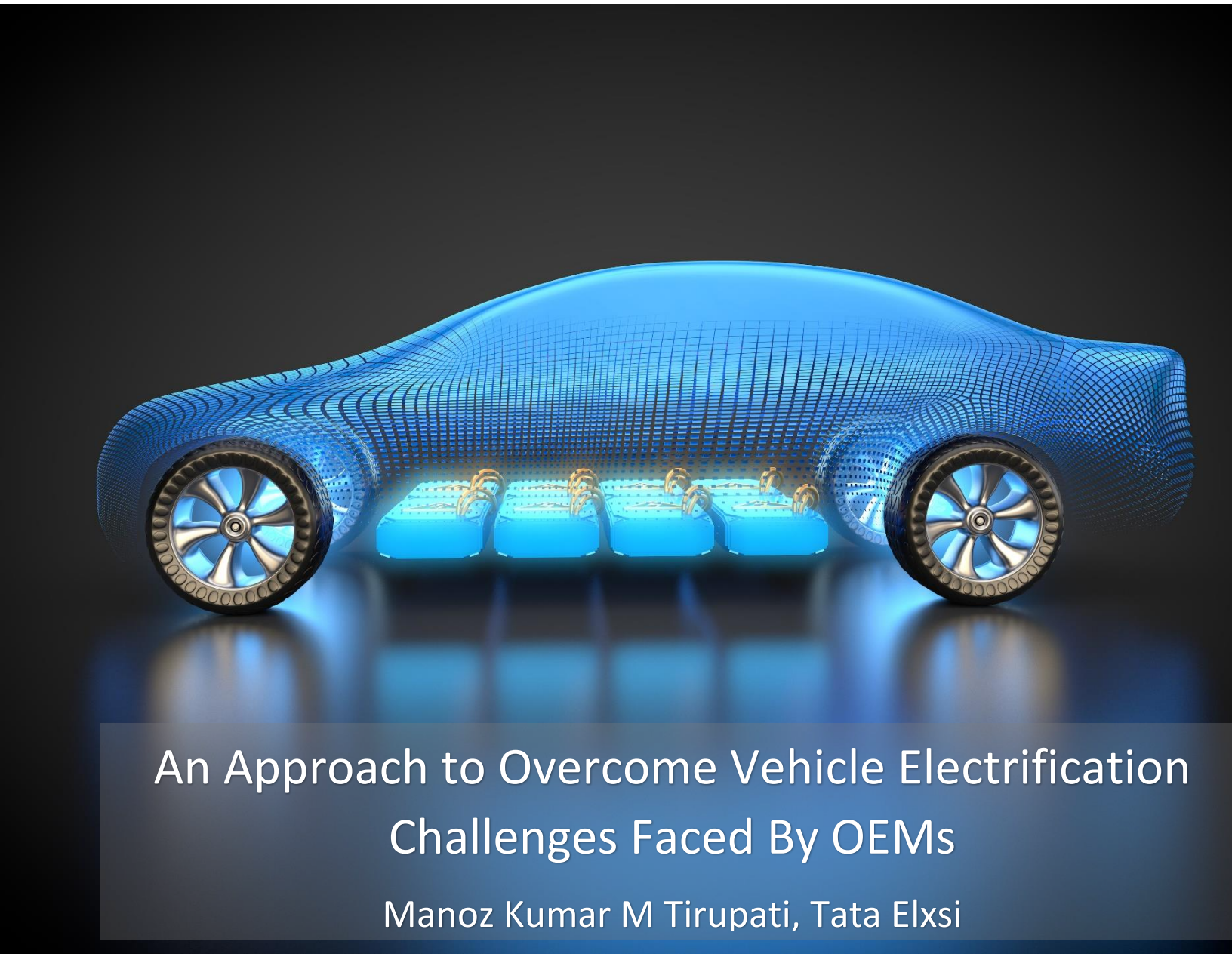

An Approach to Overcome Vehicle Electrification Challenges Faced By OEMs

Manoz Kumar M Tirupati, Tata Elxsi

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PREFACE

According to the Global Urban Ambient Air Pollution Database, Internal Combustion Engines (ICE) is one of the major contributors to air pollution emitting high levels of Sulphur dioxide and suspended particulate matter amongst other pollutants such as carbon monoxide, ozone, oxides of nitrogen and hydrocarbons. The pollutants emitted from ICE directly affect the respiratory and cardiovascular systems and indirectly result in increased mortality, morbidity and impaired pulmonary function. With the regulations in place to counter the emission issues, the alternative for Automotive Industries is to move from ICE to Electric Vehicles.

