual release brought on by Tesla, such a behaviour, particularly if patents are not extended at the SIPO, might lead, once again, to losses for the company: it is not absurd to think that mainlanders would re-engineer or simply take on of Tesla's patent and simply apply for a patent at the domestic patent office. As much as this would be illegal and unfeasible for the requirements of absolute novelty, the examination process in China is known to be permissive and not particularly strict, as hundreds of applications are filed everyday and as many are granted, even if only in the form of a utility model.

8.2 ALLEGED REASONS FOR PATENT RELEASE

It is now possible to provide some suggestions on the reasons behind the release of its entire portfolio by Tesla.

8.2.1 MARKETING MOVE

Of course the Pledge has brought significant attention to the company, as it was published by newspapers and blogs all over the world. Hence it has brought attention to the company, raising awareness on the company for those who did not know about the company at all. While at the same time further stressing the company policy, for the spreading of the electric vehicles with the noble purpose of addressing the environmental issues related with the combustion engines.

In a developing market, where the adoption rate is steadily growing but still at its initial stages increasing brand awareness might result in a significant increase in sales, particularly when considering Tesla, which despite being fairly known cannot stand the comparison with more famous and renowned companies such as BMW or Audi, among those in the upper-price segment. Such a move, even though not immediately appreciable by the general public has brought relevant attention to the brand and their ethics and principles. Most importantly, brand awareness has been sought in markets were Tesla is less known, and where also the electric vehicle adoption rate is low.

Tesla's products bring value not only due to the characteristics of the product itself but because of the image associated with the brand. The typical customer of Tesla can be identified as a highly educated professional, wealthy and aware of the environmental issues, and, in turn, the product is associated to an idea of wealth and environmental consciousness. Hence, by releasing their patents in name of the development and the advancement in the electric vehicle technology to address the current environmental

issue, Tesla further stressed their aim as an environmentally aware company, working for the benefit of the planet rather than for its own profits.

Certainly, this cannot be the sole and principal motive, but it surely contributed as a positive consequence to the 12th June announcement.

Also, the announcement was able to lift the value of the company's shares considerably, particularly when compared to the trends in the stock value in the two previous quarters. Hence, even if this could have resulted in catastrophe and further decrease the value of the company's outstanding shares, it did in fact the opposite setting a new increasing positive trend, that surely benefited the company.

8.2.2 STANDARD CREATION

One of the main explanations to this unusual and unexpected move by Tesla is believed to be the attempt of imposing its technology as a standard.

One of the reasons that might have brought Tesla's management to embrace the open source approach to Industrial Property, even if with all the limitations on the factual protection of their patents, was the hope in the establishment of a standard utilizing its patents. Specifically, as one of the big issues in the spending of the electric vehicle to the general public is the lack of recharging stations, making Tesla's models not at all appealing to consumers not residing in the Silicon Valley and those in need of a vehicle to travel the country. The creation of a capillary and well spread net of charging stations for Tesla's models would be unfeasible, due to the significant costs for the set up and the maintenance of the apparatus. By releasing the use of their patents concerning the charging stations Tesla is hoping that competitors will all adapt its standard and in turn benefit from the instalment of its own charging station all over the country. This will, more likely, render Tesla's vehicle more appealing to the general public, increasing sales and hence the margins of the company, largely offsetting the missed returns from the legal monopoly conferred by the canonically managed patent. Furthermore, the imminent construction of the Gigafactory for the construction of the technologically superior batteries, might be a further reason for hoping to attract the largest number of automakers to utilise Tesla's charging patents: this way they would probably turn to Tesla for the purchase of the batteries at low costs and this would boost Tesla's profits form the Gigafactory as well.

