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BUILDING AN ELECTRIC VEHICLE FOR A MARITIME CAMPUS

Dr. S. Thangalakshmi[1], Bessetty Ayush[2], Saad Khan[2], Raj Jitendra Singh[2] & Akshay A Kumar[2]

Abstract

This technical paper provides a detailed overview of the ongoing electric vehicle project in Indian Maritime University, Chennai Campus. The paper describes the development of various components of the vehicle at successive stages. The major components in chassis, differential, battery technology, charger station, motor, steering system, braking circuit and solar panels are examined. It defines the present market situation of concept vessels which are both efficient and economically feasible. The paper also contains illustrations in the form of rendered AUTOCAD images and actual prototype photographs. The objective is the build an electric vehicle which shall be used in the big Semmencherry Campus and also ply between the Uthandi and Semmencherry Campuses.

Keywords: Electric vehicle; energy efficiency; optimal transport solutions

1. INTRODUCTION

An electrical vehicle is a vehicle that harnesses its propulsive power from Electric Motors instead of conventional Internal Combustion Engines or Steam Driven Turbines. The electric motors may either derive their power (electric current) from extravehicular sources (Tram using electric power lines) or derive their power from batteries fitted on the vehicle. These batteries may in turn be charged with external grid power or by a generator, solar panels or fuel cells installed on the vehicle itself.

The biggest advantage of using battery and motors instead of Internal Combustion Engines is the high efficiency of power conversion from electric to mechanical through the electric motor. Secondly, the need to reduce carbon footprint has encouraged governments to support and subsidize EVs rather than conventional IC Engine driven vehicles.

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For any manufacturer to survive the present automobile sector, it has to develop at least one model in the hybrid electric vehicle segment. The popular models of EV models in the market are given in Table 1. Countries such as France and Japan are going to close the production of petrol vehicles by 2030.

Table 1- Types of EVs

Types of EVs	Hybrid EVs	Battery EVs	Fuel Cell EVs	Solar Cell
Energy System	Battery Ultra-Capacitor ICE Generator Unit	Battery Ultra-Capacitor	Fuel Cell	Solar Cell
Propulsion	Electric motor drive Internal combustion engines	Electric motor drives	Electric motor drives	Electric motor drives
Major issues	Managing multiple energy sources	Battery and battery management	Fuel cell cost Fuel processor	Solar Cell cost

It is important to note that EVs have lower operating costs as compared to conventional vehicles. The price of electricity on a day-to-day basis doesn't fluctuate and is more stable as compared to gas or liquid fuel. Therefore, with the help of EVs, we can reduce carbon footprint and the consumption of non-renewable energy resources like diesel and petrol.

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2. NEED OF AN ELECTRIC VEHICLE FOR IMU CHENNAI CAMPUS

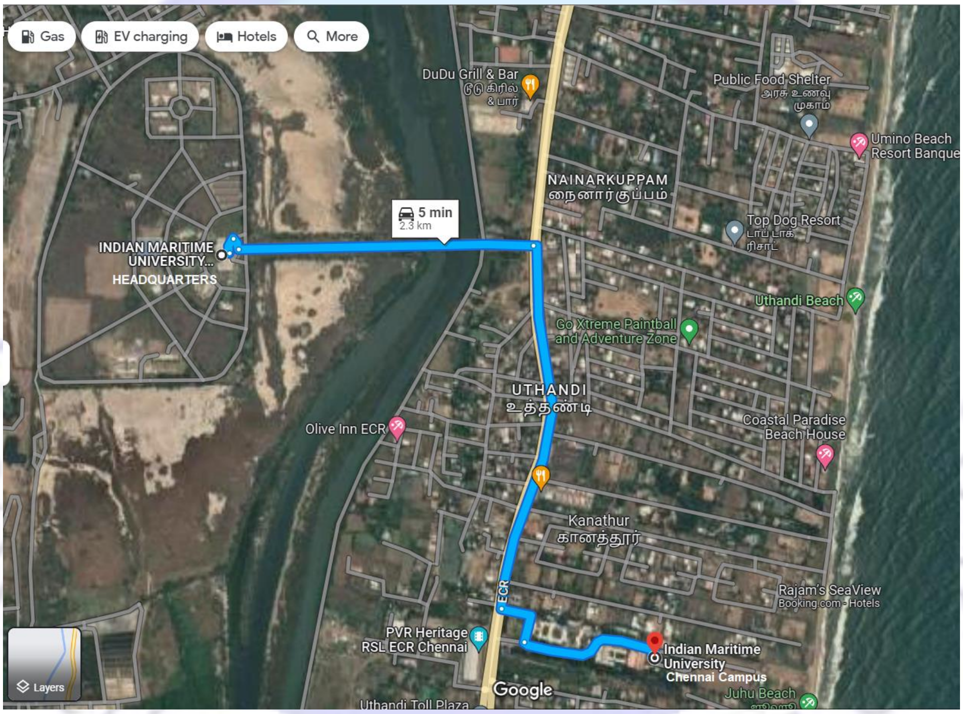
The Semmencherry Campus (SC) houses the Martine Engineering training facilities and the Head Quarters of the University. The SC has almost 100 acres of are under development out of 300 acres. There is a hostel and staff housing facilities also. Transportation and commuting inside the

SC are currently done using fossil-fuel burning vehicles. There have been measures to use more greener options (bicycles) and erection of a solar power plant etc.

