Graduate Minor Field: Sustainable Energy

Contacts: Curricular topics, contact DGS Paulette Clancy: 255-8656
Administrative or registrar topics, contact Shelby Clark-Shevalier, graduate programs office, School of Chemical and Biomolecular Engineering, 255-4550.

Summary: To meet the energy needs of not only the present global population but also the growing population of the world and the improving life styles of developing nations, without further impairing the natural environment and climate, is a grand challenge for the 21st century. Achievement of this goal requires the participation, ingenuity, and hard work of people from a great range of specialized activities, working collaboratively. Accordingly, the minor is intended to integrate scientific and engineering principles that focus on the creation, analysis and improvement of energy technologies, with knowledge of environmental systems potentially impacted by energy production, and with an understanding of human systems that are intertwined with energy-related decisions. An outcome of the minor should be an understanding of the ways in which those themes interact as a system, all of whose parts need to be understood and successfully integrated in order to progress toward meeting the world’s energy needs.

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Program Requirements:

1. Students have to be enrolled for an MS or PhD degree. Students enrolled in professional Masters students are not, at this time, eligible to participate in the minor.

2. At least one faculty member representing the minor field of Sustainable Energy is required to be a formal member of the student’s Special (Thesis) Committee.

3. Students enrolled in the minor will have to demonstrate, to the satisfaction of the faculty member representing the minor field of Sustainable Energy, that they have an adequate understanding of the area pertaining to Sustainable Energy. For students in PhD
programs, this will be demonstrated as part of their Admission to Candidacy examination, typically in the form of an oral examination. For MS students, this mastery will be demonstrated by completion of coursework (see item 4). The representative of the minor field in Sustainable Energy may also test the student’s knowledge at the final thesis defense examination.

4. All students enrolled in the minor are required to take a minimum of three energy-related courses (at least 9 credit hours), as specified on the Graduate School’s web site. These three (or more) courses must be taken from lists of approved courses in three topical areas:

(i) at least one foundational core course in sustainable energy systems
(ii) at least one course related to Energy Sources and Technologies for a Transition to Sustainability
(iii) at least one course related to environmental, policy, economic, business, political, ethical, and/or social consequences.

As a guide for students and minor field faculty, we have provided below the course numbers and titles of around 40 courses that could provide breadth in sustainable energy that we believe constitutes a firm foundation of comprehension of the area. Our goal in making these course suggestions is to allow a broad range of students from many fields and colleges to obtain a graduate minor in Sustainable Energy. Students are encouraged to take more than the minimum number of courses.

Approved Courses

i. Required Sustainable Energy Core Course in Energy Systems Analysis

All students taking the Sustainable Energy minor must take one of the following courses that emphasize an integrated or systems-like approach to the consideration of energy systems analysis.

   AEM 4510 Environmental Economics (pre-req.: intermediate microeconomics)
   BEE 4870 Sustainable Bioenergy Systems (pre-req.: thermodynamics)
   CHE 6660 Analysis of Sustainable Energy Systems (no pre-req.; thermodynamics knowledge recommended)
   EAS 4010/5010 Fundamentals of Energy and Mineral Resources (previous course in geology recommended)
   CHEME 6640 Energy Economics (no pre-req.; thermodynamics knowledge recommended)
   MAE 4000 Components and Systems: Engineering in a Social Context (offered alternate years, next expected Fall 2011; pre-req.: two yrs College physics)
   MAE 5010 Future Energy Systems (pre-req.: thermodynamics; knowledge of fluid mechanics recommended)
   ORIE 4150 Economic Analysis of Engineering Systems (no pre-req.)
   SYSEN 5100 Applied Systems Engineering (no pre-req.)
ii. Energy Sources and Technologies for a Transition to Sustainability

