WIRELESS POWER CHARGING FOR E-VEHICLE

Rehana Modinsab Taseeladar, Spoorti Prabhakar,Vaishnavi Tonapi,Md Shail Morab, Mrs Chetana Hooli, Dr Suganda

Department Of Electronics and Communication Engineering

Rural Engineering College Hulkoti- 582 205

CHAPTER 1

INTRODUCTION

The Indian automobile industry is all-set to embrace vehicles without an IC engine and a hydrocarbon fuel. The powerful purpose and the need for a cleaner environment along with dependency upon fossil-fuels are ready to create a major disruption. As per the Society of Manufacturing of Electric Vehicles, the population of e-vehicles is growing at the rate of 37.5% in India. India aspires to become 100% EV nation by 2030. However, one of the major roadblocks in the growth of e-vehicles envisaged by SMEV is availability and viability of charging infrastructure in India. In the light of the above background, it makes a compelling objective to study the commercial viability of e-vehicles and charging infrastructure required for it. Hence, it is proposed to investigate and perform detailed study on the first of its kind pilot project in India for deployment of 100 e-vehicle units by an application based fleet operator and its ollaboration with an Oil company for providing charging infrastructure.

Figure 1.1: Future Image Of E-Vehicle

An electric vehicle is powered by one or more electric motors, using rechargeable batteries which have electrical energy stored in it. Electric motors give electric cars instant torque, creating strong and smooth acceleration. Electric vehicles (EVs) are considered to be superior technology than internal combustion engine vehicle from an efficiency and environmental perspective. EVs, are about four times as efficient as vehicles with an internal combustion engine at using the energy delivered to the vehicle to overcome vehicle road load.

The automotive industry has become one of the most important world-wide industries, not only at economic level, but also in terms of research and development. Increasingly, there are more technological elements that are being introduced on the vehicles towards the improvement of both passengers and pedestrians' safety. In addition, there is a greater number of vehicles on the roads, which allows for us to move quickly and comfortably. However, this has led to a dramatic increase in air pollution levels in urban environments (i.e., pollutants, such as PM, nitrogen oxides (NOX), CO, sulfur dioxide (SO2), etc.). In addition, and according to a report by the European Union, the transport sector is responsible for nearly 28% of the total carbon dioxide (CO2) emissions, while the road transport is accountable for over 70% of the transport sector emissions . Therefore, the authorities of most developed countries are encouraging the use of Electric Vehicles (EVs) to avoid the concentration of air pollutants, CO2, as well as other greenhouse gases. More specifically, they promote sustainable and efficient mobility through different initiatives, mainly through tax incentives, purchase aids, or other special measures, such as free public parking or the free use of motorways. EVs offer the following advantages over traditional vehicles.

Governments started using fiscal policies, such as road tax, to discourage the purchase and use of more polluting cars. Green tax is imposed while re-registering the vehicle after 15 years of use to make people discontinue the use of polluting vehicles and encourage them for fuel-efficient and less polluting vehicles. Fuel taxes may act as an incentive for the production of more efficient, less polluting, vehicle and the development of alternative fuels. High fuel taxes or cultural change may provide a powerful incentive for consumers to buy lighter, smaller, fuel-efficient cars, or to not drive. (transportpolicy) The FAME India Scheme is an incentive scheme for promotion of electric and hybrid vehicles.It aims to promote electric mobility and gives financial incentives for enhancing EV production and the creation of electric transportation infrastructure. In 2015 the Ministry of Heavy Industries and Public Enterprises launched FAME to incentivize the production and promotion of eco-friendly vehicles including EV and hybrid vehicles. The scheme is proposed for establishing charging infrastructure (Jose, 2018) The National Electric Mobility Mission Plan (NEMMP) 2020, a National Mission document providing the vision and therefore the roadmap for the faster adoption of evs and its manufacturing. This plan has been designed to boost national fuel security, to supply affordable and environmentally friendly transportation, and to enable the Indian automotive industry to attain global manufacturing leadership(Gulati, 2013).

India is the fifth largest car market in the world and has the potential to become one of the top three in the near future with about 40 crore customers in need of mobility solutions by the year 2030.However, as per the Paris agreement, the increasing number of automobile customers shall not imply an increase in the consumption of conventional fuels. To ensure a positive growth rate towards achieving India's Net Zero Emissions by 2070, a transportation revolution is required in India which will lead to better "walkability", public transportation; railways, roads and better cars. Solution of "better cars" are likely to be electric.

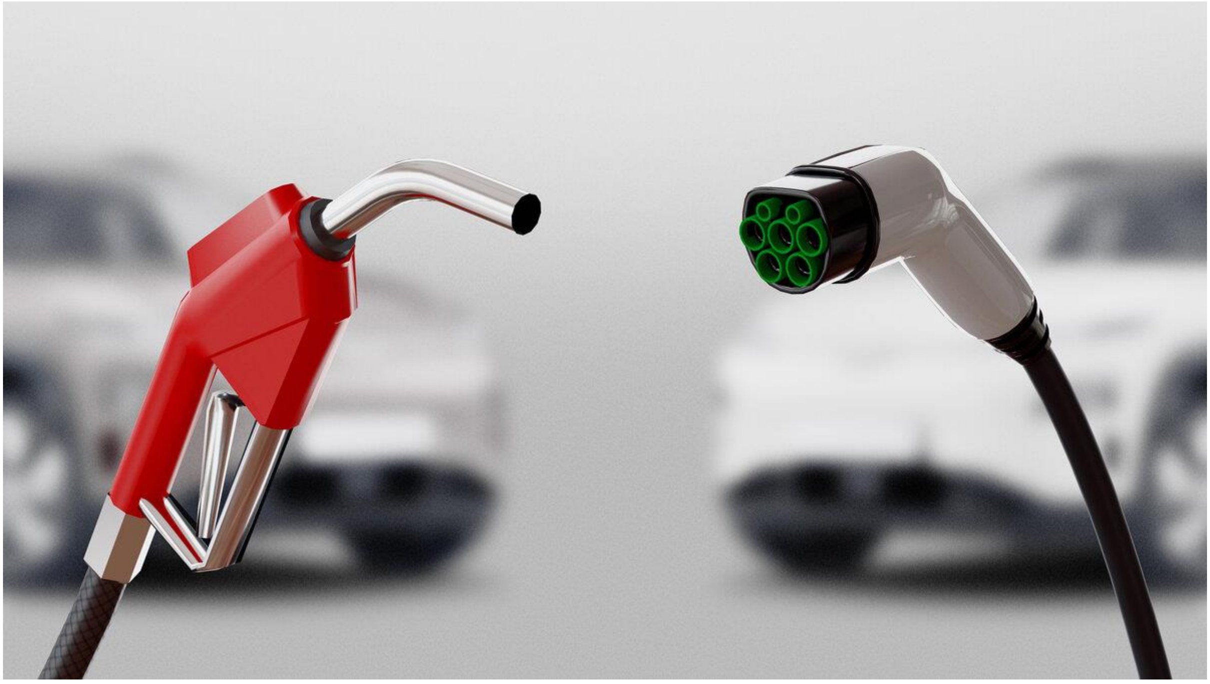

Figure 1.2 : Evolusion Of Normal Cars To Electric Vehicle Image

The world as of present times needs the extensive use of electric motor run vehicles in comparison with conventional fuel vehicles we use. The fossil fuel depletion is an imminent thing of the day, however what the global community can do would be reduce the exhaustive stress upon the conventional source and slowly shift its need to electric motor (EV) vehicles to ensure that the future generations can enjoy the fruits of our labour, sometimes exploitative labour at times. To achieve a complete cleaner fuel source, electric is the way to go. Norway has recognised it, reigning at the top with the highest market source for such motors with 2014 being its entry year. Soon the European Union followed the steps of Norway and set its goal with 2022 as the year where all vehicles in European continent shall be either EV or Hybrid.

CHAPTER 2

LITERATURE SURVEY

1. A REVIEW ON ELECTRIC VEHICLES: TECHNOLOGIES AND CHALLENGES: : MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliation.

New Challenges and Technologies in Batteries for EVs

Batteries are one the most important components of EVs, since they are one of the most costly components of the overall cost of the vehicle, and batteries directly affect the EV performance, as we have previously discussed in the Section 4. The improvement in terms of durability, in charging densities, and in the charge and discharge processes, have caused the use of multiple resources in the development of new technologies that are able to surpass the current lithium-ion batteries, which are the ones massively used in vehicles. In our view, there is still work to do in this field, fundamentally due to its impact, as the improvement of batteries can accelerate EVs success and the worldwide deployment of these vehicles in a remarkable way. At present, new technologies and components are being researched. Some of them are the following.

Lithium iron phosphate ($LiFePO_4$). This kind of battery presents an energy density of approximately 220 Wh/L, a great durability (they are able to withstand between 2000 and 10,000 cycles) and tolerate high temperatures. However, although this type of battery is starting to be tested in EVs, it still can be found in an early stage of research and development. MIT researchers have managed to reduce its weight and they have developed a prototype-cell that can be completely charged in just 10–20 s, a reduced time if we compare it with the necessary 6 min. for standard battery cells.

Magnesium-ion (Mg-Ion). These batteries change the use of lithium over magnesium, succeeding in storing more than double the charge and increasing its stability. It is expected that this type of battery can have a 6.2 kWh/L energy density [96], which would imply 8.5 times more than the best lithium batteries, which are currently able to apply up to 0.735 kWh/L. Organizations, such as the Advanced Research Projects Agency-Energy (ARPA-E), Toyota, or NASA, are investigating this type of battery.

Lithium-metal. In these batteries, graphite-anode is replaced by a fine lithium-metal layer. This kind of battery is able to store double of the power than a traditional lithium battery [99]. SolidEnergy Systems, a MIT startup, have already started to deploy this type of batteries in drones, and it is expected that they can be included in EVs [100]. Lithium-metal batteries have a high Coulombic efficiency (above 99.1%), withstanding more than 6000 charging cycles, and, after 1000 cycles they maintain an average Coulombic efficiency of 98.4%.

Sodium-air (Na2O2). The company BASF created a Sodium-air battery with an energy density of 4.5 kWh/L. In electric vehicles, this type of battery can multiply the autonomy of the current lithium batteries at least thirteen times. A great advantage of this type of batteries is that sodium is the sixth more abundant element in our planet .

Graphene. Graphene is a material that is formed by pure carbon, which has a high thermal conductivity and it is extremely light (a one square meter blade weighs 0.77 mg) . One of the major assets of graphene-based batteries is that they barely heat, enabling fast or ultra-fast charges without significant power losses due to heat. Graphenano, a Spanish company, has created a graphene battery that, added to a GTA Spano vehicle (900 hp), has been able to travel 800 km . In a high power plug, this battery could be charged in only 5 min. This kind of battery is in an early phase of development, although there exist prototypes of graphene batteries with a specific power of 1 kWh/kg, and it is expected to reach 6.4 kWh/kg.

2. CONSUMER PERCEPTION OF ELECTRIC VEHICLES IN INDIA: European Journal of Molecular & Clinical Medicine

Electric Vehicles in India: Market Analysis with Consumer Perspective, Policies and Issues: Pritam K. Gujarathi, Varsha A. Shah, Makarand M. Lokhande, Indian Scenario is different because the current market share of EV/PHEV is around 0.1%. Presently almost all vehicles consider fossil fuel-based transportation. These pollute the atmosphere by the emission of greenhouse gases & causes global warming. The gap between domestic petroleum production and consumption is widening. India imports around 70% of oil required per annum. Hence there's an urgent need to investigate factors and challenges for sustainable and cleaner alternatives. (Pritam K. Gujarathi, 2018)

Perception and Awareness Level of Potential Customers towards Electric Cars: Masurali.A, Surya P, India contributes around 18% in transport sector alone in terms of carbon emission. The Electric Vehicle (EV) is one of the foremost feasible alternative solutions to beat the crises. Several automotive companies are introducing evs and are expanding their portfolio. Promoting evs can help reduce fuel dependence and pollution and beneficial for both consumers and the nation. The education of people has significantly higher influence over their awareness level on evs. Apart from manufacturers, Government should strive hard to spread awareness and influence positive perception among potential customers. (Masurali.A, 2018).