The location and the layout of the two premises of Chennai Campus are shown in Figure 1.

The distance between the Academic and Administrative Block from the Residential Block inside Semmencherry premises is around 1Km and the distance between the Semmencherry premise and the Uthandi premise is around 2.5Km. With an EV, the dependence on these fossil-fuel burning vehicles to commute and transport will reduce and hence the Carbon emissions also.

Figure 1 - Map Showing Semmencherry and Uthandi Premises of IMU Chennai Campus



Hence, the idea of building an indigenous electric vehicle which will justify its purpose in serving the Green Campus of Indian Maritime University, Chennai is feasible. Using an EV for commuting will help both in the conservation of university resources and easy means of transport for faculty, staff and cadets.

The objectives of the project can be summarized as follows:

1. To evaluate the requirements of an Electric Vehicle suitable for Chennai Campus (Uthandi & Semmencherry premises).

2. To develop an effective and cost friendly Electric Vehicle.

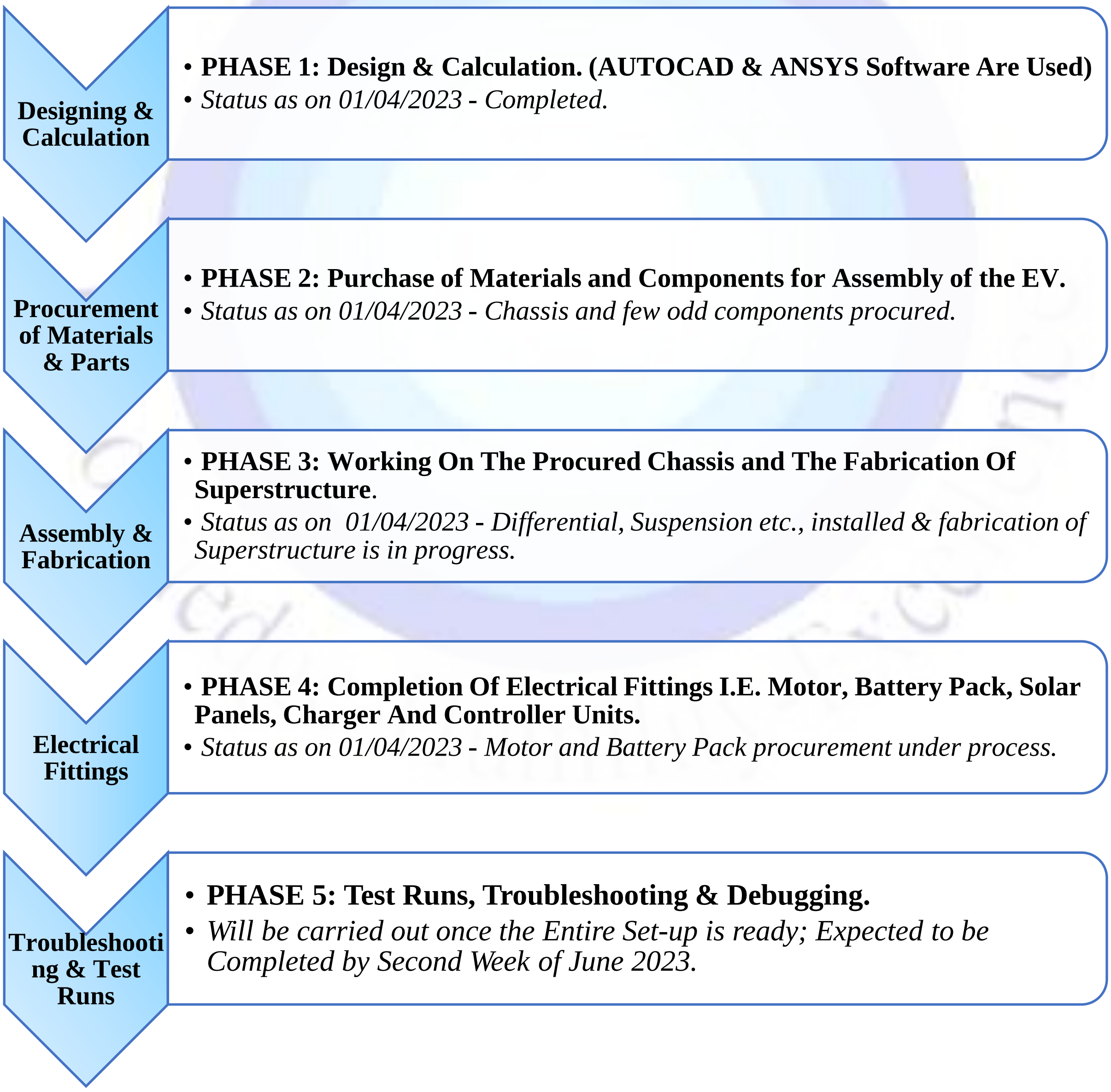
3. To put the Vehicle into regular use on the Campus.

4. To identify future scope for operation and maintenance of the EV (e.g., charging station, maintenance bay etc.)

3. METHODOLOGY

The project is planned to be executed in five phases as depicted in Figure 2.

