# Launching of electric vehicles a destiny to a better 2030

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**Abstract— Upon the continuous rise of Egypt's population, Egypt today confronts a rational pollution issue. Nevertheless, this paper is targeting a specific pollution cause, which is harmful gas emissions of conventional vehicles that are significantly increasing in number with the rapid rise in residents. This paper proposes a plan for converting transportation in Egypt from petroleum-based to electric-based. This paper is reinforced by statistical data of the number and types of various vehicles currently present in Egypt. Fortunately, Egypt is moving fast forward in the direction of renewable energy sources, such that the country would have clean sources of electrical power along with traditional sources which provide purpose to our proposal. This plan comprises of two main aspects, one of which is the infrastructure of power stations that would be developed taking into consideration the radial distance between the stations and the Electric car average range. The relevant location is also chosen based on expected residential distribution and positions of commercial, educational as well as tourist institutions. The type of charger in the station either AC or DC is chosen pertinent to location. A virtual map would be designed relative to the designated locations of the power stations. The other aspect of the plan launching electric vehicles to the market without over-satiating streets with cars. Applying this plan will help Egypt avoid the expected energy crises upon reaching the year 2030.**

***Keywords- Internal Combustion Engine, Green House Gas, Electric Vehicle, direct current, alternating current***

## I. INTRODUCTION

The global has recently manifested an immense climate change and adverse environmental effects; that is a consequent of the continuous increase in carbon dioxide emissions as well as other greenhouse gases. The Pollution issue arose on our planet since humanity witnessed the evolution of industrialization, transportation, and energy generation. The main sources of pollution are industrial activities, non-renewable energy power plants, in addition to ground and ocean transportation. However, two thirds of the total anthropogenic greenhouse gases emitted attributes to CO2, the transport sector is responsible for roughly a quarter of the world's CO2 emissions [10]. Dramatic increase in temperature degrees contributes to melting of polar ice leading to significant rise in sea level, these are the main detrimental impacts of CO2 emissions. Moreover, certain islands near the specific oceans continue to vanish due to this increase of sea level, followed by other effects such as soil erosion, distortion of sea life and farmable land, as well as causing many prevalent human diseases such as asthma, coronary heart diseases, lung cancer, and various body deficiencies due to polluted human nutrition. In 2003, Egypt was responsible for only 0.5 % of the total global CO2 emissions which was a low ratio relative to other countries at that time; however, rapid increase in transportation rate; meanwhile, facing the challenge of increasing street networks, especially in large cities such as Cairo; led to higher rates of streets congestions resulting in higher CO2 concentrations [11]. Today's global target is to decrease CO2 emissions or even eliminate it for good. Since there is a positive directional flow towards renewable energy power plants in Egypt as the world's greatest solar energy farm Beban power station has recently been established as well as other efficient wind and hydroelectrical power plants, it is crucial that our next aim would be the electrification of ground-based transportation. Earlier, we have been relying on burning of fossil fuels that produce oil and natural gas to operate the internal combustion engine of conventional vehicles; nevertheless, today we would be able to replace ICEs with electrical motors in which the vehicle's power and torque rely on the current provision by the battery. It has been estimated that electric motors conversion efficiency is greater by 60% than that of ICE in traditional cars. When greater efficiency is mentioned, less energy consumption and significant decrease in CO2 emissions is considered, since lesser energy is wasted due to breaking and no energy will be lost through mechanical components of car which is likely in ICEs as mentioned in section 4. Although electric vehicles are such an appealing solution to the pollution catastrophe we withstand today; there are challenges to the complete electrification of transport vehicles which is discussed later in this paper in section 5. This paper aims to propose a plan of electrification of twenty percent of the transportation in Egypt by 2030 along with studying the consequences of this action. The remaining of this paper discusses GHG emissions in particular that of CO2 illustrating trends of CO2 exhaustions with the aid of graphs in section 2, afterwards section 3 addresses the prior solutions to emissions issue that took place initially but were not a sufficient solution to the problematic. Section 4 then pertinently illustrates the difference between ICE vehicles and EVs stating the reason thar EVs are superior to ICE cars in terms of required maintenance, stability, operating mechanism, speed control and acceleration. Consequently, challenges of EV penetration to market are briefly discussed in section 5, which also contain an explanation of the terminology behind lithium-ion batteries along with the cooling technology used by Tesla's battery pack addressed in sections 5 A, 5 B, and 5 C. Moreover, thermal management of the battery as well as battery condition parameters are explained briefly in section 5 D. Finally, the paper proposes a prioritizing map for different types of charging stations in Sheikh Zayed city as shown in section 6.

## II. THE TREND OF CO2 EMISSIONS RELATED TO TRANSPORTATION SECTOR IN EGYPT

Along the progression of transportation in Egypt, there has been significant pollutions and $CO_2$ emissions. Transportation holds up 26% of the total share of GHG emissions which is the second highest percentage of all other parameters' contribution to emissions after electricity generation which attributes for 35.35% of the total emissions [10]. Figure 1 shown below illustrates the percentage contribution of each type of transport in the streets of greater Cairo in 2001.