Specifically, Tesla was able to develop technologically advanced systems for the charging of the electric batteries in the vehicles. The Superchargers allow for fast charging cycles, reducing the times the car has to station at the charging station for allowing the battery to recharge. Supercharger Stations are being constructed all around the World by Tesla, facing high capital investments. It is common believe that Tesla's hope in releasing their valuable superchargers and batteries patents is to attract other electric vehicles manufacturers to adopt his technology, hence increasing the users of the Supercharger stations and cutting the costs of establishing the Supercharger network by sharing the cost with the other manufacturers.

This attempt seemed to have failed as Nissan, Toyota and Mitsubishi had just signed on ChaDeMo Association aiming at increasing quick-charger installations worldwide and at standardizing EV charging, through the utilization of a different technology than that developed by Tesla.

Furthermore, the creation of a standard would put Tesla in a dominant position even in regard of innovations by the competitors. Standard establishment has proofed to be a strong tool for establishing market incumbency.

Press reports indicate that Tesla is working with Nissan and BMW to develop standards for charging stations and plugs in order to avoid a Betamax–VHS-type stalemate. Tesla wants to develop a "common, rapidly evolving technology platform," in Musk's words, but his statement did not refer to any relationships or partnerships with other companies or to making tool kits, annotated designs, or instructions available. The company does not want to be in the litigation business, but it is less clear how closely it wants to collaborate with others.

8.2.3 STRATEGIC MOVE

"Tesla will not sue, as long as it will not be sued"

As already argued by some scholars Tesla, despite being a cutting edge innovative firm does not possess an extremely powerful and qualitatively solid portfolio.

So far Tesla did not experience any litigations, it might signify huge capital drainage if any of their patents were challenged as the costs for patent litigations can reach millions of dollars throughout their course. Not to mention that in case any of their patents were challenged a provisory estoppel order by the judge might temporarily stop their production and in case the patent is actually invalidated it might also mean the economical collapse of the company. This is due to the fact that if a patented technology is found to be infringing on previously issued patents, Tesla would be forced to stop the production and withdraw their models, pay substantial damages to the infringed patents' holder and possibly negotiate a license agreement for the argued technology in order to be able to keep producing. Licensing that would put Tesla in a very disadvantaged position during the negotiations, which in turn might lead to a very disadvantageous agreement for Tesla. Hence, the possible invalidation of one of the company's key patent would seriously compromise its future and profitability.

Several weeks before Musk made the proclamation, Toyota announced that it was phasing out its deal with Tesla. Then, just a week after Musk's announcement, Toyota unveiled its hydrogen car, which will first be introduced in Japan and subsequently to the US market in the summer of 2015. In many ways, hydrogen can be a much cheaper and more readily available fuel. And with mainstream development of pure-electric vehicles relatively stagnant in recent years, we are left to wonder if Tesla is opening up its patent portfolio to preserve market share and incentivize further development. Again drawing parallels, the business lesson from Linux software is that its availability as open sourced software has encouraged its use and proliferation. Musk's decision initially seems senseless but in light of the circumstances, the decision may be a best alternative if Tesla

cannot persuade other major automobile manufacturers to continue pursuing the route of electric vehicles. In addition, with new carbon-fuel based automobile production of 100 million per year and global demand approaching over 2 billion, it will be impossible for Tesla alone to address the carbon monoxide crises. Without further and faster development, it is very possible that manufacturers will opt for a different technology such as hydrogen cars.

The promising technology belonging to Tesla is a "supercharger" technology for batteries, which can potentially increase the driving range of Tesla's Model S by 170 miles. According to Musk's announcement, companies can incorporate this technology in the production of their new vehicles without the threat of legal action. Currently the super charger stations spread across the United States are all owned by Tesla, all of which only cater to the Tesla Model S. If other auto manufacturers start using similar charging technology and build similar charger stations, the permanence of electric cars, and therefore Tesla, will be solidified.

