NITI Aayog

MOVE

GLOBAL MOBILITY SUMMIT
SEPTEMBER 7 & 8, 2018

Conference on RESEARCH AND DEVELOPMENT IN ELECTRIC VEHICLE TECHNOLOGIES

September 1, 2018, Saturday
IIT Delhi

BACKGROUND

India will see a rapid surge in population and its urban population is expected to double in the next decade. There would be more people in Indian cities living, working and travelling. This rapid growth is expected to pose many social, economic, and environmental challenges. These challenges could be turned into opportunities by building new industries that can create employment, strengthen energy security and clean the air. The recent global trend in transport sector creates a new opportunity for India to leverage its young population by creating new jobs in mobility sector, developing new technologies and being leader in electric vehicle and battery manufacturing. Electric vehicle component manufacturing can help this ambitious and capable country to achieve these important economic, social and environmental objectives.

With this objective, NITI Aayog is organizing the 'Global Mobility Summit' from 7th-8th September, 2018. While the summit will holistically cover different aspects of mobility for developing a clean, shared and connected; and affordable, accessible and inclusive transport system, a conference with the focus on Research and Development in Electric Mobility Technologies is being organized at IIT Delhi on 1st September as a precursor to the "Global Mobility Summit'. The conference on "Research and Development in Electric Vehicle Technologies" is aimed at bringing together Government bodies, Academia, Start-ups, Incubators, and Industries working on R&D in the electric mobility sector. The focus of the conference would be take stock the various initiatives undertaken by the different stakeholders and chalk out definite pathways for targeted and well-coordinated Research and Development in the field of Electric Mobility such that challenges in the electric mobility sector could be turned into a win-win opportunity by making India a leader in technology and product development. Various participants will bring together a plethora of knowledge and past experiences, which could act as a base for identifying technologies and areas for future investment, to achieve focused research outcomes.

AGENDA

Conference on Research and Development in Electric Vehicle Technologies, September 1st 2018 (Venue: Seminar Hall, Senate Hall at IIT, Delhi)

9:00 - 10:00 Hrs : Registration

10:00 – 10:45 Hrs : Opening Session (Venue: Seminar Hall)

10:00-10:05 Hrs : Welcome Remarks - Dr. V. Ramgopal Rao, Director, IIT Dellhi

10:05-10:10 Hrs : Address -Shri Amitabh Kant, CEO, NITI Aayog

10:10-10:25 Hrs : Address - Prof Ashok Jhunjhunwala, Professor, IIT Madras

10:25-10:30 Hrs : Address - Dr. K. Vijayraghavan, Principal Scientific Adviser to Government of India

10:30-10:35 Hrs : Address - Dr. V. K. Saraswat, Member, NITI Aayog

10:35-10:45 Hrs : Keynote Address - Dr. Rajiv Kumar, Vice Chairman, NITI Aayog

(Break for Tea and Coffee at 10:45 – 11:00 Hrs)

11:00-13:45 Hrs Thematic Parallel Sessions

(Venue: Seminar Hall/Senate Hall)

- Session 1: Drive-train, Chargers and Regenerative Braking for EVs
- Session 2: Li-Ion Battery technology for EVs: Packs and Cells

13:45-14:30 Hrs - Lunch Break

14:30-16:45 Hrs Thematic Parallel Sessions

(Venue: Seminar Hall/ Senate Hall)

- Session 3: Recycling and Materials for Li-Ion batteries and vehicles
- Session 4: Alternate fuel sources and Control of EVs

(Break for Tea and Coffee at 16:45 - 17:00 Hrs)

17:00-18:00 Hrs - Concluding session (Venue: Seminar Hall)

17:05-17:10 Hrs - Address - Shri Arghya Sardar, Scientist E, TIFAC

17:10-17:20 Hrs - Address - Shri Praveer Sinha, MD, Tata Power

17:20-17:40 Hrs - Takeaways from Sessions – Shri Seethapathy Chander/Prof Ashok Jhunjhunwala/Shri Anil Srivastava

17:40-17:50 Hrs - Valedictory - Dr. K. Vijay Raghavan, Principal Scientific Adviser to Government of India

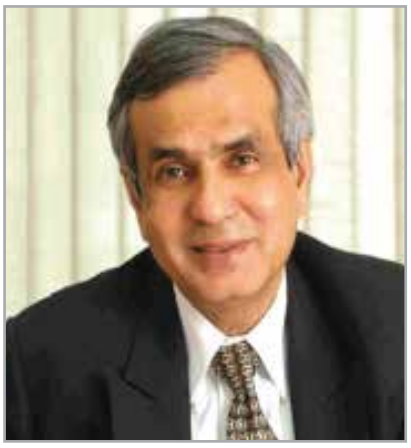
17:50-18:00 Hrs - Conclusion and Vote of Thanks Shri Anil Srivastava, Advisor, Infrastructure Connectivity and DG DMEO, NITI Aayog

