

## Tutorial Proposal

# Hybrid and Plug-in Hybrid Electric Vehicles

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This tutorial presents an overview description of the current status and future trends in the automotive industry. The motivation for the research, development, and commercialization of hybrid electric vehicles (HEVs) and plug-in hybrid electric vehicles (PHEVs) will be explained. The presentation is mainly focused on drive train configurations and presents a review of conversion strategies to hybridize different vehicles. Particular attention will be given to the role of power electronics, electric machines, and motor drives in advanced vehicles. In addition, different HEV and PHEV configurations and business models will be presented with a focus on engineering fundamentals as well as state-of-the-art research and development in the areas of system components and integration.

In this tutorial, vehicle-to-grid (V2G) aspects as well as plug-in issues of the power electronic chargers will be reviewed. Energy storage systems including Li-ion and NiMH batteries and their associated electronics and electronic control units will be described as well. Hybridizing the energy storage systems using ultra-capacitors will be presented as an attractive possibility. Furthermore, power electronic and propulsion motor drive issues will be covered in detail. Particular attention will be given to the hybrid drive trains and PHEV controllers.

Throughout the presentation, related component-level as well as system-level challenges are explained and possible solutions are recommended. Unprecedented opportunities in the areas of power electronics, energy storage, system control, and hybrid drive trains will be highlighted together with the power grid unique prospects.

The presentation concludes that hybrid and plug-in hybrid electric vehicles are emerging at a rapidly growing rate and there will be a sustained exceptional market share growth for them in the long term. Plug-in hybrid technology is the best practical solution to move forward and the proposed long-term sustainable solution includes (1) integrating the transportation industry with the electric power industry, (2) using electricity as the carrier, and (3) generating electricity more and more from the renewable energy sources: solar, wind, hydro, etc.

**Intended Audience:** This tutorial is suitable for most of the attendees of IECON from academia, industry, and government including professors, researchers, students, engineers, managers, and policy makers. An attendee with basic engineering knowledge, who is interested in hybrid and plug-in hybrid electric vehicles, will benefit from this tutorial.

**Topics as Listed in the Conference Call for Papers:** Power Electronics, Electric Motor Drives, Electric Machines, Control Systems and Applications, Renewable Energy, and System Integration.

## Short Biography of the Presenter Prof. Ali Emadi

Dr. Ali Emadi is a professor of electrical engineering and the director of the Electric Power and Power Electronics Center and Grainger Laboratories at Illinois Institute of Technology (IIT) in Chicago, where he has established research and teaching facilities as well as courses in power electronics, motor drives, and vehicular power systems. In addition, Dr. Emadi is the founder and chief technology officer of Hybrid Electric Vehicle Technologies, Inc. (HEVT). He is also the founder, director, and chairman of the board of the Industry/Multi-university Consortium on Advanced Automotive Systems (IMCAAS).

Dr. Emadi is the recipient of numerous awards and recognitions. He has been named the Eta Kappa Nu Outstanding Young Electrical Engineer of the Year 2003 (single international award) by virtue of his outstanding contributions to hybrid electric vehicle conversion by the Electrical Engineering Honor Society. He also received the 2005 Richard M. Bass Outstanding Young Power Electronics Engineer Award from the IEEE Power Electronics Society. In 2005, he was selected as the Best Professor of the Year by the students at IIT. Dr. Emadi is the recipient of the 2002 University Excellence in Teaching Award from IIT as well as the 2004 Sigma Xi/IIT Award for Excellence in University Research. He directed a team of students to design and build a novel motor drive, which won the First Place Overall Award of the 2003 IEEE/DOE/DOD International Future Energy Challenge for Motor Competition.

Dr. Emadi is the principal author/co-author of over 200 journal and conference papers as well as several books including *Vehicular Electric Power Systems: Land, Sea, Air, and Space Vehicles* (Marcel Dekker, 2003), *Energy Efficient Electric Motors* (Marcel Dekker, 2004), *Uninterruptible Power Supplies and Active Filters* (CRC Press, 2004), and *Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design* (CRC Press, 2004). Dr. Emadi is also the editor of the *Handbook of Automotive Power Electronics and Motor Drives* (Marcel Dekker, 2005).

Dr. Emadi was the founding General Chair of the 1<sup>st</sup> IEEE Vehicle Power and Propulsion Conference (VPPC'05), which was co-located under his chairmanship with the SAE International Future Transportation Technology Conference. He is currently the Chair of the IEEE Vehicle Power and Propulsion Steering Committee, Chair of the Technical Committee on Transportation Power Electronics of the IEEE Power Electronics Society, and Chair of the Power Electronics Technical Committee of the IEEE Industrial Electronics Society. He has also served as the Chair of the prestigious International Future Energy Challenge.

Dr. Emadi is the Editor (North America) of the International Journal of Electric and Hybrid Vehicles. He has been the Guest Editor-in-Chief of the Special Issue on Automotive Power Electronics and Motor Drives, *IEEE Transactions on Power Electronics*. He has also been the Guest Editor of the Special Section on Hybrid Electric and Fuel Cell Vehicles, *IEEE Transactions on Vehicular Technology* and Guest Editor of the Special Section on Automotive Electronics and Electrical Drives, *IEEE Transactions on Industrial Electronics*. He has served as an Associate Editor of the *IEEE Transactions on Vehicular Technology*, *IEEE Transactions on Power Electronics*, and *IEEE Transactions on Industrial Electronics*.