Or perhaps Musk's strategy is even simpler. Perhaps Tesla hopes that by opening its technology, other car manufacturers may become more dependent on Tesla for its other technologies, such as its batteries. Tesla is the owner or assignee of over 200 patents, with rights to a wide range of technologies that may be applicable to electric and hybrid cars. Additionally, Tesla has another 280 pending patent applications throughout the United States and across the world. It is impossible to truly evaluate Tesla's intentions until more time has passed.

Furthermore, capital availability is not one of the facts Tesla is famous for, by opening its patents Tesla might as well hope in the establishment of more and more fruitful collaboration among automakers to cut down on investments for the technology development while still producing relevant output so to keep the electric vehicle technology as the most convenient clean alternative to commercial vehicles.

8.2.4 HOPE FOR A PATENT LAW REFORM

Another possible, if even remote, reason for which Elon Musk ha decided to pledge the company's patents could be to push towards a reform of the patent system, which most consider inappropriate and outdated for the protection of the new technology and the pace at which it evolves. As the system's benefits are quickly being overrun by its costs, particularly in those industries where technological disruption is speeding up the move by Tesla, an by an increasing number of companies after them is calling out for a change in the structure of the system When core technologies are continuously being replaced before the patents on them expire, unneeded protections for inventors become an expensive and dangerous drag on both the economy and future innovation, particularly when considering the costs associated to patent litigations and disputes of the sort. With broader and more dubious patents being granted all the time, it is enough to consider the Chinese situation of the SIPO that has become the leading office in the world for granted and valueless patents, the temptation is growing both for producing and non-producing patent holders to use litigation not to protect true innovation but to slow down competitors or tap off their profits.

In fast-changing fields, overly generous patent grants that last far longer than the commercial life of any product that might make use of them are retarding the "progress of science and useful arts", the very justification for granting patent monopolies in the first place. Some scholars believe that the cost of unwarranted patent lawsuits have now eclipsed the economic value the system has generated since its inception two hundred years ago, and hence call out for a radical reform of the system as a whole in order to better adapt it to the current technological scenario.

Nevertheless, this scenario is marginal and would not affect directly the company, hence will be disregarded for the purposes of this analysis, even though it was worth mentioning.

9 CONCLUSIONS

Despite it is undeniable that Tesla might have opened the way to a new understanding of patent ownership and strategy for the benefit of the community and the environment, rather than for merely capitalistic purposes, particularly when the technology of matter is concerning highly sensitive social interests for the benefit of the society as a whole, it is equally obvious that the intentions of Elon Musk and its management team could not have been purely altruistic.

The company's future, despite growing revenues and positive outlooks on stock performances, is highly uncertain both because to the inherent market uncertainty on which will actually be the new environmentally friendly technology that will impose as the new eco solution for the transportation in the attempt of overturning the rapidly increasing environmental issue; but also due to the instability of the company's performances per se.

Tesla is struggling with low liquidity availability to permit the expansion of the productive capacity to the levels sufficient to meet the exponentially increasing demand for their products, time to market might be an obstacle for increasing the demand further: the consumer willing to purchase Tesla's car might be discouraged from purchase due to the excessive waiting times, particularly at a time when more and more producers are inputting on the market new electric cars models, specifically, luxury models and brands.

Of course, Tesla has the edge, when compared to the other EVs automakers, on the range capabilities of its batteries and the short charging time, together with the development of a capillary net of Supercharger Stations. But a car, if even electric, is not exclusively composed by its battery, and propulsion systems are one of the areas where Tesla does not excel, and has not been focusing its research and development efforts.

Tesla has an extensive patent portfolio, which focuses on its core technologies and with some additional patents concerning other functions embedded into its products. Nevertheless, the value of the portfolio is not as high as might be expected: non of the core patents by Tesla rank among the highest cited patents among those with similar IPC, whilst its weaker patents are in fact in those fields where its competitors have the higher number of valuable patents.

