Energy

Programs Offered

• Minor in Energy
• Area of Special Interest in Energy

The discovery, production, and use of energy in modern societies have profound and far-reaching economic, political, and environmental effects. As energy is one of Mines core statutory missions, several Mines departments have come together to offer Minor and Area of Special Interest (ASI) programs related to Energy. The 18-credit Energy Minor adds value to any Mines undergraduate degree program by not only addressing the scientific and technical aspects of energy production and use but its broader social impacts as well. The Energy Minor program is intended to provide engineering students with a deeper understanding of the complex role energy technology plays in modern societies by meeting the following learning objectives:

1. Students will gain a broad understanding of the scientific, engineering, environmental, economic and social aspects of the production, delivery, and utilization of energy as it relates to the support of current and future civilization both regional and worldwide.
2. Students will develop depth or breadth in their scientific and engineering understanding of energy technology.
3. Students will be able to apply their knowledge of energy science and technology to societal problems requiring economic, scientific, and technical analysis and innovation while working in a multidisciplinary environment and be able to communicate effectively the outcomes of their analyses in written and oral form

General CSM Minor/ASI requirements can be found here (catalog.mines.edu/undergraduate/undergraduateinformation/minorasi/).

Program Requirements

Minor in Energy
Minimum 18 hours required:

Required Courses (6 credit hours)
ENGY200 INTRODUCTION TO ENERGY 3.0
EBGN330 ENERGY ECONOMICS 3.0

Policy Course: Select at least one of the following (minimum 3 credit hours)
HASS490 ENERGY AND SOCIETY 3.0
HASS491 ENERGY POLITICS 3.0
HASS492 ENERGY AND SECURITY POLICY 3.0

Select the remaining electives from the following:

Social Sciences and Law
EBGN310 ENVIRONMENTAL AND RESOURCE ECONOMICS 3.0
EBGN340 ENERGY AND ENVIRONMENTAL POLICY 3.0
HASS419 ENVIRONMENTAL COMMUNICATION 3.0
HASS464 HISTORY OF ENERGY AND THE ENVIRONMENT 3.0
PEGN430 ENVIRONMENTAL LAW AND SUSTAINABILITY 3.0

All Energy Sources
CBEN469 FUEL CELL SCIENCE AND TECHNOLOGY 3.0
or MTGN469 FUEL CELL SCIENCE AND TECHNOLOGY 3.0
or MEGN469 FUEL CELL SCIENCE AND TECHNOLOGY 3.0
or MTGN469 FUEL CELL SCIENCE AND TECHNOLOGY 3.0

CBEN472 INTRODUCTION TO ENERGY TECHNOLOGIES 3.0
EENEG389 FUNDAMENTALS OF ELECTRIC MACHINERY 4.0
EENEG481 ANALYSIS AND DESIGN OF ADVANCED ENERGY SYSTEMS 3.0
EENEG489 COMPUTATIONAL METHODS IN ENERGY SYSTEMS AND POWER ELECTRONICS 3.0
ENGY497 SUMMER PROGRAMS 1-6
ENGY498 SPECIAL TOPICS 1-6
GEOL315 SEDIMENTOLOGY AND STRATIGRAPHY 3.0

Nuclear Energy
ENGY340 NUCLEAR ENERGY 3.0
NUGN506 NUCLEAR FUEL CYCLE 3.0
NUGN510 INTRODUCTION TO NUCLEAR REACTOR PHYSICS 3.0

Sustainable Energy
ENGY320 INTRO TO RENEWABLE ENERGY 3.0
ENGY350 GEOTHERMAL ENERGY 3.0
CEEN477 SUSTAINABLE ENGINEERING DESIGN 3.0
CHGN311 INTRODUCTION TO NANOSCIENCE AND NANOTECHNOLOGY 3.0
EENEG390 ENERGY, ELECTRICITY, RENEWABLE ENERGY, AND ELECTRIC POWER GRID 3.0
EENEG475 INTERCONNECTION OF RENEWABLE ENERGY, INTEGRATED POWER ELECTRONICS, POWER SYSTEMS, AND POWER QUALITY 3.0
EENEG589 DESIGN AND CONTROL OF WIND ENERGY SYSTEMS 3.0
PHGN419 PRINCIPLES OF SOLAR ENERGY SYSTEMS 3.0

Fossil Fuels
PEGN102 INTRODUCTION TO PETROLEUM INDUSTRY 3.0
ENGY310 INTRO TO FOSSIL ENERGY 3.0
CBEN480 NATURAL GAS HYDRATES 3.0
MGN438 GEOSTATISTICS 3.0
PEGN251 FLUID MECHANICS 3.0
PEGN305 COMPUTATIONAL METHODS IN PETROLEUM ENGINEERING 2.0
PEGN308 RESERVOIR ROCK PROPERTIES 3.0
PEGN450 ENERGY ENGINEERING 3.0

ENGYXXX Additional courses with energy content may be approved by the director or co-director of the energy minor.

