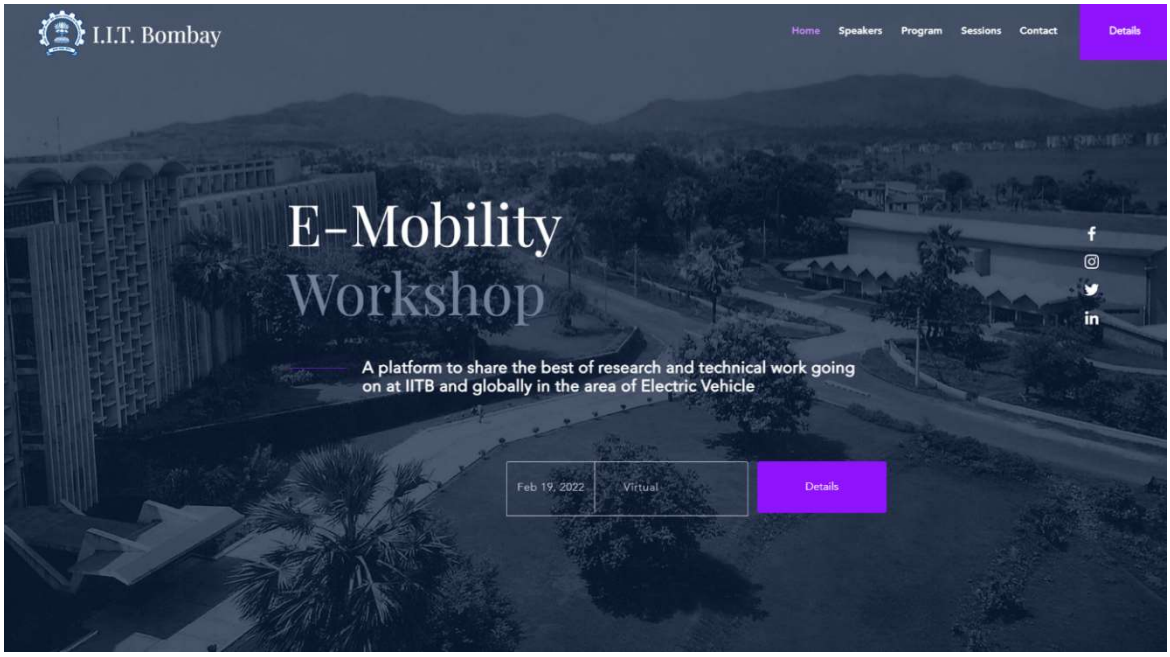
REPORT ON
Workshop on E-Mobility **AT IIT BOMBAY**
19TH FEB 2022

Indian Institute of Technology (IIT) Bombay hosted an all-day virtual workshop on e-Mobility on February 19, 2022. The workshop was the third in a series of annual workshops facilitated by the Industrial Research and Consultancy Centre (IRCC) at IIT Bombay. The first workshop in 2020 focused on Machine Intelligence and Data Science, while the second one in 2021 was centred around Sensors.

The topic for this year's workshop was in the core area of Electrical Vehicles, a subject of significant emerging interest. The workshop covered a wide range of topics, including advancements in Power Drive Train, Smart Charging Infrastructure, Sustainable Battery Technology, Hydrogen-based Mobility, Environmental Impact, E-Transportation Planning, New Vehicle Design and Mechanics.



The workshop included three plenary speakers, two keynote talks, a discussion with four panellists, and about 30 technical speakers.

The plenary speakers at the event were:

1. **Dr. Pawan Kumar Goenka**, Chairperson designate for INSPACe, Dept. of Space, Government of India and Ex-MD & CEO, Mahindra and Mahindra Limited
2. **Mr. Bhavish Aggarwal**, an IIT Bombay alumnus (B.Tech, CSE, IIT Bombay, 2008) and Founder and CEO, OLA
3. **Mr. Sunjay Kapur**, Chairman at Sona Comstar, President, ACMA and Co-Chairman, CII Manufacturing Council

The technical keynote was delivered by:

1. **Prof. Mahesh Krishnamurthy**, Professor of ECE & Academic Director of the Ed Kaplan Family Institute for Innovation and Tech Entrepreneurship, Illinois Tech (iit.edu)
2. **Prof. Raghu Murtugudde**, Research Professor, UMD and Visiting Professor at IIT Bombay

Panelists at the event included:

1. **Dr. Anuradda Ganesh**, Adjunct Professor at IIT Bombay and Chief Technical Advisor and Director, Cummins
2. **Dr. Jiten Apte**, CEO and co-Founder, igrenEnergi Inc. and igrenEnergi Services Pvt. Ltd.
3. **Mr. Nishant Arya**, Vice Chairman, JBM Group
4. **Mr. Asheesh Joshi**, Director (E), Ministry of Petroleum and Natural Gas (MoPNG)

Prof. Milind Atrey delivered the workshop's opening remarks, Dean - R&D, IIT Bombay, and Prof. Subhasis Chaudhuri, Director, IIT Bombay, gave the welcome address. The workshop was concluded with key takeaways and remarks by Prof. A. M. Pradeep, Associate Dean R&D, IIT Bombay. The overall coordination of the workshop was carried out by Prof. Sandeep Anand, with significant support from Prof. Nishant Sharma, Prof. Amartya Mukhopadhyay, and Prof. Arnab Dutta of IIT Bombay.