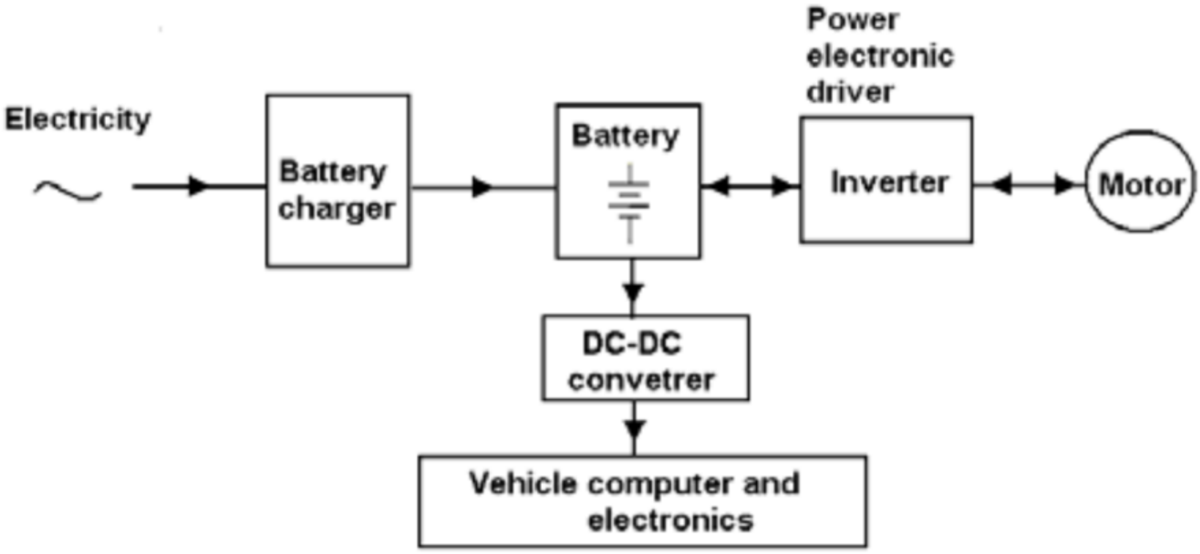
Figure 2- Flowchart describing the 5 phases of the project.



4. KEY COMPONENTS OF THE ELECTRIC VEHICLE

The electric vehicle has a simple lineup of components. Figure 3 depicts the Block Diagram arrangement, whereas Figure 4 illustrates an expanded diagram.

Figure 3 - Key Components in an EV



i. BLDC MOTOR

BLDC stands for brushless DC motors. They are the most used motors in electric vehicles because of their high starting torque, traction characteristics and high efficiency. BLDC works on both DC and AC input; commutator and brushes are not part of BLDC motors.

Motor receives the input as AC which is received via a controller, converter and inverter which inputs the required AC signal to the motor to produce the required power. Power from the motor is transferred through a rear differential to the rear wheels of the car. For our electric vehicle (EV) we are using 30 kw, 84v BLDC motor and reason for choosing it is given in the calculations.

The number of motors used in an EV depends on the type of drivetrain the vehicle is using. For example, All Wheel Drive (AWD) EVs use more than one motor. Whereas Rear Wheel Drive (RWD) or Front Wheel Drive (FWD) EVs use only one motor each connected to rear or front differential respectively. High Performance EVs such as the Tesla Model S use a total of four motors for four wheels.

The prototype being developed will have a single motor connected to the rear differential giving the vehicle a Rear-Wheel-Drive train.

ii. Battery pack for EV

Battery pack or also called traction battery pack is the component which supplies DC power to motor control unit which changes the DC supply to AC supply to the motor.

Battery packs are rechargeable li-ion batteries connected in series or parallel or both based on the voltage and current requirement of the motor.

Battery packs are recharged by an external source through a dc charger which is controlled by a dc charger controller.

In our electric vehicle we have also proposed to use solar panels to charge our Lithium Ferro Phosphate Battery Pack, 144V, Rated Current -31 A, Peak Current-250 A, with the support of an external charger.

iii. Motor controller

Motor controller, a PID controller consists of an inverter, converter and power electronics controller to control the motor output by changing its ac input. It receives signals from ignition switch, accelerator and forward-reverse switch to control the motor.

The inverter used is a bi-directional type which can be used in regenerative braking to charge the batteries in braking. The converter used is 12 V-60 V type.

iv. Auxiliary battery

These batteries are used for auxiliary equipment like head- tail lights, electronic indicators and other car accessories and in the case of failure of battery pack it can work to support the integral systems. The battery used in EV is a 6 V, 4.5Ah, li-ion battery and it is charged from the battery pack and the running condition.

v. DC charger controller

The battery pack is charges through DC supply from external source and solar panels, to control this dc supply to battery pack we use this controller.

