Energy and Resources

Minor

The Energy and Resources Group (ERG) is an academic unit within the University of California, Berkeley. Our vision is a future in which the twin goals of human well-being and a healthy environment are mutually and sustainably satisfied. ERG's mission is to develop and transmit the critical knowledge needed to make such a future possible. We view society and the environment as an inextricably coupled system. ERG research, therefore, emphasizes (1) science-based knowledge of the environmental consequences of resource use; (2) analytical tools that promote efficiency, conservation, affordability and equity in energy and resource use patterns; and (3) a deep understanding of the social and institutional contexts in which resource and environmental problems arise, and in which creative and ethical solutions can be sustained. It is this synthesis of basic science, practical problem-solving and constructive social critique that defines ERG.

The ERG Minor offers undergraduates the opportunity to develop basic knowledge and skills to help them address the complex and interdependent issues associated with the interaction of social, economic, political, technical, and environmental factors. Though it is primarily designed to complement majors in the natural sciences and engineering, students in any major with the appropriate prerequisites may pursue the ERG minor. Based on a six-course set of prerequisites in mathematics and natural sciences, the minor is satisfied by completing five upper division courses, including two core courses and three electives.

The Energy and Resources Group is responsible for monitoring the minor program and will designate one faculty member as the head ERG minor adviser. It is the undergraduate academic adviser who will be charged with certifying completion of the minor. All core faculty members will participate in advising students in the minor, just as they do graduate students.

Declaring the Minor

Students interested in pursuing the ERG minor should submit an Intent to Declare the ERG Minor form the semester in which upper division ERG minor coursework is started. The department maintains a list of students pursuing the minor to keep students informed about any ERG-related opportunities or course offerings that arise. Students completing the ERG minor are also given a special mention during the ERG commencement ceremony in May.

For information on how to submit your intent to pursue the minor, review how the lower division prerequisites may be completed with AP, IB, or A-Level exams, and declare the minor once completed, please visit the ERG website (http://erg.berkeley.edu/academics/program/#undergrad).

Students who have a strong interest in an area of study outside their major often decide to complete a minor program. These programs have set requirements and are noted officially on the transcript in the memoranda section, but they are not noted on diplomas.

General Guidelines

1. All courses taken to fulfill the minor requirements below must be taken for graded credit.
2. A minimum grade point average (GPA) of 2.0 is required for courses used to fulfill the minor requirements.
3. No more than one upper division course may be used to simultaneously fulfill requirements for a student's major and minor programs.

Lower Division Prerequisites

Some of the lower division prerequisites for the ERG minor can be satisfied with Advanced Placement, International Baccalaureate and other transfer credit. Please visit the ERG Minor Website (http://erg.berkeley.edu/academics/program/#undergrad) for more information.

Lower division prerequisites (six courses):

CHEM 1A	General Chemistry [Chem 1AL not required]	3-4
or CHEM 4A	General Chemistry and Quantitative Analysis	
BIOLOGY 1B	General Biology Lecture and Laboratory	4
Select one math sequence from the following:		
MATH 16A & MATH 16B	Analytic Geometry and Calculus and Analytic Geometry and Calculus	
MATH 1A & MATH 1B	Calculus and Calculus	
Select one physics sequence from the following:		
PHYSICS 8A & PHYSICS 8B	Introductory Physics and Introductory Physics	
PHYSICS 7A & PHYSICS 7B	Physics for Scientists and Engineers and Physics for Scientists and Engineers	

Upper Division Requirements

Upper division requirements (five courses):

Two core courses:	
ENE,RES C100/ PUB POL C184	Energy and Society
ENE,RES 102	Quantitative Aspects of Global Environmental Problems
Three upper division electives, approved by the ERG faculty (see below):	
At least one course must be in the social sciences.	
At least one course must be in the natural sciences or engineering.	
At one of the three upper division electives must be from the ERG department.	

Electives

The choice of electives should be made with two goals in mind: exploring the range of approaches available to address energy and resource issues and complementing the student's major. The latter can be achieved by adding relevant depth in closely related areas or by exploring methods and approaches that contrast with the tools and knowledge base employed in the major. Students are encouraged to discuss their program with the ERG faculty.

The following courses have been approved, but students should contact the the head ERG minor adviser to request approval of alternate courses. At least four upper division courses must be taken at Berkeley.