THEMATIC SESSIONS
List of speakers/ Panelist

Thematic Sessions	Name & Organisation
Session 1: Drive-train, Chargers And Regenerative Braking for Evs	**Moderator: Ashok Jhunjhunwala, Professor, IIT Madras**
Talk	BG Fernandes, IITB, bgf@ee.iitb.ac.in
Talk	Siva Kumar, IITH, ksiva@iith.ac.in
Talk	Prof. Amit Kumar Jain, IITD, amitjain@ee.iitd.ac.in
Panel	Anil Aggarwal, Compage Automation anil@compageautomation.com
Panel	PS Roy - Drivz info@drivz.in
Panel	NS Ramanathan, TVS Lucas, nsramanathan@lucastvs.co.in
Panel	K. Balasubramanian, NFTDC, director@nftdc.res.in
Session 2: Li-Ion Battery Technology for EVs: Packs and Cells	**Moderator: Seetapathy Chander Advisor, World Energy Council – India**
Talk	Dr. Sankar Dasgupta, CEO, Electrovaya sdasgupta@electrovaya.com
Talk	Sagar Mitra, IIT Bombay, sagar.mitra@iitb.ac.in
Talk	Prabhjot Kaur, CBEEV, IITM, prabhjot@tenet.res.in
Talk	Vijayamohanan K Pillai, CEECRI, director@cecri.res.in
Panel	Mohan Thyagarajan, Exide, MohanT@exide.co.in
Panel	Nikhilesh Mishra, Grinntech, nikhilesh@tenet.res.in
Panel	Anant Misra, Greenfuel Energy, anant.misra@greenfuelenergy.in
Panel	Niranjan C, Amar Raja niran@amararaja.co.in
Panel	T D Mercy, Vikram Sarabhai Space Centre, ISRO td_mercy@vssc.gov.in

Thematic Sessions	Name & Organisation
Session 3: Recycling of Materials for Li-Ion Batteries and Materials for Light-weighting Vehicle for EVs	**Moderator: Clay Stranger, Principal India Office of the Chief Scientist, Rocky Mountain Institute**
Talk	Raghuram Chetty, IITM, raghuc@iitm.ac.in
Talk	Ramesh Chandra, IIT Roorkee ramesfic@iitr.ac.in ; ramesfic@gmail.com
Talk	Nitin Gupta, Attero, nitin@attero.in
Panel	Sundaravan SA, Ashok Leyland Sundaresan.SA@ashokleyland.com
Panel	Sreeja Kumar Nair, Mahindra Electric NAIR.SREEJAKUMAR2@MahindraElectric.com
Panel	Anindya Deb, Indian Institute of Science adeb@iisc.ac.in
Session 4: Alternate Fuel Sources and Control of EM	**Moderator: Dr. K. Vijay Raghavan, Principal Scientific Adviser to GOI**
Talk	Prof Anil Verma, IIT Delhi, anilverma@iitd.ac.in
Talk	Prof S Mukhopadhyay, IIT KGP, smukh@ee.iitkgp.ac.in
Talk	Viswajit Joshi, KPIT
Talk	Dr. Aditi Halder, IIT Mandi, aditi@iitmandi.ac.in
Talk	R. Gopalan, ARCI, gopy@arci.res.in

EMINENT GUEST SPEAKERS
for OPENING AND CONCLUDING SESSIONS



Dr. Rajiv Kumar,
Vice Chairman, NITI Aayog

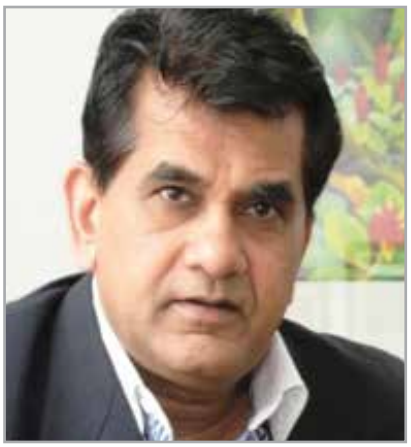
Dr. Rajiv Kumar is a leading Indian economist appointed as the Vice Chairman of NITI Aayog in September, 2017. He is the author of several books on India's economy and national security. His latest books are Modi & His Challenges (2016), Resurgent India: Ideas and Priorities (2015) and Exploding Aspirations: Unlocking India's Future (2014). He is a widely recognized economic columnist and a leading speaker on issues in Indian political economy. Presently, he is: (i) Founding Director of Pahle India Foundation (PIF), Delhi; (ii) Chancellor of the Gokhale Institute of Economics and Politics (A Deemed University, Pune), PIF, a non-profit think tank focuses on facilitating economic policy change based on objective and rigorous research. In the past he served as the Government of India nominee on the Boards of: (i) Economic Research Institute for ASEAN and Asia (ERIA) Jakarta; (ii) Central Board of the State Bank of India, Mumbai; (iii) Indian Institute of Foreign Trade, Delhi; (iv) Part Time Member, National Security Advisory Board (2006-2008); (v) Part Time Member Economics, TRAI, New Delhi (2007-2010)

Dr. V. K. Saraswat,
Member, NITI Aayog

Dr. VK Saraswat is an Indian scientist who formerly served as the Director General of the Defence Research and Development Organisation (DRDO) and the Chief Scientific Advisor to the Indian Minister of Defence. He is presently member of NITI Aayog. Mr. Saraswat is the key scientist in the development of the Prithvi missile and its induction in the Indian armed forces. He is a recipient of the Padma Shri and Padma Bhushan from the Government of India.