vi. Solar panels

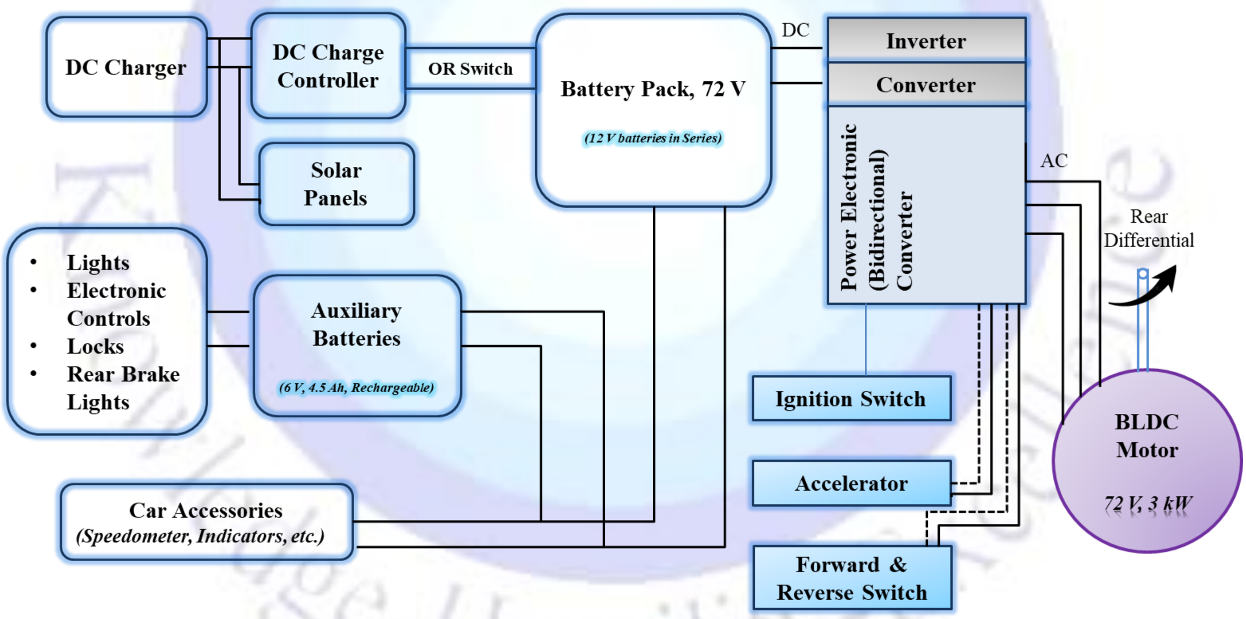
Solar panels are used as a charging module for the EV using renewable source of energy which is solar energy. We have planned to install mono-crystalline solar panels on the top of our electric vehicle. The photovoltaic cells convert solar irradiance into electric current which can be used to charge the electric vehicle.

vii. DC charger

Battery pack uses dc supply to charge the battery pack; DC charger is an external module which converts the grid AC supply into DC supply to charge the electric vehicle.

It works in parallel with solar panel when docked at a charging station to charge the battery pack.

Figure 4 - EV Block Diagram



5. AUTOCAD DESIGN

The following figures illustrate the basic frame structure and after body work design with relevant dimensions of the EV prototype that were designed on AUTOCAD.

Figure 5 - Side View (Dimensions other than wheelbases are approximate values only)

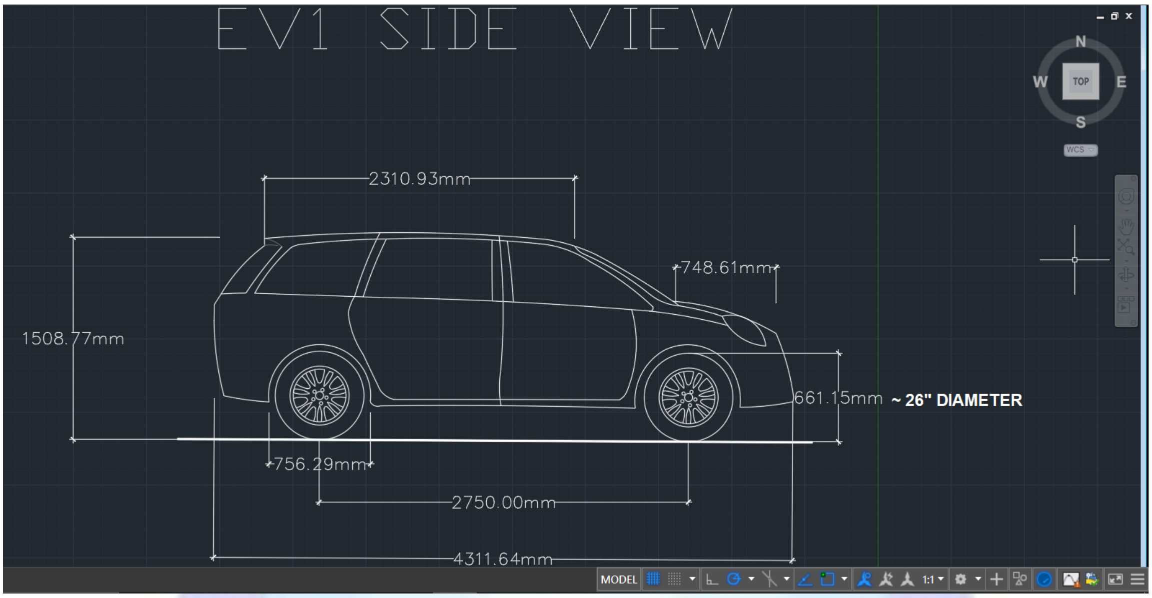
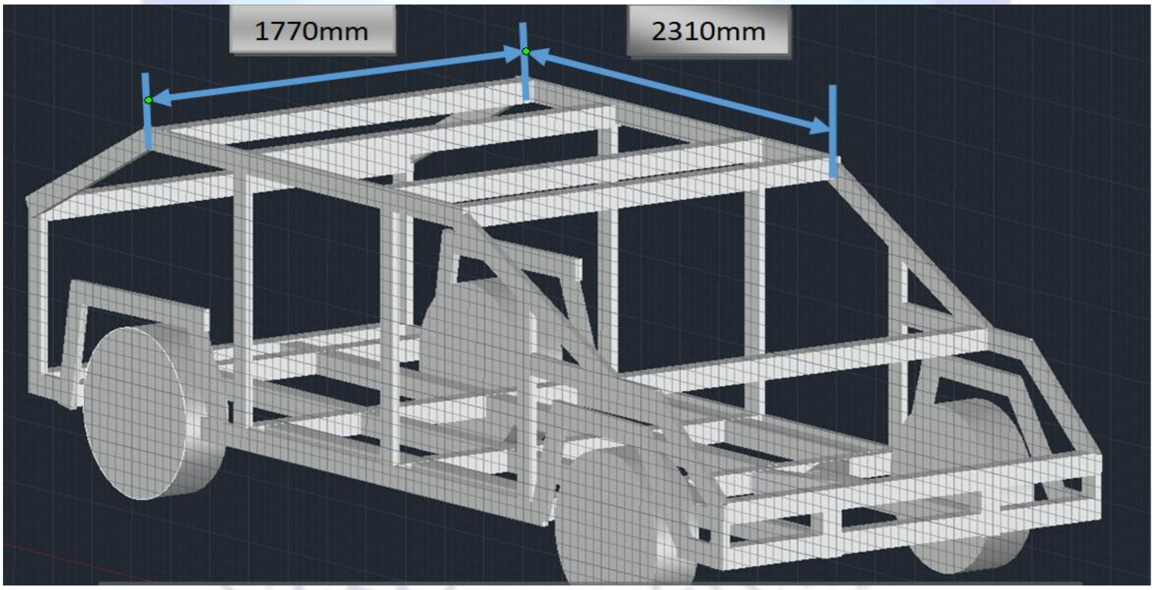