Electric Vehicles for India: Overview and Challenges: by Mr. A. Rakesh Kumar, Dr. Sanjeevikumar Padmanaban, Global pollution is on the rise and each effort made, is to cut back the CO2 emissions and save the earth. One such effort is the introduction of EVs. The transport sector is one in all the largest emitter of CO2 and hence it's important to reduce it. The government has come up with ambitious plans of introducing EVs to the Indian market and confine pace with the event of EVs globally. The National Electric Mobility Mission Plan 2020 has included an in-depth report on the EVs. India encompasses a huge challenge in shifting the transportation sector from ICE engines to EVs. This needs lots of planning along with R&D. Charging infrastructure must be adequately build to deal with range anxiety. It’s vital to form demand generation by making all government buses electric and offering tax exemptions for personal EV owners. (Mr. A. Rakesh Kumar, 2019).

Opportunities and Scope for Electric Vehicles in India: by Janardan Prasad Kesari, Yash Sharma, Chahat Goel, Developing an aggressive strategy for the adoption of EVs in India and ensuring a wellexecuted implementation is a challenge but vital for government. The geography and diversity of India will present problems that require thoughtful solutions. Public procurement is expected to be an important driver of growth of EVs, with the purchase of four-wheeled vehicles for government offices, threewheeled vehicles and buses for public transport. Investments by fleet operators such as Ola and Uber, and operators of food distribution services, are also expected to boost the initial growth of two- and fourwheeled electric vehicles. However, the private EVs may take 5-6 years to gain popularity and acceptance. (Janardan Prasad Kesari, 2019).

Indian Electric Vehicles Storm in a teacup: Yogesh Aggarwal, Vivek Gedda and Kushan Parikh, Users of scooters, who need only to travel short distances, may consider an EV, but those, who need to travel longer distances and already own bikes like a Hero Splendor, may find it difficult to move to an e2W. For cars, it is relatively simple to improve the range with increased battery size. For electric 2Ws though, every increase in kWh may provide an extra 30km in range, but the increase in weight is around 4864 10kg, approximately a 10% increase in the total weight of the bike. This weight issue is even more pronounced in smaller bikes (less than 150cc). (Yogesh Aggarwal, 2019).

3. THE FUTURE OF ELECTRIC CARS IN INDIA: Ilkogretim Online - Elementary Education Online.

Fossil Fuels are the primary source of energy for operation of vehicles and machineries in the present times. There exists tremendous environmental impact on using such fossils to generate electricity (Khazaei 2019). By burning up of such fossils, it emits massive amounts of carbon dioxide and other moderately significant greenhouse gases, which results in warming up the temperature of the atmosphere (Hamilton 1978). Such an effect of the fossil fuel cannot be overlooked and at the same time cannot be avoided, since all lives that are run behind the steering wheel are dependent upon fossil fuel. To ensure that the future generation does get to enjoy the uses of the fossils, we ought to start to plan how to enable sustainable usage of the fossil and how to reduce the immediate dependence on it, and that's where the need to shift to electric vehicles come into picture (Geurtsen and Wilford 2009). By running vehicles through electricity as the primary source of fuel, we eliminate the need for fossils, the need, reduce the global market pressure that we put on fossils and perhaps revolutionise the way people think about fuel (Williander and Stalstad 2013). EV motors are much cleaner by a large margin than the conventional fuel types, with the high price and sustainability as the sole fuel source, but that's the price we ought to be burdened with for an cleaner and alternative source of fuel (Hamilton 1978).

However, that being said, an electric energy source as fuel for vehicles isn't an absolute clean source of energy as many may perceive. To produce electricity, fossil fuels are indeed burned to produce heat to produce electricity (Figenbaum 2020). No matter that's the nature of the energy source, burning of fossil fuel is imminent and absolutely unavoidable so as to speak. With the current depletion rate of the fossils, by the year of 2040, there is a possibility that they may not exist as fossil fuel for the future generation (Contestabile 2020). Researches have been going on how to accelerate the process of decomposition of organic matter to generate the fossils, but the closest time one has arrived as of now is the period of 10 years, which is quite low when compared to the rate of consumption of the fossil and the rate of creation of fossil (Tal et al. 2020). It is estimated that 73% of the electricity we have produced as a source for EV has come from fossil as of the year 2019. It would rather be a sustainable choice to switch to the dependence on renewable sources of energy that is found in abundance around the world (Durney 2012). However, those renewable energy sources do pose a series of dangers to those who consume electricity through such energy sources. The primary source of renewable source of energy, power harnessed through wind mills, pose a serious threat to the environment, something that is often overlooked in the pursuit of a cleaner source of energy (Anderson and Anderson 2005).

However, that being said, an electric energy source as fuel for vehicles isn't an absolute clean source of energy as many may perceive. To produce electricity, fossil fuels are indeed burned to produce heat to produce electricity (Figenbaum 2020). No matter that's the nature of the energy source, burning of fossil fuel is imminent and absolutely unavoidable so as to speak. With the current depletion rate of the fossils, by the year of 2040, there is a possibility that they may not exist as fossil fuel for the future generation (Contestabile 2020). Researches have been going on how to accelerate the process of decomposition of organic matter to generate the fossils, but the closest time one has arrived as of now is the period of 10 years, which is quite low when compared to the rate of consumption of the fossil and the rate of creation of fossil (Tal et al. 2020). It is estimated that 73% of the electricity we have produced as a source for EV has come from fossil as of the year 2019.

Beyond the humane issues, the new and changed tidal course will have a negative impact on aquatic organisms and shoreline ecosystems (Jing et al. 2020).

4. RECENT DEVELOPMENT ON ELECTRIC VEHICLES: IEEE Xplore

ELECTRIC VEHICL SHOW CASES INDIA'S LARGEST ELECTRIC VEHICLE SHOW

20th & 21st May 2023, Hall No. 1, Chennai Trade Centre, Chennai

EVs are currently being developed and produced in the country. However, there is a dire need to create entrepreneurship opportunities for stakeholders to tap this huge potential market. The government of India has undertaken multiple initiatives to promote the manufacturing and adoption of electric vehicles in India. With the support of the government, electric vehicles have started penetrating the Indian market.

With **"Future is with E-mobility"** as the broader thematic platform, Franchise India Group aims at bringing together EV Innovators, Investors & Industry leaders from across management level to exchange ideas and invest in the future.

SUSPENSION

The developed direct-drive linear motor actuator for the automobile active suspension systems can generate control forces to absorb road shocks rapidly, suppress the roll and pitch motions, and ameliorate both safety and comfort, while maintaining the vehicle at a horizontal level. For conventional passive suspension systems, it is difficult to be achieved, since a soft spring allows for too much movement and a hard spring causes passenger discomfort due to road irregularities. Thus, significant improvement of suspension performance is achieved by the direct-drive linear switched reluctance actuator. Comparing with hydraulic active suspension systems, the developed active suspension system based on the direct-drive linear switched reluctance actuator is simpler since it needs fewer devices and mechanical parts. Due to no hydraulic devices, this is an oil-free system. Furthermore, it can include the energy generation from the suspension. The development includes the design of direct-drive linear switched reluctance actuator, its characterization, and the design of the automobile active suspension system. The converter drive is also needed to develop to match with the linear switched reluctance actuator. The drive is expected to fit the driving pattern of the suspension system and to provide suitable force control, energy generation control and position control.

6. ELECTRICAL VEHICLE INDUSTRY IN INDIA CURRENT STATE GOVERNMENT POLICY FUTURE OUTLOOK : TIME OF INDIA SOURCE

The Indian automotive market is slated to be the third largest by 2030 in terms of volume. Catering to a vast domestic market, reliance on the conventional modes of fuel intensive mobility will not be sustainable. In an effort to address this, federal policymakers are **developing** a mobility option that is "**Shared, Connected, and Electric**" and have projected an **ambitious target** of achieving 100 percent electrification by 2030.

By making the shift towards electric vehicles (EVs), India stands to benefit on many fronts: it has a relative abundance of renewable energy resources and availability of skilled manpower in the technology and manufacturing sectors.

According to an **independent study by CEEW Centre for Energy Finance (CEEW-CEF)**, the EV market in India will be a US$206 billion opportunity by 2030 if India maintains steady progress to meet its ambitious 2030 target. This would require a cumulative investment of over US$180 billion in vehicle production and charging infrastructure. In 2021, the Indian EV industry attracted US$6 billion in investment and is becoming steadily more attractive to private equity/venture capital investors.

Another report by India Energy Storage Alliance (IESA) projects that the Indian EV market will grow at a CAGR of 36 percent till 2026. The EV battery market is also projected to grow at a CAGR of 30 percent during the same period. Meanwhile, India's EV market is estimated to grow at 49 percent CAGR in the 2022-2030 period in a business as usual scenario as per the IESA report. Overall, by 2030, the EV industry is set to create 10 million direct jobs and 50 million indirect jobs (IVCA-EY-Induslaw report). India is also witnessing the rise of a sizeable EV financing market, with Niti Aayog projecting it to be worth US$50 billion by 2030.

7. EXISTING EV ECOSYSTEM IN INDIA AND INVESTMENT OUTLOOK :

Regardless of the country's ambitious targets, India's EV space is at a nascent stage. However, looking at it differently – India offers the world's largest untapped market, especially in the two-wheeler segment. 100 percent foreign direct investment is allowed in this sector under the automatic route.

The federal government is also prioritizing the shift towards clean mobility, and recent moves to amend the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles in India (FAME) II scheme to make electric two-wheelers more affordable, is a case in point. Under the phase two of the FAME scheme, as on July 11, 2022, about 469,315 electric vehicles were supported through demand incentives amounting to about INR 18.69 billion. Approvals have been granted to 6,315 electrical buses and 2,877 EV charging stations sanctioned in 68 cities across 25 states/Union Territories. 50 original equipment manufacturers (OEMs), both start-ups and established manufacturers, have registered and revalidated their 106 EV models. There are 1,576 charging stations sanctioned for set-up across nine expressways and 16 highways.

In addition, multiple production-linked incentive schemes intend to create a local manufacturing ecosystem to support goals around greater adoption of electric mobility transport. This is sought to be achieved by incentivizing fresh investments into developing indigenous supply chains for key technologies, products, and auto components.

8. Government Policies and Incentives for Electric Vehicles in India: e-vehicleinfo.com/

Over the last decade, the global Electric Vehicle (EV) sector has expanded substantially. China has been the leader in the EV industry with great developments in battery manufacturing capabilities, charging infrastructure, new EV model developments. China can produce EV's at a lower rate due to its large manufacturing capacity. India, on the other hand, is behind other markets in terms of the market penetration of Electric Vehicles. the country has a low acceptance rate when it comes to Electric Vehicles. Considerable work remains to be done in terms of model types, infrastructure available for charging, and financial incentives given to EV.

9. CHARGING THE FUTURE CHALLENGES AND OPPORTUNITIES FOR ELECTRIC VEHICLE ADOPTION: Belfer Center for Science and International Affairs | Harvard Kennedy School

Will Declining Battery Costs Make EVs Competitive?

This paper compares the lifetime costs of battery-only cars (BEVs), plug-in hybrids (PHEV) and gasoline-fueled internal combustion-engined vehicles (ICE), using a range of gasoline prices, discount rates, and battery costs. The PHEV is more expensive than the ICE in almost all scenarios, while the BEV is robustly cost-competitive, once installed battery prices reach $200-$250 per kWh. Hence, further reductions in battery costs will still be needed for BEVs to be a viable alternative to ICEs. The paper compares the lifetime costs of the Chevrolet Bolt BEV to the costs of an equivalent PHEV and ICE, using a range of gasoline prices, discount rates, and battery costs. The PHEV is more expensive 2 Charging the Future: Challenges and Opportunities for Electric Vehicle Adoption than the ICE in almost all scenarios, while the BEV is cost-competitive once battery prices reach $200-$250 per kWh.

Will Charging Infrastructure Support EV Adoption?