Dr. K. VijayRaghavan,
Principal Scientific Adviser to Government of India

Prof. K. VijayRaghavan is the Principal Scientific Adviser to the Government of India. Prof. Vijay Raghavan served as the Secretary of DBT from January 2013 till February 2018. In addition, he also held additional charge of Secretary, Department of Science & Technology (DST), Secretary, Council of Scientific & Industrial Research (CSIR), Secretary, Ministry of Earth Sciences (MoES) and Secretary, Department of Health Research (DHR) during his stint at New Delhi. He has been elected as Fellow of Royal Society and as a Foreign Associate of the US National Academy of Sciences. In addition, he is elected to major academies in India and abroad. Earlier, he has also been conferred with the Padma Shri (2013), H K Firodia Award (2012), Infosys Prize (2009), and many such accolades.



Shri Amitabh Kant,
CEO, NITI Aayog

Amitabh Kant is the CEO of NITI Aayog (National Institution for Transforming India). Until March, 2016 Mr. Kant was posted as Secretary, Department of Industrial Policy and Promotion (DIPP). He was responsible for formulation and implementation of industrial policy and strategies for industrial development, monitoring the industrial growth and performance of specific industrial sectors, formulation of foreign direct investment (FDI) policy and FDI promotion and facilitation. Related policies covered intellectual property rights relating to patents, trademarks, industrial design and geographical Indications. He was also responsible for promotion of productivity, quality and technical cooperation. He is the recipient of One Globe Award-2016 for leadership in Transforming Governance for the 21st Century. He is a Member of the Steering Board of “Shaping the Future of Production Systems” of the World Economic Forum.

Dr. V. Ramgopal Rao,
IIT Delhi

V. Ramgopal Rao is the director of the IIT Delhi. Ramgopal Rao has more than 430 publications in various journals, and 40 patents in the areas of Electron devices and Nanoelectronics. Mr. Rao was the first elected chairman for the Indian Section of the American Nano Society. He is also the recipient of multiple prizes including the Swarnajayanti Fellowship in 2004, Shanti Swarup Bhatnagar Prize in 2005, Infosys Prize in 2013, Techno-Mentor award from the Indian Semiconductor Association in 2009 and the IBM faculty award in 2007. He is a Fellow of IEEE, Fellow of the Indian National Academy of Engineering (INAE), Indian Academy of Sciences (IASc), National Academy of Sciences (NASI) and the Indian National Science Academy (INSA).

Arghya Sardar,
Scientist E, TIFAC

Arghya Sardar is a Scientist at the Technology Information Forecasting and Assessment Council (TIFAC), an autonomous body under the Department of Science and Technology, Government of India. He has been working in TIFAC since 1997. He is involved with technology foresight studies in the areas of automotive and transportation, electric and hybrid electric vehicles

Praveer Sinha, Managing Director, Tata Power Co Ltd

Mr. Praveer Sinha has been the Chief Executive Officer and Managing Director of Tata Power Co Ltd since May 1, 2018. He served as the Project Director of Eastern Region Projects of Tata Power Co. Ltd. since joining on September 5, 2007. Mr. Sinha served as Executive officer of Nagarjuna Power Corporation Ltd. He served as CPO of Power of Nagarjuna Fertilizers and Chemicals Limited, Lanco Infratech Limited. He served as Senior Project Manager of Jai Prakash Steel Ltd. He served as Chief Operating Officer of Nagarjuna Power Corporation Ltd. Mr. Sinha has total experience of 23 years in the fields of Marketing and Projects in the Steel and Power Sectors in reputed companies such as Crompton Greaves Ltd. and Jai Prakash Industries Ltd.

Ashok Jhunjhunwala, Professor, IIT Madras

Ashok Jhunjhunwala is the Professor in the Department of Electrical Engineering, IIT Madras. Dr. Jhunjhunwala is considered to be pioneer in nurturing Industry -Academia interaction in India towards R&D, Innovation and Product Development. He is the Chairman of Technology Advisory Group for Electric Mobility, He has been Chairman and member of various government committees and has been on Boards of several education institutions in the country. At the same time, he has been on the Boards of a number of public and private companies. Dr. Jhunjhunwala was conferred Padma Shri in 2002.

Seetapathy Chander,
Advisor, World Energy Council – India

Seethapathy Chander served as Special Senior Adviser of Infrastructure and Public-Private Partnerships at Asian Development Bank. Mr. Chander has also been involved in developing a corporate and strategic plan for India's largest power generator, NTPC. He has over 37 years of professional experience, 15 years at NTPC, India and over 22 years at the Asian Development Bank (ADB) in Manila, Philippines. At ADB, he led the financing of infrastructure in public and private sector operations in Afghanistan, Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Kazakhstan, Laos, the Maldives, Nepal, Sri Lanka and Uzbekistan.

Mr. Anil Srivastava,
Advisor, Infrastructure Connectivity and DG DMEO, NITI Aayog

Mr. Anil Srivastava belongs to Indian Administrative Service. Prior to the current assignment Mr. Anil Srivastava has held various senior level positions of responsibility including the Chairman & Managing Director, Pawan Hans Helicopters Ltd. for three years. With the State Government he has held the positions of Secretary to the Government of various departments including Finance, Revenue, New & Renewable Energy, Commerce & Industries etc. He has also worked as Commissioner of Treasuries, Commissioner of Industries & Commerce, Managing Director of various PSUs, District Magistrate and Municipal Administrator. He has also served on the Boards of various organisations. He has participated in a three weeks Executive Education Program for Senior Managers in Government at Harvard Kennedy School of Government, Harvard University U.S.A. in 2016. He is driving e- mobility initiatives of Government of India at NITI Aayog.