The factual release of the company's intellectual property might in fact be a strategic and unofficial attempt of concluding a tacit agreement with the owners of relevant patents, who might decide to go ahead and challenge the validity of Tesla's patents. With its proposition of not suing for patent infringement, Tesla's team of lawyers underlined that it will be the case only when the exploiter of the company's IP has never challenged the validity of any of Tesla's patents. By owning the most advanced technology on the batteries and its charging systems, Tesla could be able to challenge some of its competitors' patents, but with its Pledge the company is probably hoping to be able to keep itself out of court, away form expensive, exhausting and everlasting trials.

The move collected both positive and negative reactions, but the stock market praised Musk's statement and the value of the company's share started to grow again after losing a significant number of points during the previous two financial quarters. Clearly, the company benefited also from the free publicity that came from the spreading of the news all over the newspapers, raising awareness on the company, its company's values but, most importantly, its products. However, the patent release was almost completely ignored by Tesla's competitors who, in some cases, did not even acknowledge the bold move taken by the producers of one of the best selling EVs worldwide. Hence, if it cannot be possibly to affirm that Tesla attempted to impose its batteries and charging systems as the industry's standard by allowing their free use (also in light of the imminent construction of the Gigafactory for the production of the very same batteries, to be possibly commercialized, as Tesla's vehicles' sales will hardly employ the totality of the production capacity of the facility), it surely can be said that its competitors have not taken the bait and have ignored Tesla's offer, whilst they have intensified their efforts in developing new batteries related technologies to outpace Tesla.

What can be concluded from this study is that Tesla's reasons for the public release of its most valuable asset, its IP, might have lied in diverse strategic motives, and on the possible invalidations threats on some of its patents.

Through the analysis of the patent portfolios of both Tesla and its competitors it was possible to understand the current status of the technology development and the actual value embedded into the patents of the various market players, arriving at the conclusion that Tesla's patents might not be as valuable and as strong as it might be thought, particularly when considering the market cap on the stock market. This either means that the hype on the company's technology is excessive, or that the majority of the company's value lies in the trademark and the brand image.

Further analysis could be conducted in light of the future developments with regards to the company's IP and its market performance and the future possible disputes arising form the use by third parties of Tesla's patents.

What can be surely stated is that Tesla has opened the path to new highly innovative firms to open their patent and possibly has started a patent strategy revolution, reversing the canonical use of Intellectual Property, which aside from the underlying reasons behind it, might lead to a patent revolution and possible amendments in the current legislations on Intellectual Property.

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11 APPENDICES

11.1 APPENDIX A - RELEASED PATENTS UNDER JUNE 2014TH PATENT PLEDGE

AU 2008276398	Battery charging based on cost and life
CA 2608448	Method and apparatus for mounting, cooling, connecting and protecting batteries
CA 2645056	Battery pack and method for protecting batteries
CA 2729480	Selective cure of adhesive in modular assemblies
CA 2736341	Thermal management system with dual mode coolant loops
CN ZL200880107602.X	Battery charging based on cost and life
CN ZL200880107604.9	Battery charging
CN ZL201110132287.X	Thermal management system with dual mode coolant loops
DE 602006031107.9	Method and apparatus for mounting, cooling, connecting and protecting batteries
DE 602008028434.4	Mitigation of propagation of thermal runaway in a multi-cell battery pack
DE 602009003179.1	Varying flux versus torque for maximum efficiency
DE 602009013381.0	All wheel drive electric vehicle power assist drive system
DE 602010000742.1	User configurable vehicle user interface
DE 602010008000.5	Adaptive soft buttons for a vehicle user interface
DE 602010020070.1	Active thermal runaway mitigation system for use within a battery pack
DE 602010010295.5	Adaptive audible feedback cues for a vehicle user interface
DE 602011000601.0	Battery pack with cell-level fusing and method of using same
DE 602011007513.6	AC current control of mobile battery chargers
DE 602012000199.2	Charging efficiency using selectable isolation
DE 602012003275.8	Battery pack gas exhaust system
EP 1880433	Method and apparatus for mounting, cooling, connecting and protecting batteries
EP 2181481	Mitigation of propagation of thermal runaway in a multi-cell battery pack
EP 2213494	All wheel drive electric vehicle power assist drive system
EP 2226870	Improved heat dissipation for large battery packs
EP 2266201	Varying flux versus torque for maximum efficiency
EP 2302727	Active thermal runaway mitigation system for use within a battery pack
EP 2305506	Adaptive soft buttons for a vehicle user interface
EP 2308713	Adaptive audible feedback cues for a vehicle user interface
EP 2416405	Battery pack with cell-level fusing and method of using same
EP 2498370	Charging efficiency using selectable isolation
EP 2506336	Battery pack gas exhaust system
EP 2587583	AC current control of mobile battery chargers
FR 2226870	Improved heat dissipation for large battery packs
FR 2266201	Varying flux versus torque for maximum efficiency
FR 2302727	Active thermal runaway mitigation system for use within a battery pack
FR 2305508	User configurable vehicle user interface