Commercial success for EVs will require installing charging infrastructure that is accessible, easy to use, and relatively inexpensive—whether at home or in public locations. The form this infrastructure will take is still uncertain, with a range of charging technologies currently available and more expected to emerge over the next five years. The current range of equipment spans slower alternating current (AC) chargers best suited to home or office locations and short trips (Level 1-2 in this paper), and much faster direct current fast chargers (DCFC) for rapid refueling in public locations, best suited for recharging on longer journeys (Level 3-5). The time taken to add 100 miles of range varies from 26 hours for the slowest AC charger, to six minutes for the fastest DCFC charger—still far slower than the 300 miles-per-minute enjoyed by a 30 mile-per-gallon ICE. The costs of charging infrastructure are both fixed (installation, utility service, transformers, and equipment) and variable (electricity charges). For chargers on commercial electricity tariffs, demand charges can dominate operating costs. As a result, the total cost of power from fast charging stations is higher than slower residential chargers unless the former can achieve sufficiently high utilization rates. Modeling different types of charging infrastructure and comparing them with the operating costs of an ICE suggests that simple home charging is competitive with today's more efficient gasoline cars and could be significantly cheaper if a time-of-use electricity tariff, with lower prices in off-peak periods, is in place. More powerful home charging is sensitive to capital costs, but is competitive with moderately efficient ICEs and substantially cheaper under a time-of-use tariff. For commercial chargers (Level 3-5), the price of electricity required for investment in the system to break even falls sharply at progressively higher utilization rates. At 30% utilization, all variants are cheaper than fueling an average ICE, and at 40% utilization, they are competitive with an efficient ICE. Belfer Center for Science and International Affairs | Harvard Kennedy School 3 At current levels of utilization (optimistically, 10%), commercial chargers are almost universally not economically profitable, suggesting a significant, sustained increase in demand will be needed for commercial charging infrastructure to deliver financial returns, and compete with both ICEs and cheaper residential charging. Managing additional power demand from EVs is both a challenge and an opportunity for distribution utilities. High concentration of EV home charging during peak periods can overload local transformers. Utilities may have to procure additional peak capacity, unless they are able to shift demand to off-peak periods. Time-of-use electricity pricing, along with smart metering, have already been deployed in some states to incentivize off-peak charging and manage peak loads, respectively. It is unclear whether they will be sufficient to offset demand increases. Vehicle-to-grid technology, allowing EVs to serve as mobile electricity storage units, could complement these efforts but will need adequate incentives, which are not presently available.

CHAPTER 3:

BATTERY INTRODUCTION OF E-VEHICLE

3.1 CHARACTERISTICS OF THE BATTERIES

Capacity. The storage difficulty and cost is one of the main problems of electric power. Currently, this results in the allocation of great amounts of money in the development of new batteries with higher efficiency and reliability, thus improving batteries' storage capacity. The battery capacity represents the maximum amount of energy that can be extracted from the battery under certain specified conditions. This unit can be expressed in ampere hour (Ah) or in watt hour (Wh), although the latter one is more commonly used by electric vehicles. When considering that, in EVs, the capacity of their batteries is a critical aspect, since it has a direct impact in the vehicles' autonomy, the emergence of new technologies that enables the storage of a greater energy quantity in the shortest possible time will be a decisive factor in the success of this kind of vehicles. shows data that are related to the battery capacities of EVs. As shown, the capacity of batteries is continuously growing and vehicles with more that 100 kWh batteries are expected very soon.

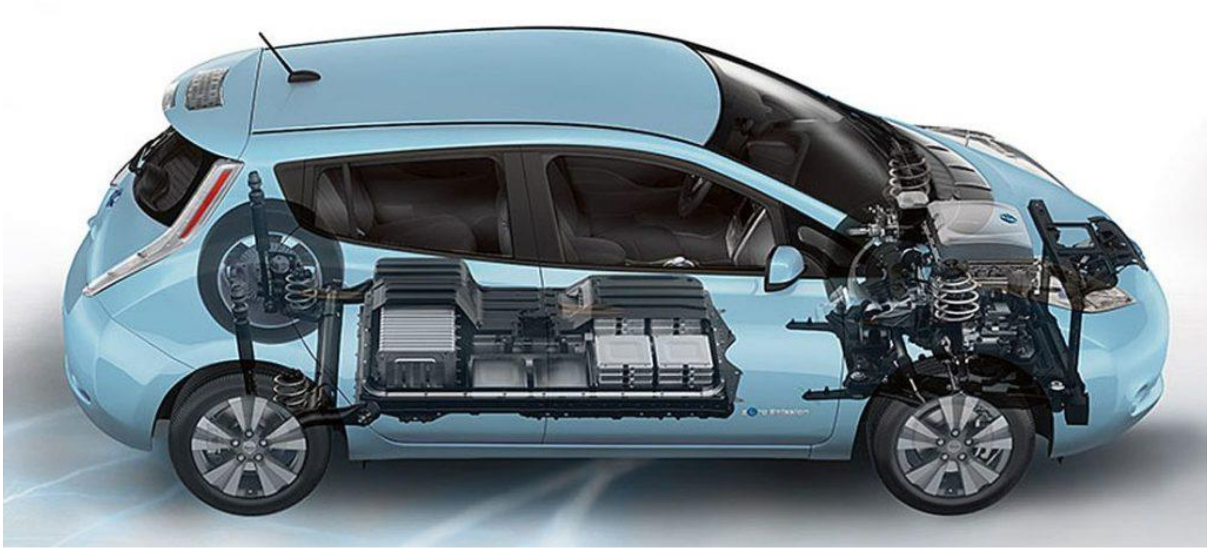

Figure 3.1.1 : Battery Arrangement In E-Vehicle

Charge state. Refers to the battery level with regard to its 100% capacity. Energy Density. Obtaining the highest energy density possible is another important aspect in the development of batteries, in other words, that with equal size and weight a battery is able to accumulate a higher energy quantity. The energy density of batteries is measured as the energy that a battery is able to supply per unit volume (Wh/L).

Specific energy. The energy that a battery is able to provide per unit mass (Wh/kg). Some authors also refer to this feature as energy density, and it can be specified in Wh/L or Wh/kg.Specific power. The power that a battery can supply per unit of weight (W/kg).

Charge cycles. A load cycle is completed when the battery has been used or loaded 100%. Lifespan. Another aspect to consider is the batteries lifespan, which is measured in the number of charging cycles that a battery can hold. The goal is to obtain batteries that can endure a greater number of loading and unloading cycles.

Internal resistance. The components of the batteries are not 100% perfect conductors, which means that they offer a certain resistance to the transmission of electricity. During the charging process, some energy is dispelled in the form of heat (namely, thermal loss). The generated heat per unit of time is equal to the lost power in the resistance, so the internal resistance will have a greater impact in high power charges . Thus, more energy will be lost during quick charging processes when compared to slow ones. Therefore, it is highly important that batteries can support quick charging and higher temperatures induced due to the internal resistance. In addition, the decrease of this resistance can reduce the charging time that is required, which is one of the most important drawbacks of this type of vehicles today.

Efficacy. It is the percentage of power that is offered by the battery in relation to the energy charged.

TABLE 1 : Battery Capacities Of Different Electric Vehicles

Vehicle	Year	Capacity (kWh)
Jaguar I-Pace	2017	90
Nissan Leaf	2017	40
Tesla Model S	2017	75, 100
Volkswagen e-Golf	2017	35.8
Audi e-tron	2018	95
Kia Soul EV	2018	30
Nissan Leaf	2018	60
Renault ZOE 2	2018	60
Renault ZOE 2 rs	2018	100
Tesla Model 3	2018	70, 90
Mercedes-Benz EQ	2019	70
Nissan Leaf	2019	60
Volvo 40 series	2019	100
Audi e-tron	2020	95
BMW i3	2020	42
Hyundai Kona e	2020	64
Mercedes EQC	2020	93
Mini Cooper SE	2020	32.6
Peugeot e-208	2020	50
Volkswagen ID.3	2021	77
Ford Mustang Mach-E	2021	99
Tesla Roaster	2022	200

3.2 BATTERY COST, CAPACITY, AND CHARGING TIME

Currently, the batteries are the main obstacle to EV wider adoption. The development of better, cheaper, and higher capacity batteries will extend vehicles autonomy, and the users view them as a true alternative to the internal combustion engine vehicles. In fact, batteries are a key component in EVs and therefore, there are increasing manufacturers (e.g., LG, Panasonic, Samsung, Sony, and Bosch) that invest to develop improved and cheaper batteries. The most expensive component, in any EV, is the battery pack . For instance, lithium-ion batteries of the Nissan LEAF initially represented a third of the cost of the whole vehicle. However, it is expected that this cost will be progressively reduced; at the end of 2013, the battery pack costs around $500 per kWh (up to half the price per kWh it cost in 2009); currently, the price per kWh is of $200, and it is expected to fall around $100 in 2025. Another fact that reinforces the battery cost reduction trend is that Tesla Motors is building a “Gigafactory” in order to cut down on the production costs and raise the manufacturing of batteries. The Gigafactory is designed to produce more lithium-ion batteries annually than the produced worldwide in 2013 . The lower battery cost would have an obviously direct impact on EV price drop, which makes them more competitive with regard to traditional vehicles. Regarding the capacity, Figure 5 shows the capacity of the batteries of different EVs from 1983, the date on which the Audi Duo was marketed with an 8 kWh battery until 2022, the date on which Tesla announced that will market a Tesla Roadster with a 200 kWh battery . When traveling with an EV, the key factor is the autonomy, but another limiting factor is the time that is required for charging the batteries. The standard power outlets provide around 3 kW power, which would imply a 10 h load on average for charging a maximum of 30 kWh energy in a battery . Even in the case of using fast charging systems, charging a vehicle may require between 1 and 3 h. In order to solve this problem, an alternative is the creation of Battery Exchange Stations (BESs), which are also known as Battery Swap Stations (BSSs), where batteries are exchanged by similar ones already 383 charged. Israel initially located 33 BESs , although Better Place (the company that developed battery-switching services for EVs) filed for bankruptcy in May 2013. However, this approach was extended to the city of Nanjing in 2015 , a city of eight million people, which has thousands of electric buses operating. BESs were also tested by taxi vehicles in Tokyo in 2010 . Thinking about this strategy, Tesla created a system in their Model S, in which batteries can be exchanged in only 90 s . Denmark is studying the possibility of creating a sufficient number of BESs with the purpose of providing an infrastructure with 900 charging points and charging batteries stations that are operated by robot.

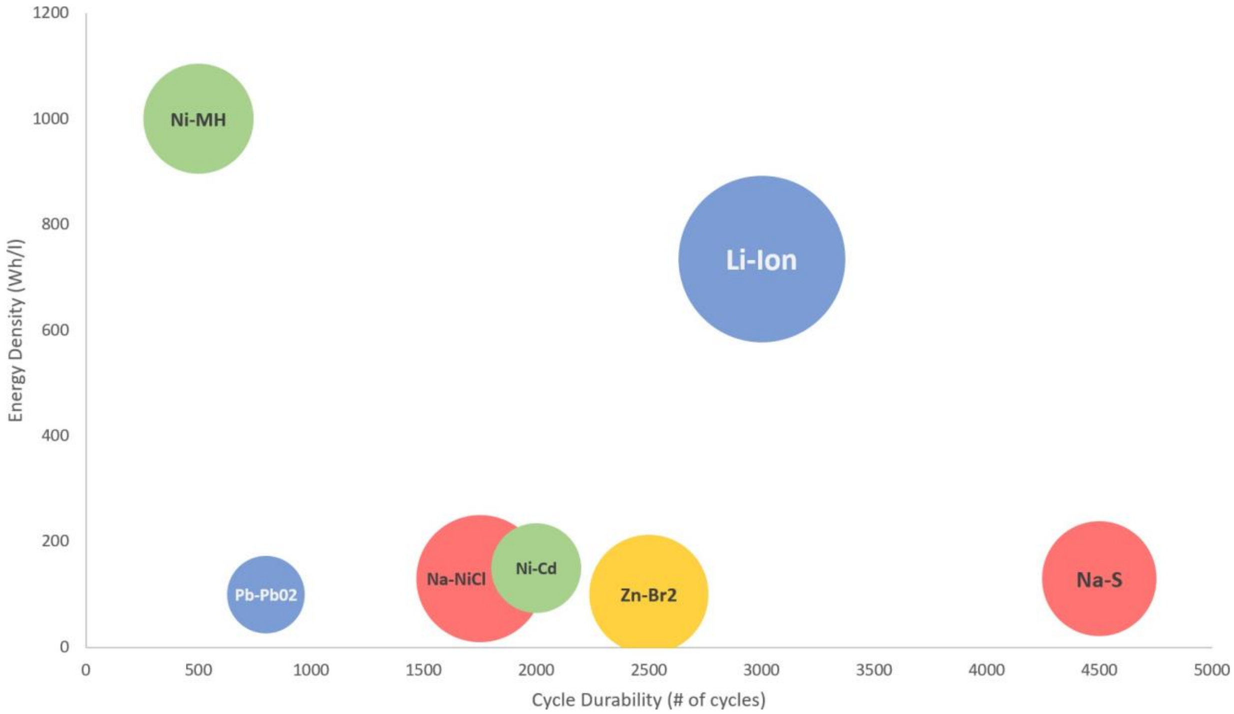

Figure 3.2.1 : Evolution Of The Battery Capacity Since The Mid 80s Until Now.