THEMATIC SESSIONS AND THE KEY SPEAKERS/PANELIST

SESSION 1: Drive-train, Chargers and Regenerative Braking for Electric Vehicles

Electrification of a vehicle's drive-train has necessitated optimization in design and performance of each of its components and sub-systems, to get the best performance out of the vehicle. The energy efficiency of the electric vehicle, measured in terms of Watt-hour per km (Wh/km), depends significantly on the efficiency of the drive-train. Higher the energy efficiency of the vehicle, lower is the consumption of battery energy resulting in a smaller size battery for a given range. Besides the drive-train, other factors impacting the efficiency of the vehicle are aerodynamics of the vehicle design, vehicle weight and quality of tyres. Apart from efficiency, the drive-train design also impacts driving satisfaction as it enables full torque availability at start and high pick-up. Key components of the drivetrain include:

Motor

This device is the primary driver of the vehicle, converting electrical energy from the batteries to motion. Some commonly used motors are AC Induction (ACIM), Brushless DC (BLDC), Permanent Magnet DC (PMDC), and Permanent Magnet Synchronous (PMAC), Switched Reluctance, Synchronous Reluctance and Permanent Magnet assisted synchronous reluctance.

There is tremendous scope for improvement in the motor-design, impacting energy-efficiency, peak power characteristics, thermal management and costs especially for high performance demands. Moreover, there is an increasing push to develop motors without using permanent magnets, which use heavy rare earth metals.

In India, there is and will be increasing demand for low-cost, higher performing motors across the spectrum ranging from smaller 250 W to 5 kW motors for 2-wheelers and 3-wheelers, medium sized (10 kW to 100 kW) for passenger vehicles, and larger (> 100 kW) for commercial vehicles. 2-wheelers and 3-wheelers use 48V, small cars use 48V and 72V, medium sized cars use 350V and buses use 750 Volts motors.

Motor-Controller

High performance electronics controllers are required to control the motor. The design of the controllers equally impacts the overall drive-train efficiency. They need to be compact, low-cost and should be also capable of dissipating heat, even when the motors are used in over-drive mode. Inverter systems which convert the chemical energy stored in the battery

Regenerative Braking

Electric Vehicle motors are also capable of acting as a generator during the act of braking and when the vehicle slows-down. It recovers the mechanical energy and converts it to electricity to recharge the battery. This has multiple benefits – firstly, slowing the vehicle down faster than the regular disc brakes while saving wear on them and secondly, converting a part of the dissipated energy back into electricity, resulting in a range boost for the Electric Vehicle. Regenerative efficiency is a key parameter impacting the net-efficiency of the vehicle. Therefore, its design must keep in mind the power and thermal characteristics of the electric motors being used in the vehicle. Indian research may gain from some select international collaboration in the area.

DC-DC converters and EV Chargers

An Electric Vehicle will require several DC-DC converters on-board as well as external EV chargers. The chargers could would very all the way from 1 kW to 200 kW or even more. Low-cost and efficient chargers and converters are required to make electric vehicles economically viable.

India must focus on developing and commercialising all kinds of motors and controllers form low-power to high power in three years. It is possible to have all these motors, controllers and chargers to be Made in India.

Session 1- Speakers/Panelist

Ashok Jhunjhunwala,
Professor, IIT Madras (Moderator)

Ashok Jhunjhunwala is the Professor in the Department of Electrical Engineering, IIT Madras. Dr. Jhunjhunwala is considered to be pioneer in nurturing Industry -Academia interaction in India towards R&D, Innovation and Product Development. He is the Chairman of Technology Advisory Group for Electric Mobility, He has been Chairman and member of various government committees and has been on Boards of several education institutions in the country. At the same time, he has been on the Boards of a number of public and private companies. Dr. Jhunjhunwala was conferred Padma Shri in 2002.

BG Fernandes,
Professor, IIT Bombay

B. G. Fernandes is currently Professor in Department of Electrical Engineering in IIT Bombay. He has broad interest in the field of power electronics and electrical machine design, including inverter topologies for VAR compensation, power electronic interfaces for non-conventional energy sources, permanent magnet machines for wind power generation and switched reluctance machines for electric vehicles. Prof. B. G. Fernandes is co-investigator in the STAAP project and his team is investigating on converter topologies for interfacing PV sources to the grid, for low and medium power levels. The aim of the study is to improve efficiency, reliability and reduce the cost of converters interfacing PV sources.

Siva Kumar,
IIT Hyderabad

Siva Kumar is the Associate Professor, Dean International and Alumni Relations, Department of Electrical Engineering, His area of interest is multilevel inverters, open-end winding induction motor drives, switched mode power conversion, micro grids, power quality and control.

Prof. Amit Kumar Jain,
IIT Delhi

Amit Kumar Jain is an Associate Professor, in the Department of Electrical Engineering, IIT Delhi.

Partha Sarathi Roy,
Drivz

Mr. Roy started his professional career in 1974 with M/s Lohia Machines Ltd (LML), then a manufacturer of Textile Machines in technical co-operation with M/s ARCT of France. Later LML became a two wheeler manufacturer in collaboration with M/s Piaggio of ItalyDuring the period 2009-2015. He partnered the world leader in Permanent Magnet Motors M/s Nidec of Japan for developing electronic controls for their BLDC motors. However, his clients persuaded him to convert his design house to a manufacturing unit. This process is going on. Apart from this, Mr. Roy is also associated with the IIT Madras Research Park at Chennai as a senior advisor for power electronics and PM Motor development for electric vehicles.

