

National Conference on  
**Innovations in Electric Vehicle  
Technologies  
(IEVT 2019)**



**7-9 March 2019**

### **Introduction**

India is now in the process of adopting Electric Vehicles (EVs) as a means of transportation. Though the processes started years back, more focus was there during last couple of year. Fairly good visibility is there with respect to the progress of electric vehicle industry. But much attention is not given in the electric vehicle technology area and still India depends on China for EV components. The important subsystems of an EV are Electric Propulsion System (EPS), Energy Storage System (ESS) and other Auxiliary Systems. In the EPS, the important parts are the electric motor, motor controllers and power converters. ESS is basically, battery, augmented with other energy storage devices like supercapacitors, fuel cells etc. In both of these areas, China promote the products which use special material abundant in their country, same time not available in other countries In this context, it is quite essential to identify EV technologies that do not depend on special materials and focus on innovative technologies which will reduce the cost as well as make the country self-reliant in EV technology area.

In this context College of Engineering Trivandrum has hosted this national Conference on “Innovations in Electric Vehicle Technologies” with a focus to discuss on the present status of EV technologies in India, the advances in this technology area and obtain a fairly good direction for the future. The sessions were so planned such that the EPS and ESS areas are well focussed and the participants also get a good understanding on the over all growth of EV technology industry in India.

There was good participation from academic institutes, industry and other Government organisations in the conference and an exhibition was also organised focusing electric vehicles and charging infrastructure. The conference had technical sessions for invited talks and contributory papers. There was also a panel discussion on second day of the conference which was well attended by different stake holders in the E-Mobility initiative of Kerala.

## **Inauguration – Sri. K. R. Jyothilal IAS**

The three-day conference was inaugurated by Sri. K, R, Jyothilal IAS, Principal Secretary, Dept. of Transport, Govt. of Kerala in a session chaired by the Principal, College of Engineering Trivandrum. In the inaugural address, Sri. K R Jyothilal elaborated on the prospects of e-mobility and stressed the need of the participation of academic institutes in the action plan. Dr. S Ushakumari, Head of Department of Electrical Engineering, Dr. PG Jairaj, Dean(Research), Dr. Savier J S, Professor of Electrical Engineering and Dr. Francis M Fernandez, Coordinator of IEVT 2019 spoke at the inaugural session.

## **Key Note address - Dr. P V Unnikrishnan**

The keynote address was delivered by Dr. P V Unnikrishnan, Strategic Advisor, Kerala Development and Innovation Strategic Council (K-DISC). In his address he compared the growth of Electric Vehicle Industry in India with that of other countries and stressed that India is well below the level of other countries. Urban air quality is very much dependant on type of vehicles and there is a need for reduction of oil imports. The answer for all these is Electric Vehicles. The main challenges in EV industry are cost, range anxiety, availability of charging infrastructure and product availability.

Kerala has an ambitious plan for 1 million electric vehicles on road by the year 2022. This will include two wheelers, three wheelers, goods carriers, buses and ferry boats. Government's focus will be on three wheelers and buses.

## **Technical Session 1**

(March 7, AN)

### **Sri. Vijayan Nandalan**

The first talk in session 1 was on “ Advances in Electric Vehicle Technologies: Major trends and Future development” was handled by Sri. Vijayan Nandalan, Former Scientist, ISRO. In his presentation, he briefly explained about the present scenario both in EV and EV technology area. Then he elaborately discussed on the major trends that is happening across globe in the field of electrical vehicle technology areas viz. EPS and ESS. In EPS area, the advanced electric motor drive technologies and advances in power electronics were discussed. He emphasised the need for development of Non-rare earth magnet motors as well as optimised Non- magnet motors like Synchronous reluctance motors, switched Reluctance motors etc. These technologies will make India self reliant in EV electrical drives.

Advances in Power Electronics help in realising highly efficient, low cost Motor controllers, Inverters, charging units etc . He pointed out the examples of SiC MOSFETs and LLC converters presently used by foreign companies working in EV industry. Brief mentioning was made about wireless charging scheme also

The ESS forms heart of an EV. With brief introduction of present capabilities of ESS, he discussed in detail about future high energy batteries such as Metal-air batteries and

Metal-ion batteries without the use of special materials. Other ESS like Ultracapacitors and Fuel cells were also discussed.

**Smt. Sujatha S.**

Second talk was on battery technologies was handled by Smt. Sujatha S, Head of Advanced Power System Division, VSSC. She explained on various battery technologies used in launch vehicles, satellites and for societal application. Previously Metal ion batteries of low energy densities were used and subsequently VSSC took up the development of Lithium-ion batteries. VSSC developed high energy NCA (Lithium Nickel Cobalt Aluminium Oxide) battery for space use which got good potential for EV industry also.

