COLUMBIA | ENGINEERING
The Fu Foundation School of Engineering and Applied Science

IEEE PES Power & Energy Society®

IAS IEEE INDUSTRY APPLICATIONS SOCIETY

Columbia 2017 Forum

6th October 2017

Electrified Transportation: Challenges and Future Trends

The transportation sector is one of the main consumers of energy in the U.S.; it is second only to the electric power sector, accounting for 28% and 40% of the total energy consumption, respectively, according to the Energy Information Administration (EIA). However, transportation remains largely dependent on petroleum products that provide 92% of the energy. As a result the transportation sector has recently exceeded the electric power sector in terms of CO_2 emissions.

Electrifying the transportation sector is a proactive strategy with strong projected environmental, economic, and customer benefits. Electrified transportation significantly reduces the tank-to-wheel and well-to-wheel energy consumption and cuts the CO_2 emissions by 51% (based on the current U.S. energy mix) to 98% (based on the current Swedish energy mix). As federal, state, and local legislatures are increasingly pushing for stricter fuel economy and air quality regulations, electrification is a prime candidate to satisfy upcoming requirements. Furthermore, electric vehicles have demonstrated the ability to exceed the performance of conventional vehicles. As of 2017, the 3 fastest accelerating vehicles (in 0-60mph timings) feature various degrees of drivetrain electrification, and the 0-60mph world record is held by a prototype with electric drivetrain. These are the statistics that attract the attention of the general public, however, they have been technically achievable for many years now. The key challenges to the inception of more electrified transportation are the various energy storage and conversion mediums, electro-chemical batteries and fuel cells being two examples, cost effective power-train components, i.e. machine and power conversion electronics, and the impact of the move of transportation energy to national electrical utilities.

In recent years, electrified transportation evolved significantly, with the appearance of plug-in hybrid and electric vehicles and a 160% annual market growth. Electric vehicle technologies are progressing rapidly. New battery technologies are being studied and the battery costs have decreased by ~80% since 2010. Furthermore, the power electronic technologies are evolving which result in improved grid interfaces for fast-charging. Wide-bandgap switching technologies reduce the weight and volume of the drivetrain and are predicted to make a market entry in 2019.

This forum discusses challenges and trends in electrified vehicle technologies, such as power conversion and energy storage, the grid integration of electrified transportation and transportation policies, that pave the way for a higher penetration of electrified transportation.

Prof. Matthias Preindl

Registration

Eventbrite: www.eventbrite.com/e/columbia-2017-forum-electrified-transportation-challenges-and-future-trends-tickets-36690009807

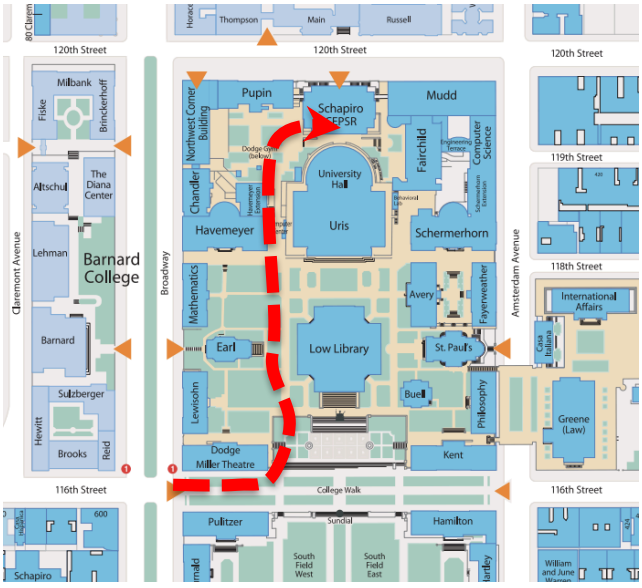
Short URL: goo.gl/AbNTCN

Sponsorship

The 2017 Forum is jointly sponsored by
Department of Electrical Engineering, Columbia University
Department of Mechanical Engineering, Columbia University
IEEE New York joint PES and IAS Section

Location.

Columbia University in the City of New York, Davis Auditorium in the Schapiro Center for Engineering and Physical Science Research (Schapiro CEPSR, 4th floor - campus level, room 412), 530 West 120th Street, between Broadway and Amsterdam.