Anil Aggarwal,
Compage Automation

Anil Aggarwal is the Managing Director of Compage Manufactures. The company is a team of 52 persons involved in R&D, solutions and softwares of drive systems, motors, PLC and motion controller. One of the largest groups in the industry focused on the subject.

K. Balasubramanian,
CEO, NFTDC

NFTDC is an autonomous and self-financing R & D institution under the aegis of Ministry of Mines, dedicated to the development of Advanced Materials , Innovative Processes on the one hand and Engineering Design, Analysis and Electronics, Instrumentation, Control leading to component and systems development & integration on the other.

NS Ramanathan,
TVS Lucas

N S Ramanathan is Head of Advanced Engineering in Lucas TVS. He has over 30 years of experience in Engineering/ Research and Development. His experience covers the development of Electrical machines/Electrical/Electronic Embedded systems, Mechanical systems and Mechatronics. He is a graduate from College of Engineering, Guindy, Chennai and Master of Business Administration from UK. He is instrumental in development of a wide range of new products at Lucas TVS – Electrical and Electronic products for automotive application and indigenous highly energy efficient Brushless DC motors for both automotive and non-automotive applications . He along with his team at Lucas TVS have developed indigenous traction motor drive solutions for E rickshaw and 2W /3W vehicles and the same was overwhelmingly received lot of attention and response in the recent Auto Expo 2018 at New Delhi. His focus areas include Technology development and New Product development aimed at Electric vehicles and fuel efficiency and emission reduction products for IC engine vehicles

SESSION 2: Li-Ion Battery technology for Electric Vehicles

Battery packs in Electric Vehicles are the energy source for these vehicles. As internal combustion engine vehicles get replaced by electric vehicles, the demand for batteries will scale exponentially. It is imperative that India produces all its electric vehicle (EV) batteries locally in the years to come.

The Battery Pack value consists of the following: materials and chemicals, which account for almost 40% of the value, cell manufacturing which account for almost 30% of the value and finally the battery pack assembly which accounts for an additional 30%.

India needs to ensure that it is firmly established in the entire value chain of EV battery manufacturing in the coming years.

Battery Packs

The cell to pack design consists of the following components:

(i) Thermal Design: This ensures that cells operate at optimum temperature in Indian driving and charging situations.

(ii) Mechanical Design: This ensures that the right pressure is exercised on each cell so as to maximise its life.

(iii) Battery Management System (BMS): This ensures that each cell is charged and discharged appropriately to enhance battery life and to ensure that the proper thermal conditions are maintained for safe operations.

It is important to optimize costs on all these components for successful commercialisation. Fortunately, Indian industry is already engaged in the assembly of battery packs along with many start-ups. However, designing battery for all kinds of applications and successful scaled-commercialisation is a challenge. It is possible, however, for India to become leader in the segment.

Cell Manufacturing

Cell manufacturing is a critical piece in the value chain that requires significant R&D. While some work in this direction has been going on, efforts in finding the fine balance between the chemistry, the process and the costs is critical. India has produced cells, but the level of competitiveness does not come close to the numbers available internationally, 200 Watt hour per Kilo Gram cells at a cost of $135 per KWh and having 2500 cycles in Indian temperature conditions. India may set-up manufacturing plant for cells as a joint venture today. However, it is critical that R&D efforts enable the country to use its own technology in coming years as it is estimated that the annual requirement of cells by 2025 would be close to 25 GWh.

Session 2- Speakers/Panelist

Seetapathy Chander,
Advisor, World Energy Council – India (Moderator)

Seethapathy Chander serves as Special Senior Adviser of Infrastructure and Public-Private Partnerships at Asian Development Bank. Mr. Chander has also been involved in developing a corporate and strategic plan for India's largest power generator, NTPC. He has over 37 years of professional experience, 15 years at NTPC, India and over 22 years at the Asian Development Bank (ADB) in Manila, Philippines. At ADB, he led the financing of infrastructure in public and private sector operations in Afghanistan, Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Kazakhstan, Laos, the Maldives, Nepal, Sri Lanka and Uzbekistan.

Sagar Mitra,
IIT Bombay

Sagar Mitra is an Associate professor in Department of Energy Science and Engineering. His research interests are nanostructured materials-synthesis, organization and integration lithium ion batteries, hybrid vehicles, Na-ion and Mg- ion batteries, hybrid capacitors

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Prabhjot Kaur,
Centre for Battery Engineering and Electric Vehicles

Prabhjot Kaur is the CEO at Centre for Battery Engineering and Electric Vehicles (C-BEEV). She also works as Deputy Director Reliance at IITM Telecom Centre of Excellence.

Vijayamohanan K Pillai, CEECRI

Vijayamohanan K. Pillai assumed charge as Director, CSIR-CECRI on April 24, 2012. An alumnus of the Indian Institute of Science, Dr. Pillai's research work of more than 20 years is primarily focussed on batteries, fuel cells, bio-electrochemistry, electrochemical sensors, chemically modified electrodes, anodization, electro-deposition, electro-organic synthesis, etc. Dr. Pillai has more than 220 research papers and 20 patents to his credit.