FR 2416405	Battery pack with cell-level fusing and method of using same
FR 2587583	AC current control of mobile battery chargers
GB 2266201	Varying flux versus torque for maximum efficiency
GB 2305508	User configurable vehicle user interface
GB 2416405	Battery pack with cell-level fusing and method of using same
GB 2587583	AC current control of mobile battery chargers
JP 4915969	Battery pack temperature optimization control system
JP 4931161	Battery charging
JP 4972176	Intelligent temperature control system for extending battery pack life
JP 5055347	Multi-mode charging system for electric vehicle
JP 5081962	Adaptive soft button for a vehicle user interface
JP 5088976	Battery charging based on cost and life
JP 5119302	Active thermal runaway mitigation system for use within battery pack
JP 5184576	Integrated battery pressure relaxing portion and terminal isolation system
JP 5216829	Adaptive vehicle user interface
JP 5235942	Method and device for maintaining completeness of cell wall using high yield strength external sleeve
JP 5237342	Method for determining dc impedance of battery
JP 5258871	System for improving cycle lifetime for lithium-ion battery pack and battery cell pack charging system
JP 5285662	Battery pack having resistance to propagation of thermal runaway of cell
JP 5306426	Battery pack provided with fuse at cell level and method for using the same
JP 5325259	Thermal management system with dual mode coolant loops
JP 5325844	Preventing of thermal runaway of cell using double expansible material layers
JP 5372128	System for absorbing and diffusing side impact energy using battery pack
JP 5416664	Battery cell charging system using adjustable voltage control
JP 5529191	Apparatus for improving charging efficiency using selectable isolation
JP 5548149	Triple layer winding pattern, and methods of manufacturing same
JP 5608881	AC Current Control of Mobile Battery Chargers
JP 5603902	A Battery Pack Dehumidification System and the Method of Controlling the Humidity of a Battery Pack
KR 1195077	Thermal management system with dual mode coolant loops
US 7404720	Electro mechanical connector for use in electrical applications
US 7433794	Mitigation of propagation of thermal runaway in a multi-cell battery pack
US 7489057	Liquid cooled rotor assembly
US 7579725	Liquid cooled rotor assembly
US 7602145	Method of balancing batteries
US 7622897	Multi-mode charging system for an electric vehicle
US 7629772	Multi-mode charging system for an electric vehicle
US 7629773	Multi-mode charging system for an electric vehicle
US 7667432	Method for interconnection of battery packs and battery assembly containing interconnected battery packs
US 7671565	Battery pack and method for proctecting batteries