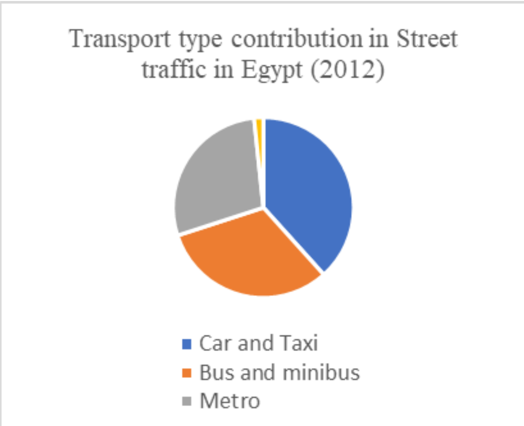


Figure 1 shows the ratio by which each transportation mode attributes to the traffic in 2001 in Greater Cairo [11]

It has been interpreted by the pie chart shown above that the car and taxi attributes to the most transport type utilized by Egypt's population in 2001. The average rate of increase of number of cars per year from 1998 till 2001 is about 4.7% [11], this rate of increase clarifies the following two assumptions, that there is an acknowledged elevation in mobility of residents of Greater Cairo due to encouragement of transportation services; moreover, the rate at which vehicles are introduced to the streets is way faster than the rate at which the streets' network is upgraded. This correlates to the slower traffic through years resulting in a continuous enlargement in GHG exhaustion density. Ground-based Transportation GHG emissions are $CO_2$, $CH_4$, and $N_2O$ [11]; nonetheless, $CO_2$ emissions are directly correlated with fuel consumption and fossil fuel combustion as it is the mostly emitted gas of all GHG gases as clearly declared by figure 2 below.

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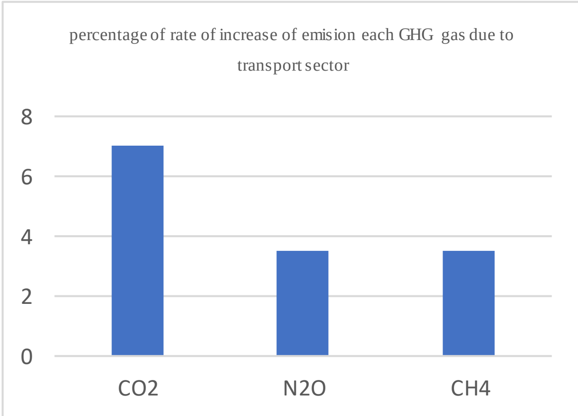


Figure 2 shows a comparison between percentages of rates of increase of each of GHG gases respectively from year 1971 through 2001 [11]

Egypt contributes by only 1% of the world's energy consumption, this energy consumption is related to the fuel consumption that operates vehicles. Gasoline and diesel fuels have lower calorific values than that of natural gas; hence, more vehicles in Egypt were starting to operate with natural gas instead as shown in figure 3 below according to the ministry of petroleum and Mineral resources.

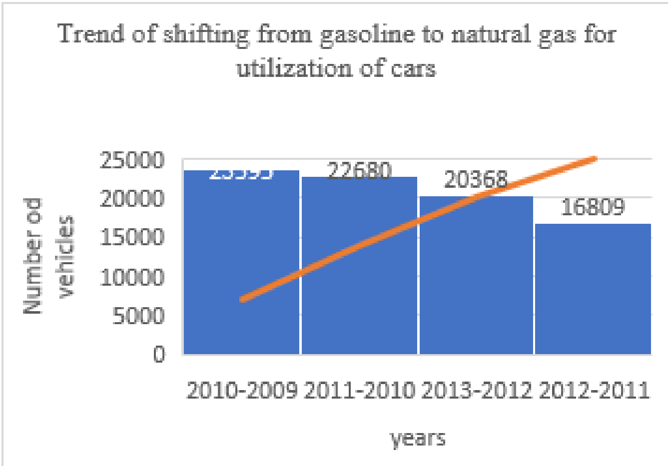


Figure 3 shows how many cars are shifting from gasoline gas to operate with natural gas [18]

Even though natural gas has greater energy content such that natural gas operating vehicles will consume less energy; incomplete ignition of gas takes place compared to gasoline consequently increasing the emission of hydrocarbons increasing pollution in country. Increased trend of usage of natural gas instead of gasoline or diesel as shown by figure 3 is not a sustainable solution to elimination of detrimental impacts caused by emissions.

TABLE I.

| year | Indicators of fuel price | | |
|---|---|---|---|
| | Local price in $ million | International price in $ M | International oil price in $ per barrel |
| 1971 | 21.7 | 24.5 | 6.00 |

| year | Indicators of fuel price | | |
|---|---|---|---|
| | Local price in $ million | International price in $ M | International oil price in $ per barrel |
| 1978 | 56.2 | 73.8 | 14.35 |
| 1987 | 279.7 | 287.5 | 17.66 |
| 1998 | 485.0 | 388.6 | 11.84 |
| 2001 | 560.8 | 737.3 | 21.82 |

Table 1. illustrates the expenses of fuel for transportation sector [11]

An approximately 7.2 million tons of CO2 equivalent of GHG emissions from ground-based vehicles occurred in 2001[11], this has many interpretations of which are liberalization of car importing, activation of metro service, increased number of private educational institutions and universities reaching up to 39 universitis in 2012, and increased number of car ownerships by residents that reached up to 1.2 cars per household for those with high income. Also as shown in table 1, there is an interpreted elevation in the local fuel prices from 1971 through 2001 which is an implication of continuous increasing bearing of fuel consumption and CO2 emissions [11].