It is high time for a paradigm shift of owning the design by OEM. This white paper provides an insight into various areas an OEM can leverage from the existing situation.

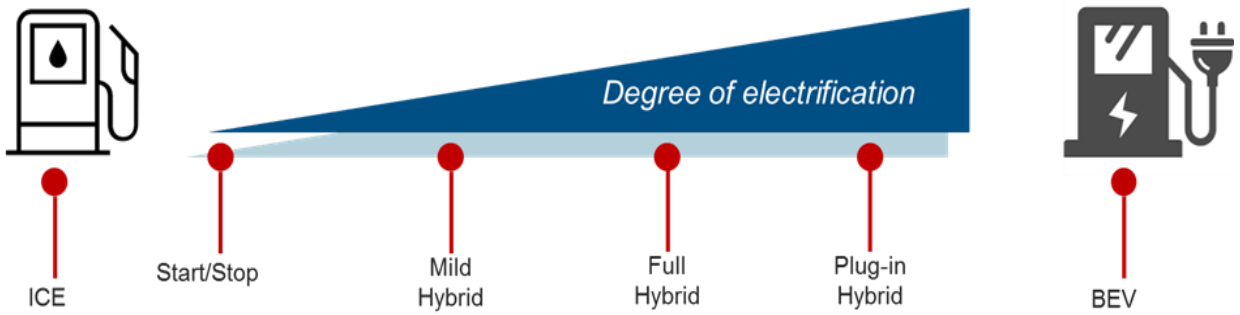


Figure 1: Evolution of Electric Vehicles

Infrastructure Development for Electric Vehicles

In line with the changes in the type of vehicles in the coming years, there is an essential need to develop infrastructure, which would enable the vision of migration from ICE to Electric Vehicles come true. The major concerns raised by the customers are with drive range of Electric Vehicles, which is directly linked with battery capacity and charging stations availability to match the rollout or migration from Internal Combustion Engines.

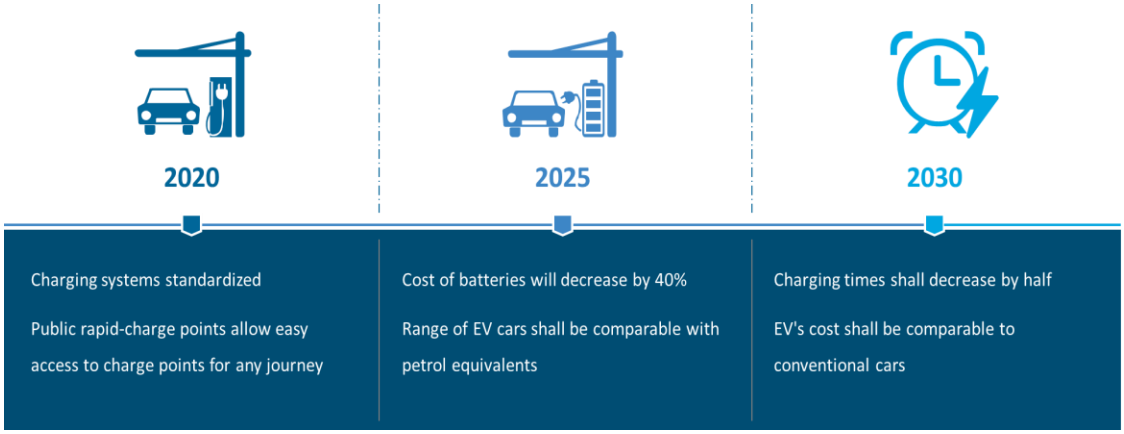


Figure 2: Timelines For Migration from ICE to Electric Vehicles

Forecast of Battery Electric Vehicle Manufacturing

With most of the OEM's gearing up to the changing trend, it is high time for the adoption of new requirements arriving out of the situation. Major OEMs already have mitigation plan in terms of Electric Vehicle roll out, more information on the strategy of Electric Vehicle manufacturing with respect to OEM, model and geographic location showcased in Fig 3.