The Area of Special Interest in Energy requires a minimum of 12 credit hours of acceptable course work:
ENGY200 INTRODUCTION TO ENERGY 3.0
EBGN330 ENERGY ECONOMICS 3.0
Two additional energy-related courses 6.0
Total Semester Hrs 12.0

Courses

ENGY200. INTRODUCTION TO ENERGY. 3.0 Semester Hrs.
Introduction to Energy. Survey of human-produced energy technologies including steam, hydro, fossil (petroleum, coal, and unconventional), geothermal, wind, solar, biofuels, nuclear, and fuel cells. Current and possible future energy transmission and efficiency. Evaluation of different energy sources in terms of a feasibility matrix of technical, economic, environmental, and political aspects. 3 hours lecture; 3 semester hours.

ENGY310. INTRO TO FOSSIL ENERGY. 3.0 Semester Hrs.
(I) Geothermal energy resources and their utilization, based on worldwide occurrences of resources and their classification, heat and temperature, extraction, processing, production, marketing, and finally to their end-use in society. Students will be introduced to the key technical concepts of flow through rock, the geothermal temperature and pressure gradients, hydrostatics, and structural statics as needed to understand the key technical challenges of mining, drilling, and production. Students will then be introduced to unconventional (emerging) fossil-based resources, noting the key drivers and hurdles associated with their development. Students will learn to quantify the societal cost and benefits of each fossil resource across the full course of exploitation and in a final project will propose or evaluate a national or global fossil energy strategy, supporting their arguments with quantitative technical analysis. 3 hours lecture; 3 semester hours.

ENGY320. INTRO TO RENEWABLE ENERGY. 3.0 Semester Hrs.
(I) Survey of renewable sources of energy. The basic science behind renewable forms of energy production, technologies for renewable energy storage, distribution, and utilization, production of alternative fuels, intermittency, natural resource utilization, efficiency and cost analysis and environmental impact. 3 hours lecture; 3 semester hours.

ENGY340. NUCLEAR ENERGY. 3.0 Semester Hrs.
(I) Survey of nuclear energy and the nuclear fuel cycle including the basic principles of nuclear fission and an introduction to basic nuclear reactor design and operation. Nuclear fuel, uranium resources, distribution, and fuel fabrication, conversion and breeding. Nuclear safety, nuclear waste, nuclear weapons and proliferation as well economic, environmental and political impacts of nuclear energy. 3 hours lecture; 3 semester hours.

ENGY350. GEOTHERMAL ENERGY. 3.0 Semester Hrs.
(I) Geothermal energy resources and their utilization, based on geoscience and engineering perspectives. Geoscience topics include world wide occurrences of resources and their classification, heat and mass transfer, geothermal reservoirs, hydrothermal geochemistry, exploration methods, and resource assessment. Engineering topics include thermodynamics of water, power cycles, electricity generation, drilling and well measurements, reservoir-surface engineering, and direct utilization. Economic and environmental considerations and case studies are also presented. 3 hours lecture; 3 semester hours.

ENGY501. ENERGY RESOURCES AND ELECTRIC POWER SYSTEMS. 3.0 Semester Hrs.
(I) This course will provide successful students a quantitative understanding of how fossil, renewable and nuclear energy resources are harnessed to electric power. A foundational underpinning will be the thermodynamics of energy conversion, using fundamental principles and language bridging physics, chemistry and engineering. Examples will be taken from both established and emerging technologies spanning solar, nuclear, wind fossil fuel and bioenergy conversion. Students will also learn how to analyze electricity generation, transmission, and grid-scale storage systems with a focus on the U.S. as a framework for analyzing other developing markets. 3 hours lecture; 3 semester hours.