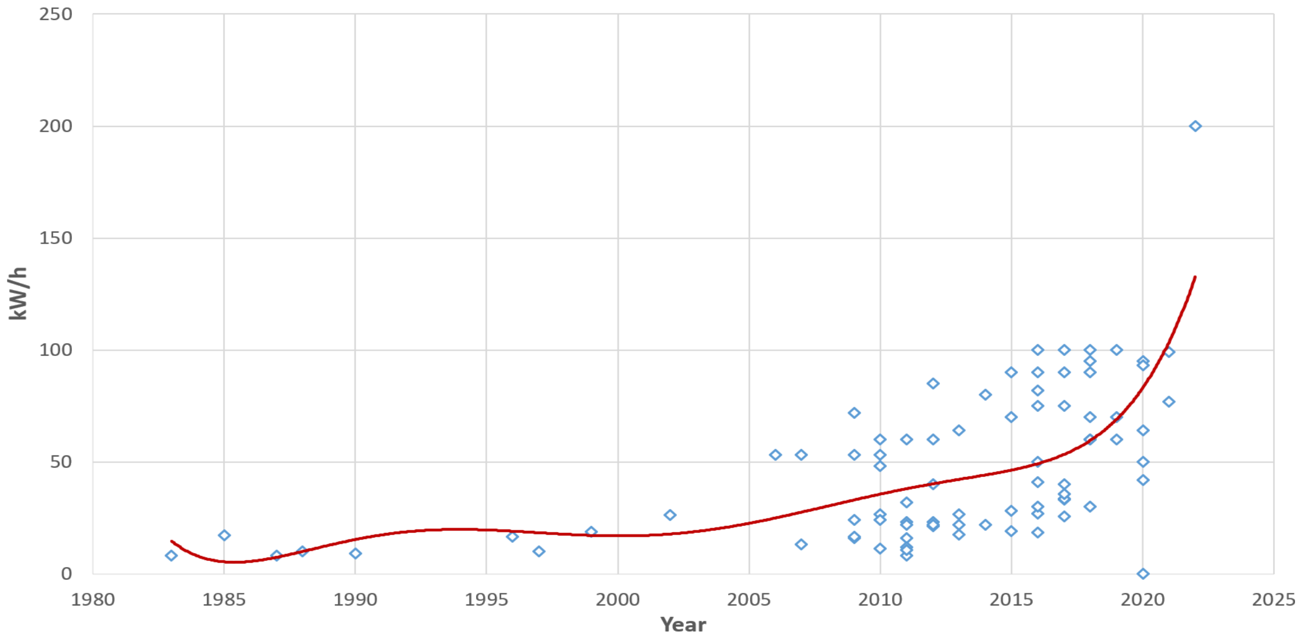

Figure 3.3.1 : A Comparison Of Battery Technologies In Terms Of Their Cycle Durability (X-Axis), Energy Density (Y-Axis), Specific Energy (Bubble Size), And Working Temperature (Bubble Color). Note That Warm Colors Represent Higher Working Temperatures.

3.3 DIFFERENT COMPONENTS AND BATTERY TYPES

The increase of the number of EV models, as well as the different types of batteries and the lack of standardization, are not making the use of bess a feasible process, since all of the vehicles served by BES should use identical batteries [65]. In fact, although lithium-ion batteries (Li-ion) are increasingly used in evs, there exists a great variety of batteries, among which the following stand out.

Concerning the specific power, lead and zinc batteries offer worse results (up to 100 W/kg), while the kinds of batteries with the best scores are those of Ni-MH (with a maximum of 1000 W/kg), and Li-ion, which offer up to 3000 W/kg. As far as the cells voltage, batteries that are formed by nickel and zinc are the ones with lower voltage, while sodium batteries (Na-S y Na-NiCl) and Li-ion use a higher voltage. On the other hand, with respect to the life cycles, the batteries that offer worse results are those of Ni-MH and lead-acid. Lastly, lithium batteries are able to support up to 3000 cycles, and those of Na-S are those that offer better results, supporting up to 4500 cycles. When considering all of the above parameters, current electric vehicles rely on lithium ion technology for their batteries, as this technology presents the best performance in almost all of the analyzed characteristics.

CHAPTER 4 :

MODES AND TYPES OF CHARGING E-VECHICLE

4.1 CHARGING OF ELECTRIC VEHICLES

Besides the autonomy, another important aspect is the duration and the characteristics of the charging process of the batteries. In order for the EVs to definitely succeed, it will be necessary that the users can charge their vehicles in a fast and simple way. To do so, it Smart Cities 2021, 4 386 will be fundamental to have an infrastructure deployment that allows such fast and simple charge. This implies charging at homes, and the creation of electric charging stations that provide quick charges during long commuting. Below, the different standards or rules that are created for electric vehicles charging technology are presented. In particular, we detail the different charging modes that are defined in the current standards, as well as the connectors.

When charging electric vehicles, we can find different standards, which are determined, mainly, by the region in which they are being used or applied. More specifically, in North America, and in the Pacific zone, the SAE-J1772 standard for loading electric vehicles is used. However, in China, the GB/T 20234 standard is used, whereas, in Europe, the IEC-62196 standard was introduced. The main difference Between These Three Standards Is That While

The Two Former Ones Classify The Charging Modes according to the power type (DC or AC power), the latter one classifies such modes by the charging power involved. The SAE-J1772 [73] mode is a North American standard of electric connectors for electric vehicles created in 1996, and supported by SAE International. This standard is common in USA and Japan, and it establishes the following charging modes AC Level 1. Standard electrical outlet that provides voltage in AC of 120 V offering a maximum intensity of 16 A, which serves a maximum power of 1.9 kW. AC Level 2. Standard electrical outlet with 240 V AC and a maximum intensity of 80 A, so it offers a maximum power of 19.2 kW.

Table 2 : Charge Ratings Of The Sae-J1772

Charge Method	Volts	(Amps-Continuous)	Maximum Power
AC Level 1	120 V AC	16 A	1.9 kW
AC Level 2	240 V AC	80 A	19.2 kW
DC Level 1	200 to 500 V DC maximum	80 A	40 kW
DC Level 2	200 to 500 V DC maximum	200 A	100 kW

1. AC Level 1. Standard electrical outlet that provides voltage in AC of 120 V offering a maximum intensity of 16 A, which serves a maximum power of 1.9 kW.

2. AC Level 2. Standard electrical outlet with 240 V AC and a maximum intensity of 80 A, so it offers a maximum power of 19.2 kW.

3. DC Level 1. External charger that by inserting a maximum voltage of 500 V DC with a maximum intensity of 80 A, it provides a maximum power of 40 kW.

4. DC Level 2. External charger that, by inserting a maximum voltage of 500 V DC with a maximum intensity of 200 A, provides a maximum power of 100 kW.

4.2 CHARGING MODES :

The IEC-62196 standard is an international standard created by the International Electrotechnical Commission (IEC) in 2001 for charging electrical vehicles in Europe and China. The IEC-62196 establishes the general characteristics of the charging process, as well as the way in which the energy is supplied. This norm derives from the IEC-61851 and it provides a first classification of the charging type according to its nominal power and, thus, of the charging time . Users are provided with four modes in order to charge the vehicles.

1) **Mode 1** (Slow charging): It is defined as a domestic charging mode, with a maximum intensity of 16 A, and it uses a standard single-phase or three-phase power outlet with phase(s), neutral, and protective earth conductors. This mode is the most used in our homes.
2) **Mode 2** (Semi-fast charging):This mode can be used at home or in public areas, its defined maximum intensity is of 32 A, and, similar to the previous mode, it uses standardized power outlets with phase(s), neutral, and protective earth conductors.
3) **Mode 3 (**Fast charging):It provides an intensity between 32 and 250 A. This charging mode requires the use of an EV Supply Equipment (EVSE), a specific power supply for charging electric vehicles. This device (i.e., the EVSE) provides communication with the vehicles, monitors the charging process, incorporates protection systems, and stops the energy flow when the connection to the vehicle is not detected.

4) **Mode 4 (**Ultra-fast charging):Published in the IEC-62196-3, it defines a direct connection of the EV to the DC supply network with a power intensity of up to 400 A and a maximum voltage of 1000 V, which provides a maximum charging power up to 400 kW. These modes also require an external charger that provides communication between the vehicle and the charging point, as well as protection and control.

Table 3 : . Charge Ratings Of The IEC-62196

Charge Mode	**Phase**	**Maximum Curent**	**Voltage Max**	**Maximum Power**	**Specific Connecter**
MODE 1	AC SINGLE AC THREE	16A	230-240A 480A	3.8KW 7.6KW	NO
MODE 2	AC SINGLE AC THREE	32A	230-240A 480A	7.6 KW 15.3 KW	NO
MODE 3	AC SINGLE AC THREE	32-250A	230-240A 480A	60 KW 120 KW	NO
MODE 4	DC	250-400A	600-1000A	400 KW	YES

It is also worth noting the case of Tesla Company, which, although it is not an international standard itself, it has its own fast charging points, called Supercharger Stations. Tesla's superchargers work in DC and use their own system, whose patents have been mostly released. Although they have a maximum charging power of 145 kWh, such power is currently limited to 120 kWh, which allows for charging half of the battery of a Model S in only 20 min., or 80% in half an hour .

Although Tesla affirms that its superchargers are ultra-fast charging points, if we consider the IEC-62196 criterion , these charging points would be equal to a Mode 3 (fast charging). Tesla's Supercharger Stations are being installed in main routes every 200 km. Currently, there are 1604 stations and a total of 14,081 superchargers around the world . Additionally, the users of these vehicles have 400 kWh of free charging, which is enough for driving about 1600 km, a strategy that seeks to encourage users to purchase Tesla vehicles.

4.3 CONNECTORS TYPES:

Electric vehicles have an AC/DC converter that allows charging their batteries at home through the use of traditional outlets (e.g., the Schuko in Europe). However, when requiring faster charges, Electric Vehicle Charging Stations must be used, since they can directly supply DC power to the batteries. Charging Stations can supply electricity through different connectors, depending on the standard supported, and they present the following advantages.

i. They are sealed solutions (not affected by water or humidity).
ii. They carry a mechanic or electronic blockage.
iii. They enable communication with the vehicle.
iv. Electricity is not supplied until the blockage system is not activated.
v. While the blockage system is activated, the vehicle cannot be set in motion, so that a vehicle cannot leave while plugged.
vi. Some connectors are able to charge in three-phase mode.

There currently exists a wide range of connectors for charging electric vehicles. These connectors are defined by the different standards: the Society of Automotive Engineers (SAE) is in charge of its normalization in the US and in part of the Pacific countries; the IEC is responsible for its standardization in a great part of the countries in the world, mainly in Europe; and, the Guobiao Standards (GB) manages the standardization in China. J1772-2009 connectors include different protection levels, and they can even

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be used in rainy conditions. The AC version was designed for single-phase electric systems with 120 V or 240 V, and they consist of five pins.

a. AC pins, two pins to provide power to the vehicle (phase and neutral).
b. Ground connection, a security measure, which connects the electrical system to the ground.
c. Proximity detection, which avoids the vehicle to move while plugged.
d. Pilot Control, which allows communication with the vehicle.