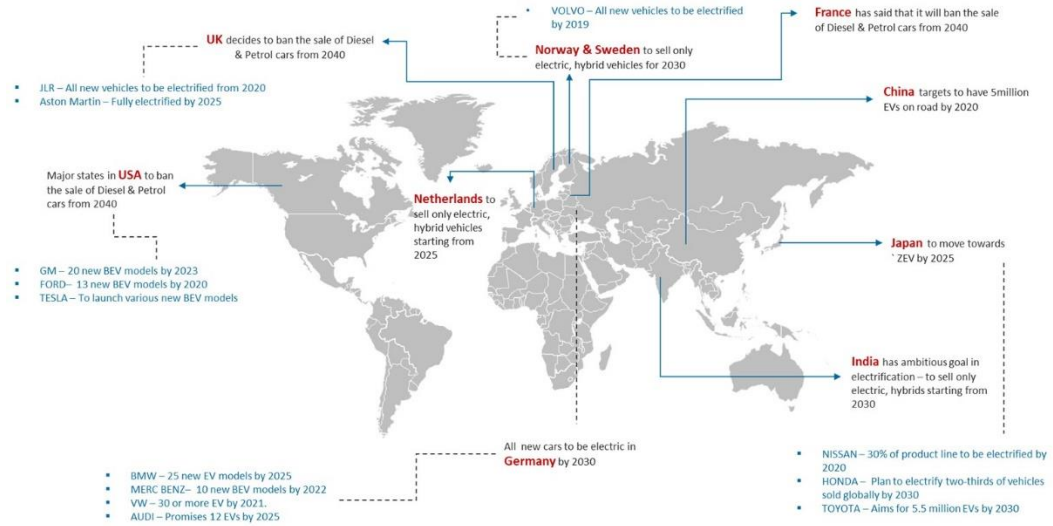


Figure 3: Forecast on Global BEV Manufacturing

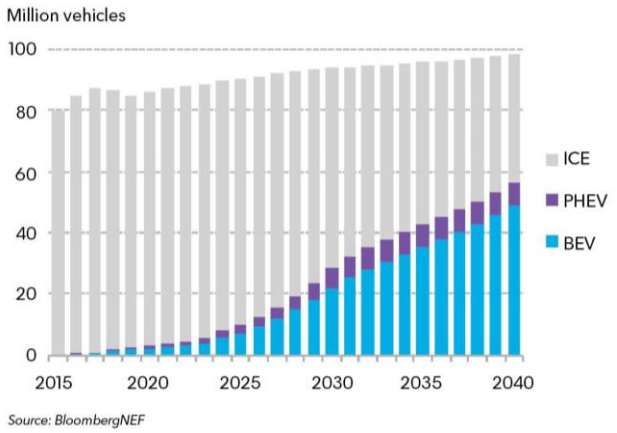


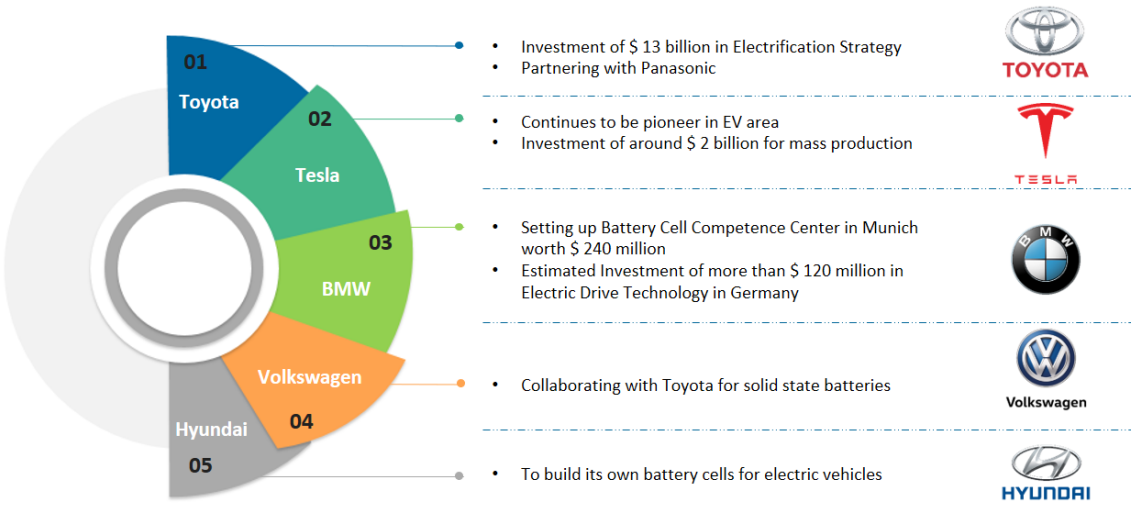
Figure 4: Global long-term passenger vehicle sales by drivetrain

AUTO INDUSTRY TRENDS

In-House Battery Development

Currently, the European automotive industry sources most of its EV components from Asian suppliers, including the batteries that are at the heart of all-electric vehicles. With manufacturers dependent on this supply, there are risks that the market could suffer if suppliers increase prices or are unable to gather together materials. Therefore, carmakers are attempting to bring battery development in-house.