Total registration for the event was about 1800, out of which the event had an e-footfall of about 1380, with participation from various stakeholders, including OEMs, vehicle manufacturers, policymakers, testing agencies, entrepreneurs, students, faculty members and alumni of IITB.

Details of each session of the workshop are given below:

Inaugural Session

The session started with the inauguration address by Prof. Milind Atrey, Indian Institute of Technology Bombay (IITB), India. He talked about the broad aspects covered in the workshop, including environmental impacts and planning, advancements in power drive trains, sustainable battery technology, intelligent charging infrastructures, hydrogen-based mobility, new vehicle design and manufacturing, and a panel discussion plenary session. Next, the welcome address was given by Prof. Subhasis Chaudhuri, Director, IITB, who welcomed all guest and participants to the workshop. He emphasized that IITB has been working very hard to bridge the current gap between academia and industry. He talked about creating a synergistic relationship between industry and other

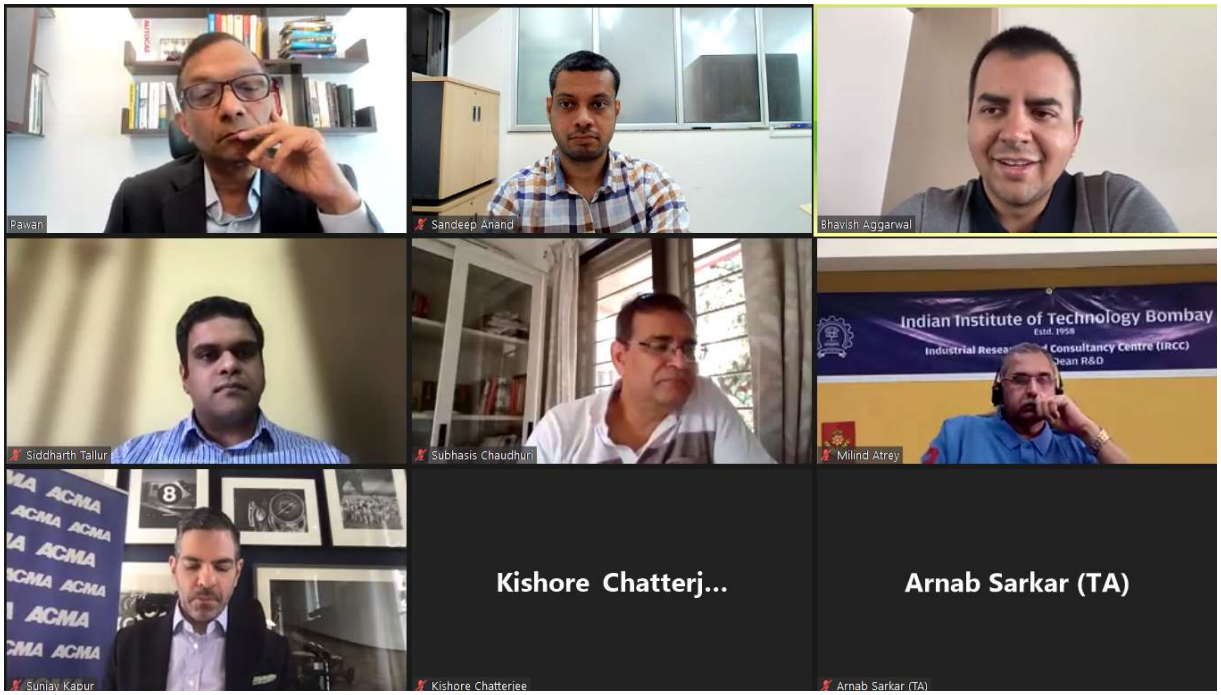
researchers so that a complete and open system is formed, which can benefit India as a whole.

The first plenary speaker was Dr. Pawan Goenka, the Chairperson designate for INSPACe - Dept of Space, Government of India and Ex-MD & CEO, Mahindra and Mahindra Limited. Dr. Goenka spoke about the recent technological disruption in the mobility industry. He talked about the four alphabets, ACES, which capture the change in the industry. These alphabets stand for autonomous, connected, electric, and shared. The importance of the accessibility of mobility and safety in the Indian context was emphasized regarding the shared car movement. Further, he mentioned that the IITB e-mobility centre should lead the connected car movement in India. He said, “We have to look at how does the technology that we are putting into these mobility centres make a difference and add to the technical know-how and innovations that go into our vehicles.” Moreover, he posed a critical question on what is needed to be done by researchers to make electric vehicles mainstream in India. If Indian innovators are able to come up with a battery chemistry that is dependent on material easily available in India, rather than imported materials, then India can really make a big stride in terms of what it can do with electric vehicles. Further, he said, “the industry also has to play a key role in the success of the mobility centre,” and implored Ola to lead the way of this consortium that will help the mobility centre to bring in other OEMs on the table and direct the research activity and provide the outlet for the research to be used.