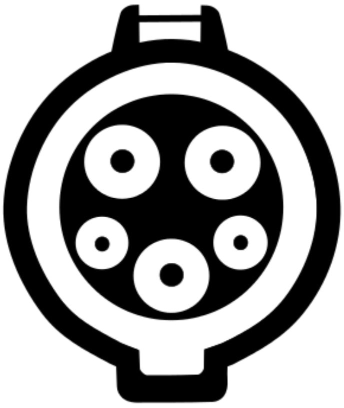

Figure 4.3.1 :J1772-2009 Type 1 For Ac Charging

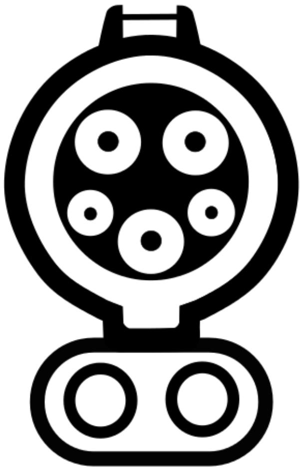

Figure 4.3.2 :J1772-2009 Type 2 For Ac/Dc Charging

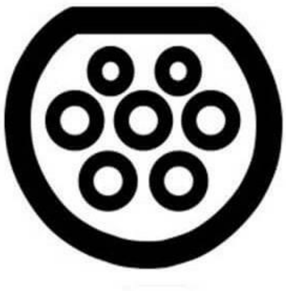

Figure 4.3.3 : Iec-62196 Type 2 (Mennekes)

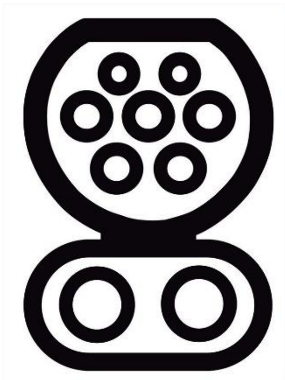

Figure 4.3.4 : Iec-62196 Type 2 (Mennekes Ccs)

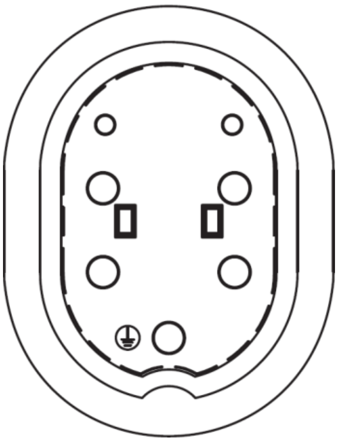

Figure 4.3.5 : Iec-62196 Type 3 (Scame)

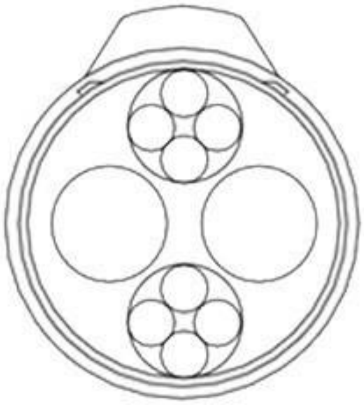

Figure 4.3.6 : Iec-62196 Type 4 (Chademo)

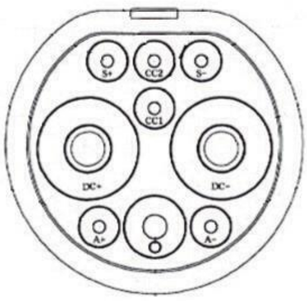

Figure 4.3.7 : Gb/T 20234 Fast Charging Connector

Figure 4.3.8 : Tesla Connector For United States

Type 1 (SAE-J1772-2009) Yazaki. With the aim of finding a standardized connector, the Type 1 AC charging, apart from being included in the SAE-J1772 standard, was also included in the IEC-62196-2. In fact, this connector is commonly found in charging equipments for EVs in North America and Japan , and it is used by a great amount of vehicles, such as the Nissan Leaf, the Chevrolet Volt, the Toyota Prius Prime, the Mitsubishi i-MiEV, the Ford Focus Electric, the Tesla Roadster, and the Tesla Model S. This connector can be observed in Figure.

Type 2 (VDE-AR-E 2623-2-2) Mennekes. It was originally designed to be used in the industrial sector, so it was not specifically designed for EVs (see Figure 7c). In singlephase it is limited up to 230 V, but, in three-phase, is able to hold high voltages and intensities. This connector has 7 pins, i.e., four for the power (in three-phase mode), one ground connection, and two pins to communicate with the vehicle (blockage and communications). An example of a vehicle that uses this connector is the Renault Zoe, which can be charged with the Mennekes connector up to 43 kWh.

Type 3 (EV Plug Alliance connector) Scame. Single-phase and three-phase connector, designed by the EV Plug Alliance in 2010. It supplies 230 V/400 V and from 16 to 63 A . France and Italy suggested the use of this connector for their vehicles but, due to the poor acceptance, the production of Type 3 connectors has been finally abandoned.

Type 4 (EVS G105-1993) CHAdeMO. Promoted by TEPCO (Tokyo Electric Power Company), it is commonly found in the EVs charging equipment in Japan, although it is also used in Europe and USA This connector has ten pins, two for DC power supply, one for ground connection, and seven pins for communicating with the network.

CHAPTER 5 :

WIRELESS POWER CHARGING SYSTEM FOR E-VEHICLES

5.1 BLOCK DAIGRAM OF WIRELESS POWER CHARGING SYSTEM FOR E VEHICLES.

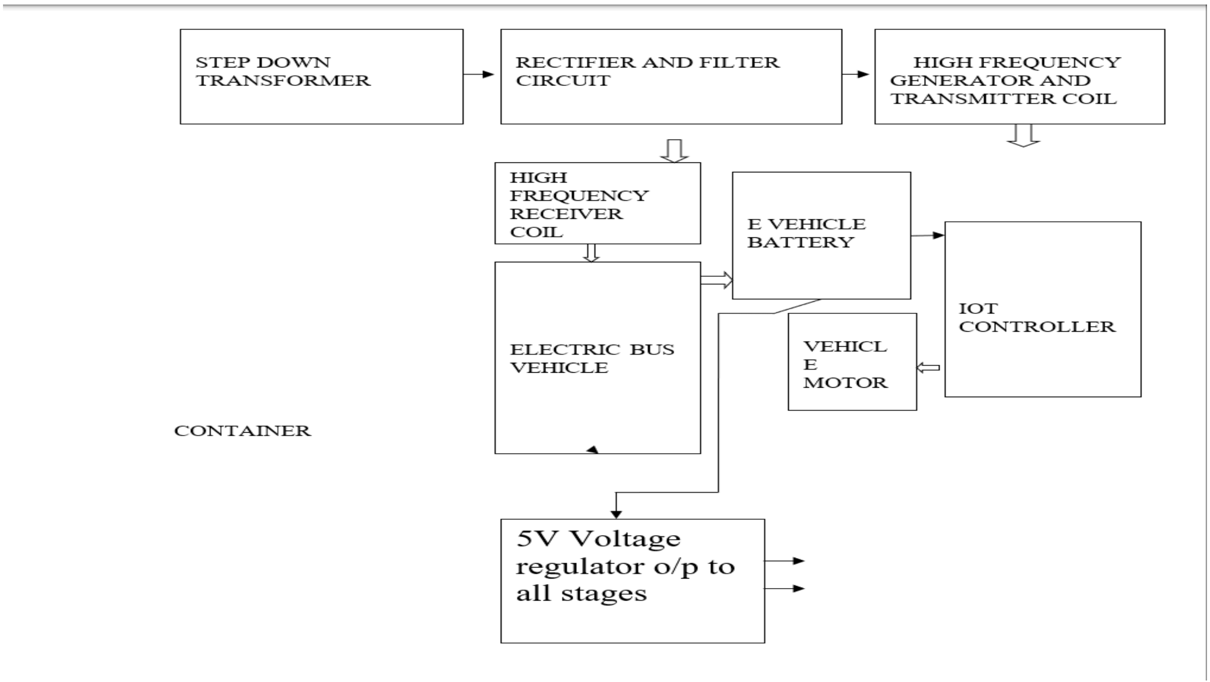

Figure 5.1.1 :Block Diagram Of Wireless Power Charging For E-Vehicle

Since many of us now charge our smartphones and earphones without cables, placing them on a wireless charging pad at the end of each day, an obvious question from electric car drivers presents itself – can we do the same with an EV?

At a technical level, the answer is yes. Electric cars use the same lithium-ion battery technology as devices like smartphones, so if equipped accordingly their batteries could also be charged without plugging in a bulky cable. Handy if it's raining, or for on-street parking where installing chargers at the roadside isn't convenient.

It is still early days for wireless EV charging, but progress is being made on numerous fronts. Vehicle manufacturers like BMW have already experimented with the technology, and today there are trials already in operation where specially-equipped cars can be charged wirelessly in public parking spaces.

5.1.1 How does wireless electric vehicle charging work?

Charging cars without wires works in a similar way to the wireless phone charger you might already own, just on a bigger scale. You might have noticed how you can lift your phone very slightly off its charger without stopping the flow of electricity - wireless car chargers work in the same way, but at a distance measured in inches instead of millimeters.

In both cases, the technology required is called inductive charging. This is where electricity is transferred through an air gap from one magnetic coil in the charger to a second fitted to the smartphone or car. All you have to do is park in the right place, to ensure both coils are aligned, then charging can begin.

One EV wireless charging trial happening right now, run by a charging company called Char.gy, is a 12-month trial that kicked off in the UK in October 2021 that will eventually see 10 wireless charging pads installed into parking spaces across the county of Buckinghamshire.
The first is located in Marlow, 35 miles west of London, and can be used by a fleet of 10 Renault Zoe cars modified to work with the wireless chargers.

Char.gy said when the trial began: "This infrastructure means no charging cable – potentially hazardous for other road or pavement users – and no lamp-post charging and is only activated when an EV parks over it."Similar inductive charging technology has been in use by the #7 bus route in Milton Keynes, UK since 2014, wirelessly topping up the battery for 10 minutes at the start and end of the service's 15-mile route.In a similar fashion, Nottingham, UK began a wireless charging trial for electric taxis. In this case, 10 taxis were fitted with inductive charging technology, which they used to top up their batteries while parked at certain ranks and waiting for their next fare.

This is a common theme when talking about wireless EV charging – a little-and-often approach, instead of the quicker but less frequent use of fast plug-in chargers.As for installing such a charger in the home, a US firm called Plugless Power (formerly Plugless) is working on its third-generation inductive EV charger, due in 2022.

These are designed to work with a US domestic 240V output, fit to existing cars, and the company claims power can be delivered through an air gap of up to 12 inches, meaning wireless charging of taller vehicles like SUVs and trucks could be possible.

Plugless Power says its upcoming third-generation wireless charger has a target price of $3,500, plus installation, and it is working on chargers for the European market too.

5.1.2 Which cars can be charged wirelessly today?

Currently, it is the charger manufacturers that are making both the chargers and the hardware needed to give an EV inductive charging. Some vehicle manufacturers have expressed interest in adding inductive charging as standard, with BMW running a trial with its 5 Series 530e iPerformance hybrid in 2018.The trial began in Germany and expanded to the US in 2019, with a small group of California residents invited to lease a 530e hybrid with wireless home charger for 36 months.

Power is transmitted over an air gap of three inches and is delivered with 85 percent efficiency. It has a charging power of 3.2kW, which is enough to fill the battery in 3.5 hours.Genesis is also working on inductive charging, and is making the feature available as an option on the new GV60 EV. Genesis claims the optional inductive charger will refill the SUV’s 77.4kWh battery more quickly than a typical home wall charger. Genesis is quoting a full charge of the 280-mile vehicle in six hours, compared to 10 hours via a conventional wall charger.

Figure 5.1.2.1:Charge While In Motion

Solar panels, hydrogen and wireless charging – Kia's big plans for its EV future

The inductive hardware comes from charging specialist WiTricity, but buyers will have to buy the actual charger, to be fitted into the floor of their garage, themselves.

Genesis says the feature will only be available in South Korea initially, and the inductive charging system won't be activated on vehicles until late-2022.Speaking of WiTricity, the Massachusetts-based firm was established in 2007 and has worked on wireless charging technology ever since. The VC-backed startup acquired Qualcomm's Halo inductive charging technology in early-2019, with Qualcomm becoming a minority shareholder in WiTricity.WiTricity claims it can charge wirelessly with a power efficiency of between 90 and 93 percent at a rate of between 3.6kWh and over 11kWh, and across a distance of between 10 and 25cm. Qualcomm has previously said how its halo technology could charge wirelessly at up to 22kW, suggesting WiTricity is keeping plenty in reserve.

5.1.3 Charging while driving

This is the holy grail of electric car technology; the ability to power a car as it drives over chargers embedded into the surface of the road.

As part of its development of the Halo system, Qualcomm proved in 2017 that charging while driving is possible, even with the vehicle traveling at up to 70mph.