Figure 6 - 3D View of Frame Structure



6. ENERGY STORAGE

6.1 Batteries

Battery Pack is the energy storage in an EV. In recent times, a number of research studies are being pursued in the development of battery packs. Li-ion Battery is currently the most used battery in electric vehicles. The danger of the instability of the battery has been studied in many experiments.

The Lithium Ferro Phosphate ($LiFePO_4$) type Battery is preferable because of its chemically stable and inherent nature. Other Lithium-ion such as $LiCoO_2$, Li ($Ni_{1/3}Mn_{1/3}Co_{1/3}$) O_2 and $LiMn_2O_4$ have the thermal and overcharge concern. But Lead-acid batteries are still dominant in the market because of their relatively low cost.

Alternative for future prototypes - Ultra-capacitor

A capacitor is a static component having no chemical reaction in its components. Its charging and discharging speeds are very fast as compared to batteries. However, the energy storage is limited.

In particular the energy storage density is less than 20% of the lead-acid battery. The number of cycles and the temperature range is excellent. Table 2 shows the comparison.

Table 2 - Comparison of different energy storage unit

	Lead Acid	NiMH	Li-ion	Ultra-Capacitor
Energy Density (Whr/kg)	40	70	110	5
Cycle Life	500	800	1,000	500,000
Working Temperature(°C) **Cost $/k Whr**	-30 ~ +50 1,000	-40 ~ +50 2,400	-40 ~ +60 5,000	-40 ~ +85 50,000

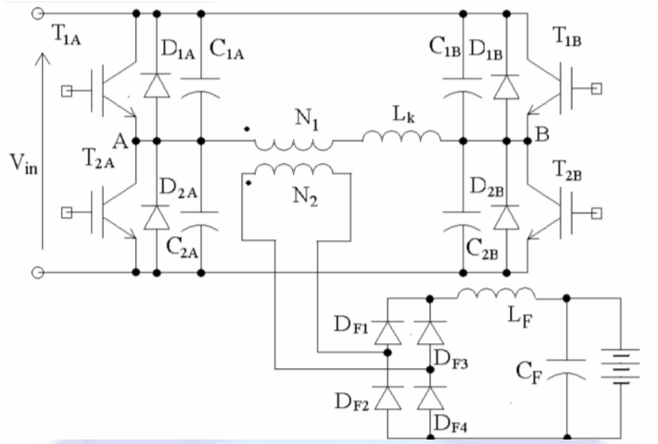
Thus, ultra-capacitor is useful for fast speed or transient energy storage because it allows high current charging, its charging time can be shortened to within a few minutes. It is still in the initial stages of development. As per the general trend, it is expected that the costs will reduce, and the energy density will go up rapidly in the next few years.

7. CHARGING SYSTEM

7.1 General charger

The charger needed for the battery system for slow charging or fast charger are both required to handle high power. The H-bridge power converter is needed. Figure 4 shows the converter. The converter is famous for its efficiency and has found application in charger and DC-DC converter.