Entering From Campus: From the campus entrance, walk in along College Walk, head north up the steps, go around Low Library and to the back of Uris Hall (the Business School).

Entering From 120th Street: Entering the building from 120th Street, you will come through a set of iron gates. You can access the stairs or the elevator from the lobby.

Public Transportation: Take the #1 train to 116th Street (Columbia University) station.

Parking: You may park on the street or use one of the local parking garages. The following two parking garages are within a 5-10 minute walk from Davis Auditorium.

Claremont Parking Corp., Riverside Church, 120th Street (between Claremont Ave. & Riverside Drive), open from 6 a.m. to midnight

GMC Garage, 532 West 122nd Street (between Broadway & Amsterdam Ave.), open from 6 a.m. to midnight

Agenda

Registration (8:30 to 9:00am)

Opening Remarks and Welcome (8:45 to 9:00am)

Early Morning Session: Transportation System (9:00 to 10:30am)		
09:00	Stability Analysis of Stand-Alone Microgrids: Application to Electrified Transportation Systems	Babak Nahid-Mobarakeh Université de Lorraine
09:30	Power Conversion for Hydrogen Fuel Cell Hybrid Electric Vehicles Propulsion	Dazhong Gu Unique Technical Services
10:00	Recuperation of Regenerative Braking Energy in Electric Rail Systems	Ahmed Mohamed City University of New York (CUNY)

Coffee break (10:30 to 10:45am)

Late Morning Session: Power Conversion (10:45 to 12:15pm)		
10:45	*Repetitive Control of Power Electronics Conversion Systems*	Pericle Zanchetta University of Nottingham
11:15	SiC Enabling Electric Vehicle Power Conversion	Matt O'Grady United Silicon Carbide
11:45	*Model-Based Control*	Davide Da Rù and Milo De Soricellis Aalborg University and Robert Bosch GmbH

Lunch (12:15 to 1:15pm)

Early Afternoon Session: Energy Storage (1:15 to 2:45pm)		
1:15	Advanced Battery Modeling and Estimation for Electrified Transportation	Pawel Malysz FIAT Chrysler Automobile
1:45	Battery Modeling for System Design	John Milios Sendyne Corp
2:15	Multi-Life Opportunities of EV Batteries for Grid Applications	Lucía Gauchía Michigan Technological University

Coffee break (2:45 to 3:00pm)

Future Trends (3:00pm to 4:00pm)		
3:00	The Future of EV and Electric Grid	Andrew Reid Consolidated Edison
3:30	The Future of Batteries	Martin Payne Gotion Inc.

Closing remarks (4:00pm)

Speaker Information

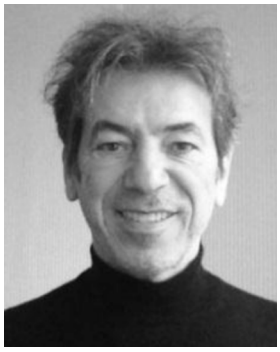
Matthias Preindl (Organizer) received the B.Sc. degree in electrical engineering (summa cum laude) from the University of Padua, Padua, Italy, the M.Sc. degree in electrical engineering and information technology from ETH Zurich, Zurich, Switzerland, and the Ph.D. degree in energy engineering from the University of Padua, in 2008, 2010, and 2014, respectively.
He is an Assistant Professor in the Department of Electrical Engineering, Columbia University in the City of New York, NY, USA, where he established and leads the Motor Drives and Power Electronic Laboratory.
He was an R&D Engineer of Power Electronics and Drives at Leitwind AG, Sterzing, Italy (2010-2012), a Post Doctoral Research Associate with the McMaster Institute for Automotive Research and Technology, McMaster University, Hamilton, ON, Canada (2014-2015), and a Sessional Professor in the Department of Electrical and Computer Engineering, McMaster University (2015). He received the Career Award of the Futura Foundation in South Tyrol, Italy, and the CAREER Award of the US National Science Foundation (NSF), USA, in 2016 and 2017, respectively.

Davide Da Ru' eceived the B.S. and M.S. in Electrical Engineering from the University of Padova in 2012 and 2014 respectively. He is working toward the Ph.D. Degree within the Electrical Drives Laboratory at the same University. He is currently a visiting researcher at the Energy Technology Department at the Aalborg University (Denmark).