Underneath the regular-looking road surface of its 100-meter test track, Qualcomm installed a wireless charging system capable of sending power to a fleet of specially modified Renault Kangoo electric vans, each fitted with two 10kW charging pads.

Fast-forward to 2021, and while public roads can't yet charge electric vehicles, the US states of Michigan and Indiana are both keen to implement the technology.

Most recently, Michigan governor Gretchen Whitmer said in October 2021 how a one-mile stretch of road would be chosen to run a vehicle charging pilot.
As with in-pavement charging trials in Indiana, the exact location (and a timeframe) hasn't been disclosed. Such trials are also taking place in Israel and Norway.

Now a days world is shifting towards electrified mobility to reduce the pollutant emissions caused by nonrenewable fossil fueled vehicles and to provide the alternative to pricey fuel for transportation. But for electric vehicles, traveling range and charging process are the two major issues affecting it's adoption over conventional vehicles.

With the introduction of Wire charging technology, no more waiting at charging stations for hours, now get your vehicle charged by just parking it on parking spot or by parking at your garage or even while driving you can charge your electric vehicle. As of now, we are very much familiar with wireless transmission of data, audio and video signals so why can't we transfer power over the Air.

Thanks to great scientist Nikola Tesla for his limitless amazing inventions in which wireless power transfer is one of them. He started his experiment on wireless power transmission in 1891 and developed Tesla coil. In 1901 with the primary goal to develop a new wireless power transmission system Tesla started developing the Wardenclyffe Tower for large high-voltage wireless energy transmission station. The saddest part is to satisfy Tesla's debts, the tower was dynamited and demolished for scrap on July 4th 1917.

5.1.4 Companies Currently Developed and Working on WCS

1. **Evatran group's** making Plugless Charging for passenger EVs like Tesla Model S, BMW i3, Nissan Leaf, Gen 1 Chevrolet Volt.
2. **WiTricy Corporation** is making WCS for Passenger cars and SUVs till now it is working with Honda Motor Co. Ltd, Nissan, GM, Hyundai, Furukawa Electric.
3. **Qualcomm Halo** is making WCS for Passenger, sport and race car and it is acquired by Witricity corporation.
4. **Hevo Power** is making WCS for Passenger car
5. **ssBombardier Primove** is making WCS for Passenger car to SUVs.
6. **Siemens and BMW** is making WCS for Passenger car.
7. **Momentum Dynamic** is making WCS Corporation Commercial fleet and Bus.
8. **Conductix-Wampfler** is making WCS for Industry fleet and Bus

5.2 7805 REGULATED POWER SUPPLY

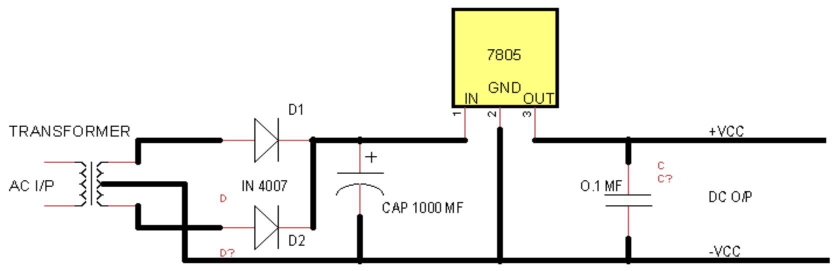

Figure 5.2.1 : 7805 Regulated Power Supply

A full-wave rectifier is a device that has two or more diodes arranged so that load current flows in the same direction during each half cycle of the ac supply.

we need to rectify AC power to obtain the full use of both half-cycles of the sine wave, a different rectifier circuit configuration must be used. Such a circuit is called a full-wave rectifier. One kind of full - wave rectifier, called the center-tap design, uses a transformer with a center-tapped secondary winding and two diodes.

A **DC** power supply system, which maintains constant voltage irrespective of fluctuations in the main supply or variation in the load, is known as Regulated Power supply.

The **7805 IC** referred to fixed positive voltage regulator, which provides fixed voltage 5 volts. The **7805** regulator is known as fixed voltage regulator.

Fixed –Voltage regulator design has been greatly simplified by the introduction of 3-terminal regulator ICs such as the 78xx series of positive regulators and the 79xxx series of negative regulators, which incorporate features such as built-in fold back current limiting and thermal protection, etc. These ICs are available with a variety of current and output voltages ratings, as indicated by the 'xxx' suffix; current ratings are indicated by the first part of the suffix and the voltage ratings by the last two parts of the suffix. Thus, a 7805 device gives a 5V positive output at a 1mA rating, and a 79L15 device gives a 15V negative output at a 100mA rating.

3-terminal regulators are very easy to use. The regulators ICs typically give about 60dB of ripple rejection, so 1V of input ripple appears as a mere 1mV of ripple on the regulated output.

A rectified filter and unregulated **DC** voltage is given to pin of **IC** regulator. A bypass capacitor is connected between input and ground to bypass the ripples and oscillations. The output capacitor is connected between output and ground to improve transient response. The unregulated input is applied to the **IC** must be always more than the regulated output.

The regulated 5v power supply is connected to microcontroller, timer, op amps or other circuits of the project**.**

5.3 TRANSMITTER AND RECEIVER

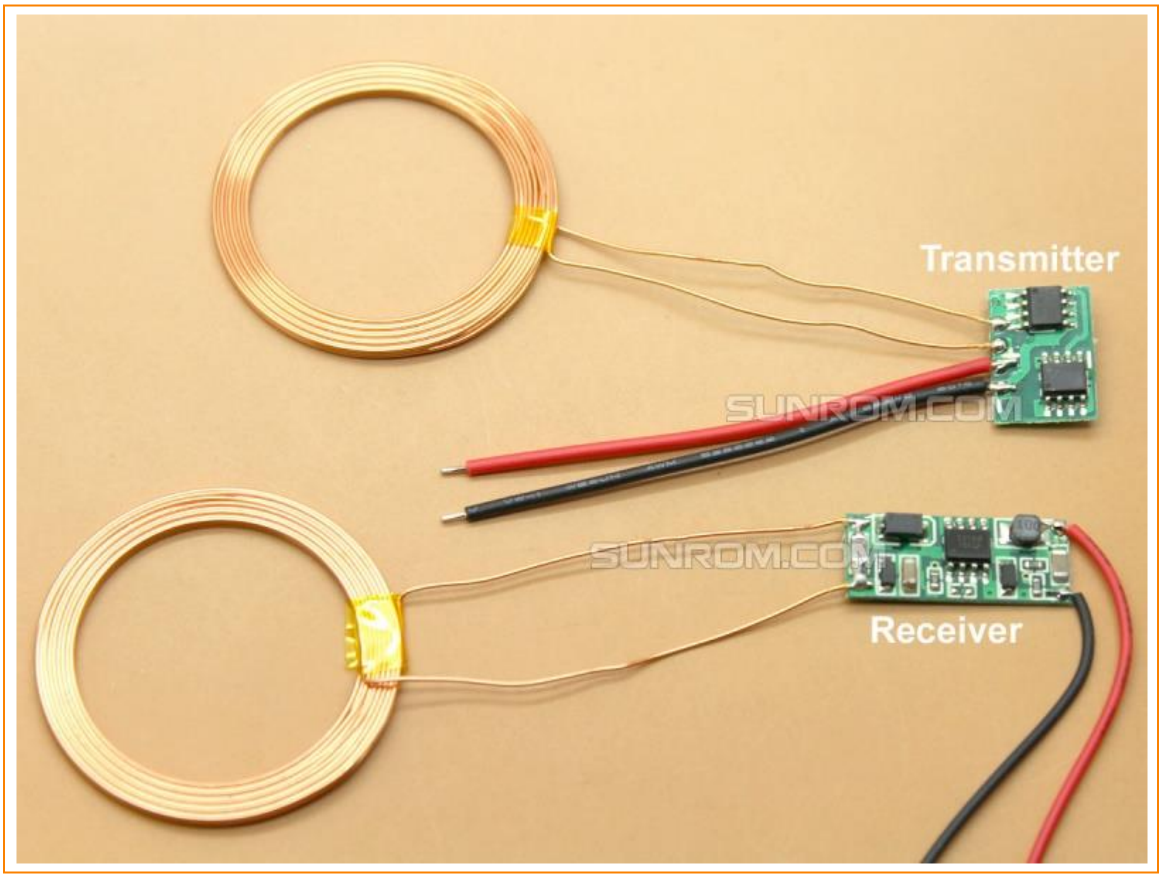

Figure 5.3.1 : Transmitter And Receiver

The Wireless Power Transfer and Charging Module can be used in electronic equipments in common use for close wireless charging or power supply. Consist of a Transmitter & Receiver and coil, it could serve as a replacement for the Wireless Power Supply with stable 5V output voltage and maximum 600mA output current. Its small size and insulation coil is more suitable for using in wireless project.

This module use an electromagnetic field to transfer electric energy between a transmitter circuit and a receiver circuit.

An induction coil creates an alternating electromagnetic field from within the transmitter circuit powered with 12V. The second induction coil takes power from the electromagnetic field and converts it back into electrical current to the receiver circuit that outputs 5V - 600mA.

5.3.1 SPECIFICATIONS OF TX AND RX

Table 4: Specifications Of Tx And Rx

Transmitter Input Voltage	+12V DC
Maximum Transmitter Input Voltage	+13.5V DC
Receiver Output Voltage	+5V DC regulated fixed
Maximum Receiver Current Capacity	600mA (Based on distance)
Coil Inductance	30uH
Transmit Receive Distance	1-20mm
Coil Dimensions	38mm Diameter x 2mm Height

5.3.2 WORKING PRINCIPLE

During any energy conversion there will be losses in going from one form to another. The magnitude of those losses is what dictates the practicality of any type of wireless charging. Magnetic or inductive charging, in particular has been effectively used for some time to power various kinds of biomedical implants. Presently it is the safest and most enduring method to accomplish the job of transferring power to the inside of the body. In these systems, oscillating current in an external coil of wire generates a changing magnetic field which induces a voltage inside an implanted coil. The current resultant from this voltage can charge a battery or power the device directly.

While a moving magnet might just as well be used to externally generate the field, an external coil is simply more practical. Apple has just filed a patent for hardware which could make the shake to charge concept a reality, at least in theory. They claim a unique design incorporating internal moveable magnets, and a flat printed circuit board coil. Current chip efficiencies will however preclude practical implementation of this scheme for some time.

Many smartphone users will be wondering wonder whether their near field communication (NFC) chip can be used to harvest power from a dedicated external source, or perhaps an ambient electromagnetic source like WiFi. In theory it is possible and such systems are on the market already, however not every NFC chip would be up to the task. To achieve maximum efficiency the system should be optimized for a use at a particular separation distance, angle of incidence, phase, and frequency such that it is in a resonant condition.

Resonance in an electromagnetic system can be likened to pushing a child on swing only when the swing is at the high point. Anywhere else and the energy transferred to the child will be reduced. If the separation distance is no more than a quarter of the wavelength, such a system can operate at efficiencies up to 35%.

One thing to keep in mind when considering wireless charging: If your charging system is throwing away nearly all of the 10 or so amps available from your wall outlet just to provide you with convenient at-a-distance charging, not only will charging be wasteful but it will be slow. Other wireless charging technologies relying on ultrasound or solar power are being developed, for example by Ubeam. For the time being, however, magnetic inductive charging technologies — spearheaded by the Qi consortium and smartphones like the Nokia Lumia 920 — such have taken the stage.