Figure 7 - The H-bridge converter for charger



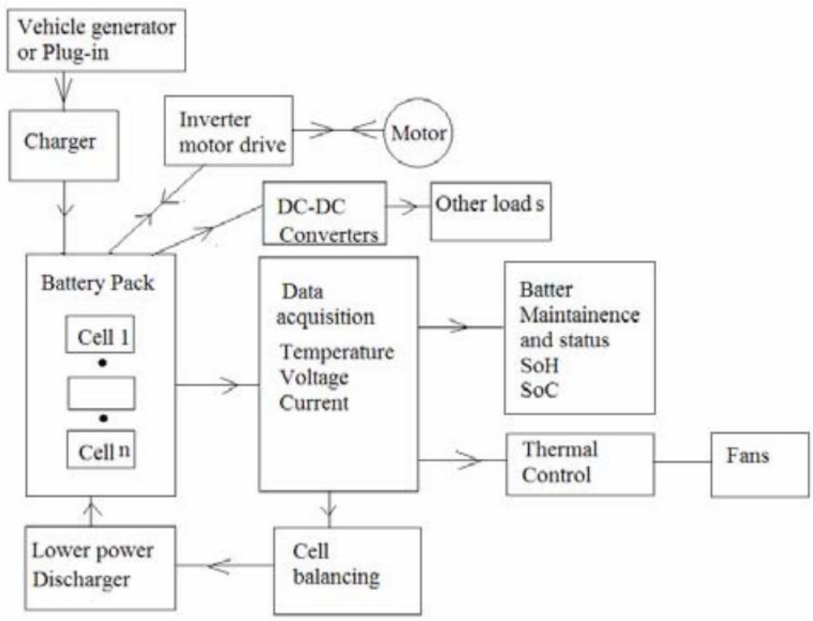
7.2 Alternative for future prototypes - Battery management systems

It is also referred to as BMS. The battery system is formed by a number of battery ells. They are connected in parallel or series that is according to the design. Each of the cells should be monitored and regulated. The conditioning monitoring includes the voltage, current and temperature.

Two parameters are usually provided. The SoH is to record the health or aging condition. There are a few definitions but the prominent one is:

$$SoH = \frac{\text{Nominal Capacity} - \text{Loss of Capacity}}{\text{Nominal Capacity}}$$

Figure 8 - Schematic Diagram of BMS



7.3 Charging Network

The charging method of EV is controversial because of the uncertainty of the power needed, location and the charging time. The charging time of batteries has been reported to be shorter in the recent development. The lead-acid batteries are restricted by their technology.

The charging rate is less than 0.2C and quicker charging rate seriously shortens its lifetime. Other batteries such as Li-ion has recommended charging rate of 0.5C.

Usually most of the electric vehicles have an on-board battery charger. A power cable is connected from the vehicle to a charging point. A charging station should provide a number of power points and a suitable transaction program to calculate the tariff.

The power needed for the charging station is not a concern. Usually for private car, a standard charging power is less than 2.8 kW. Single-phase power line is used. In average a vehicle is needed to be charged every 3 days. Using Hong Kong as an example, it will only affect the power consumption of less than 2% even all the private cars are charged to EV.

8. STRUCTURAL ANALYSIS OF INNOVA 2013 CHASSIS

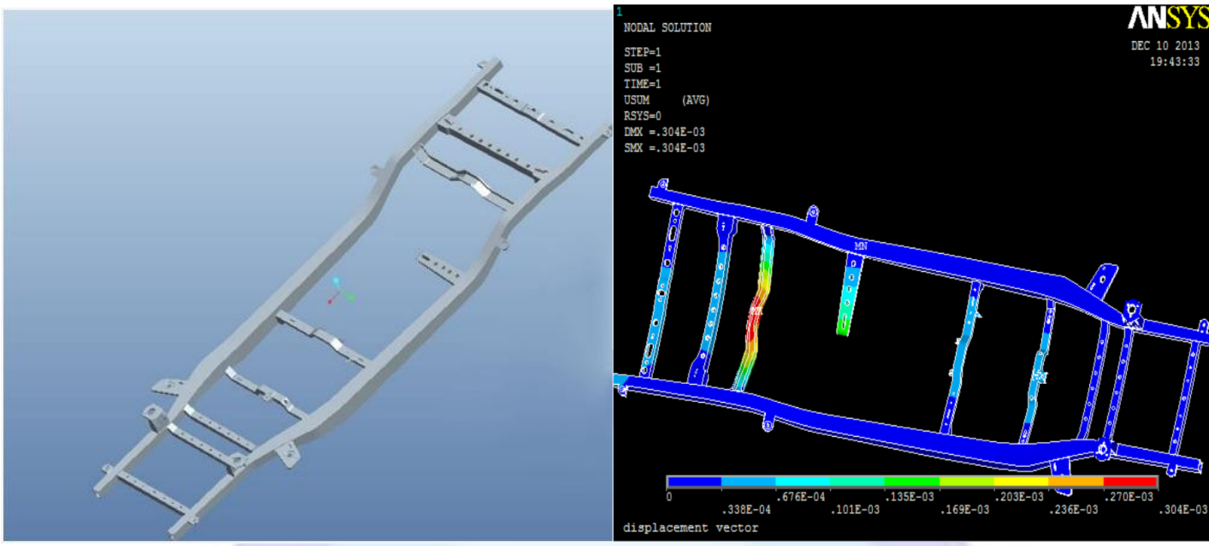
The Chassis of an automobile is a skeletal frame on which most of the mechanical parts such as the engine, axle assembly, tires, brakes, differential etc. are fitted. The chassis is the most significant component of a vehicle.