Lucia Gauchia is the Richard and Elizabeth Henes Assistant Professor of Energy Storage Systems at Michigan Tech University since Fall 2013 and she holds a joint appointment in the ECE and ME-EM departments. In 2017 she has been awarded a prestigious NSF CAREER Award on her work on battery aging testing and estimation for multiple life applications. Before her current appointment she was a Postdoctoral Associate at McMaster University (Canada) on energy storage technologies for transportation electrification at the McMaster Institute for Automotive Research and Technology. She obtained her Ph.D. on Electrical Engineering at the University Carlos III of Madrid (Spain) in 2010.

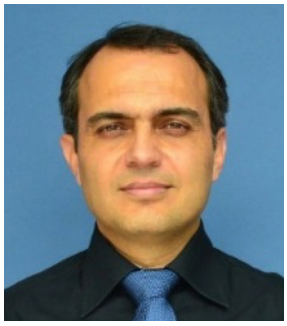
Dazhong Gu received his Ph.D. degree from Tandon School of Engineering, New York University in 2015. He obtained his B.S. degree in Electrical Engineering from Wuhan University, China in 2009. At NYU, he worked on various power conversion research topics for aerospace applications. In 2015, he joined United Technologies Research Center at East Hartford, CT as a senior research engineer, where he worked on next-generation power conversion technologies for UTC products. From 2017, he has joined Unique Technical Services, LLC to lead various technologies development for transportation electrification.

Pawel Malysz received the B.Eng. degree (summa cum laude) in engineering physics, the M.A.Sc. and Ph.D. degrees in electrical engineering from McMaster University, Hamilton, ON, Canada, in 2005, 2007 and 2011 respectively. Throughout his graduate studies he received scholarship awards such as the Ontario Graduate Scholarship, Queen Elizabeth II graduate Scholarship, and National Science and Engineering Research Council (NSERC) of Canada graduate scholarships. In 2003-04 he was a biomedical engineering intern at the Juravinski Cancer Centre, Hamilton, ON, Canada. From 2012-2014 he was a Principal Research Engineer at the McMaster Institute for Automotive Research and Technology, a Canada Excellence Research Centre. He is an associate editor for IET Power Electronics, a licensed professional engineer (P. Eng.) in the province of Ontario, a Golden Key International Honor Society member, and currently a Battery Management Systems Control Engineer at Fiat Chrysler Automobiles in Michigan, USA. Dr. Malysz co-received the Chrysler Innovation Award in 2014. In 2015, he was appointed Adjunct Assistant Professor in the department of Electrical and Computer Engineering at McMaster University. In 2017, Dr. Malysz became a Senior Member of IEEE (SMIEEE), and joined the Mechanical Engineering department of Lawrence Technological University, Southfield, MI, USA, as an adjunct professor where he teaches a course in hybrid electric and all-electric vehicles. He holds two patents and has published over 37 peer-reviewed journal/conference papers. His research interests include energy systems, battery management software design, electrified transportation, and advanced control engineering.



John Milios received the B.Sc. degree in physics, the M.Sc. degree in electronic automation from the National University of Athens, Athens, Greece, and the Ph.M. degree from Columbia University New York, NY, USA. He has participated in the committees for the creation of several industry standards, including the Smart Battery System, SMBus, USB HID and Bluetooth. He has served as the CTO of Semtech, Camarillo, CA, USA, and he is currently the CEO of Sendyne Corp., New York, NY. He holds 11 U.S. patents.

Ahmed Mohamed received the PhD degree in Electrical Engineering from Florida International University in 2013. He is an Assistant Professor at the Department of Electrical Engineering, City College of the City University of New York (CUNY), and the founding director of the CUNY Smart Grid Laboratory. Prior to joining CUNY, he worked as a post-doctoral research fellow at the Energy Systems Research Laboratory, Miami, Florida, and served as a consultant to several companies. His research interests include Power Grid Resilience, Microgrids, Critical Infrastructures Interdependence and Traction Power Systems. He received research grants from various companies and national funding agencies, e.g. the National Science Foundation, and has more than 70 publications as book chapters, and articles in premier journals and conference proceedings. He received several honors, and several of his papers received prestigious awards, such as the IEEE Electric Machinery Committee Best Paper Award for one of his publications in the IEEE Transactions on Energy Conversion. He is a Senior Member of IEEE, and has held several IEEE executive positions, such as the Vice Chair of the professional IEEE/PES chapter, Miami Section.