She further explained the theory of different battery technology developed by VSSC, criticality in developments, its testing and performance features. She shared her development experience of each technology and was really a good technical session benefitted by both industry and student community.

Smt. Sujatha pointed out that Metal-air batteries are having higher energy densities and the development is also to be looked at to reduce the cost and volume of the battery. Another development work carried out by VSSC is on Supercapacitors. It can hold good amount of energy and can be quickly deliver high power, which is an essential requirement for an EV, when frequent start and stop of the vehicle is needed and when the vehicle is climbing the slope. This scheme was tried as a retrofit in a maruti-omni vehicle and the trial run was successful.

**Sri. Anush G. Nair**

Third talk was on the “Selection of Traction of Motors for Electric Vehicles” and was delivered by Sri. Anush Nair from Tata Elxsi, Technopark, TVM. They have extensive experience in various aspects and phases of Powertrain development, from program management to calibration and software development. They provide solutions for hybrid electric vehicles including hybrid controllers, battery management systems, DC-DC convertors, battery plant modes, motor controllers, and Invertors. Tata Elxsi has successfully created methods and techniques to provide architectural solutions and incorporate safety integrity functions in compliance with ISO 26262.

He explained about the schematic of an Electric Vehicle System and its sub systems. Then he briefed about different types of motors used in EV and their torque speed characteristics. The selection criteria of the motor, test cycles etc were also explained with help of sketches

Tata Elxsi do the modelling and simulation of EV. He narrated their experience on retrofitting of a car taken up by the design team to better understand get acquaintance with the system. On a request from the audience to have visit by students to their facility, he agreed to talk to their management and obtain required permission.

## **Technical Session 2**

(March 8, FN)

The first technical session on day 2 was handled by Smt. Sreedevi M. L., Principal Engineer, Power Electronics Division, C-DAC on the topic “EV/HEV System Design using xEV simulator”. This project was taken up in line with the nation’s E-Mobility programme. She explained about the requirement of a simulation in EV system. The analytical method will give only single operating point where as with simulation it is possible to handle dynamic situations . The simulation techniques help to produce and analyse vehicles in the very conceptual model.

The xEV simulator is a tool developed in Matlab which is having features for forward simulation and backward simulation. The EV power train model was explained and how various test conditions can be given as input and results can be obtained to confirm the design margin. To a query , Smt. Sreedevi informed that the R&D phase of the xEV simulator is just completed and the CDAC management will have plans to commercialise the product.

## **Technical Session 3**

(March 8, AN)

The session on “Motor design for EV application” was handled by Sri. Tijo Thomas, Entuple Technologies, Bangalore. Mr. Tijo in his lecture, highlighted the sad state of affair in the country with reference to high energy materials needed for developing efficient, cost effective electric motor drives in India.

He emphasised the need for a quality EV in place and cautioned that industry will be facing several issues, if the quality requirements are not properly addressed. For example, the typical requirements of an electric motor for automotive application spell out lot of stringent specification to be met and how many design agencies in India really know and adhere to this requirement is a real question.

Sri. Tijo subsequently presented the different simulation tools and associated software enabling the EV design community to achieve optimised parameters for any type of EV drive system. The procedure followed is Analytical studies, detailed analysis and the accurate simulation which will result in an optimised design. He illustrated with sketches and simulation results that how powerful is the simulation tools now and along with a properly selected motor controller, any type of motors can be selected for EV application.

## **Technical Session 4**

(March 9, FN)

Two parallel sessions were held for presenting contributed papers for paper presentations. Ten papers were presented in these sessions. The sessions were chaired by Prof. A. S. Shajilal, Professor, MBCET, Thiruvananthapuram, Dr. Dinesh Gopinath, Associate Professor, GEC, Idukki, Dr. S. Indulal, Associate Professor, GEC, Idukki and Prof. A. Asok Kumar, Associate Professor, GEC, Barton Hill. The papers discussed various aspects

related to drivetrain and control of electric vehicles. There was an observation that there is a need for a focussed research approach by student community on EV technology.

### **Technical Session 5**

(March 9, FN)

Sri. Visakh Sasikumar, CEO, PI BEAM an alumnus of CET who is running EV start up in IIT-M technology park gave a detailed presentation on the type of electric vehicles developed by PI BEAM for selected sectors like e-cycle rickshaw, food movement vehicle, commercial vehicles etc. In his lecture he narrated his story of how he become an EV entrepreneur and moved ahead in spite of different problems. His session was really a motivation for the younger generation who are interested to start their own venture.