As a direct relationship between CO2 outflow and vehicles' emissions is interpreted from the bar chart shown by figure 2, we consider CO2 as the main GHG gas resulting in the environmental catastrophe we are witnessing today. One of the adverse environmental impacts of carbon dioxide exhaustion is global warming resulting in dramatic increase in atmospheric temperature all over the planet which is illustrated by table 2 below.

TABLE II

| year | Values of temperature degrees versus % CO2 emission | |
|---|---|---|
| | % CO2 exhaustion (ppm) | Elevation in temperature in degree Celsius |
| 1980 | 335 | 0.42 |
| 1990 | 351 | 0.58 |
| 2000 | 373 | 0.8 |
| 2010 | 403 | 1.1 |

Table 2. describes how increase in temperature correlates to CO2 emissions [18]

Table 2 above assembles a direct correlation between percentage increase in carbon dioxide emissions and continuous elevation in temperature. CO2 resembles a huge problematic to the globe as irreversible increase in temperature occurs with greater transport congestion; therefore, the solution is either solving the congestion problem of traffic with new efficient traffic polices and mobility limitation of vehicles which is not a feasible solution as the daily productivity of many businesses would be effected, or another choice would be electrification of most of transportation modes especially private cars as it attributes to the greatest share of CO2 emissions. Nevertheless, there are prior solutions that has already taken place but unfortunately were not sufficient to solve the problematic, those initially implemented solutions are thoroughly discussed in the upcoming section of prior solutions.

## III. Prior Solutions

### *A. Hybrid cars*

Some companies such as Toyota, Hyundai, and Kia introduced a new type of cars called hybrid cars. The main purpose for these companies was to reduce carbon footprint and reduce the usage of gasoline [2]. Basically, hybrid cars depend on two motors to move, of which are electric motor and gasoline motor. Also, there are several types of hybrid cars, these are Parallel Hybrid, Series Hybrid, Series/Parallel Hybrid, Plug-in Hybrid

#### *1) Parallel Hybrid*

In parallel hybrid cars both the internal combustion engine and the electric engine work together to produce the designated torque to move the car. The parallel hybrid car cannot operate solely on electric motor, it is used as a boost for the internal combustion engine.

#### *2) Series Hybrid*

In this type of cars, the torque generated to the wheels is caused by the electric motor alone, in which gasoline engine is just used to recharge the batteries for the electric motor. Batteries in series hybrid cars are larger; however, this kind of cars are more efficient in stop-and-go traffic.

#### *3) Series/Parallel Hybrid*

Series/Parallel Hybrid cars combine the advantages of the series and parallel hybrid cars, such that it operates as series hybrid car at low speed and parallel using both electric and internal combustion engine at high speeds for higher efficiency Henceforth, it requires larger battery capacity and higher technology of computing power to switch between the two systems.

#### *4) Plug-in Hybrid*

Plug-in Hybrid cars have long range batteries that are charged from external source of electricity, and it acts as a fuel tank. If the charge is depleted, the car transforms into a conventional hybrid car.

Hybrid cars might look like a viable solution, but if you look deeper into it you will determine that hybrid cars designs are heavier consuming more energy, opposing the main purpose of their manufacturing. Another aspect of its limitation is their manufacturing, which consumes more energy than conventional cars; Consequently, burning more fossil fuels and producing more carbon emissions.

Moreover, the manufacturing of hybrid batteries requires more energy than normal batteries. Hybrid cars could reduce carbon emissions in comparison to conventional cars, but it still emits considerable amount of greenhouse gases such that the problematic is remained unsolved.

### *B. Catalytic converters*

The main purpose of catalytic converters is to remove carbon monoxide from the emissions of diesel engine. Carbon monoxide is considered a toxic gas; it can lead to serious brain damage and sometimes leads to death [5]. Carbon monoxide is emitted with high concentrations of 30,000 ppm or more from a typical car; nonetheless, adding catalytic converter to the mix reduces carbon monoxide content to 1000 ppm [9]. It also reduces harmful pollution caused by hydrocarbon-based fossil fuels and nitrous oxide in cars.

*1)Assembly*

Catalyst core

Its main purpose is to act as a frame for the catalyst Washcoat to support it, which mainly comprises of ceramic monolith in a honeycomb structure. Catalyst cores are usually made of iron-chromium combination.

Catalyst Washcoat

Catalyst needs a large surface area to be more efficient. Washcoat acts as this carrier for the catalyst and has an irregular and rough surface to increase its surface area. Its composition is usually titanium dioxide, silicon dioxide, or a mixture of silica and alumina.

Oxygen provider

To convert the carbon monoxide to carbon dioxide, oxidation must occur such that a source of oxygen must be present. In catalytic converters, Ceria or Ceria-Zirconia are used [8].