US 7671567	Multi-mode charging system for an electric vehicle
US 7683570	Systems, methods, and apparatus for battery charging
US 7683575	Method and apparatus for identifying and disconnecting short-circuited battery cells within a battery pack
US 7698078	Electric vehicle communication interface
US 7719232	Method for battery charging based on cost and life
US 7736799	Method and apparatus for maintaining cell wall integrity during thermal runaway using an outer layer of intumescent material
US 7739005	Control system for an all-wheel drive electric vehicle
US 7741750	Induction motor with improved torque density
US 7741816	System and method for battery preheating
US 7742852	Control system for an all-wheel drive electric vehicle
US 7747363	Traction control system for an electric vehicle
US 7749647	Method and apparatus for maintaining cell wall integrity during thermal runaway using a high yield strength outer sleeve
US 7749650	Method and apparatus for maintaining cell wall integrity during thermal runaway using multiple cell wall layers
US 7755329	Battery charging time optimization system based on battery temperature, cooling system power demand, and availability of surplus external power
US 7763381	Cell thermal runaway propagation resistance using dual intumescent material layers
US 7781097	Cell thermal runaway propagation resistance using an internal layer of intumescent material
US 7782021	Battery charging based on cost and life
US 7786704	System for battery charging based on cost and life
US 7789176	Electric vehicle thermal management system
US 7820319	Cell thermal runaway propagation resistant battery pack
US 7821224	Voltage estimation feedback of overmodulated signal for an electrical vehicle
US 7841431	Electric vehicle thermal management system
US 7847501	Varying flux versus torque for maximum efficiency
US 7890218	Centralized multi-zone cooling for increased battery efficiency
US 7911184	Battery charging time optimization system
US 7923144	Tunable frangible battery pack system
US 7928699	Battery charging time optimization system
US 7939192	Early detection of battery cell thermal event
US 7940028	Thermal energy transfer system for a power source utilizing both metal-air and non-metal-air battery packs
US 7956574	System and method for interconnection of battery packs
US 7960928	Flux controlled motor management
US 8004243	Battery capacity estimating method and apparatus
US 8008827	Manufacturing method utilizing a dual layer winding pattern
US 8018113	AC motor winding pattern
US 8044786	Systems and methods for diagnosing battery voltage mis-reporting
US 8049460	Voltage dividing vehicle heater system and method
US 8054038	System for optimizing battery pack cut-off voltage
US 8057630	Selective cure of adhesive in modular assemblies

US 8057928	Cell cap assembly with recessed terminal and enlarged insulating gasket
US 8059007	Battery thermal event detection system using a thermally interruptible electrical conductor
US 8063757	Charge state indicator for an electric vehicle
US 8069555	Manufacturing method utilizing a dual layer winding pattern
US 8076016	Common mode voltage enumeration in a battery pack
US 8078359	User configurable vehicle user interface
US 8082743	Battery pack temperature optimization control system
US 8088511	Cell cap assembly with recessed terminal and enlarged insulating gasket
US 8092081	Battery thermal event detection system using an optical fiber
US 8095278	Interface for vehicle function control via a touch screen
US 8117857	Intelligent temperature control system for extending battery pack life
US 8122590	Manufacturing method utilizing a dual layer winding pattern
US 8124263	Corrosion resistant cell mounting well
US 8125324	Charge state indicator for an electric vehicle
US 8133287	Method of controlled cell-level fusing within a battery pack
US 8133608	Battery pack with cell-level fusing
US 8137833	Condensation-induced corrosion resistant cell mounting well
US 8153290	Heat dissipation for large battery packs
US 8154166	Dual layer winding pattern
US 8154167	Manufacturing method utilizing a dual layer winding pattern
US 8154256	Battery thermal event detection system using an electrical conductor with a thermally interruptible insulator
US 8168315	Battery thermal event detection system utilizing battery pack isolation monitoring
US 8173295	Method and apparatus for battery potting
US 8178227	Battery thermal event detection system utilizing battery pack isolation monitoring
US 8180512	Efficient dual source battery pack system for an electric vehicle
US 8190320	Efficient dual source battery pack system for an electric vehicle
US 8216502	Method for the external application of battery pack encapsulant
US 8241772	Integrated battery pressure relief and terminal isolation system
US 8242739	Leakage current reduction in combined motor drive and energy storage recharge system
US 8247097	Battery pack dehumidifier with active reactivation system
US 8263250	Liquid cooling manifold with multi-function thermal interface
US 8263254	Cell with an outer layer of intumescent material
US 8268469	Battery pack gas exhaust system
US 8277965	Battery pack enclosure with controlled thermal runaway release system
US 8286743	Vehicle battery pack ballistic shield
US 8293393	Apparatus for the external application of battery pack encapsulant
US 8298692	Collection, storage and use of metal-air battery pack effluent
US 8304108	Method and apparatus for maintaining cell wall integrity using a high yield strength outer sleeve
US 8313850	Battery pack pressure monitoring system for thermal event detection
US 8322393	Selective cure of adhesive in modular assemblies