The next plenary speaker was Mr. Bhavish Aggarwal, Founder and CEO at Ola, India’s largest mobility platform. His session was in fireside chat format, with Prof. Siddharth Tallur as moderator. He started by sharing his personal journey at Ola. He talked about how he started the company in 2011 and then scaled up the company with the help of venture capitalists. From 2016 to 2019, there was a very aggressive growth in the ride-hailing industry in India, and Ola grew from 4-5 cities to almost 200 cities. In 2017, Ola set up a sister company Ola Electric, which focuses on electrifying mobility for the future. He said, “Tesla kind of companies are building electric vehicles for the west; our ambition with Ola electric is to build electric vehicles for the rest.” This is because the majority of the world uses urban mobility vehicles such as two-wheelers, three-wheelers, and mid-size four-wheelers. Hence, for electrifying mobility in a global sense, there is a need for electrifying urban mobility. In the end, he enthusiastically agreed to explore contributing to the industry-academia consortium for the e-mobility centre at IITB.

The third plenary speaker was Mr. Sunjay Kapur, Chairman at Sona Comstar and President at Automotive Component Manufacturers Association (ACMA), India. Prof. A. M. Pradeep was the moderator was this talk. He said that ACMA would be glad to partner with IIT Bombay for the e-mobility centre of excellence and support it with the required industry connect. He hoped this centre would become a hallmark for industry

and academia collaboration. Further, he spoke about the current market trends in the global electric vehicle industry. He talked about the slew of policy incentives by the Government of India that has been instrumental in adopting electric vehicles and resulted in bolstering the confidence of industry and consumers. Lastly, he also acknowledged the emergence of start-ups in the electric vehicle industry.



Panel Discussion on Challenges and Opportunities for EV in India

This workshop session was joined by eminent personnel from academia and industries. The topic of the discussion was the present and future EV deployment scenario in India and relevant implementation challenges.

Mr. Ashees Joshi (Director (E), Ministry of Petroleum and Natural Gas) started the discussion in this session. He mentioned several schemes launched by the Indian Government, such as the FAME scheme to promote the usage of EVs. Mr. Joshi also said that the ambitious project of carbon footprint reduction might also boost EV penetration. He also expressed that the vehicle market would not be dominated by only EVs probably till 2030; rather, it will be a mix of EV, hydrogen, and fossil fuel-based cars. Further, he pointed out that the policy to further promote EVs in India needs to be different from western countries, where the majority of the vehicles are four-wheelers.

In the following discussion, Prof. Anuradda Ganesh (Chief Technical Advisor and Director, Cummins, Adjunct Professor, IIT Bombay) talked about a few challenges which could be significant hurdles for EV integration. She mentioned that significant charging infrastructure needs to be built, particularly for long-haul electric trucks. In this

context, Prof. Ganesh discussed that the battery swapping technique could be a potential solution for long-haul electric trucks. Further, she also mentioned that we should continuously improve EVs' performance, safety, and standardization.

The next talk was delivered by Mr. Nisant Arya (Vice Chairman, JBM Automobiles). He pointed out that this field is developing. Therefore, there is an immense scope of learning, unlearning, and relearning. He also discussed that competition and collaboration are needed to create a knowledge pool. In this direction, he emphasized the importance of start-ups in this area. He pointed out that start-ups can improve the agility of the existing techniques, while good collaboration with the start-ups can lead to successful implementation. While answering why PV deployment in India was not up to the mark as expected and the possibility of a similar thing for EV, Mr. Arya pointed out that the structured approach regarding EV deployment is already in place, which was not the case for PV. He points out that the main driving force behind the success of the EV is its application in several sectors.

Dr. Jiten Apte delivered the concluding talk in this session. He pointed out one of the significant challenges in EV industries - "Kitna Deti Hai," which means there should be more return value for every penny spent. This is very well relevant to the EV and battery industries also. Therefore, he suggested ensuring more value addition in battery, the combination of power electronics and machine learning could be a potential solution. Further, Dr. Apte pointed out that start-ups can significantly help develop efficient software for battery management systems.

Session on Environmental Impact and Planning

This virtual IITB E-Mobility workshop session had Prof. Subimal Ghosh as the session chair. The session started with the keynote speaker Prof. Raghu Murtugudde discussing the impact of pollution and aerosols on the climate. As a result of the increase in pollution, the Indian summer monsoon is weakening. However, aerosol interaction with cloud microphysics increases extreme rainfall events. Pollutants like PM2.5 causes various health impacts like respiratory tract diseases and diabetes. The transport sector is India's third major CO2 emitter among various energy sectors. The modal shift also plays a vital role in getting India's transport emissions to zero. EV shifting and public transport electrification are some ways of modal shifting. However, using EVs only will not help if we do not have clean energy sources. Pollution from transport will remain high, as the significant contributors, e.g. heavy trucks and buses will be electrified at the end.