Catalyst

The main component of catalytic converter is the catalyst, as explained before all other components provide the catalyst with the perfect environment to be efficient [7]. Precious metals are used as catalysts, such that Platinum can be used as an oxidation and reduction catalyst. Nevertheless, the limitation of platinum is its price, so alternatives like Rhodium and Palladium would be more convenient.

*2)Types*

Two-way

It is the basic type of catalytic converter in which carbon monoxide is oxidized into carbon dioxide and hydrocarbons are oxidized into carbon dioxide and water.

Three-way

The three-way catalytic converter has the advantage of reducing nitric oxide and nitrogen dioxide into nitrogen and water.

Using catalytic converter is revolutionary; it reduced the emission of carbon monoxide from conventional cars immensely. Cars would be unusable without it, but it is not enough. Catalytic converter reduced carbon monoxide but at the cost of carbon dioxide, which is a greenhouse gas that causes global warming. Catalytic converter solution is a viable short-term solution; however, the serious problem lies in cars and its diesel motors, as carbon must be emitted.

## IV. COMARISON BETWEEN ICE VEHICLES AND EVS

In conventional cars, the operation takes place based on the principle of ICE's, such that the motor is provided with fuel and Oxygen with some working parts to control the process. On the other hand, Electric vehicles are based on magnetism mechanism, in which the electric engine consumes power from the batteries creating magnetic force that moves the car. Thus, electric cars depend on 3 main parts: batteries, Electric motor, and controller.

Electric cars' acceleration is higher than ICE cars, as they produce higher torque in a small amount of time reaching 0 to 100 in a negligible amount of time; meanwhile, Combustion cars reach this torque in a longer period. As aforementioned, IC cars acquire high maintenance due to the number of moving parts in the car. Lubricants are necessary to prevent friction; however, its counterpart requires minimal maintenance due to its rigid structure with minimum movement. Contrary, braking in Electric vehicles is more efficient; it even generates electricity as the motor transforms from being a motor to a generator that charges the battery of the car. This mechanism is called regenerative braking; this reduces the friction increasing timespan before the maintenance of the brakes. This mechanism of regenerative braking is absent in internal combustions engines.

In brief, EV's emits neither carbon dioxide nor other greenhouse gases. You might say that the electricity powering EV's is the only source of pollution regarding EVs, but in 2020 Egypt had 20% excess in electricity [15]. Powering electric cars can be with zero carbon emissions, also electricity is generated from renewable source of energy, such as solar, wind, hydro. For conventional cars, typical passenger car emits 2350 gram/liter of carbon dioxide [1], besides carbon dioxide ICE automobile produces methane and nitrous oxide.

Ranges in Electric cars is the most crucial aspect that the driver worry about. Here we will take DONGFENG E70 as a case study, as it will be the EV officially introduced to the Egyptian market in the name of NASR. Its combined range is 350 km, 60 Km constant speed is 500 Km, and maximum vehicle speed is 150 Km [3]. Comparing ranges of DONGFENG E70 to petroleum cars we can conclude that E70 is very efficient in short distances and for long distances conventional cars will be more efficient. Air friction plays a crucial role in decreasing the efficiency, so at high speeds, battery of the car is drained at a higher rate.

## V. THE CHALLENGES OF ELECTRIC VEHICLES (EVS) IMPLEMENTATION

One of the major aspects of an electric vehicle (EV) is the rechargeable battery, which is the main source of power for the vehicles' torque and inductive motor operation. Therefore, any limitations in the battery cause a serious restriction to the whole concept of EV causing it to be not prevalent enough as petroleum vehicles. The battery is the only component in EV that may contribute in $CO_2$ emissions when it's provided with nonrenewable energy during the manufacturing stage and recharging, also battery attributes to approximately a third of the total weight of EV resulting in greater amount of energy consumption indirectly increasing CO2 exhaustions in energy generation power plants [10]. The battery container is responsible for about a half of the total EV cost [10], and it is the only source of expenses after buying an EV as it can be required to replace it with a new one as it has a limited lifetime that is dependent on the rate of charge and discharge cycles, the electrochemical potential of metal from which the battery is manufactured, the thermal management system of EV, and the efficiency of cooling terminology used. There are countless efforts contributing to elimination of the abovementioned battery restrictions at a high pace; indeed, there have been great improvements in the battery's efficiency, safety, and energy consumption within a no time from when EV's were first introduced to market. First, we need to briefly understand the terminology behind which the battery operates, taking lithium-ion battery as an example model to explain its technology as it is the mostly used battery type today. Lithium ion is used in manufacturing an EV battery as it has the highest electrochemical potential, it is lighter than lithium, also it has the highest energy density to weight ratio; moreover, lithium- ion batteries are approximately 80 to 90 % energy efficient [10], have high conversion efficiency, have higher rate of charge meaning faster charging time. In 1991, there was the first rechargeable lithium-ion battery introduced by Sony with a cell voltage of 3.7 and a battery capacity rating of 370 milli ampere hour (mAH).