Sankar Dasgupta, Electrovaya

Sankar Dasgupta is an entrepreneur and an award-winning scientist with over 50 US patents who is passionate on the urgency to reduce the effects of Climate Change. He has been a member of many committees including the White House Committee on Energy & Environment, chaired by then Vice-President Al Gore. He is a founder charter member of TIE-Toronto and is a frequent invited speaker at preeminent conferences and universities worldwide. Mr. Sankar received his doctorate from Imperial College, London and is a graduate from Presidency College, Calcutta. He is derving as an Adjunct Professor in the Faculty of Engineering at the University of Toronto

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Mohan Thyagarajan, Exide

He is the General Manager of Exide Industries Limited , Lithium-ion Group Design of LIB for automotive application. His research accomplishments include, providing technical support to Mahindra Reva for the Lithium-ion batteries for the E2O car and establishing the Lithium-ion battery assembly facility at IITM Research Park Chennai.

Nikhilesh Mishra, Grinntech

Nikhilesh Mishra is the Co-Founder of Grinntech. Grinntech was founded in early 2013 and incubated at the prestigious IIT-Madras in 2017. The name Grinntech stands for Green Innovation with Technologies across multiple high-impact application areas. At Grinntech he developed an EV conversion kit which can transform an LCV to EV with 2 minute battery swapping feature

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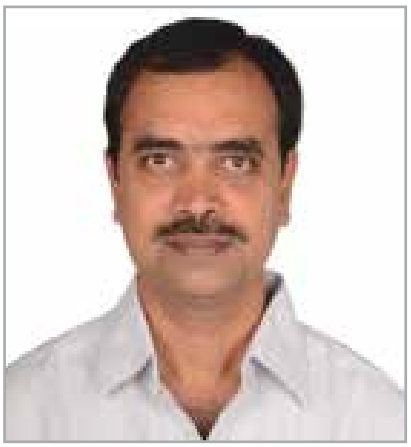
Anant Misra, Greenfuel Energy

Anant Misra is the Business Head of Greenfuel Energy. Greenfuel Energy is a supplier of automotive components to original equipment manufacturers (OEMs) for vehicles that run on alternate gaseous fuels. It provides best suited components for CNG/Hydrogen or H CNG vehicles.



Niranjan Cherukuri, Amar Raja Batteries

Niranjan Cherukuri is a senior member of the Technology Function at Amara Raja Batteries and is currently holding the position of Senior General Manager, Advanced Products & EV Projects, Amara Raja Batteries Ltd. He has been associated with the group for over 23 years.

T D Mercy,
Vikram Sarabhai Space Centre, ISRO

Mercy TD graduated from then Visveswaraya Regional College of Engineering, Nagpur in Metallurgy and joined Vikram Sarabhai Space Centre (VSSC) in 1992. She is actively involved in the development of Electrochemical Energy Systems for space applications. During early years, Mercy contributed to the development and production of Ni-Cd cells to meet ISRO's requirements. Nickel-Cadmium cells were successfully flown in various satellites. She played a pivotal role in the indigenization of Lithium-ion cell Technology and establishment of facilities to produce cells of varying size and capacities. Presently she is heading Energy Systems Division of PCM Entity, VSSC. Indigenously developed Lithium cells were used in Satellite and Launch vehicles. She is a recipient of ISRO ASI Award -2015, Certificate of Appreciation Mahesh Modi Environmental Excellence award and ISRO Team excellence Award -2016.

SESSION 3: Recycling of Lithium-Ion batteries and other Materials for Electric Vehicles

Recycling of Li-Ion

Li-Ion batteries primarily use Lithium, Cobalt, Manganese, Nickel and Graphite. Unfortunately, India does not have the natural resources for any of these materials. Further, the international prices of these materials are very volatile and rising. Therefore, to avoid dependence on imports of these materials in the future, India should focus on recycling used Li-Ion batteries. It is possible to recover up to 95% of Lithium and Cobalt, as well as 93% of Nickle and Manganese and 90% of Graphite.

It is imperative that India develops zero-effluent processes for recycling used Li-Ion batteries. A significant amount of Li-Ion batteries used in electronic products such as mobile phones and laptops is today being discarded as waste. The country needs to create mechanisms to collect such batteries and recover their constituent materials. As EVs are gradually adopted in India, it is necessary to put in place regulations for the mandatory collection, sorting and recycling of the precious resource.

Further, it should be ensured that this urban mining is a strictly zero-effluent process, not affecting the environment adversely in any way. Any foreign technology collaborations should adhere to the same stringent environmental requirements. Moreover, the Hazardous Waste Management & Handling Rules 2016 and other relevant laws should be amended to enable import of lithium battery wastes for recycling in India rather than the current situation of exporting of this crucial material to other countries. Collection of electronic waste to reclaim rare earth metals for magnets and materials for batteries will be critical for the growth of the industry.

New Materials for EVs

Another key aspect that requires significant R&D effort is the development of materials for light-weighting of vehicles. The energy efficiency of the vehicles (and therefore the size and costs of the battery for a certain range) is inversely proportional to the weight of EVs. Use of light-weight materials for EVs would considerably reduce overall costs of EVs, helping achieve high power/ weight ratios while ensuring vehicle safety.

An air-conditioning system in EVs uses the same energy source (EV batteries) for cooling of the vehicle as used by the drive-train to drive the vehicles. Thus, air-conditioning systems could limit the range of the vehicles considerably, a key challenge for EVs in India. Use of advanced composite materials with improved insulation could help in reducing the energy required by air-conditioners as well as enable better thermal management of batteries (composite battery cases).