Next, Prof. Anil Dikshit discussed the environmental impacts of urban mobility modes in the Mumbai metropolitan region. Assessment of the environmental performance of the current public transport system is remarkably significant. It is essential to consider the

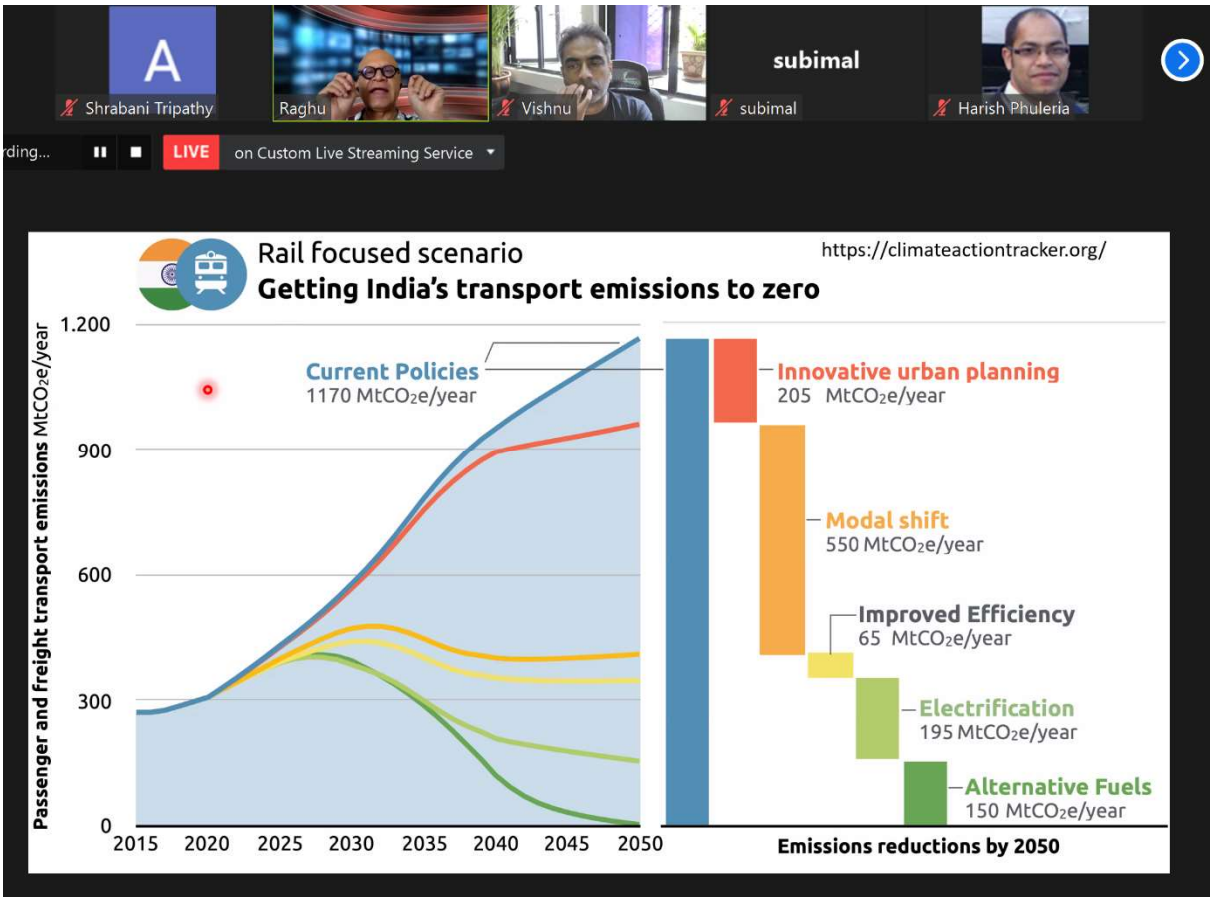
impact of construction, maintenance, and operation to understand the system entirely. Life cycle assessment is an ideal tool to assess the main drivers of environmental impacts. In terms of environmental impacts, suburban railways dominate due to the use of fossil fuels in electricity generation. This can be mitigated by replacing the usage of fossil fuels for electricity generation with renewable and green energy. Vehicle operation is identified as the most crucial phase of public road transport's life cycle environmental impact. Tailpipe emissions are significant and should be given utmost significance while considering the environmental impact of the transport sector.

The next speaker, Prof. Yogendra Shastri, talked about the need, current status and challenges of the environmental impacts of transport options. He mentioned that road transport contributes to 73-80% of the total GHG emissions and needs to transition to the necessary sustainable and green transport options. There are several green and sustainable options: electric, biofuels, CBG, fuel cell, and hybrid. Electrical transition makes EVs attractive as it reduces local pollution. Apart from fuel, other components like the lithium-ion battery, car body, power electronics, and electric motor are also critical for assessing the environmental impacts of EVs. Infrastructure development, battery production, use and disposal still needs to be explored.

Based on various studies, Prof. Harish Phuleria discussed the importance of estimating current and future exhaust emissions. Air pollution was responsible for nearly 5 million deaths in 2017 due to various decease like pulmonary deceases, diabetes, heart disease, lung cancer, and stroke deaths. Private passenger vehicles majorly contribute to gaseous and particulate emissions from vehicles. Vehicular emissions will reduce by 50% by 2030 if 30% of ICE vehicles are replaced with EVs.

Finally, Prof. Prabhir Vishnu Poruthiyil discussed the importance of electrification of age-friendly vehicles. The elderly population in India is proliferating compared to the total population growth. Age-friendly design of cities is the need of the hour for efficient usage of the infrastructure and ease of the people. Transportation is an essential aspect of age-friendly cities. Well-connected transport routes in-between the cities as well as with nearby cities are also required. The vehicle should be made accessible, clean and well maintained.

In the end, Prof. Subimal Ghosh concluded the discussion by summarizing all the talks. The Q&A sessions were quite interactive.



