Sustainable Energy

The U.S. is undergoing an historic transition of its energy system in order to decarbonize and help mitigate the worst effects of global climate change. Optimistically, the electrical system will become largely based on renewable and sustainable sources in the next ten years, and major energy consumption sectors of transportation, residential and commercial buildings, and industrial production will electrify and approach net-zero carbon emissions around 2050. These controversial changes constitute complex transitions in economic, political, and regulatory alignments along with technological innovation and continuing scientific advances. There is an urgent and growing need for technically and scientifically literate practitioners who can join cross-disciplinary teams working in both the public and private sectors to craft transition pathways and help deploy sustainable energy systems. The Sc.M. in Sustainable Energy challenges students to integrate knowledge across a wide range of science, engineering, policy, and business topics, develop a focused expertise in one aspect of sustainable energy systems, and prepare to enter or re-enter a career path directly impacting the progress of electrification and decarbonization.

Core Courses (To be approved after program approval)

The core of the Sc.M. in Sustainable Energy is envisioned as 3 new required and customized 2000-level courses. One of these is structured as 2 “ristretto” mini-courses, each being a one-half-credit module. Together, these 3 courses aim to condense a large body of cross-disciplinary material into a cohesive foundation for would-be practitioners. In general, we are building a future-focused framework; not just collecting what is known today and practiced today, but instead positing pathways that conceptualize and exhibit how the energy system could evolve in the next 2-3 decades, driven by climate mitigation goals and technology investments. All students shall take all 3 courses, in the same sequence, at least initially.

ENGN 2XX1: Sustainable Energy Science and Technology (graduate enrollment in ENGN 1932P; Andrew Peterson, SoE). Students will learn the fundamental thermodynamics of energy conversions, as well as the tools to analyze energy technologies. The course will cover the basic science of greenhouse-gas induced climate change, and analyze energy technologies in terms of the trade-offs involved in emissions, cost, scalability, land use, and resource ability.

ENGN 2XX2A: Policy and Economics of Energy Transitions (Dr. Kathryn Chelminski, Lawrence Berkeley National Laboratory). This ½-credit module provides an intensive overview of the policy and economic processes involved in the clean energy transition, with examples drawn from the U.S. as well as the world. Technological feasibility is necessary but not sufficient for the successful decarbonization of energy systems. Empirical social science documents the political factors that matter for climate policy outcomes, such as special interest groups, costs to develop and deploy renewable energy systems, preferences for clean energy, and measures and perceptions of distributive justice associated with transitions. Through weekly readings from current research, policy, regulatory and other sources, students encounter a diverse set of perspectives and issues arising in the planning and implementation of energy projects and their technical and societal impacts. Weekly writing assignments require synthesizing key learnings, reviewing relevant regulatory docket orders, and connecting to the major concepts presented in class. Students will complete a final research paper including interviews with industry experts, or an essay exam based on class themes.

ENGN 2XX2B: Energy and Climate Systems Modeling (Dr. Jun Ukita Shepard, U.S. Department of Energy, Office of Policy). This ½-credit module examines global energy systems from a variety of technological and economic perspectives: technological transitions, renewable energy markets, climate science, and the complex relationship between energy consumption and climate change negotiations.

ENGN 2XX3: Electrification and Decarbonization (Rod Beresford, School of Engineering) Demand for electricity is surging and will continue to grow to as much as 2 or 3 times current capacity, as combustion energy sources are retired in favor of renewable sources in the transportation, buildings, and industrial sectors. Students will learn the fundamentals of the electrical grid in the U.S., including its history, ownership and regulatory structure, physics, and economics. The emphasis is on how the traditional and risk-averse focus on reliability and low cost can evolve in the decarbonization transition, expanding to target a smarter, more resilient, and more equitable set of societal goods.

Existing Engineering and Physical Science Courses

For their remaining 5 courses in the 1-year / 8-credit program, students shall select one focus area consisting of at least 3 related courses, with the remaining courses being free electives. In all cases, students consult with the Program Director in choosing from among existing Brown courses, including those comprising the following focus areas:

Energy Conversion Processes, Components, and Systems (at least 3 courses)

CHEM 1560N	Organometallic Chemistry	1
CHEM 1560S	The Chemistry of Polymeric Organic Materials	1
CHEM 1700	Nanoscale Materials: Synthesis and Applications	1
CHEM 2320	Solid State Chemistry	1
EEPS 2410	Kinetics of Geochemical Processes (Other 2000-level courses with approval)	1
ENGN 1130	Chemical Engineering Thermodynamics	1
ENGN 1931A	Photovoltaics Engineering	1
ENGN 1931P	Energy and the Environment	1
ENGN 2830	Compressible Fluid Flow	1
ENGN 2920H	Materials and Interfaces for Energy Storage Devices	1
PHYS 1530	Thermodynamics and Statistical Mechanics	1
PHYS 2140	Statistical Mechanics	1
PHYS 2410	Solid State Physics I	1
PHYS 2600	Computational Physics	1
Other 2000 level courses with approval		

Energy and Environment: Economics and Policy of Systems in Transition (At least 3 courses)

ECON 1110	Intermediate Microeconomics	1
or ECON 1130	Intermediate Microeconomics (Mathematical)	
ECON 1210	Intermediate Macroeconomics	1
ECON 1350	Environmental Economics and Policy	1
ECON 1355	Environmental Issues in Development Economics	1
ECON 1480	Public Economics	1
ECON 1490	Designing Internet Marketplaces	1
EEPS 1400	Climate Modeling I	1
EEPS 2410	Kinetics of Geochemical Processes	1
ENGN 2920H	Materials and Interfaces for Energy Storage Devices	1
ENGN 1931P	Energy and the Environment	1
POLS 1435	Politics of Climate Change	1
PHP 1730	Climate Risks and Health Solutions	1
PHP 1855	Infectious Disease Modeling	1
PHYS 2410	Solid State Physics I	1
PHYS 2600	Computational Physics	1
SOC 1315	Macro-Organizational Theory: Organizations in Social Context	1
SOC 2385	Environmental Sociology	1
Other 2000-level course with approval		