It gives flexibility, stability and strength to the automobile under a wide range of real-life conditions. Automotive frames are mainly manufactured from Steel and Aluminum.

The front frame is a network of metal beams that forms the framework which also supports the front wheels. This provides the strength needed for the supporting components and payload placed upon it.

The chassis procured for the project is of Toyota Innova 2013 model.

Figure 97 - Rectangular Section & Stress Distribution in Chassis



A 3D model of the Innova chassis is used for analysis in the ANSYS software. The loading conditions are considered to be constant. The element chosen in the software is the "SOLID-186" which is a higher order of the 3D 20 node solid element that exhibits quadratic displacement behavior.

The element is inherently defined by 20 individual nodes which have 3 degrees of freedom per node, that is translations in the nodal x, y & z directions. SOLID186 supports plasticity, large deflection, hyper elasticity, stress stiffening, creep and large strain capabilities.

8.1 Basic Calculation for Rectangular Cross Section

Gross Vehicle weight = 1200 kg

The gross vehicle weight is applied in the form of pressure.

The total area of application of load as calculated from chassis dimensions = 1525175 mm2.

Hence the total load to be applied = 1200*9.81 = 11772.0 N

Pressure to be applied = 11772.0/1525175 = 0.00771845854 MPa

8.2 Result Summary

Table 3 - ANSYS Result Summary

TYPE	STRESS INTENSITY (Mpa)	VON MISES STRESS (Mpa)	TOTAL DEFORMATION (mm)
Rectangular cross Section(original)	69.954	63.857	0.00026

Figure 10 - Photographs of Chassis before and after installation of parts

9. BRAKING

Disc Brakes and Drum Brakes have been the most common types of braking systems available in the market. An Electric Vehicle should incorporate both mechanical and electrical braking. In this type of hybrid braking, initially electrical power is regenerated with the concept of electrical braking where during deceleration, the kinetic energy of the vehicle is returned to the battery pack.

After this process is completed, mechanical braking is used in the final region of braking. This provides safety and energy saving.

Motors with relatively high power of regeneration are easily available in present day markets. To enhance the ability of power regeneration, the motor should have the ability to provide high reverse torque to stop the vehicle. This can be done using High Power Design Plugging Mode. The motor drive should be designed to incorporate a high frequency decoupling capacitor so as to absorb the fast transient of the reverse current.

10. SOLAR PANEL CALCULATIONS

Load = 10,000 W (RATED POWER) where PEAK POWER = 30,000 W

a. Inverter / UPS Rating:

Inverter / UPS rating should be greater than 25% of the total load (for the future load as well as taking losses in consideration)

10000 x (25/100) = **2500W**

Our Load + 25% Extra Power = 10000+2500 = **12500 Watts**

This is the rating of the UPS (Inverter) i.e., we need 12,500W UPS / Inverter for solar panel installation according to our need (based on calculations)

b. Required No & Backup Hours of Batteries

Suppose we are going to install **SIX 150Ah, 48 V batteries,**

48V x 150Ah = **7,200 Wh**

Now for 6 Batteries

7200 Wh x 6 Batteries = **43,200 Wh**

Now for one Battery (i.e., the Backup time of one battery)

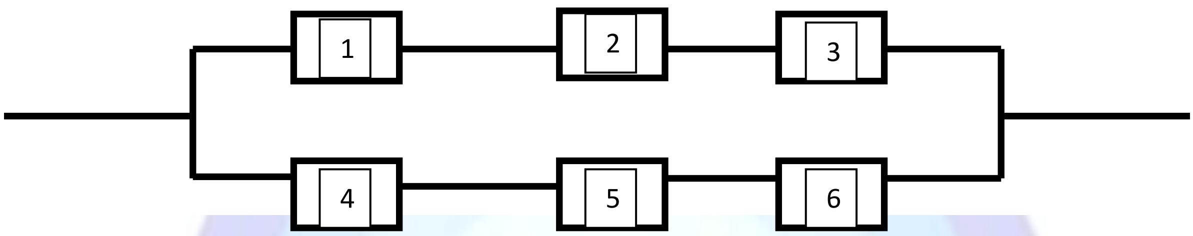
7200 Wh / 10,000 W = **0.72 Hours**

Backup hours of 6 batteries:

= 43,200 Wh / 10,000 W = **4.32 hours.**

We will use 144V inverter system; therefore, we will have to connect **3 batteries in Series and the 2 sets of series in Parallel.**

Figure 11 - Battery Pack Arrangement



c. **Charging Current for Batteries**

Now the **Required Charging Current** for these two **batteries**.

(Charging current should be 1/10 of batteries Ah)

300Ah x (1/10) = **30A**

d. Charging Time required for Battery.

Here is the formula for the Charging Time of a Lead acid battery.

Charging Time of battery = Battery Ah / Charging Current

i.e., **T = Ah / A**

For example, for a single 48V, 150Ah battery, the charging time would be:

T = Ah / A = 150Ah / 15A = 10 Hrs. (Ideal Case)

Due to some losses, (it has been noted that 40% of losses occurred during the battery charging), this way, we take 15-18 A charging current instead of 15 A, this way, the charging time required for a 48V, 150Ah battery would be:

Charging Time = Battery Rating / Charging Current

Charging Time = (150Ah + (150Ah x (40/100))

Battery rating would be = 150Ah + 60 Ah = **210 Ah** (150Ah + losses)

Charging Time is = 210Ah / 18A = 11.67 Hours (ONLY BY SOLAR PANELS)

e. Required No of Solar Panels (Series or Parallel)

DC Load is Not Connected i.e. Only Battery Charging

P = VI ………… (Power = Voltage x Current)

Putting the values of batteries and charging current.