Session on Advancements in Power Drive Train

In this session, various speakers from industry and academia discussed the advancements in power drive trains in the context of electric vehicles. The session was chaired by Prof. Kishore Chatterjee from the Indian Institute of Technology Bombay (IITB), India. In addition to the presentations by the speakers, there were interactive question-answer sessions with the audience.

The first speaker, Prof. Mahesh Krishnamurthy from Illinois Institute of Technology, Chicago, USA, spoke about the energy and transportation research there. In addition to performing research on vehicle design, electric motors, and reliability of energy storage systems, the team also competes in the Formula SAE race car competition. Further, he shared some interesting statistics that showed a tremendous change and highly accelerated electrification rate in the automotive industry. He talked about the targets set by the United States Department of Energy to accelerate the adoption of electric drive technologies. These targets comprise of reduction of the system-level costs, increase of power density, and doubling of the component life. Technological innovations are needed in core lamination materials, permanent magnets, winding systems, insulations systems, cooling systems, and sensors for achieving the above

targets. A system-level understanding of the target application is critical to optimize each of these sub-systems. Machine learning algorithms and data mining of various drive cycles can also be used for effective machine design and increased efficiency.

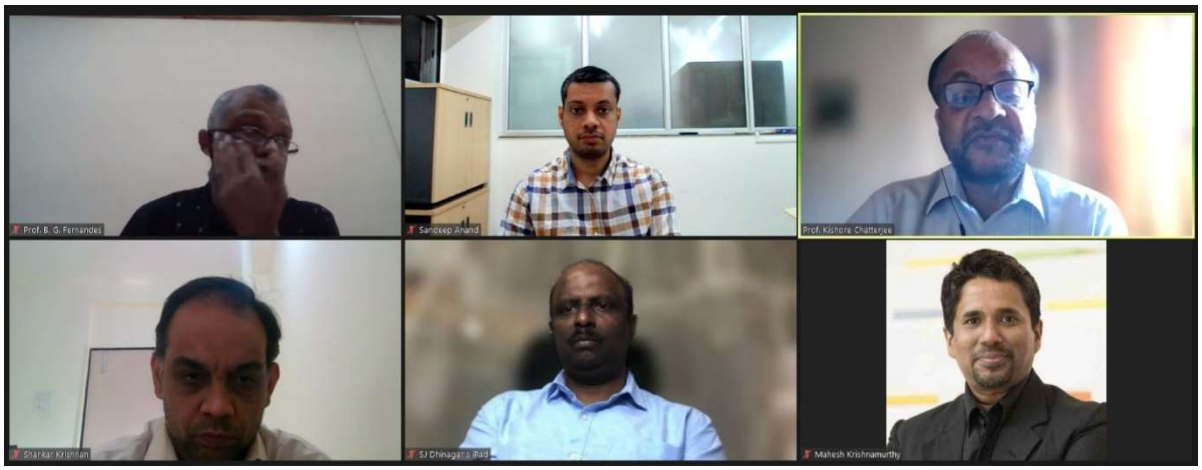
The next speaker, Dr. S. J. Dhinagar from the TVS Motor Company, India, talked about India's two and three-wheeler vehicle industry. About 528 and 130 start-up companies in India make two and three-wheeler vehicles, respectively. The fuel-efficient two and three-wheeler vehicles typically use 7 – 8 kW rated motors and 200 – 220 cc engines. Most of the powertrain comes from China, and the companies assemble them as per demand. The vehicle's design is driven by two constraints – high-speed requirement and gradeability requirement. Cost, packaging, and thermal management are critical challenges in addition to the above constraints. The design has to be tailormade so that the manufacturing process becomes efficient.

In the following presentation, Prof. B. G. Fernandes from IITB, India, shared that work has been going on in IITB in electric motors for more than two and half decades. At present, PM-assisted synchronous reluctance motors, surface-mounted PM synchronous motors, and integrated motor magnetic gear for in-wheel application are the main focuses of research. For facilitating fast-charging stations for electric vehicles, solid-state transformers and dual and quad active bridge converters are being developed using wide-bandgap devices. Combinations of different kinds of magnetic materials are being used to develop cost-effective and power-dense motors.

Prof. Shankar Krishnan from IITB, India, talked about the thermal management technologies for electrified power drive trains. In the case of power semiconductor devices used in electric vehicles, the junction temperature and the junction temperature swing must be kept under a limit. He talked about the influence of thermal capacitance of several cooling solutions, such as air cooling and liquid cooling, on the junction temperature and its relation with the expected life of the power semiconductor module.

Prof. Swaroop Ganguly from IITB, India, talked about the wide-bandgap power devices research in the IITB nanofabrication facility. The facility includes material growth, device fabrication, and device testing infrastructures. A significant amount of incubation has taken place in the facility, including agricultural sensors, explosive detectors, semiconductor chips for encryption, and artificial intelligence.

The session was concluded with the presentation of Prof. Sandeep Anand from IITB, India, where he talked about the requirements of the engine of an electric vehicle. High efficiency, compactness, reliability, and safety are some of the critical requirements. He also talked about the challenges of wide-bandgap devices which are to be used in electric vehicles to achieve the above requirements.