Social science electives

ENE,RES/ ENVECON/IAS C176	Climate Change Economics	4
ENE,RES 175	Water and Development	4
ENE,RES 180	Ecological Economics in Historical Context	3
ECON/ ENVECON C102	Natural Resource Economics	4
ECON C171/ ENVECON C151	Economic Development	4
ESPM 102D	Climate and Energy Policy	4
ESPM 155AC	Sociology and Political Ecology of Agro-Food Systems	4
ESPM 160AC/ HISTORY 120AC	American Environmental and Cultural History	4
ESPM 161	Environmental Philosophy and Ethics	4
ESPM 168	Political Ecology	4
ESPM 169	International Environmental Politics	4
Natural science and engineering electives		
ENE,RES 101	Ecology and Society	3
CIV ENG 103	Introduction to Hydrology	3
CIV ENG 107	Climate Change Mitigation	3
CIV ENG 111	Environmental Engineering	3
CIV ENG 114	Environmental Microbiology	3
CIV ENG 115	Water Chemistry	3
EPS 117	Geomorphology	4
ESPM 111	Ecosystem Ecology	4
ESPM 112	Microbial Ecology	3
ESPM 120	Soil Characteristics	3
ESPM/EPS C129	Biometeorology	3
ESPM 131	Soil Microbial Ecology	3
ESPM 140	General Entomology	4
ESPM/ EPS C180/ CIV ENG C106	Air Pollution	3
INTEGBI 106A	Physical and Chemical Environment of the Ocean	4
INTEGBI 152	Environmental Toxicology	4
INTEGBI 153	Ecology	3
INTEGBI 157LF	Ecosystems of California	4
Other electives		
ENE,RES 190	Seminar in Energy and Resources Issues	3
CY PLAN 119	Planning for Sustainability	3
ESPM 118	Agricultural Ecology	3

Energy and Resources

ENE,RES 24 Freshman Seminar 1 Unit

Terms offered: Fall 2015, Spring 2012, Spring 2011
The Freshman Seminar Program has been designed to provide new students with the opportunity to explore an intellectual topic with a faculty member in a small-seminar setting. Freshman Seminars are offered in all campus departments, and topics may vary from department to department and semester to semester.
Freshman Seminar: Read More [+]
Rules & Requirements

Repeat rules: Course may be repeated for credit when topic changes. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 1 hour of seminar per week

Additional Details

Subject/Course Level: Energy and Resources Group/Undergraduate

Grading/Final exam status: The grading option will be decided by the instructor when the class is offered. Final exam required.

Freshman Seminar: Read Less [-]

ENE,RES 39A Freshman and Sophomore Seminar: Complex Systems, Information Theory, and Big Data 2 Units

Terms offered: Fall 2016
Freshman and sophomore seminars offer lower division students the opportunity to explore an intellectual topic with a faculty member and a group of peers in a small-seminar setting. These seminars are offered in all campus departments; topics vary from department to department and from semester to semester. Enrollment limits are set by the faculty, but the suggested limit is 25.
Freshman and Sophomore Seminar: Complex Systems, Information Theory, and Big Data: Read More [+]
Hours & Format

Fall and/or spring: 15 weeks - 2 hours of seminar per week

Additional Details

Subject/Course Level: Energy and Resources Group/Undergraduate

Grading/Final exam status: Letter grade. Final exam not required.

Instructor: John Harte

Freshman and Sophomore Seminar: Complex Systems, Information Theory, and Big Data: Read Less [-]

ENE,RES 98 Directed Group Study for Lower Division Students 1 - 4 Units

Terms offered: Fall 2018, Fall 2017, Fall 2016
Lectures and small group discussions focusing on topics of interest that vary from semester to semester.
Directed Group Study for Lower Division Students: Read More [+]

Rules & Requirements

Credit Restrictions: Enrollment is restricted; see the Introduction to Courses and Curricula section of this catalog.

Repeat rules: Course may be repeated for credit under special circumstances: Course may be repeated with consent of department.Course may be repeated with consent of department.

Hours & Format

Fall and/or spring: 15 weeks - 1-4 hours of directed group study per week

Additional Details

Subject/Course Level: Energy and Resources Group/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

Directed Group Study for Lower Division Students: Read Less [-]

ENE,RES 99 Supervised Independent Studies for Freshmen and Sophomores 1 - 4 Units

Terms offered: Fall 2018, Fall 2017, Fall 2016
Supervised research on specific topics related to energy and resources.
Supervised Independent Studies for Freshmen and Sophomores: Read More [+]

Rules & Requirements

Prerequisites: Consent of faculty adviser directing research; lower division standing (3.3 GPA or better)

Credit Restrictions: Enrollment is restricted; see the Introduction to Courses and Curricula section of this catalog.