Session 3- Speakers/Panelist

Clay Stranger,
Principal, India Office of the Chief Scientist,
Rocky Mountain Institute (Moderator)

As Director of the Office of the Chief Scientist at RMI, Mr. Clay Stranger oversees research, communications, and diverse engagements both within and outside RMI. Clay also serves as Project Manager for Reinventing Fire: China, a partnership with the Chinese government to examine the maximum feasible share of renewables and efficiency technology in the Chinese energy economy through 2050. The project's aim is to develop a transparent, adjustable, and enduring model to inform China's energy future. Clay has worked on energy strategy in more than a dozen countries.

Dr. Raghuram Chetty,
Associate Professor, IIT Madras

Presently, the Associate Professor at IIT Madras. He is on the Editorial Board of 'NanoHybrids', an interdisciplinary journal which focuses on all aspects of nanoscience and nanotechnology. Since 2010, he is heading the Society for Advancement of Electrochemical Science and Technology, Madras Chapter as Vice Chairman. Besides, he is also a member of the International Society of Electrochemistry, Society of Chemical Industry and Royal Society of Chemistry. He has been a commendable invitee to a long list of seminars and talks on topics such as fuel cell technology, electrochemical techniques, solar energy conversion, carbon nanotubes and many more. Dr Raghuram Chetty has also been awarded Top cited article certificate from Elsevier for his paper entitled "PtRu nanoparticles supported on nitrogen-doped multiwalled carbon nanotubes as a catalyst for methanol electro-oxidation".

Dr. Ramesh Chandra,
Professor, IIT Roorkee

A PhD scholar from National Physics Lab, New Delhi and IIT, Delhi, Dr. Ramesh Chandra is a Professor from IIT Roorkee. With 24 years of teaching and research experience in areas like super capacitors, nanostructures, gas sensors etc., he has also established the Nanoscience Laboratory to synthesize Nanostructured materials by PVD processes. He has published approximately 171 papers in refereed journals on topics and attended 122 national/ international conference. Besides, he has been awarded Dr A N Chatterjee memorial award on High-Tc squids, Commonwealth fellowship at University of Cambridge, UK, visiting scientist at TIFR, Mumbai and many more.

Nitin Gupta,
Chief Executive Officer, Attero Recycling Private Ltd

Nitin Gupta serves as Chief Executive Officer of Attero Recycling Private Ltd. Mr. Nitin has held various leadership positions at Lotus Interworks in USA. Mr Nitin has extensive experience in technology start-ups. He serves as a Director of Attero Recycling Private Ltd. India's largest electronic asset management company and clean-tech pioneer, Attero actively promotes eco-friendly reuse and recycling of electronics. As India's only end-to-end e-waste recycler and metal extraction company, we aim to turn today's waste into sustainable resources for tomorrow. Attero has also established one of India's largest electronics refurbishing facility, backed by cutting edge technology, to extend the useful life of old electronics and promote reuse.

Sundaresan S A,
Vice-President, Ashok Leyland

S. A. Sundaresan has been an entrepreneur and a technology innovator. He finds the challenges of conceiving, nurturing and realizing products or processes or organizations equally fulfilling and enjoyable. Past experiences range from developing hermetic compressors, sheet metal engineering, plant and business digitalization long before it was a buzz word, systems engineering, digital twin, and embedded software development tools. Latest foray has been into electric vehicles and e-Mobility as a service as the Vice-President of the recently constituted Ashok Leyland's EV and e-Mobility Business.

Anindya Deb,
Indian Institute of Science

Mr. Anindya Deb areas of Interest include Vehicle Crashworthiness and Occupant Safety; Pedestrian Safety; Impact Modeling and Testing; Behavior of Lightweight Materials under Impact Loading, Design of Automotive Systems; Design and Prototyping of Lightweight Electric Vehicles; Practical Multidisciplinary (Vehicle) Design Optimization (MDO) involving NVH, Durability, Vehicle Dynamics, Vehicle Crash Safety, etc.; Integrated Multi-Physics Approach to IC Engine Design; Lumped Parameter Modeling of Vehicle Suspension Systems; Explicit Nonlinear Dynamic Finite Element Modeling of Wheel Bearings, Computer-Aided Engineering (CAE) in Design; Constitutive Modeling.

SESSION 4: Alternate fuel sources and Control of Electric Vehicles

Lithium Ion batteries are cost competitive, efficient and have revolutionized the battery space. However, they come with their set of challenges safety, limited material availability to name a few. The world is now looking for promising potential alternatives to keep up with the growing demand from various industries and especially the EV space. What are the likely contenders for the power source of the future?

Lithium Ion Batteries with alternate chemistries

Today NMC-Graphite is known to be the best battery for EVs as they are cost-effective and light-weight. However, alternate chemistry within Li-Ion is knocking at the doors, taking the specific capacity form around 200 Wh/kg to 300 Wh/kg in near future and 400 Wh/kg in mid-term. Indian needs aggressive R&D towards this.

Hydrogen fuel cells

Theoretically this one is exceptionally efficient, cleaner than most other options and can be recycled! But today practically these are huge and not cost effective. Institutions around the world are working with alternatives to convert water into hydrogen.