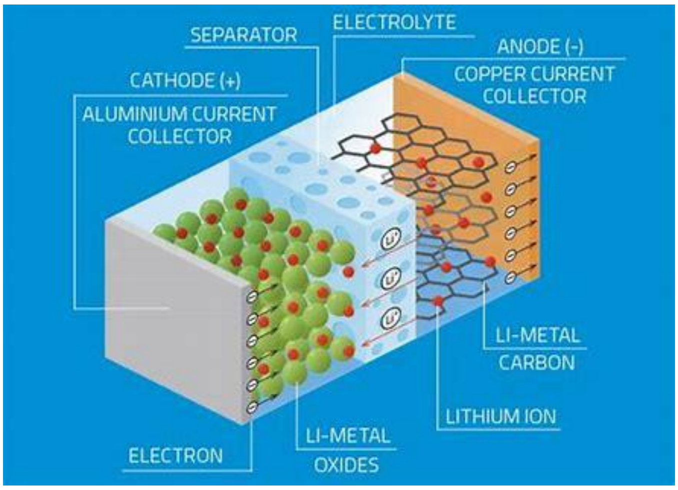


Figure 4 shows battery cell inner arrangement [16]

### A. The lithium-ion battery working technology

Lithium-ion battery operates based on electrochemical potential, in which lithium has an electron in its outermost cell that continuously needs to lose. However, the lithium is more stable when forming a chemical bond with oxides than being in the form of ion. The interpreted configuration is as follows; lithium oxide is placed near the positive side of a power supply while detached graphite layers are placed on the negative side of the power source forming cathode and anode terminals respectively as shown above in fig 4. Firstly, electrons in the outermost shell of lithium are attracted to the positive terminal of source flowing through source as an external path as it is forbidden from passing through the electrolyte in between the two terminals; leaving behind positively charged lithium ion that is then attracted towards the negative terminal that motivates it to pass through the electrolyte and stay between the graphite layers. This procedure repeats itself until all lithium ions are settled in between the graphite layers, and this is when charging process is completed successfully. The discharge process occurs when a load in this case is attached between anode and cathode instead of the power source, in such situation the lithium ions are stimulated to form a bond with the oxides to be more stable, such that electrons flow in the reverse direction of its initial flow thorough the external wire allowing lithium ions to flow through the electrolyte joining the oxides forming lithium oxide once again. This procedure repeatedly occurs until all lithium ions are detached from the graphite layers, and this is when the cell is fully discharged. The electrolyte comprised of organic salt solution of lithium; moreover, a separator that is an insulating sheet that segregates anode and cathode forbidding them from connecting forming a short circuit resulting in an explosion in a situation when the battery is exposed to high temperature outside its temperature optimum range that cause the electrolyte to evaporate. Another cell protecting phenomenon is the known as the Solid Electrolyte Interface (SEI) which is an accidently discovered technology which takes place when the first charge of the cell takes place; as lithium ions are penetrated through the electrolyte , the electrolyte solution coats the lithium ion causing a chemical reaction with the graphite forming a layer called SEI that prevent electrons from being in direct contact with the electrolyte which could result in a degradation of electrolyte resulting in a short circuit and cell ignition.

### B. The three metal layers forming the cell

The graphite layers and lithium oxides (anode and cathode) are adhered onto the copper and aluminum foil sheets respectively which gathers charge easily and can be connected to positive and negative poles relatively to allow flow of electrons when an external circuit is required. In addition, the electrolyte is coated on to the separator sheet. Finally, the three sheets are bounded together in a cylindrical shape with a steel as the core of cylinder forming a tightly closed package of a single battery cell. Many series cells are placed in a parallel configuration forming a battery module; for instance, Tesla battery container comprises of 16 modules.

### C. How do many tiny battery modules serve the efficiency and safety regulations of an EV battery pack?

The usage of many tiny packed modules in a battery pack instead of one massive battery cell has great advantages to the safety of battery operation; such that when there is an emergency need for a DC fast charging (also known as high power charging) the pressure exerted on battery is distributed among the large number of cells. This terminology has the following advantages to state of battery health (SOH), of which is that temperature increase while charging process takes place on a much lower scale for each tiny cell; hence, the battery lifetime is significantly longer. Lower heat generation during charging protects battery capacity from degrading, also it permits less frequent battery replacement leading to less energy consumption to and less CO2 emissions. This means high rate of charging can take place more frequently than it could in a gigantic battery pack, faster charging time leads to the attraction of public to a more energy efficient EV. This brings us to the next section which assembles the parameters in which a battery state can be determined, also it addresses the battery's thermal management system.

### *D. Battery's state variables and thermal management system*

Firstly, we need to address the reason behind battery cell damage especially under unevenly distributed stress. As aforementioned, battery container in an EV comprises of many groups of series tiny cells packed together in a parallel configuration, what can happen in this case is that charging capacity differs among cells such that when the battery is charged, some cells are exposed to greater amount of stress than others because they have lower charge tendency. This leads us to one of the reasons of degradation of battery power and capacity, which is uneven heating of battery cells causing difference in temperature among cells. The main parameters used to determine the state of battery are as follows; state is of charge (SoC) that the remaining charge of battery, state of battery health (SoH) which is the decomposition of capacity of battery relative to a full capacity battery, and state of function ( SoF) that is how much useful power the battery can provide to the EV [6]. The abovementioned parameters are used to assess to what extent a battery is harmed when subjected to high temperature, fast charging of large capacity (high power charging), as well as sudden impact or mechanical wear.