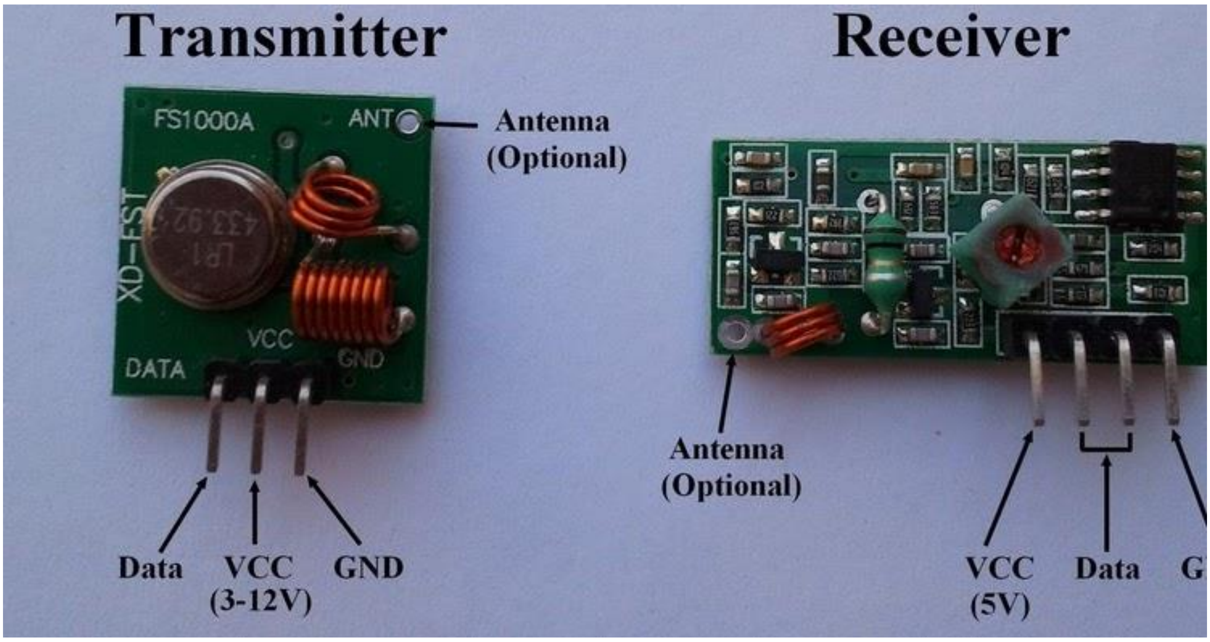

Figure 5.3.2.1 :Image Of Transmitter And Receiver

5.3.3 CURRENT CONSIDERATION

The transmitter coil and the receiving coil distance suitable is from 1mm to 20 mm. Increase the number of turns of the receiver coil to increase the transmission distance when low current is suitable in your application. As distance increase current capacity of receiver will drop.

Table 5 : Test Data For Current As Distance Increases Are As Below

Distance	Receiver Voltage - Fixed Regulated DC	Receiver Current
1mm	5V	600 mA
2mm	5V	450 mA
3mm	5V	360 mA
4mm	5V	310 mA
5mm	5V	240 mA
6mm	5V	210 mA
7mm	5V	162 mA
8mm	5V	150 mA
9mm	5V	132 mA
10mm	5V	120 mA
11mm	5V	110 mA
12mm	5V	70 mA
13mm	5V	54 mA
14mm	5V	41 mA
15mm	5V	28 mA
16mm	5V	19 mA
17mm	5V	17 mA
18mm	5V	10 mA

We have used 1:10 probe so a 5V peak is actually 50V peak signal. Multiply all voltage levels by 10x.

5.4 GEARED DC MOTOR

Geared DC motors can be defined as an extension of DC motor which already had its Insight details demystified here. A geared DC Motor has a gear assembly attached to the motor. The speed of motor is counted in terms of rotations of the shaft per minute and is termed as RPM .The gear assembly helps in increasing the torque and reducing the speed. Using the correct combination of gears in a gear motor, its speed can be reduced to any desirable figure. This concept where gears reduce the speed of the vehicle but increase its torque is known as gear reduction. This Insight will explore all the minor and major details that make the gear head and hence the working of geared DC motor.

5.4.1 OUTER BODY OF GEAR HEAD & REAR VIEW

The outer body of the gear head is made of high density plastic but it is quite easy to open as only screws are used to attach the outer and the inner structure. The major reason behind this could be to lubricate gear head from time to time.

The plastic body has a threading through which nut can be easily mounted and vice versa from the gear head.

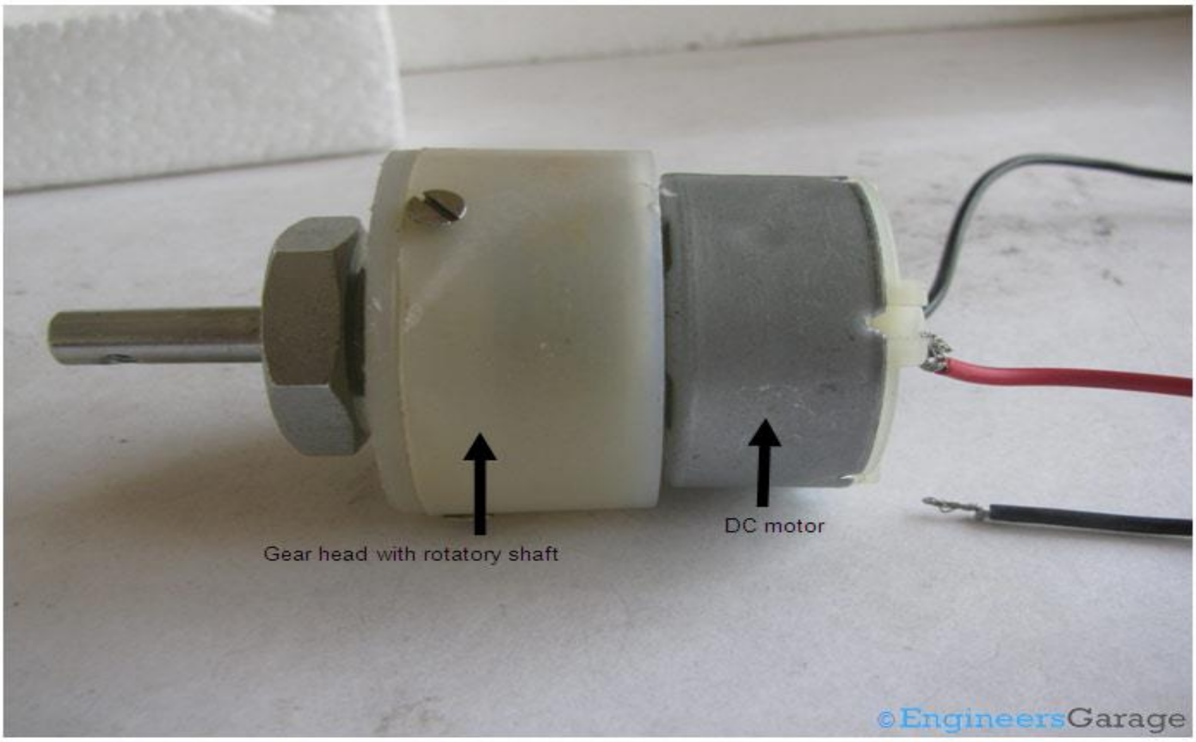

Figure 5.4.1.1 : Outer Body Of Gear Head & Rear View

5.4.2 INTERNAL STRUCTURE

On opening the outer plastic casing of the gear head, gear assemblies on the top as well as on bottom part of the gear head are visible. These gear assemblies are highly lubricated with grease so as to avoid any sort of wear and tear due to frictional forces. Shown below is the top part of the gear head. It is connected to rotating shaft and has one gear that allows the rotation. A strong circular imprint shows the presence of the gear that rotates the gear at the upper portion.

Figure 5.4.2.1 :Internal Structure Of Dc Motor

5.4.3 BOTTOM GEAR ASSEMBLY

A closer look at the bottom gear assembly shows the structure and connection with other gears. The gear assembly is set up on two metallic cylinders whose working can be called as similar to that of an axle. A total of three gears combine on these two cylinders to form the bottom gear assembly out of which two gears share the same axle while one gear comes in between them and takes a separate axle.

The gears are basically in form of a small sprocket but since they are not connected by a chain, they can be termed as duplex gears in terms of a second cog arrangement coaxially over the base. Among the three gears, two are exactly same while the third one is bigger in terms of the number of teeth at the upper layer of the duplex gear. The third gear is connected to the gear at the upper portion of the gear head. The manner in which they are located near the upper part of the gear head can be seen through the image shown below.

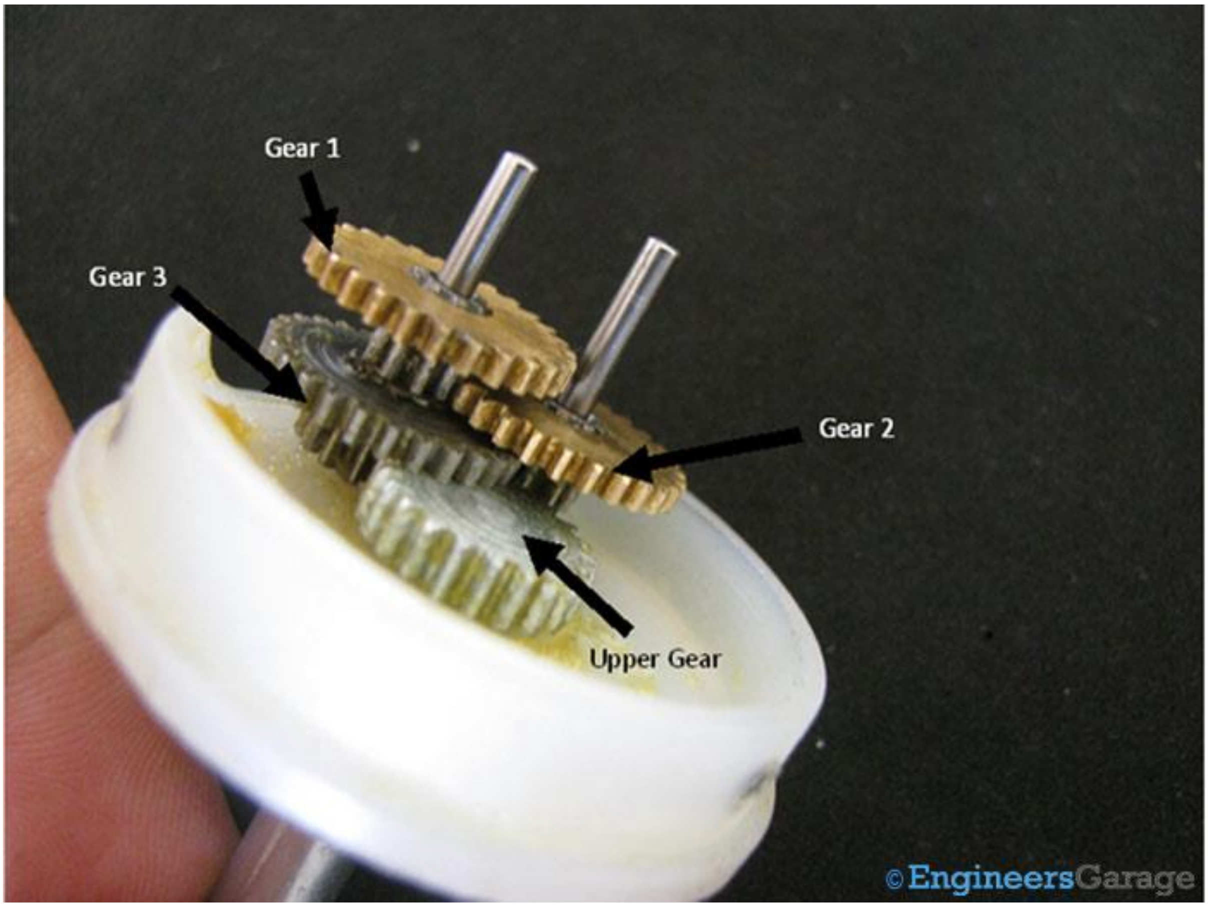

Figure 5.4.3.1 : Bottom Gear Assembly

5.5 NODE MCU (WI FI MODULE)

Node MCU is an open source IOT platform. It includes firmware which runs on the ESP8266 Wi-Fi SOC from Express if Systems, and hardware which is based on the ESP-12 module. The term "Node MCU" by default refers to the firmware rather than the development kits. The firmware uses the Lau scripting language. It is based on the Lau project, and built on the Espressif Non-OS SDK for ESP8266

Node MCU was created shortly after the ESP8266 came out. On December 30, 2013, Espressif Systems began production of the ESP8266.The ESP8266 is a Wi-Fi SOC integrated with a Tensilica Xtensa LX106 core, widely used in IOT applications. Node MCU started on 13 Oct 2014, when Hong committed the first file of Node MCU -firmware to github. Two months later, the project expanded to include an open-hardware platform when developer Huang R committed the Gerber file of an ESP8266 board, named development kits. V0.9. Later that month, Tuan PM ported MQTT client library from Contiki to the

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ESP8266 SOC platform, and committed to Node MCU project, then Node MCU was able to support the MQTT IOT protocol, using Lua to access the MQTT broker.