It is evident that in recent past, major auto companies such as VW, BMW, Toyota, Volvo, Suzuki, GM, and Tesla have continued to invest in building in-house capabilities to manufacture electric vehicles and turn their steering wheels to electrification strategies completely.



Dynamics of Alliance with Suppliers

Few of the OEMs have already established strong links with cell manufacturers through alliances or ownership stakes. For example Toyota with Panasonic in Japan and Daimler Trucks & Buses and battery manufacturer Contemporary Amperex Technology Co. Limited (CATL). Such an arrangement would provide an opportunity for OEM to access expertise on Technology and production capacity allowing them to segment its vehicles based on the selected battery technology. This would enable OEMs to ensure best solution for their robust design, as it would require detailed understanding of both end application and cell chemistry (Drive Cycle – Power/Energy inputs required) which would result in determining which cell will be most appropriate for the desired application. This would also help in integration, as cells for Electric Vehicles can be a variety of different form factors – prismatic, cylindrical and pouch cell and different chemistries.

BATTERY MARKET FOR ELECTRIC VEHICLES

With the changing trend in the sales of Electric Vehicles, battery cost is one of the major component, which decides the vehicle cost. There is an essential requirement of design and development of Batteries for automotive applications with newer and cost effective technologies, which could enable OEMs to rule the market and improve the business. The trend also indicates that Battery requirement would exponentially grow until 2030. The major concern on BEV is the cost of Battery Pack, which stands close to 42% of the cost of the vehicle. There is a forecast of reduction of cost in years to come, and would stand at 18% based on the volume of consumption and advancement in technology.

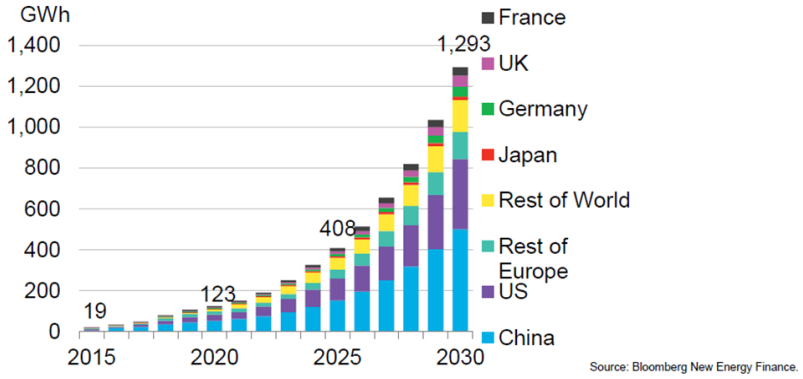


Fig 6: Forecast demand for Li-Ion Batteries from

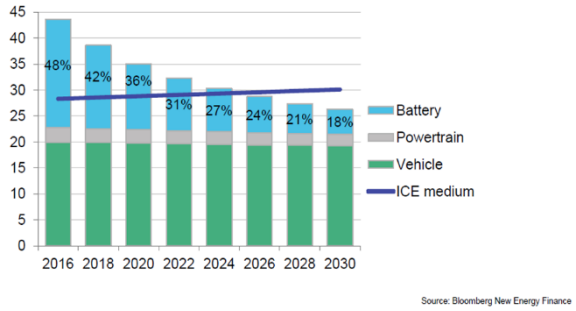


Fig 7: Forecast of Battery Cost in decline till 2030

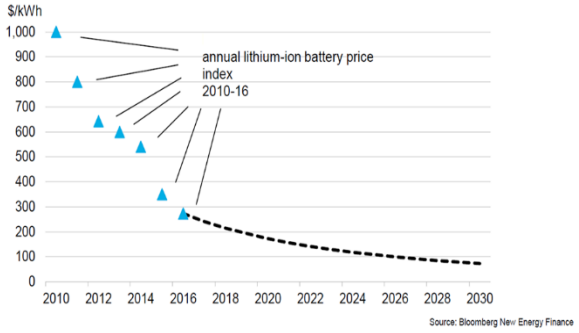


Fig 8: Forecast of Li-Ion Battery price index until

Cell Chemistry

When it comes to the selection of battery chemistry, there are five principal Lithium-Ion Battery Technologies. Attributes such as Safety; Performance; Life Span; Cost; Specific Energy; Specific Power should be considered based on which the chemistry is finalized. If we look at the attributes in various battery chemistry, Lithium Titanate (LTO) is one of the best cases for automotive applications. It remains a challenge to arrive at break-even with respect to performance, life Span and cost. This involves more

research to improve the Specific Power of Battery.

