

Vehicle Electrification

Session Co-chairs: Sanjeev Naik, General Motors, and Michael Degner, Ford Motor Company

The automobile industry is currently under-going one of the most dramatic and rapid transformations in its history. This transformation, commonly referred to as "vehicle electrification", is being driven around the world by concerns about global warming, sustainability, and national security. In response to these concerns, many countries have implemented regulations that mandate dramatic improvements in the fuel economy of automobiles over the next 10 to 15 years, more than double the fuel economy of just a couple of years ago. Automobile manufacturers are developing many advanced powertrain technologies to meet these regulations, with hybrid electric, plug-in hybrid electric, and battery electric vehicles (HEV, PHEV, and BEV) being some of the most promising powertrain technologies currently under development.

The concept of vehicle electrification is not new. In fact, battery electric vehicles were the most common type of vehicle in the late 1800's and very early 1900's. This early dominance of electrified vehicles was very quickly displaced by improved internal combustion engines that have dominated the automobile powertrain landscape for more than 100 years. The dominance of the internal combustion engine is being challenged by vehicle electrification like it has never been before, enabled by dramatic improvements in energy storage systems, electric machine drives, and electrical system integration & control. The speakers in this session will discuss some of these enablers, the on-going research to make further improvements, and some of the challenges that will need to be addressed in the near future for widespread vehicle electrification.

The first speaker, Dr. Jeff Sakamoto, will cover the efforts to improve automobile electrical energy storage systems. Reducing the cost, size, and weight of electrical energy storage systems is one of the key challenges preventing the widespread adoption of plug-in electric vehicles (PHEV and BEV's), which show the most promise to dramatically reduce the world's dependence on petroleum. Dr. Sakamoto will present some of the recent improvements seen in battery technologies, the forward-looking industry targets required to enable widespread adoption of plug-in vehicles, and some of the on-going research to meet these targets.

The second speaker, Dr. Matthew Willard, will cover the challenges and research underway to develop improved magnetic materials, one of the key classes of materials used in electric machine drives. Magnetic materials of both the hard (permanent magnets) and soft (electrical steels and magnetic cores) type are critical in the design of high performance electric machines and power electronic converters. Dr. Willard's presentation will cover the key desired material characteristics, some of the research challenges to develop better materials, and the efforts currently underway to reduce the usage of critical, strategic materials, like rare earth elements, in these magnetic materials.

The third speaker, Dr. Arindam Maitra, will cover the impact of vehicle electrification on the electrical transmission and distribution systems. Widespread adoption of plug-in electric vehicles would represent a significant increase in the load on the electrical transmission and distribution system. Dr. Maitra's presentation will cover the efforts underway to better understand the impacts created by this increased load and the changes necessary in the electrical transmission and distribution systems to address these impacts.

The fourth speaker, Dr. Rahul Mangharam, will cover some of the behavioral barriers to widespread adoption of electrified vehicles. Automobile users are accustomed to having vehicles with immediate availability, a long driving range before re-fueling, and a convenient and rapid re-fueling infrastructure. Plug-in vehicles have limitations in meeting these expectations and may require changes in user behaviors. Dr. Mangharam will present some of these behavioral challenges and how innovation and engineering are being used to address them.