Session on Sustainable Battery Technology

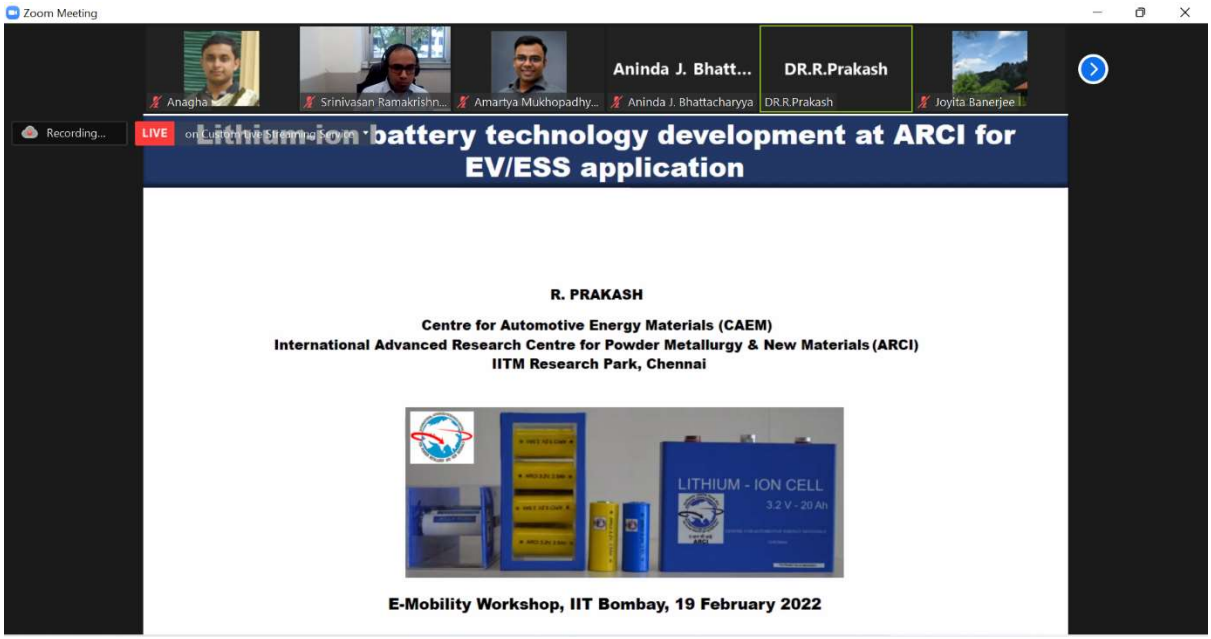
This session started with a lecture by Prof. Aninda J Bhattacharyya from IISc Bengaluru. Various strategies for developing efficient metal-sulfur batteries were discussed in the context of the main problems associated with this chemistry. These include the insulating nature of sulfur, volume expansion of cathode, and anode poisoning. Different methods were pointed out, including selecting a suitable sulfur host, which can provide effective sulfur confinement and effectively manage polysulphide shuttling. Such a structure should also be able to contain the enormous volume expansion of sulfur cathode. Another way is an alternate Li-S configuration with an interlayer (NiOH/NiO interlayer), which can arrest the shuttle effect. Li-S battery with Li2S cathode and Li-free anode, where Li2S is already in the expanded state, can solve the issue of volume expansion, which requires suitable activation.

The progress regarding Li-ion battery development at ARCI for EV/ESS applications was discussed in the following talk by Dr. R Prakash from ARCI Chennai. Different stages of electrode fabrication (viz., slurry preparation, coating and drying, slitting) and cell fabrication (viz., winding and ultrasonic welding) were explained.

Next, Prof. Bharatkumar Suthar from IIT Bombay discussed the Impedance-based characterisation of Li-ion batteries and the classification of internal resistance of Li-ion batteries. It was elucidated that all the resistances can be combined into a couple of resistances depending on the purpose, i.e., it can be done for quick screening and preliminary level control or application. However, it is not a good idea to determine the capacity to fade or design a battery. The different ways to characterise the internal resistance of a battery system (step test, pulse test and oscillating signal test) was also discussed. The impedance-based characterisation was discussed in detail with an example of porous electrode impedance spectra; the methodology to deconvolute Rion and Rct was also explained.

Prof. Srinivasan Ramakrishnan from IIT Bombay discussed electrochemistry and interfacial engineering for safe and long cycle life batteries. This is significant since the life cycle and safety depend greatly on interfacial degradation. Since cathode limits the energy density of a Li-ion cell, the two common strategies to improve the energy density associated with Li-NMC include rendering it Ni-rich and Li-rich. As the amount of Li/Ni increases, the cathode specific capacity increases, but at the cost of increasing the thermal and interfacial instabilities. CO2 and O2 evolutions are manifestations of interfacial degradation, which can be studied via in-situ gas analysis with DEMS to obtain quantitative information on the evolving gas. Ex-situ titration is another methodology to study gas evolution. Interfacial passivation can be done to prevent such evolutions and instabilities, improving performance.

Finally, Prof. Venkatasailanathan Ramadesigan from IIT Bombay presented an overview of the PHEVs, charging infrastructure, and available charging methods. Different aspects of an EVs' battery management systems (BMS), like reliability, accuracy, manufacturability, cost, and power, were discussed. The functions and objectives of BMS were explained in detail. Since there is no way to measure the state-of-charge (SOC) and state-of-health (SOH), different models (empirical, single particle, P2D model) have to be used, which are physics-based and are valid across a wide range of operating conditions.