US 8324863	Trickle charger for high-energy storage systems
US 8336319	Thermal management system with dual mode coolant loops
US 8346419	Operation of a range extended electric vehicle
US 8353545	Compact energy absorbing vehicle crash structure
US 8361642	Battery pack enclosure with controlled thermal runaway release system
US 8361649	Method and apparatus for maintaining cell wall integrity using a high yield strength outer casing
US 8365392	System and method for an efficient rotor for an electric motor
US 8367233	Battery pack enclosure with controlled thermal runaway release system
US 8367239	Cell separator for minimizing thermal runaway propagation within a battery pack
US 8389139	Integrated battery pressure relief and terminal isolation system
US 8389142	Method and apparatus for the external application of a battery pack adhesive
US 8393427	Vehicle battery pack ballistic shield
US 8402776	Thermal management system with dual mode coolant loops
US 8421469	Method and apparatus for electrically cycling a battery cell to simulate an internal short
US 8423215	Charge rate modulation of metal-air cells as a function of ambient oxygen concentration
US 8424960	Front rail configuration for the front structure of a vehicle
US 8428806	Dual mode range extended electric vehicle
US 8441826	Fast switching for power inverter
US 8445126	Hazard mitigation through gas flow communication between battery packs
US 8448696	Thermal management system with dual mode coolant loops
US 8448966	Vehicle front shock tower
US 8449015	Method of controlling a dual hinged vehicle door
US 8449997	Thermal energy transfer system for a power source utilizing both metal-air and non-metal-air battery packs
US 8450966	Method of operating a recharging system utilizing a voltage dividing heater
US 8450974	Electric vehicle extended range hybrid battery pack system
US 8453770	Dual motor drive and control system for an electric vehicle
US 8463480	Dual mode range extended electric vehicle
US 8463481	Dual mode range extended electric vehicle
US 8471521	Electric vehicle extended range hybrid battery pack system
US 8481191	Rigid cell separator for minimizing thermal runaway propagation within a battery pack
US 8493018	Fast switching for power inverter
US 8493032	Bidirectional polyphase multimode converter including boost and buck-boost modes
US 8511738	Dual hinged vehicle door
US 8511739	Control system for use with a dual hinged vehicle door
US 8511745	Integrated energy absorbing vehicle crash structure
US 8534703	Dynamic anti-whiplash apparatus and method
US 8536825	State of charge range
US 8539990	Vehicle port door with wirelessly actuated unlatching assembly

