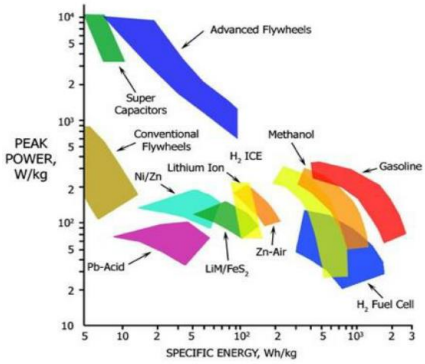
Energy Modules

CHEME 6660, Analysis of Sustainable Energy Systems

Lead instructor: Jeff Tester (jwt54@cornell.edu)

Assessment of current and potential future energy systems, covering resources, extraction, conversion, and end-use, with emphasis on meeting regional and global energy needs in the 21st century in a sustainable manner. Quantitative engineering methods for performance analysis of renewable and conventional technologies are utilized. Methods will include thermodynamics, financial analysis of performance, life cycle cost calculation, transport and reaction engineering considerations for energy capture, extraction and conversion described within a system framework that aids in evaluation and analysis of sustainable energy technology options in the context of political, social, economic, and environmental goals. Open to graduate students and upper-class undergraduates. Quantitative engineering analysis methods applied assuming previous exposure to thermodynamics, physics, and calculus. (2 credits for problem sets and prelims; 3 credits adds a term project)



CHEME 6679, Energy Storage

Lead instructor: Tobias Hanrath (tobias.hanrath@cornell.edu)

Efficient energy storage technologies have been described as the Achilles' heel in our transition towards a sustainable energy portfolio that integrates inherently intermittent renewable energy sources like wind and solar. The infrastructure used to transmit, distribute and store chemical, electrical, and thermal energy is extensive, multiscale, and capital intensive. Coverage in this module includes thermal and mechanical energy storage, and electrical energy storage and conversion. Technologies evaluated include fuel cells, batteries, compressed air energy storage (CAES), pumped hydro, supercapacitors and flywheels. Emphasis will be placed on understanding technology options including their operating principles, development status, benefits, scaling limits, and life cycle environmental issues and costs. We will discuss challenges and opportunities for grid-level energy storage and the role of improved battery technologies in enabling the broader deployment of electric vehicles. (1 credit)

CHEME 6672, Electric Power: Economics, Operations and Sustainability

Lead instructors: Lindsay Anderson (cla28@cornell.edu) and Michal Moore (mcm337@cornell.edu)

Energy in many forms is a key pillar of modern society. The form most people recognize is electricity, the thread that ties economic activity, digital access and sustainable life styles together. Without electricity, modern civilization would not be possible. The operation, pricing and oversight of electricity systems, however, is not clearly understood by policy-makers, many academics and the public at large despite increasing public and regulatory interest in developing alternatives such as hydro, wind, geothermal, and solar. The challenge of electricity systems is a characteristic of high capital intensity, rigorous and constant management demands and unique regulatory and environmental oversight. We will address that challenge in this module by examining and reviewing the range of generation, transmission, and distribution characteristics that represent most electric systems. We will discuss the differences between so-called fossil fuel generation and renewable power and use this knowledge to frame the trade-offs between demand for electricity and environmental quality. We conclude by tying these to an overview of market structures, financing projects and regulatory requirements. (1 credit)

CHEME 6667/CEE 6667, Transportation Energy Systems

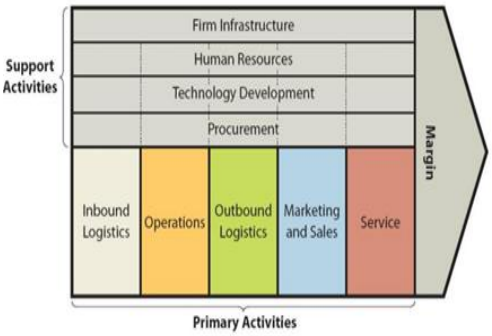
Lead instructor: Ricardo Daziano (daziano@cornell.edu)

The course focuses on understanding the link between transportation demand and energy consumption and on how to build a path for a conversion to sustainable energy sources. The objective of the course is to provide students the engineering systems tools for analyzing the interactions among the transportation, economic, energy, and environmental systems. Analytical tools from transportation economics and engineering will be covered to assess the energy consumption and environmental effects of long-term projects over complex, large-scale transportation systems. (1 credit)

CHEME 6640, Energy Economics

Lead instructor: Muqtadar Quraishi (maq22@cornell.edu)

Qualitative and quantitative examination of energy's evolving role in economic local, regional and global levels. What are the diverse drivers of energy supply and demand? How is their consumption forecast? How are energy resources priced? How do energy markets function? Can demand be shaped? How are renewable and non-renewable energy projects evaluated? Interplay between economics, energy, politics and sustainability. Many case studies. (3 credits)



CHEME 6641, Energy Value Chain

Lead instructor: Muqtadar Quraishi (maq22@cornell.edu)

Energy value and supply chain systems include oil, natural gas, coal, electricity, nuclear and renewables. Qualitative and quantitative review and analysis of end to end flow dynamics, drivers, optimization parameters, and influencing elements including regulations and technology. How is safety stock determined? What is an economic order quantity? Basic forecasting methods. Assessment of the linkages between different chains. Case studies. (1 credit)

CHEME 5870 / ECE 5870 / MAE 5459, Energy Seminar I

Lead instructors: Lynden Archer (laa25@cornell.edu) and Max Zhang (kz33@cornell.edu)

Energy resources, their conversion to electricity or mechanical work, and the environmental consequences of the energy cycle are discussed by faculty members from several departments in the university and by outside experts. Topics include energy resources and economics, coal-based electricity generation, nuclear reactors, solar power, energy conservation by users, and air pollution control. (1 credit)