Lithium-sulphur

This is in R&D stage and promises to come to market in a few years. Known issues include the electrodes degrade too fast for commercial applications right now. A number of institutions are working on this. Cost is also of concern. Lithium-sulphur might be a halfway house replacement for lithium-ion, rather than a radical and left-field successor, but it is on the way and it will be a significant improvement.

Graphene super capacitors

Graphene holds the key to a massive quantum leap forward for mankind. IT promises to be coming for more than a decade but some of the world's brightest minds have come up short so far. Commercially available graphene sheets at the right price-point is still an uncertainty.

Redox flow batteries

By adding hydrochloric and sulphuric acid to the mix, researchers have produced prototype batteries with 70% more energy density than a lithium-ion battery of similar proportions. They also offer up to four times the lifespan and much greater storage. However commercial viability is still not there.

Aluminium-graphite batteries

A smartphone could take a full charge in just 60 seconds and a car could charge in minutes. With an aluminium negatively charged cathode and a graphite anode, it's safe, lightweight and it does have the potential for improved energy density. But it is not even close to a perfect, commercially viable aluminium-graphite battery yet.

Solid state batteries

The battery could, theoretically, last a lifetime! Better efficiently, packaging, eliminate the risk to fire are other advantages. Technically, solid state batteries could provide the same kind of leap that thin film batteries could provide over lithium-ion.

Control of EVs

EV control system plays a major role in making the EVs possible. It consists of a processor board and associated control software. This board interfaces with all the other vehicle sub-systems, usually on a standardized protocol such as CAN (Controller Area Network).

In the future, distributed control systems where each wheel is controlled locally by a separate processor may play a major role in improving vehicle efficiency. Moreover, advancements in fuzzy logic and Artificial Intelligence will lead to better power management, drive control and safety.

India has the capability to become a leader in EV controls and software due to inherent expertise in software research and development.

Session 4: Speakers/Panelist

Dr. K. VijayRaghavan,
Principal Scientific Adviser to Government of India
(Moderator)

Prof. K VijayRaghavan, is the Principal Scientific Adviser to the Government of India. Prof. Vijay Raghavan served as the Secretary of DBT from January 2013 till February 2018. In addition, he also held additional charge of Secretary, Department of Science & Technology (DST), Secretary, Council of Scientific & Industrial Research (CSIR), Secretary, Ministry of Earth Sciences (MoES) and Secretary, Department of Health Research (DHR) during his stint at New Delhi. He has been elected as Fellow of Royal Society and as a Foreign Associate of the US National Academy of Sciences. In addition, he is elected to major academies in India and abroad. Earlier, he has also been conferred with the Padma Shri (2013), H K Firodia Award (2012), Infosys Prize (2009), and many such accolades.

Anil Verma,
IIT Delhi

Anil Verma is an Associate Professor at IIT Delhi. He is interested in the research areas like Sustainable Environergy Electrochemical Systems: Redox Flow Batteries; CO2 Electrochemical Reduction to Hydrocarbons; Microbial Fuel Cell, PEM/DM Fuel Cell; Graphene Synthesis and C/C Composite for Energy Devices. Dr Anil Verma is known for his two patents, books and a commendable list of publishes. He has been awarded Amar Dye-Chem Award for Excellence in Research and Development (under the age of 35 Years) by IIChE (2011).

S Mukhopadhyay,
IIT Kharagpur

Siddhartha Mukhopadhyay is a Professor in the Department of Electrical Engg. & the Steel Technology Centre as well as the Dean of Alumni Affairs and International Relations. His current research interests are in CAD and Verification of AMS circuits and systems, Integrated Vehicle Health Management, Tracking and Guidance, Industrial Automation and Cyber-Physical Systems. He has co-authored about 200 technical papers in national and international journals and conferences, a textbook on Industrial Instrumentation, Control and Automation, an Edited Volume entitled "Measurement and Instrumentation: Trends and Applications". He serves on Review Committees at DRDO labs.

Viswajit Joshi,
KPIT Technologies Ltd.

Viswajit Joshi, is a Senior Manager and manage the Government Relations and Market Affairs at KPIT. KPIT Technologies Ltd. is a global technology company providing IT Consulting and Product Engineering solutions and services to Automotive and Transportation sectors and and Energy and Resources. He is working for bringing the transformational Innovation of key technologies like ITS, REVOLO (electrification technology for public transportation) and other solutions to the markets in India and abroad. Vishwajit has been an active participant in different committees on standardization like TAG-EM (under Department of Heavy Industries), TED-27 (Hybrid & Electric vehicles), TED-28 (ITS), AIS 140 (ITS), and AIS 138 part I (charging stations) etc. and has contributed in making standards for automotive industry.

Aditi Halder,
IIT Mandi

Aditi Halder is an Assistant Professor at IIT Mandi. Her specialization is in Design and development of new functional nanomaterials for the application of renewable energy, nano-electronics and sensor.

R Gopalan,
Centre for Automotive Energy Materials

R Gopalan is a Scientist -G and Head of Centre for Automotive Energy Materials. Mr. Gopalan research interests focused towards High Tech Superconductors, Magnetic materials, Li-ion battery, Thermoelectric, structure-property correlation of functional materials. He has three patents on - A process for preparing nanocrystalline olivine structure transition metal phosphate material, Indian Patent Application; Nanocomposite magnet and process for producing the same; and Fabrication of bulk nanocrystalline Fe-C alloy by spark plasma sintering of mechanically milled powder- Japanese patent filed.

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