### **Panel Discussion**

(March 8, FN)

The most interesting and well attended part of the conference was the panel discussion on “Challenges in growth of Electric Vehicle industries in India” and was moderated by Dr. Ajith Prabhu, Joint Director, Kerala State Council of Science Technology and Environment (KSCSTE). The deliberations in the panel discussion is summarised below.

#### **Moderator**

Dr. V. Ajit Prabhu, Joint Director, KSCSTE

#### **Panel of Experts**

Sri. Vijayan Nandalan, Former Scientist, ISRO

Sri. Amal S, Principal Engineer, CDAC

Sri. Ajith Gopi, Joint Technical Director (Solar Photovoltaic Programme) ANERT.

Sri. V. K. Joseph, Chief Engineer, Renewable Energy and Energy Savings, KSEBL

Sri. A. M. Narayanan, Former Head, Energy Efficiency Division, Energy Management Centre

Sri. Tijo Thomas, Product Manager, Entuple Technologies Pvt. Ltd, Bangalore

Smt. Sujatha S., Scientist-SG and Head, Advanced Power Systems Division, VSSC

The discussions started with an introduction by the moderator, Dr. Ajith Prabhu, Joint Director, KSCSTE. After briefly mentioning the significance of the topic he introduced each of the participating experts. Each of the experts were invited to present their view on the topic. The major points of discussion by each of the experts are as follows.

#### **Smt. Sujatha S.**

Smt. Sujatha put forwarded the issue of development of efficient energy storage system for Electric Vehicle (EV) applications. Energy storage system serves as the heart of the EV,

and hence better storage devices with improved energy density is required for further development of EVs. Current technology is based on Li-ion cells, which is costly and can be replaced by Li based sources. She mentioned about the research going on at VSSC in the areas of energy sources. EV application demands high current from the energy source. When battery alone is used to meet this requirement, higher capacity cells are required which work under high stress, eventually reducing the life of the battery. This problem can be solved by the hybridisation of the energy sources – using Super capacitors along with the battery. Super capacitors using new technologies, like using activated carbon for construction is under consideration. Metal – Air batteries are another solution, using which driving ranges upto 500 km are achievable for EV. Ms. Sujatha also motivated the students and faculty to take up ISRO INSPIRE projects, which will allow them to work on battery technology research projects.

### **Sri. Tijo Thomas**

Sri. Tijo Thomas introduced the major challenges in material availability for battery as well as motor manufacturing in India. The main three components of EV technology are the motor, power converter and battery. Motor manufacturing calls for procurement of low loss copper and steel, which are currently being imported from Europe or Japan. The permanent magnets are being imported from China. For the manufacturing of power converters, no power semiconductors are currently being manufactured in India, and needs to be imported from Europe. Thus, the first problem faced by EV technology is scarcity of materials for initiation of manufacturing in India. Along with that, formulation of better Indian standards for the EV technology is to be done, with the vision to be at par with the rest of the world. The charging infrastructure development is another issue to be addressed. There should be a drastic change in government policies for faster adaption of the new technology.

### **Sri. A. M. Narayanan**

Sri. A. M. Narayanan gave an overview of the grid capacity to the requirement of EV technology and the problem of supplementing the grid energy to overcome the use of petroleum products. The advantages of introduction of EV technology, with special mention to the reduction of carbon emission as well as the saving in terms of vehicle running cost for consumers were discussed. However, a phase wise conversion is to be done to EV technology, considering the amount of carbonisation possible and the amount of distributed generation contribution to the grid.

### **Sri. V. K. Joseph**

Sri. V. K. Joseph listed out six major problems related to the introduction of EV technology, first one is the problem of acceptance of the new technology by the public. Second one is the impact of the EV technology on the existing system. Proper measures should be taken up the government to interact with the system, like providing incentives for people and industry for EV usage. Third issue is how the utility will respond to the change. Fourth issue put forwarded was regarding the proper disposal of the used batteries. A reuse or reconditioning technology is required in this regard, without which it can lead to serious environmental and health issues. Introduction of special tariff for EV applications by the govt.

regulatory system was discussed as the fifth issue. Lastly, the commissioning and proper management of the charging stations was discussed. He concluded with the hope that it can lead to employment opportunities for new generation.

