Electrification of Transportation for Energy Storage and Smart Mobility

Yiguang Ju
Robert Porter Patterson Professor of Mechanical and Aerospace Engineering
Director, Program in Sustainable Energy

Abstract

About two-thirds of U.S. electricity is produced from fossil fuels and two-thirds of oil is consumed by transportation. Electricity and transportation are the major sources of greenhouse gases and environmental pollution. Wind and solar offer a pathway to clean energy generation, but without a large capacity of energy storage, the intermittency of renewables represents a major challenge. The recent development of electric vehicles and autonomous driving technologies provides a promising solution to the challenges of renewable energy production and storage and emissions from transportation via the electrification of transportation and intelligent management of mobility. The key technical questions are: 1) how to couple the electric grid to the transportation grid and in what energy form and capacity; 2) how to forecast and intelligently optimize the transportation system, balancing generation, transmission and storage; 3) how to develop the infrastructure to enable dynamic charging and smart battery management as well as wireless sensing and data transfer; and 4) how to develop new battery materials and create a scalable hierarchy for electrochemical electrodes to increase battery energy density as well as charging speed and cycles.

With the support of the Andlinger Center for Energy and the Environment, a multi-disciplinary team at Princeton with 12 researchers has been assembled to address these technical questions. The objectives of this research are to initiate a collaborative effort to develop: models for transportation and electrical grid integration; forecast and optimization methods for energy storage and transportation planning; new technologies for advanced sensing, communication, dynamic charging and battery management; and new nanomaterials synthesis methods and scalable hierarchy strategies for electrochemical electrodes to produce low cost, high energy density, fast charging, and long life time batteries.