Traditional sources:
EAS 4010/5010 Fundamentals of Energy and Mineral Resources
CHEME 5204/5206/5207 Turbomachinery/ Petrochemicals: From Rocks to Docks/ Petroleum Refining (series of three 1-credit hour courses)
CHEME 6650 Energy Engineering
CHEME 4130 Intro to Nuclear Science and Engineering (also AEP/ ECE/ MAE/ NSE/ TAM 4130)
CHEME 6665-6666 are 1-credit modules associated with CHEME 6660 but which can be taken as stand-alone modules.
  CHEME 6665 Geological Carbon Sequestration
  CHEME 6666 Unconventional Natural Gas Development from Shale Formations
MAE 4490 Combustion Engines and Fuel Cells
MAE 4580 Intro to Nuclear Science (also ECE 4130)
MAE 4590 Nuclear Fusion (also NSE 4840)
MAE 5430 Combustion Processes
MAE 6560 Nanoscale Energy Transport & Conversion
MSE 4330 Materials for Energy Production, Storage & Conversion
NSE 6330 Nuclear Reactor Engineering

Renewable sources:
CEE 6200 Water-Resources Systems Engineering
CHEME 6661-6664 are 1-credit modules associated with CHEME 6660 but which can be taken as stand-alone modules.
  CHEME 6661 Biofuels
  CHEME 6662 Wind and Wave Energy
  CHEME 6663 Geothermal Energy
  CHEME 6664 Solar Energy
BEE/EAS 4940 Geoengineering of climate warming
ECE 4510 Electric Power Systems I
ECE 4520 Electric Power Systems II
ECE 4840 Intro to Controlled Fusion
MAE 4020 Wind Power
MAE 4040 Materials Selection for Clean Mechanical Designs
MAE 4140 Mechanics of Lightweight Vehicles
SYSEN 4100 Applied Systems Engineering
SYSEN 4200 Systems Analysis Architecture, Behavior and Optimization

iii Environmental and Social Impacts

AEM 4510 Environmental Economics
BEE/EAS 4880 Our Changing Atmosphere: Global Change and Atmospheric Chemistry
BEE 4900 Biofuels
BEE/EAS 4940 Geoengineering of climate warming
BEE 6740 Ecohydrology
Examples of Typical Student Course Fulfillment of the Minor

Example 1: Typical Student Curriculum (starting the minor in the Fall):
- Fall (Year 1 of starting the minor): BEE 4870 Bioenergy Systems
- Spring (year 1): CEE 6200 Water Resources.
- Fall (year 2): MAE 5430 Combustion Processes

Example 2: Typical Student Curriculum (starting the minor in the Spring):
- Spring (Year 1 of starting the minor): AEM 4510 Environmental Economics
- Fall (year 2): MAE 5020 Wind Power
- Spring (year 2): CHEME 6610 Air Pollution Control

Example 3: Typical Student Curriculum (starting the minor in the Fall):
- Fall (Year 1 of starting the minor): CHEME 6660 Analysis of Sustainable Energy Systems
- Fall (year 2): MAE 4020 Wind Power
- Fall (year 3): EAS 4400 Climate Science, Impacts and Mitigation
Minor Graduate Field Faculty for Sustainable Energy

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*GFA:* Shelby Clark-Shevalier, Chemical & Biomolec. Engr., 255-4550, sjc14@cornell.edu

The faculty listed in the table below are members of the minor graduate field in Sustainable Energy.

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<thead>
<tr>
<th>Minor Field Faculty (alphabetical order)</th>
<th>Primary Field Affiliation</th>
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<th>Primary Field Affiliation</th>
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<tr>
<td>Richard Allmendinger</td>
<td>GS</td>
<td>David Hammer</td>
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<td>Lars Angenent</td>
<td>BEE</td>
<td>Tobias Hanrath</td>
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<td>Lynden Archer</td>
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<td>Richard Hennig</td>
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<td>A. Brad Anton</td>
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<td>Anthony Ingraffea</td>
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<td>Susan Christopherson</td>
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<td>Paulette Clancy</td>
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<td>Larry Walker</td>
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<td>Zellman Warhaft</td>
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