One of the factors that is indeed a turning point to the game of EV is high power charging (HPC), which means high rate of charge of large battery capacity. Millions of Hybrid Power Pulse Characteristic (HHPC) tests took place pertinent to the process of enhancement of EV's battery performance [14], also HHPC test is undergone for the sake of controlling voltage during fast charging, because if we would be able to charge a long-range battery in a shorter time using metals of higher energy density; the major limitation to the EV resolved.

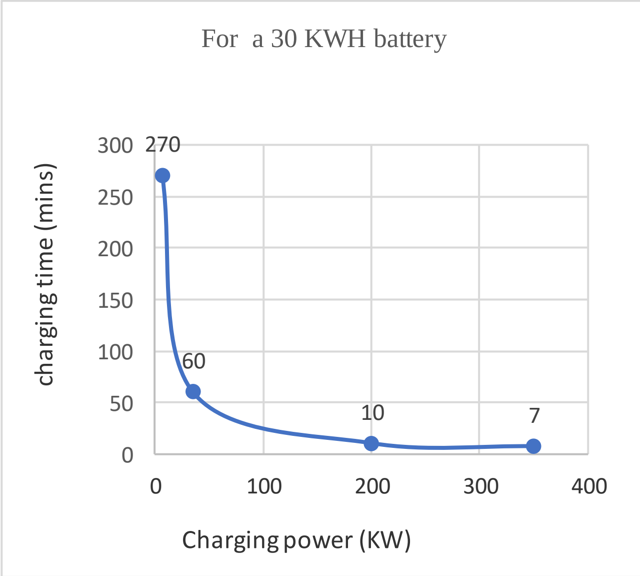


Figure 5 shows correlation of charging time against charging power [12]

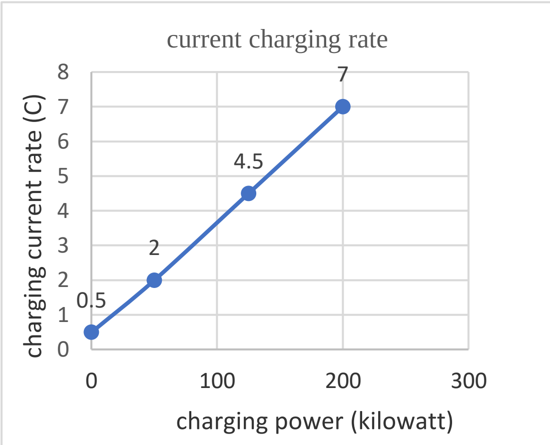


Figure 6 shows correlation between charging power per a unit of time and charging current rate [12]

HPC is considered a main detrimental factor to the charge capacity of a battery, as fast charging with high charging rate above 2 C leads to thermal running and self-heating of battery, subsequently internal resistance of battery increases enormously decomposing the power capacity. After several applications of the HHPC test, it has been depicted that the extent to which the battery is charged during a HPC is the original factor that affects durability of battery in this case. Tests revealed that a battery that has been exposed to HPC but charged to an SoC of 80 % experienced very low detrimental effects on battery capacity compared to the same battery which is charged to the highest SoC that manifested great decomposition in battery charge capacity. Both batteries where subjected to the same rate of charge and the equal number of charge and discharge cycles.

Moreover, HHPC tests have interpreted that as charging power per a unit of time the charging current rate highly increases as illustrated by the graph in fig 6 shown above. Contrary, as the charging power per unit of time enlarges, the time taken for charge of long-range battery significantly increase as depicted by fig 5[12].

Efficient cooling system of battery is one of the roles of thermal management systems that protects battery from self-heating and thermal running during fast charging rate. For instance, Tesla's battery cooling technology is superior to that of Nissan's battery cooling technology, where Tesla Glycol-based cooling technology in which the flow rate of glycol is monitored by Thermal management system conserving battery capacity from decomposition.
Finally, with the forementioned battery state parameters and thermal management system, not only we can increase rate of charge of high-capacity battery, but also, we are now able to use long range energy efficient batteries with higher durability resolving the people's insecurity concerning range anxiety.

### *E. The procedures Egypt has taken as a step forward to penetration of EVs to the Egyptian market.*

It is acknowledged that EVs introduction to the Egyptian market will eliminate a great deal of the GHG emissions, as Egypt already has an adequate number of clean electricity generation power plants, of which are Aswan High Dam with an annual provision of 312,000 megawatt of power capacity, Ben Ban solar park with a 2000-megawatt annual power capacity. Egypt has got Zafarana wind farm with an electrical power capacity of approximately 745 Mega Watt per year which operates 700 turbines models with a great range of power capacities for higher efficiency in power generation; moreover, Zabal Al Zayt wind station annually generates about 240 MW operating 120 turbines each of a power output of 2 MW [17]. Egypt aims to convert 20 % of the country's total energy generation in 2022 to renewable energy generation; a clean source of electricity is provided to charge EV batteries with a negligible amount of GHG emissions relative to ICE vehicles emissions.