P = 48V x 15 A

P = 720 Watts

This is the required wattage of solar panel (only for battery charging, and then battery will supply power to the load i.e., direct load is not connected to the solar panels)

720W/330W = 3 Nos of Solar panels

Therefore, a total of **3 Solar panels (each of 330W, 24V)** in series will be connected.

11. CONCLUSION

The Electric vehicle project is scheduled to be completed by June 2023. Future works including the development and installation of charging stations at strategic locations inside the Semmencherry and Uthandi premises are being worked upon simultaneously. The charging booths will utilize solar power in addition to being connected with the grid. Depending upon the success of this project, additional EVs will be developed in succession. The future prototypes will benefit from this project and will turn out to be more technologically advanced and efficient.

In the broader spectrum, electric vehicles hold a great promise to replace internal combustion engine vehicles (ICEVs) for a vast array of applications. They can address the carbon footprint by reducing the reliance on fossil fuels, thereby improving air quality index by eliminating green-house gas emissions. Electrification of automobiles is imminent and is synchronous with the de-carbonization trend of the twenty first century. Technology and governmental regulations can change societal mindset which will support the necessary transition toward a greener, efficient, and more affordable mobility solution for all.

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REFERENCES

Nagaraju, N. S., Kumar, M. V., & Koteswarao, U. (2013). Modeling and analysis of an innova car chassis frame by varying cross section. International Journal of Engineering Research and Technology, 2, 1-12.

Muratori, M., Alexander, M., Arent, D., Bazilian, M., Cazzola, P., Dede, E. M., & Ward, J. (2021). The rise of electric vehicles—2020 status and future expectations. Progress in Energy, 3(2), 022002.

Rahman, K. M., Fahimi, B., Suresh, G., Rajarathnam, A. V., & Ehsani, M. (2000). Advantages of switched reluctance motor applications to EV and HEV: design and control issues. IEEE transactions on industry applications, 36(1), 111-121.

Williams, A. MIT Battery Breakthrough Could Revolutionize Electric Cars. March 12th, 2009 in Batteries, Electric Cars (EVs).

Jones, W. D. (2007). Putting electricity where the rubber meets the road [NEWS]. IEEE Spectrum, 44(7), 18-20.

Schuss, C., Fabritius, T., Eichberger, B., & Rahkonen, T. (2019). Impacts on the output power of photovoltaics on top of electric and hybrid electric vehicles. IEEE Transactions on Instrumentation and Measurement, 69(5), 2449-2458.

Yang, S., & Knickle, H. (2002). Design and analysis of aluminum/air battery system for electric vehicles. Journal of power sources, 112(1), 162-173.

Sufyan, M., Rahim, N. A., Muhammad, M. A., Tan, C. K., Raihan, S. R. S., & Bakar, A. H. A. (2020). Charge coordination and battery lifecycle analysis of electric vehicles with V2G implementation. Electric Power Systems Research, 184, 106307.

Peled, E., Golodnitsky, D., Mazor, H., Goor, M., & Avshalomov, S. (2011). Parameter analysis of a practical lithium-and sodium-air electric vehicle battery. Journal of Power Sources, 196(16), 6835-6840.

Tian, Y., Zeng, G., Rutt, A., Shi, T., Kim, H., Wang, J., ... & Ceder, G. (2020). Promises and challenges of next-generation "beyond Li-ion" batteries for electric vehicles and grid decarbonization. Chemical reviews, 121(3), 1623-1669.

Gan, J., Chau, K. T., Chan, C. C., & Jiang, J. Z. (2000). A new surface-inset, permanent-magnet, brushless DC motor drive for electric vehicles. IEEE Transactions on Magnetics, 36(5), 3810-3818.

Yildirim, M., Polat, M., & Kürüm, H. (2014, September). A survey on comparison of electric motor types and drives used for electric vehicles. In 2014 16th International Power Electronics and Motion Control Conference and Exposition (pp. 218-223). IEEE.

Huang, C., Lei, F., Han, X., & Zhang, Z. (2019). Determination of modeling parameters for a brushless DC motor that satisfies the power performance of an electric vehicle. Measurement and Control, 52(7-8), 765-774.

Khan, M. A., Ahmed, A., Husain, I., Sozer, Y., & Badawy, M. (2015). Performance analysis of bidirectional DC–DC converters for electric vehicles. IEEE transactions on industry applications, 51(4), 3442-3452.

Jiang, J., Bao, Y., & Wang, L. Y. (2014). Topology of a bidirectional converter for energy interaction between electric vehicles and the grid. Energies, 7(8), 4858-4894.

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www.iire.in

NGO - Equality, Dignity and Safety

ISF Maritime and Offshore Institute

ISF Software and Publications
www.ispelearning.net

ISF Management and Consultancy Services

ISF Surveys, Testing, Audits Research & Rating Services

ISF HR Services

www.iire.in, www.inner-search.org, www.isfgroup.in, www.isfgi.com,
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