ENGY502. ENERGY FOR TRANSPORTATION. 3.0 Semester Hrs.
(I) This course focuses on multiple aspects of current and proposed transportation technologies to analyze the challenges and opportunities of moving toward more sustainable transportation infrastructure. This course is designed to train students to develop analytical skills and to use computational tools for evaluating performance and environmental impacts of various vehicle and fueling technologies. Successful students will develop a framework for assessing energy resource requirements and environmental concerns within the context of technical performance, policy frameworks, and social perspectives. The course will include the following topics: travel demand and travel modes; transportation technologies; fossil-fuel and electric power plants and associated fuels; emissions (CO2 and pollutants) formation and impacts on air quality, climate, and human health; national/international transportation policy; and transportation planning. 3 hours lecture; 3 semester hours.

ENGY503. ENERGY SYSTEMS INTEGRATION AND EFFICIENCY. 3.0 Semester Hrs.
(I) This course will provide students with basic skills to analyze the operation and evolution of the electric grid and electricity utilization with a particular emphasis on trends toward increased renewable energy penetration. The course will develop students’ analytical skills to evaluate how electricity generation, transmission, distribution and storage are managed and controlled. Successful students will gain a basic understanding of electromechanical machines for power conversion and AC power distribution as well as renewable energy sources and battery systems with DC storage. The course will introduce students to how efficient energy utilization and demand response management impact the electric grid performance and electricity markets. An emphasis on managing energy loads in buildings, the commercial sector, and energy-intensive manufacturing will expose students to system-level modeling tools that can assess how to manage power demands with transient power generation and market forces. The course will also address the integrated nature of energy systems with an emphasis on connections to water demands and on risks arising due to cybersecurity and resiliency threats facing the electric grid. 3 hours lecture; 3 semester hours.

ENGY691. NREL ROTATION: ANALYSIS OF INTEGRATED ENERGY SYSTEMS. 3.0 Semester Hrs.
(I) This course introduces graduate students enrolled in the Advanced Energy Systems Program to research opportunities, culture, and expectations in energy science and technology with a particular emphasis on systems and/or policy analysis. Students will work within directorates at NREL with an emphasis on systems modeling, analysis, and/or integration. This class will engage students in a semester-long research project in energy system analysis and prepare students for best practices with respect to research project and data management, literature reading, report writing, and presentation. 1 hour lecture; 6 hours lab; 3 semester hours.
ENGY692. NREL ROTATION: ENERGY SCIENCE & TECHNOLOGIES.
3.0 Semester Hrs.
(I) This course prepares graduate students enrolled in the Advanced Energy Systems Program in research practices, culture, and expectations in energy science and technology with a particular emphasis on science and engineering related to energy materials, processes, and/or systems. Students will work within directorates at NREL with an emphasis on science and/or technology. This class will engage students in a semester-long research project in energy science and/or technology. Students will also learn and practice journal publication and research poster best practices, research career path planning, and proposal funding strategies. 1 hour lecture; 6 hours lab; 3 semester hours.

Professors
Reuben T. Collins, Physics Department Emeritus
Elizabeth Van Wie Davis, Humanities, Arts, and Social Sciences
Roderick G. Eggert, Division of Economics and Business
Linda Figueroa, Division of Environmental Science and Engineering
Greg S. Jackson, Mechanical Engineering
Mark P. Jensen, University Chair in Nuclear Science and Engineering
Manika Prasad, Petroleum Engineering
Angus A. Rockett, Professor of Metallurgical and Materials Engineering and Head of Department
Sridhar Seetharaman, Metallurgical and Materials Engineering
P.K. Sen, Electrical Engineering
Roel Snieder, Department of Geophysics, Keck Foundation Professor of Basic Exploration Science

Associate Professors
Kathleen Hancock, co-director, Division of Humanities, Arts, and Social Sciences
John Heilbrunn, Division of Humanities, Arts, and Social Sciences
Andrew M. Herring, Department of Chemical Engineering
Kathryn Johnson, Department of Mechanical Engineering
Masami Nakagawa, Department of Mining Engineering
Timothy R. Ohno, co-director
Marcelo Simoes, Division of Engineering
Neal Sullivan, Associate Professor
Eric Toberer

Assistant Professors
Eric Toberer, Department of Physics
Jeffrey C. King, Department of Metallurgical and Materials Engineering
Jeramy Zimmerman

Teaching Professors
Linda Battalora, Department of Petroleum Engineering
Charles Stone, Department of Physics

Teaching Associate Professors
Joseph Horan, Division of Humanities, Arts, and Social Sciences
John M. Persichetti, Department of Chemical Engineering