Today, Egypt prepared a strategy for penetration of Dong Feng E70 electric vehicle (Nasser) to the Egyptian streets, this EV has a lithium battery type, lithium is the lightest of all metals, has a great energy density, high electrochemical reaction, and supply battery with high energy efficiency reducing energy consumption. Dong Feng has 2 different capacities of battery, of which are 50.8 kwh and 61.3 kwh. It has a maximum speed of 150 km/h, an acceleration from 0 to 100 within 9.9 seconds; also, the greater battery capacity has a charging time of 9.5 hours and the battery with a lower capacity has got a charging time of approximately 8 hours [3].

## VI. MODEL ELECTRICAL CHARGING STATIONS INFRASTRUCTURE IN ZAYED CITY.

The planning of powering stations infrastructure is such a critical phase in the penetration of EVs to streets of Egypt. People utilizing EV drives are subjected to a phenomenon called range anxiety, which is that users always stress during their drive about depletion of charge of battery somewhere out of reach of electric power to recharge battery. Therefore, aside from enhancing the battery efficiency for longer time of discharge, a plan of the positioning of electric power stations might be designed such that the average distance per charge of EV should be acknowledged. Dong Feng E70 also known as Nasser that will penetrated in the Egyptian market, has a distance per charge of about 150 to 250 kilo meters [3]. Hence, outside Cairo city, there would be a DC charging station which works with HCP technology positioned every 80 Km, for provision of charge whenever there is an urgent circumstance.

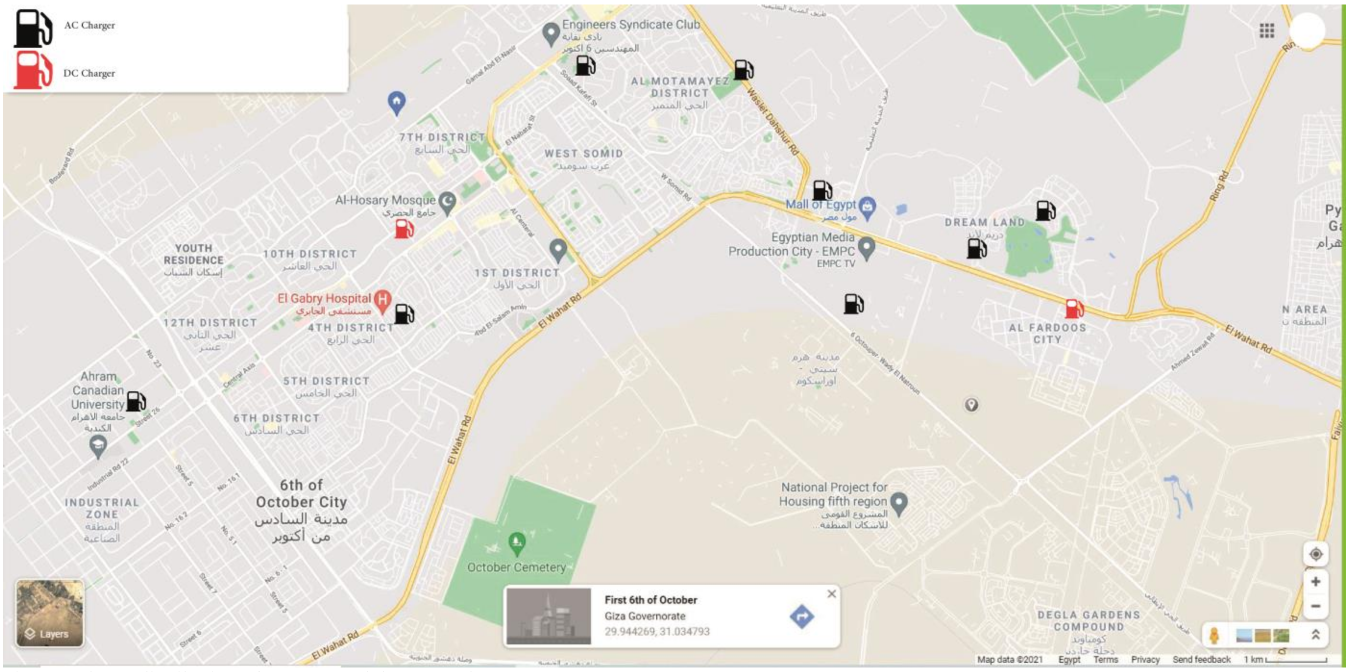

Figure 7 shows distribution of EV's ac and dc power charging stations relatively in Sheikh Zayed city.