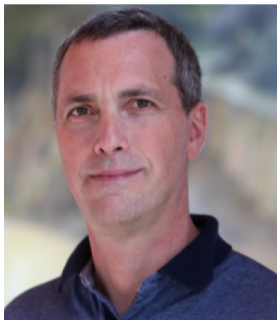
Babak Nahid-Mobarakeh received the Ph.D. degree in electrical engineering from the Institut National Polytechnique de Lorraine (INPL), Nancy, France, in 2001. From 2001 to 2006, he was an Assistant Professor with the Centre de Robotique, Electrotechnique et Automatique, University of Picardie, Amiens, France. In September 2006, he joined the Ecole Nationale Superieure d'Electricite et de Mecanique, Université de Lorraine, Nancy, where he is currently a Professor. He is the author or coauthor of over 200 international peer reviewed journal and conference papers as well as several book chapters. He has been the recipient of several awards. Dr. Nahid-Mobarakeh was the General Co-Chair of the 2015 *IEEE Transportation Electrification Conference and Expo* (ITEC). Currently, he is the Chair of the *Industrial Automation and Control Committee* (IACC) of the *IEEE Industry Applications Society* (IAS). He is also an Associate Editor of the *IEEE Transactions on Transportation Electrification*.

Matt O'Grady is Applications Manager at United Silicon Carbide. In this role he promotes adoption of SiC devices and assists customers in the use of SiC devices. He drives SiC use both as replacement for silicon devices in existing designs and as an enabler for new circuit designs. He also contributes to the design and testing of SiC based power converters and characterization of SiC devices. He has 20 years of experience as an electrical engineer and holds a BS in Electrical Engineering from Penn State and MSE in Management of Technology from the University of Pennsylvania.

Martin Payne, as R&D Director at Gotion, Inc, is responsible for the global development of electrolytes and materials for Li batteries. He has overall responsibility for the technical personnel at the Gotion technical center in Independence, OH and collaborates with the research, development and technical services teams worldwide. He has over 25 years of experience in the chemical industry, including 20 years experience in the battery field, including development and commercialization of cathode materials, lithium salts, additives for electrolytes and new electrolyte formulations. Prior to joining Gotion, Dr. Payne worked at BASF, Novolyte Technologies, A123 Systems and OM Group in various technical/managerial positions. He holds a BS from the University of Buffalo and a PhD in Chemistry from The Ohio State University.

Andrew Reid is a Senior Engineer in Con Edison's Research & Development department in New York City where he shapes, executes and manages projects that adopt new technologies to address strategic needs and operational sustainability for the electric business. Prior to joining Con Edison, Andrew worked in Japan for Yokagawa Electric Company in their Industrial Automation department designing new analytical products for process control. He has also worked at Infineon Technology's Wireless Solutions Business, later acquired by Intel, performing field tests of baseband software for many popular mobile phones on the market today. During his role at GE Global Research, Andrew's technical focus included Control & Communications Systems for Battery Energy Storage, Electric Vehicle Infrastructure for Smart Charging and embedded electronics for Distribution Network Observability & Controllability. Andrew graduated from Lehigh University with a B.S. and M.S. in Electrical Engineering and a Minor in Japanese.

Milo De Soricellis was born in Verona, Italy, in 1990. He received the B.Sc. degree in Engineering of Energy at the University of Padova, Italy, in 2012 and the M.Sc. degree in Electrical Engineering at the University of Padova, in 2015. He is currently working toward the Ph.D. degree at the Department of Industrial Engineering at University of Padova, in collaboration with Robert Bosch GmbH, Germany. His research interests include high performance electrical drives for traction application in the automotive field.



Pericle Zanchetta received his MEng degree in Electronic Engineering and his Ph.D. in Electrical Engineering from the Technical University of Bari (Italy) in 1993 and 1997 respectively. In 1998 he became Assistant Professor of Power Electronics at the same University. In 2001 he became lecturer in control of power electronics systems in the PEMC research group at the University of Nottingham (UK), where he is now Professor in Control of Power Electronics systems. He has published over 260 peer-reviewed papers and he is Chair of the IAS Industrial Power Converter Committee IPCC. His research interests include control of power converters and drives, Matrix and multilevel converters.