Session on Smart Charging Infrastructure

In this session, experts from academia and industry presented their perspectives on various issues related to Smart Charging Infrastructure. The session commenced with Prof. Pablo Frias's (IIT Comillas, Spain) presentation on European policies and

regulations for smart EV charging. Prof. Frias highlighted various challenges of smart charging facilities with particular reference to EU. One of the main problems is the lack of coordination between stakeholders such as generators, retailers, EV owners and distribution system operators (DSOs). Some “smart” features are still in the conceptual stage.

The following presentation was by an industry expert, Mr. Sandeep Bangia (EV Head, Tata Power). Mr. Bangia felt that the loading on the grid is not expected to be a big challenge in the near future, and conventional electrical power systems can accommodate large-scale charging infrastructure. Mr. Bangia presented various charging infrastructure opportunities, mainly in hardware, software, and electrical distribution systems. Usage of the second life of the battery and subsequent recycling was also discussed. Some practical issues on charging infrastructure locations were brought out. For example, although the charging points can be set up near an electrical substation (quite convenient for the DSO), it can be intimidating for customers to see massive substation transformers and switchgear. Public locations where the vehicles (2 wheelers, three-wheelers, and four-wheelers) are on standby, like parking lots, residential apartments, malls, and food malls, would thus be more suitable for a consumer perspective.

The next talk was delivered by Prof. Prashant Navalkar (Department of Electrical Engineering, IITB) on location and opportunities in EV charging stations. Various simulation and modelling aspects for accommodating charging infrastructure in electrical power systems were discussed. Stochastic models of generators and load mix to study V2G (vehicle to grid) effects in the power system were presented. Determination of the strategic locations of the EV charging infrastructure could be formulated as an optimization problem.

Prof. Zakir Rather from the Department of Energy Science Engineering, IIT Bombay, delivered the next session on “Smart Charging of Electric Vehicles in the Indian EV Ecosystem”. Various roadmaps and policies for promoting EV technology by the Government of India were presented. Classifications and requirements of the smart charging infrastructure were presented. Time-based EV tariffs are implemented in certain countries, similar to the time of the day metering.

The concluding session was delivered by Prof. Ashutosh Gupta (Department of Computer Science Engineering, IITB), on “EV charging networks: a critical infrastructure of the future.” Prof. Gupta shared his personal experience with using charging infrastructure in Mumbai. The software platform is a critical component in the charging infrastructure.

Prof. Gupta emphasized that the software UI/UX and customer experience should be thoroughly tested and evaluated apart from the hardware infrastructure. The questions and answers session following these presentations was lively and enriching. The overall feeling was that the widespread adoption of EVs would bring in new challenges, creating new opportunities for better utilization of energy resources and power system infrastructure.

Session on Hydrogen Based Mobility

In this session, there was an enriching, interactive, and extended discussion on the design, manufacturing process, and existing challenges in developing hydrogen as a fuel device.

The session started with Prof. P.C. Ghosh, IIT Bombay, wherein he discussed the Fuel Cell and PEM Fuel cell, which is considered an alternative to battery-based electric vehicles. Further, he explained the costs arising from different components, which are the main hurdles to commercialization. The session was concluded with information on developing a prototype vehicle designed in his lab. Prof. Abhishek Dey, IACS Kolkata, presented the next session. Here, he discussed the Practical Aspects of Water splitting Catalysis. He further focused on the Pathway to Design the oxygen tolerant noble/non-noble metal catalysts for Water splitting for a parallel and viable route for H2 production. The session included a video showing a Hydrogen production demo from a bio-inspired catalytic design performed in his lab. Remarks on the Selectivity, Sustainability and scalability of the catalysts for large deployment were also discussed.

The next session was delivered by Dr. Snehangshu Patra, founder & director of Eliteck India Pvt. Ltd. India. In his talk, he discussed the development of efficient electrodes/devices for H2 production systems that are ready to hit the market with an efficiency close to 100%, providing 1 kg of H2 at the expense of 40kWh and designing H2 vending machines which can be applied to inhale/cook at home as well as can perform gas cutting/high temp welding at the industry. In his concluding remarks, he proposed a new project on using on-demand H2 to enhance mileage and lower the pollution of existing IC engines by utilizing the perfect combustion properties of H2.

Prof. Pratibha Sharma, IIT Bombay, delivered the next session. She presented extensive results observed in her lab on the Storage of Hydrogen on a large scale via Hydrides, Hollow glass microspheres and High entropy alloys based systems and their mechanism. Further, she added the details on performing DFT studies to Model Materials for Hydrogen storage and then selecting the materials, tune their performance for industrial-scale usage.

The Question-and-Answer sessions were very interactive. The entire session helped everyone understand the basics to in-depth knowledge of designing catalysts and devices for Hydrogen production and its storage. The challenges exist in the individual branch and the scope of work that can be done for the commercialization.

Session on New Vehicle Design and Manufacturing

In this session, various views and processes of Design and Manufacturing were presented and discussed. Six presentations followed, and interesting questions and doubts were discussed.