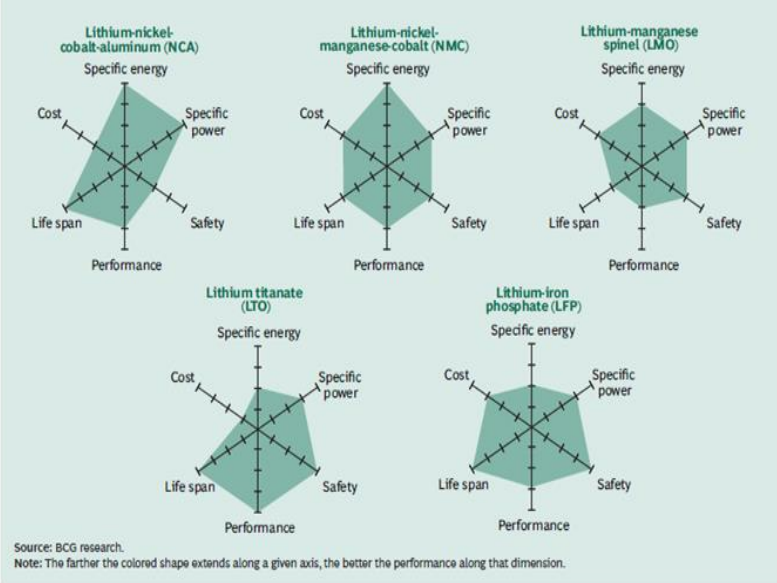


Fig 9: Trade off on Cell Chemistry

Battery Development cycle for Electric Vehicle Application

Battery development involves seven stages encompassing:

- Manufacturing of anode and cathode active materials, binder, electrolyte, and separator
- Production and assembly of single cell
- Configuration of cells into larger modules that include some electronic management
- Integration of modules together with systems that manage power, charging and temperature
- Integration of battery pack into the vehicle structure including the battery car interface
- Usage
- Re-use and Recycle

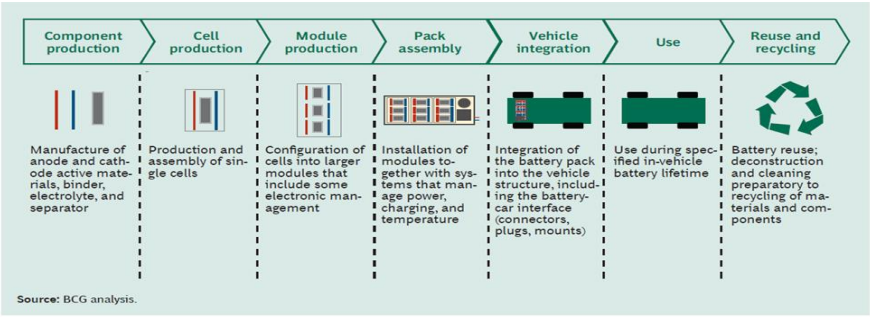


Fig 10: Stages of Battery Module Development

CONCLUSION

Based on the current scenario at OEMs, it is understood that OEMs are focusing on developing a few major electrical systems/components in-house and the key focus is on traction battery. The major driving factor for this paradigm shift adopted by OEMs being:

- Achieve flexibility in battery specification
- Adopt battery capacity based on the new range of vehicle offerings
- Reduce lead time for development
- Opportunity for modular design
- Align to latest battery technology

Fig 11: High Voltage Traction Battery

ABOUT TATA ELXSI

Tata Elxsi is a global desgn and services company. Tata Elxsi works with domestic and overseas OEMs & Tier 1 Suppliers in providing Mechanical solutions in the area of Traction Battery for Electric Vehicle (EV) and other EV systems.

This is backed by over 25 years of design and engineering experience and deep specialization in current automotive mechanical trends with a global delivery presence and offshore development centers in India. For more information, please visit www.tataelxsi.com

Tata Elxsi Capabilities in Electrification

Tata Elxsi has been associated with major automotive OEMs for more than a decade and has built capabilities, expertise extensively in the area of design and validation of Powertrain, Vehicle engineering, Body and Electro-Mechanical packaging. Tata Elxsi has well-established infrastructure matching world-class requirements and the team is competent with OEM way of working - Processes / Procedures / Guidelines.

Research

Design of Electrical Component / System, with feasibility check and to validate Technology for future Electric Vehicle requirement

Design & Development

Package and design of Electrical Components / Systems, Supplier engagement for development in line with vehicle specification

Design Verification & Simulation

CAE Simulation for structural requirement, CFD simulation for thermal management

Production & Delivery

Validation of supplier capability by checking CMM reports, generation of production drawings with stack up & GD&T, interaction with supplier to ensure delivery as per the time line