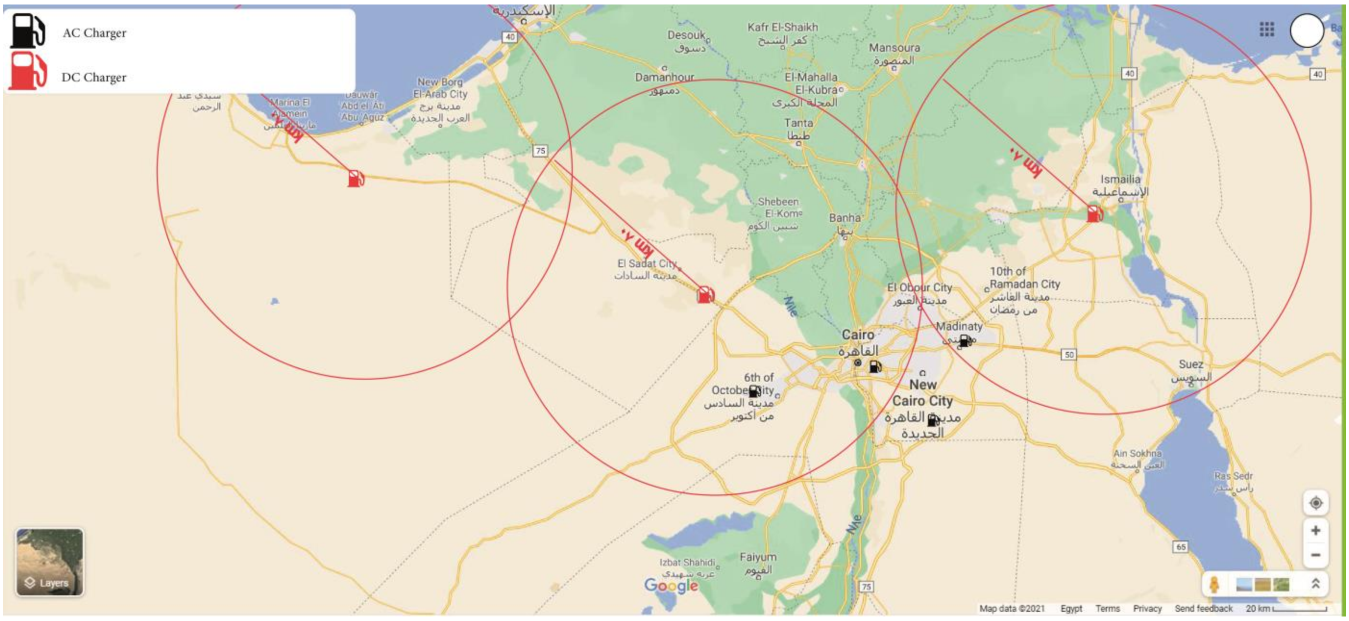

Figure 8 shows distribution of EV's dc chargers around some cities in Egypt

Figure 7, shown above illustrates the distribution of DC and AC chargers respectively, such that AC chargers are placed in commercial, industrial, educational, and residential areas. The red charger stands for DC (high rate of current charging), meanwhile the black charger resembles AC charging which takes quite large time to fully charge. The reason of positioning AC chargers in such places is that people when visiting those kinds of places usually spend enough time that enables complete battery charging. For instance, figure 7 shows that AC chargers are positioned at dream land theme park, Mall of Egypt, Engineers syndicate club, Al Gabry hospital, Egyptian Media Production City, Al Motamayez district, and Ahram Canadian University. Contrary, DC chargers are situated at Al hosary mosque and at Al Wahat road as marked in figure 7, where people would acquire a quick battery power charging for an emergency. Figure 8 shown above, illustrates that outside city of Cairo there should be every 80 Kilo Meter a DC charging station with high power charging for provision of power in the case of a road trip.

## VII. Conclusion

To sum up, ever since EVs have been introduced, it has been an appealing solution to the problematic of increased

$CO_2$ emissions. Nonetheless, EVs had a critical limitation that prevents it from being ubiquitous in vehicles market, which is that the powering of high-capacity batteries consumes a great deal of time that would not be always affordable in cases of emergencies. Further, high power charging of batteries causes the temperature of batteries to enormously increase, subsequently the internal resistance of batteries increases which attributes to decreasing the extent to which a battery can be fully charged, in other words high rate of current charging leads to decomposition of battery capacity and power provision on the long run. As aforementioned in section 5 D, there are many factors that allow enhancement to battery efficiency enabling charging of long-range batteries within shorter time without detrimental effects on capacity. Firstly, HPC of batteries to an SoC of a wider range; for instance, charging battery to an SoC of 70 to 80 % has proven that it leaves much reduced damaging impact on the capacity. Thermal management system uses cooling technology, in the case of Tesla battery the glycol- based technology is utilized, such that the control system determines to what extent the battery would be cooled as sharp reduction in temperature also damages the battery. Moreover, with the aid of battery state parameters, controllers of EV are programmed such that they would detect if there is a serious danger on the battery health and durability by comparing the values of state parameters with the ideal values for an EV especially during charging. Other than battery manufacturing emissions, EV has negligible amount of $CO_2$ emissions especially that renewable energy share of total electricity generation in Egypt is in continuous elevation. With the implementation of pertinent charging station infrastructure map, people's reserving regarding range of distance per charge of EV would be resolved as the specific type of chargers whether DC or AC would be situated in its relevant place where people can charge their EVs whenever they are required to. EVs penetration to the Egyptian market would indeed be a game changer in terms of environmentally friendly transportation, also as Egypt got an excess of 20% of its total energy generation that is an overflow over population's requirements. Henceforth, cost of transportation would significantly decrease; this would encourage more daily trips in streets such that in the future there would necessarily be an effective enhancement to street networks to avoid congestion of traffic. EVs are expected to be the solution that will eliminate $CO_2$ emissions and GHG due transportation for good; thus, I call it a chance to a better 2030.

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