US 8541126	Thermal barrier structure for containing thermal runaway propagation within a battery pack
US 8541127	Overmolded thermal interface for use with a battery cooling system
US 8543270	Efficient dual source battery pack system for an electric vehicle
US 8552693	Low temperature charging of li-ion cells
US 8555659	Method for optimizing battery pack temperature
US 8557414	Control, collection and use of metal-air battery pack effluent
US 8557415	Battery pack venting system
US 8557416	Battery pack directed venting system
US 8567849	Dual load path design for a vehicle
US 8567855	Bumper mounting plate for double channel front rails
US 8567856	Swept front torque box
US 8572837	Method for making an efficient rotor for an electric motor
US 8573683	Front rail reinforcement system
US 8574732	Hazard mitigation within a battery pack using metal-air cells
US 8579635	Funnel shaped charge inlet
US 8585131	Rear vehicle torque box
US 8618775	Detection of over-current in a battery pack
US 8626369	Charge rate modulation of metal-air cells as a function of ambient oxygen concentration
US 8627534	Cleaning feature for electric charging connector
US 8627860	Fuel coupler with wireless port door unlatching actuator
US 8629657	State of charge range
US 8638063	AC current control of mobile battery chargers
US 8638069	Bidirectional polyphase multimode converter including boost and buck-boost modes
US 8643330	Method of operating a multiport vehicle charging system
US 8643342	Fast charging with negative ramped current profile
US 8647763	Battery coolant jacket
US 8651875	Electromechanical pawl for controlling vehicle charge inlet access
US 8659270	Battery pack overcharge protection system
US 8663824	Battery pack exhaust nozzle utilizing an sma seal retainer
US 8664907	Fast switching for power inverter
US 8672398	In-line outer sliding panorama sunroof tracks
US 8686288	Power electronics interconnection for electric motor drives
US 8696051	System for absorbing and distributing side impact energy utilizing a side sill assembly with a collapsible sill insert
US 8702161	System for absorbing and distributing side impact energy utilizing an integrated battery pack and side sill assembly
US 8708404	Sunroof utilizing two independent motors
US 8720968	Charge port door with electromagnetic latching assembly
US 8754614	Fast charging of battery using adjustable voltage control
US 8757709	Reinforced b-pillar assembly with reinforced rocker joint
US 8758924	Extruded and ribbed thermal interface for use with a battery cooling system
US 8760898	Fast switching for power inverter

US 8761985	Method of operating a dual motor drive and control system for an electric vehicle
US 8765276	Common mode voltage enumeration in a battery pack
US 8771013	High voltage cable connector
US 8773058	Rotor temperature estimation and motor control torque limiting for vector-controlled AC induction motors
US 8773066	Method and apparatus for extending lifetime for rechargeable stationary energy storage devices
US 8778519	Battery pack exhaust nozzle
US 8803470	Electric vehicle extended range hybrid battery pack system
US 8803471	Electric vehicle extended range hybrid battery pack system
US 8807637	Angled front hood sealing assembly
US 8807642	Mechanism components integrated into structural sunroof framework
US 8807643	Sunroof mechanism linkage with continuous one part guide track
US 8807644	Sunroof positioning and timing elements
US 8807807	Illumination apparatus for vehicles
US 8810198	Multiport vehicle dc charging system with variable power distribution according to power distribution rules
US 8810208	Charging efficiency using selectable isolation
US 8817892	Redundant multistate signaling
US 8818624	Adaptive soft buttons for a vehicle user interface
US 8819162	Host communications architecture
US 8833499	Integration system for a vehicle battery pack
US 8861337	Robust communications in electrically noisy environments
US 8862414	Detection of high voltage electrolysis of coolant in a battery pack
US 8866444	Methodology for charging batteries safely
US 8867180	Dynamic current protection in energy distribution systems
US 8875828	Vehicle battery pack thermal barrier
US 8887398	Extruded member with altered radial fins
US 8892299	Vehicle user interface with proximity activation
US 8899492	Method of controlling system temperature to extend battery pack life
US 8901885	Low temperature fast charge
US 8906541	Battery module with integrated thermal management system
US 8907629	Electric vehicle battery lifetime optimization operational mode
US D660219	Vehicle wheel front face
US D660767	Vehicle wheel front face
US D669008	Vehicle wheel front face
US D672307	Vehicle integrated display and mount
US D673393	Vehicle seat mount
US D678154	Vehicle door
US D683268	Vehicle
US RE44994	Augmented vehicle seat mount

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