Arduino.cc began developing new MCU boards based on non-AVR processors like the ARM/SAM MCU and used in the Arduino Due; they needed to modify the Arduino IDE so that it would be relatively easy to change the IDE to support alternate tool chains to allow Arduino C/C++ to be compiled down to these new processors. They did this with the introduction of the Board Manager and the SAM Core. A "core" is the collection of software components required by the Board Manager and the Arduino IDE to compile an Arduino C/C++ source file down to the target MCU's machine language. Some creative ESP8266 enthusiasts have developed an Arduino core for the ESP8266 Wi-Fi SOC that is available at the github ESP8266 Core webpage. This is what is popularly called the "ESP8266 Core for the Arduino IDE" and it has become one of the leading software development platforms for the various ESP8266 based modules and development boards, including Node mcus. For more information on all things ESP8266, check out the ESP8266 Community Forum on github.

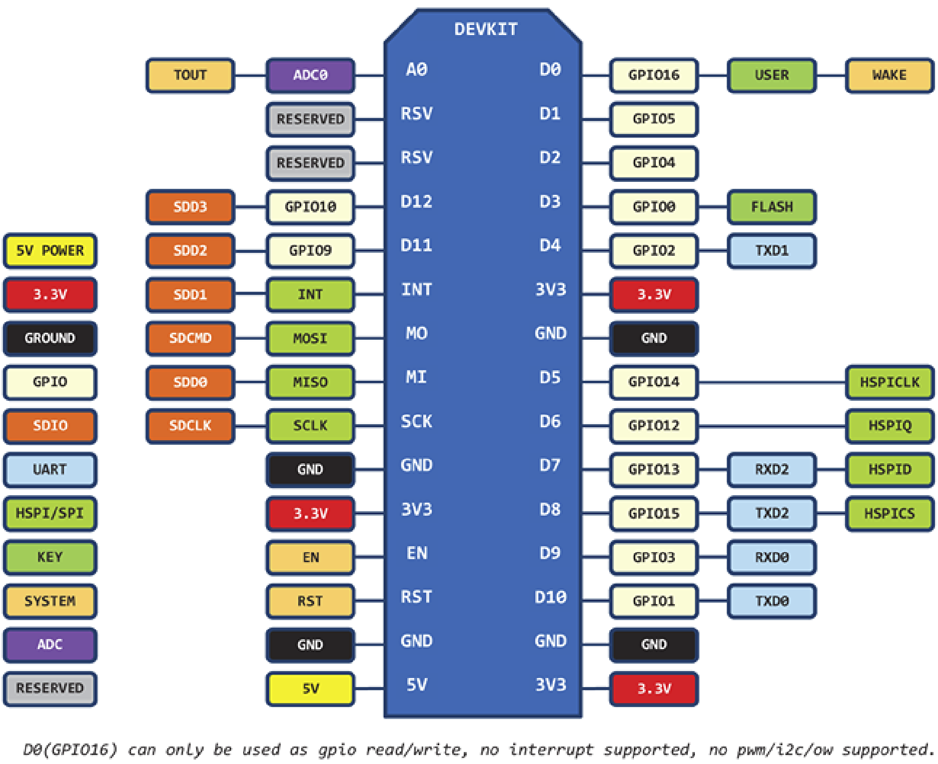

Figure 5.5.1 : Pin Configuration Of Node Mcu

5.5.1WHAT IS ESP8266

ESP8266 (presently ESP8266EX) is a chip with which manufacturers are making wirelessly networkable micro-controller modules. More specifically, ESP8266 is a system-on-a-chip (SOC) with capabilities for 2.4 GHz Wi-Fi (802.11 b/g/n, supporting WPA/WPA2), general-purpose input/output (16 GPIO), Inter-Integrated Circuit (I²C), analog-to-digital conversion (10-bit ADC), Serial Peripheral Interface (SPI), I²S interfaces with DMA (sharing pins with GPIO), UART (on dedicated pins, plus a transmit-only UART can be enabled on GPIO2), and pulse-width modulation (PWM). It employs a 32-bit RISC CPU based on the Tensilica Xtensa LX106 running at 80 MHz (or overclocked to 160 MHz). It has a 64 KB boot ROM, 64 KB instruction RAM and 96 KB data RAM. External flash memory can be accessed through SPI.

Figure 5.5.1.1:ESP266

Various vendors have consequently created a multitude of modules containing the ESP8266 chip at their cores. Some of these modules have specific identifiers, including monikers such as "Wi07c" and "ESP-01" through "ESP-13"; while other modules might be ill-labeled and merely referred to by a general description — e.g., "ESP8266 Wireless Transceiver." ESP8266-based modules have demonstrated themselves as a capable, low-cost, networkable foundation for facilitating end-point IOT developments. Espressif's official module is presently the ESP-WROOM-02. The AI-Thinker modules are succinctly labeled ESP-01 through ESP-13. Node MCU boards extend upon the AI-Thinker modules. Olimex, Adafruit, Sparkfun, WeMos, ESPert (ESPresso) all make various modules as well. See the ESP8266 article on Wikipedia for more information about popular ESP8266 modules.

5.5.2 INTERNET OF THINGS :

The Internet of Things (IOT) is the network of everyday objects physical things embedded with electronics, software, sensors, and connectivity enabling data exchange. Basically, a little networked computer is attached to a thing, allowing information exchange to and from that thing. Be it light bulbs, toasters, refrigerators, flower pots, watches, fans, planes, trains, automobiles, or anything else around you, a little networked computer can be combined with it to accept input (esp. object control) or to gather and generate informational output (typically object status or other sensory data). This means computers will be permeating everything around us ubiquitous embedded computing devices, uniquely identifiable, interconnected across the Internet. Because of low-cost, networkable micro-controller modules, the Internet of Things is really starting to take off.

5.5.2.1 WHAT IS BLYNK?

Imagine a prototyping board on your smartphone where you drag and drop buttons, sliders, displays, graphs and other functional widgets. And in a matter of minutes these widgets can control Arduino and get data from it.How it works

Blynk works over the Internet. So the one and only requirement is that your hardware can talk to the Internet.

No matter what type of connection you choose - Ethernet, Wi-Fi or maybe this new ESP8266 everyone is talking about – Blynk libraries and example sketches will get you online, connect to Blynk Server and pair up with your smartphone.

Currently, Blynk libraries work with this stuff:

1. USB
2. Ethernet shield
3. WiFi shield
4. Arduino with Ethernet
5. Arduino YÚN (testing in progress)
6. ESP8266
7. Raspberry Pi (Blynk will communicate with Pi's GPIOs)
8. more Arduino compatible shields and boards (this list will be updated as we test the compatibility)

9. We are excited to extend this list with other awesome internet enabled products. These are our next integrations:
10. Electric Imp
11. Spark Core
12. The AirBoard
13. Wicked Wildfire
14. TinyDuino
15. WunderBar

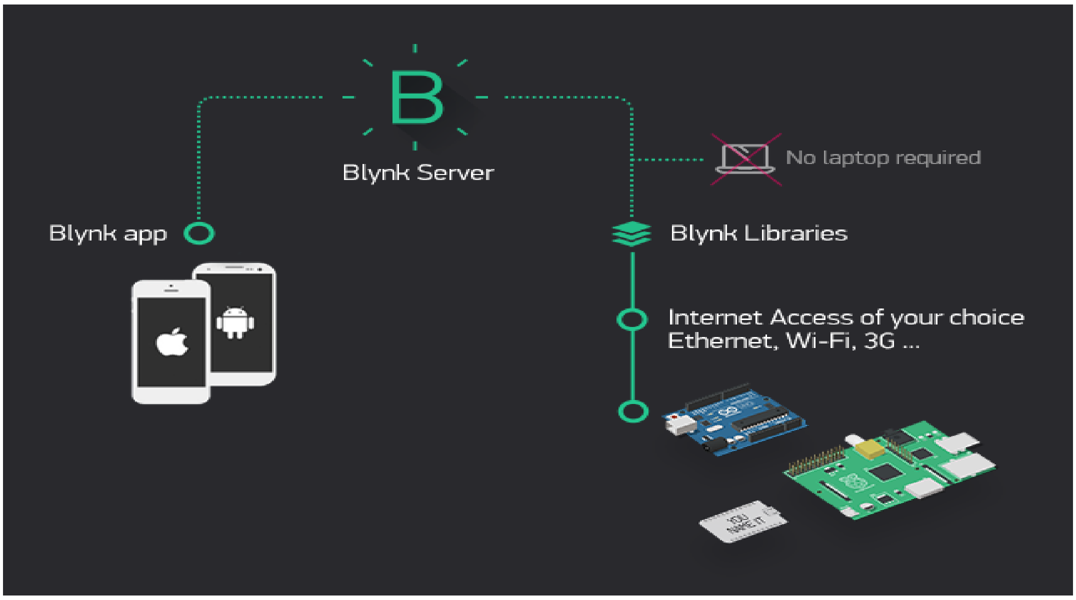

Figure 5.5.2.1 : Blynk's Architecture

Blynk works out of the box: no new languages to learn, no additional software to install and no long documentation reading.

If you just started tinkering with Arduino, Blynk is your way to quickly get into Internet of Your Things, as you don't even need to write a code for trying out it's power.

For those of you who are building more complex projects like robots or home automation, Blynk will save time writing an app for each project. The platform is very flexible and customizable.Super easy setup When designing Blynk, we really focused on simplifying things so that you could see your first results very quickly. However, if you are into writing more serious code, you'll have the full freedom in your hands.

Here is the simplest set up: That's it. Seriously. Now you can start building something awesome!

For those who missed our Kickstarter video, this quick tutorial will show you how easy it is to turn on the lights with Blynk.

Things you can do with Blynk

We don't know what you will do with it... Really, it’s like listing what you can do with Arduino. Anyway, here are just a few examples for your inspiration:

Got Milk?

Make Arduino take photos each time you open the fridge. Next time you are in a groceries store - open the Blynk app, check the photo and buy only what's needed.

Current status and future plans

We already have working prototypes for each of Blynk's platform components: apps for iOs and Android, libraries for Arduino and Raspberry Pi, and Blynk server.

Your help is needed to complete the development, build awesome widgets and ensure best experience and excellent performance of the platform. Adding support to a wider variety of hardware also requires additional investment.

We have tons of ideas on how to make Blynk even more useful and will continue developing those far beyond the Kickstarter campaign. Here are some of the items on our roadmap:

1. adding more sophisticated widgets
2. expanding the list of supported hardware;
3. adding bluetooth support;
4. integrating with services like Temboo, Xively, IFTTT.

If we get a lot of support on Kickstarter, we will introduce very exciting stretch goals, unlocking Eventor and Bridge Widgets.

Looking forward to bringing Blynk to makers all over the world!

Risks and challenges

The main challenge for Blynk upon successful start with Arduino and Raspberry Pi is keeping up with the large and growing variety of maker's hardware. Being able to identify the most promising platforms and quickly ensuring compatibility with Blynk is a challenge, but we are well-equipped to face it. First of all, Blynk platform has been designed as very flexible to allow for rapid updates. Secondly, the open-source nature of the product will allow the community to participate and help us better satisfy their needs.

CONCLUSION

In this project, we analyzed the types of EVs, the technology used, the advantages with respect to the internal combustion engine vehicles, the evolution of sales within the last years, as well as the different charging modes and future technologies. We also detailed the main research challenges and open opportunities.

Regarding EVs, batteries are a critical factor, as these will determine the vehicle's autonomy. We analyzed several kinds of batteries, according to these features. We also presented the possible technologies that can be used in the future, such as the graphene, which is expected to be a solution that enables the storage of higher amounts of power, and charge in shorter periods of time. The EV could also benefit from this type of technology, reaching higher ranges, something that could help its adoption by drivers and users.

The development of batteries with higher capacities will also favor the use of the fastest and most powerful charging modes, as well as better wireless charging technologies. The creation of a unique connector that can be globally used is another aspect that could benefit the deployment of electric vehicles. The EV will play a highly important role in the future Smart Cities, and having different charging strategies that can adapt to the users' needs will be of special relevance. Therefore, future BMS should consider the new scenarios that were introduced by new batteries and Smart Cities requirements.

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