The session started with Prof. Shreedhara Sheshadri from IIT Bombay delivering an opening speech addressing the speakers and participants. He introduced Prof Selby Coxon from Monash University as the session's first speaker. Prof Selby started with an interesting slide - a picture taken in Melbourne showing an abandoned petrol pump. He asked if that is a sign of changing times and if EVs are taking over fossil fuel vehicles. He spoke about his role at Monash University as the Director of Research and Mobility Design. Discussion about Volgren E-Buses. Portable chargers were taken up as an example of technology that will be primarily affected in the future. Prof. Stewart Birrell of Coventry University delivered the following talk on user experience and interface design for future mobility. He talked about the future of the human-machine interface in the next one or two years, including factors like in-car augmented navigation, enhanced passenger info and the connected nature of cars. He also discussed the future of rail transport and interesting factors like Smart Ticketing and Dynamic Reservation.

The next talk was delivered by Prof. Prashant P. Date from IIT Bombay. He talked about the Manufacturing of Lightweight Structures for EVs. He then discussed the strategies of weight reduction in IC engine vehicles and EVs, which showed possibilities of more significant measures in EVs vs IC engine vehicles in coming years. He also talked about details of weight reductions possible by using multi-materials. Prof. V. Kartik delivered the following talk on challenges in the design of public transit vehicles. He talked about barriers to adopting EVs like Range anxiety, Finances, Grid issues, Recycling, and Govt aims for strategic autonomy. We also saw some torque vs speed and power vs speed characteristics. We also heard about Rotary Engines as Range Extenders, with high reliability and power to weight ratio.

Prof. Sugandh Malhotra delivered the following talk from IIT Bombay. He talked about the type of projects done at IDC- Practical problem solving and vision-based projects. We saw slides about the double diamond process of the design journey. He talked about the expectations in future vs what we have today. We also saw a graph about 100 great products in the last millennia as product genre vs time.

Finally, Prof. Nishant Sharma from IIT Bombay delivered the conclusive talk. He talked on the topic of E Rickshaw-The present of the future. He talked about a project that he undertook on a manual rickshaw for disabled people. He talked about the part of e-rickshaws in contributing to the present EV market in India. Also, he talked about the socio-economic, environmental benefits of E-rickshaws and encouraging government policies.

The questions and answers session was quite interesting, with questions like a debate about IC engines and EVs, and the future of ticketing and automatic check-ins using unique identification cards.

List of Speakers:

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2. Mr. Bhavish Aggarwal, Founder and CEO at OLA
3. Mr. SunjayKapur, Chairman at Sona Comstar || President at ACMA || Co-Chairman at CII Manufacturing Council
4. Prof. Mahesh Krishnamurthy, Professor of ECE & Academic Director of the Ed Kaplan Family Institute for Innovation and Tech Entrepreneurship, Illinois Tech
5. Prof. Raghu Murtugudde, Research Professor, UMD and Visiting Professor IITB
6. Mr. Nishant Arya, Vice Chairman, JBM Group
7. Dr. Anuradda Ganesh, Chief Technical Advisor and Director, Cummins
8. Mr. Asheesh Joshi, Director (E), Ministry of Petroleum and Natural Gas (MoPNG)
9. Dr. JitenApte, CEO, co-Founder, igrenEnergi, Inc and igrenEnergi Services Pvt.
10. Prof. Anil Dikshit, Environmental Science and Engineering, IITB
11. Prof. Yogendra Shastri, Department of Chemical Engineering, IITB
12. Prof. Harish C. Phuleria, Environmental Science and Engineering, IITB
13. Prof. Prabhir Vishnu Poruthiyil, Centre for Policy Studies, IITB
14. Mr. S. J. Dhinagar, Vice President, TVS Motors
15. Prof. B. G. Fernandes, Dept. of Electrical Engineering, IITB
16. Prof. Shankar Krishnan, Dept. of Mechanical Engineering, IITB
17. Prof. Swaroop Ganguly, Dept. of Electrical Engineering, IITB
18. Prof. S. Anand, Dept. of Electrical Engineering, IITB
19. Prof. Aninda J Bhattacharyya, IISC
20. Dr. R. Prakash, ARCI, Chennai
21. Prof. Bharat Suthar, Dept. of Chemical Engineering, IITB
22. Prof. Srinivasan Ramakrishnan, Dept. of Chemistry, IITB
23. Prof. Venkat Ramadesigan, Dept. of Energy Science and Engineering, IITB
24. Prof. Pablo Frías, IIT Comillas, Spain
25. Mr. Sandeep Bangia, Tata Power
26. Dr. Prashant Navalkar, Dept. of Electrical Engineering, IITB
27. Prof. Zakir Rather, Dept. of Energy Science and Engineering, IITB
28. Prof. Ashutosh Gupta, Dept. of Computer Science and Engineering, IITB
29. Prof. Abhishek Dey, IACS
30. Dr. Snehangshu Patra, Eliteck
31. Prof. Pratibha Sharma, Dept. of Energy Science and Engineering, IITB
32. Prof. Prakash C. Ghosh, Dept. of Energy Science and Engineering, IITB
33. Prof. Selby Coxon, Monash University, Australia
34. Prof. Stewart Birrell, Coventry) University, UK
35. Prof. V. Kartik, Dept, of Mechanical Engineering, IITB
36. Prof. Sugandh Malhotra, IDC School of Design, IITB
37. Prof. P. P. Date, Dept. of Mechanical Engineering, IITB
38. Prof. Nishant Sharma, IDC School of Design, IITB