### **Sri. Ajith Gopi**

Sri. Ajith Gopi discussed the application of renewable energy and related systems in EV technology. Introduction of grid connected as well as off grid connected solar charging stations was mentioned. It was suggested that in rural areas, EV technology supplemented by solar powered off grid connected charging stations can provide rural transportation solutions. The major challenges in utilization of renewable energy was also discussed. Proper charging habits can improve the system by reducing the disparity between the bell curve of generation and the duck curve of utility. Day time charging of EV is to be encouraged, with introduction of public charging places in offices or public places. A time of the day tariff can be introduced to encourage off peak hour charging. Also, the idea of embedded solar vehicles was also introduced.

### **Sri. Amal S.**

Sri. Amal S. addressed the issue from two viewpoints - from customer view point and from developer view point. From the customer view point the major problems identified are: fear of acceptance, reliability and cost. The public acceptance can be improved by providing proper charging infrastructure with suitable parking space, as the charging may take up to 3 hrs. E-mobility can be restricted to certain sectors of vehicles. Proper tariff introduction with separate metering for charging EV is also required. The reliability issue can be solved by using battery swapping mechanism to overcome range anxiety. For the purpose, smart batteries with SOC sensing is needed in swapping stations. From the developer point of view the major problems identified are – availability of the materials for manufacturing, proper methodology for the development of the EVs and the employment issues related to automobile experts. The need of urban mining for recycling materials, use of nonmagnetic motor drives and development of proper drive cycles for each city that can be used for simulation studies corresponding to EV deployment were also discussed.

### **Sri. Vijayan Nandalan**

Sri. Vjayan Nandalan classified the problems in two aspects – technology aspect and market aspect. The issues mentioned in the technological aspect are the availability of indigenous materials for manufacture and introduction of government policies to support the phased manufacturing program for EV. From the market aspect, the need of public awareness was discussed. Need to educate people about the advantages of using EV by conducting 'EV mela' or 'EV camps', with options for demo of EV were discussed. He mentioned about the low profile currently given for EV promotion, stating the absence of any economic aid for procuring EV. He concluded stating that synergy between all governmental and non-governmental agencies are required for successful implementation of EV technology.

After the discussions by individual experts, moderator, Dr. Ajith Prabhu consolidated the points mentioned by each of them. He added that proper awareness among engineers as

well as public is to be initiated for accelerating the acceptance of EV technology. With this he opened the topic for discussion with audience.

### Questions from audience

*Q1. Can you explain the recently introduced Kerala EV policy.*

Mr . V.K. Joseph answered the question:

As the policy was published only days before, detailed discussion is not possible. The major points included are:

- tax exemption for EV
- Provisions for commissioning EV charging stations by private individuals or companies.
- A five rupee tariff for EV charging
- In order to overcome space constraints for charging stations, road spaces can be utilized.
- In accordance with the MNRE policy, the charging stations will be set along with solar stations
- The mission is to make all vehicles of Trivandrum city electric driven by 2020, starting with two wheelers and three wheelers.
- Battery swapping stations to be encouraged rather than charging stations.
- Also KSRTC is planning to replace all buses in Trivandrum with electric buses. Currently ten electric buses are plying between Trivandrum and Kochi.

*Q2. Which agency will take up the process of integration between R&D and government policies?*

Dr. Ajith Prabhu answered:

Although currently no clear idea regarding the issue is not available, many agencies like SECRI, RLL,IITM, etc can be considered as the integrating agency. The issue requires top level discussion.

*Q3. Even though the introduction of EV is said to reduce the green house gas emission of transportation sector, how much actual saving regarding the emission can be achieved in India? India being a primarily thermal based electric generation country?*

Mr. Narayanan answered the question:

Mentioning the calculations regarding the carbon emission from IC based vehicles and thermal power generation, he said that currently 5-10 kg of carbon saving can be achieved with EV technology. By increasing the share of renewable energy sources in power generation, further saving of CO<sub>2</sub> emission as well as petroleum product import cost can also be saved.

The moderator concluded the discussion by mentioning the need of new legal standards and regulations regarding the EV technologies. Also, he wondered, whether immediate wiping of IC vehicles is possible, or should we go through a hybrid vehicle phase before the introduction of EV technology.

## **Outcome of the Conference**

The outcomes of the Conference may be listed as below.

- The conference had paper presentations and discussions on the advances now coming up in EV technology area and the participants benefitted from the ideas and topics that are presented.
- The need for indigenisation of EV technologies and their commercialisation were well discussed in the conference. The advances and innovations now happening EV industry were brought to light.
- The need for a consortium comprising both Private, Government and domain experts were felt by the participants so that indigenisation activities of EV technologies will get a momentum and will accelerate the programme.
- This conference brought together the various agencies doing their developments in EV area. This networking will really help these entities to have broader discussion in EV technology area.