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1-4 hours of independent study per week

Additional Details

Subject/Course Level: Energy and Resources Group/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

Supervised Independent Studies for Freshmen and Sophomores: Read Less [-]

ENE,RES C100 Energy and Society 4 Units

Terms offered: Fall 2018, Summer 2018 10 Week Session, Fall 2017
Energy sources, uses, and impacts: an introduction to the technology, politics, economics, and environmental effects of energy in contemporary society. Energy and well-being; energy in international perspective, origins, and character of energy crisis.
Energy and Society: Read More [+]

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Summer:
8 weeks - 6 hours of lecture and 1.5 hours of discussion per week
10 weeks - 6 hours of lecture and 1.5 hours of discussion per week

Additional Details

Subject/Course Level: Energy and Resources Group/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Kammen

Also listed as: PUB POL C184

Energy and Society: Read Less [-]

ENE,RES 101 Ecology and Society 3 Units

Terms offered: Summer 2018 8 Week Session, Summer 2017 8 Week Session, Fall 2014
This course introduces students to the many ways in which our lives are intertwined with the ecosystems around us. Topics will include ecological limits to growth, climate change and other threats to biodiversity, the value of ecosystem goods and services, the ecology of disease, ecotoxicology, the evolution of cooperation in ecosystems, industrial ecology, and the epistemology of ecology.
Ecology and Society: Read More [+]

Rules & Requirements

Prerequisites: One college level course, or high school Advanced Placement, in either physics or biology; introductory calculus

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Summer:
6 weeks - 7.5 hours of lecture per week
8 weeks - 6 hours of lecture per week

Additional Details

Subject/Course Level: Energy and Resources Group/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: TBA

Ecology and Society: Read Less [-]

ENE,RES 102 Quantitative Aspects of Global Environmental Problems 4 Units

Terms offered: Spring 2018, Spring 2017, Spring 2016
Human disruption of biogeochemical and hydrological cycles; causes and consequences of climate change and acid deposition; transport and health impacts of pollutants; loss of species; radioactivity in the environment; and quantitative models to understand these environmental problems.
Quantitative Aspects of Global Environmental Problems: Read More [+]
Objectives Outcomes

Course Objectives: Application of basic principles of natural science to the analysis of human influence on environmental conditions and processes at continental to global scale. Topics covered include dimensions of the physical world and of human modifications of it; techniques of estimation and back of the envelope calculation; box models of environmental stocks and flows: equilibrium and feedback; chemical equilibria in the environment; nutrient cycles and their disruptions; acid deposition and its consequences; climate change and its consequences; stratospheric ozone depletion; sources, fate and effects of toxic substances in the global environment; radioactivity and radiation; macroecology; carrying capacity and human population growth; biodiversity and its diminution; epidemics.

Student Learning Outcomes: Students will also have gained insight into the multi-disciplinary nature of environmental science, having used physical, chemical, and biological principles to create and solve analytical models.
Students will be familiar with and able to apply a diverse set of quantitative tools for understanding and analyzing environmental problems.

Rules & Requirements

Prerequisites: Upper division standing; calculus (Mathematics 1A-1B or 16A-16B); Physics (7A-7B or 8A-8B), Chemistry (1A or 4A), Biology (1B), or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 2 hours of laboratory per week

Summer: 8 weeks - 6 hours of lecture and 4 hours of laboratory per week

Additional Details

Subject/Course Level: Energy and Resources Group/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Kueppers

Quantitative Aspects of Global Environmental Problems: Read Less [-]

ENE,RES 170 Environmental Classics 3 Units

Terms offered: Summer 2018 Second 6 Week Session, Fall 2011, Fall 2009
What is the history and evolution of environmental thinking and writing in the USA? How have certain ‘environmental classics’ shaped the way in which we think about nature, society and progress? Why did these become ‘classics’ and why/how did they influence environmental thought and policy? What is their relevance today? This course includes substantial reading assignments.
Environmental Classics: Read More [+]
Objectives Outcomes

Course Objectives: This 6-week course will use a selection of books and papers from the last 6 decades that have had a profound impact on academic and wider public thinking -- primarily in the USA -- about the environment and society to probe these issues. In class, we will situate the key reading in its historical context and discuss its contributions, critiques and consequences. Through these classics the class will explore: the evolution of environmental thought; the connections between environment, perception and policy; and the links between scientific thought and public perception.

Hours & Format

Summer: 6 weeks - 6 hours of seminar per week

Additional Details

Subject/Course Level: Energy and Resources Group/Undergraduate

Grading/Final exam status: Letter grade. Alternative to final exam.

Instructor: TBA

Environmental Classics: Read Less [-]

ENE,RES 175 Water and Development 4 Units

Terms offered: Spring 2016, Spring 2014, Spring 2013
This course introduces students to water policy in developing countries. It is a course motivated by the fact that over one billion people in developing countries have no access to safe drinking water, three billion do not have sanitation facilities, and many millions of small farmers do not have reliable water supplies to ensure a healthy crop. Readings and discussions will cover: the problems of water access and use in developing countries; the potential for technological, social, and economic solutions to these problems; the role of institutions in access to water and sanitation; and the pitfalls of the assumptions behind some of today's popular "solutions."
Water and Development: Read More [+]
Rules & Requirements

Prerequisites: Upper division standing or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Energy and Resources Group/Undergraduate

Grading/Final exam status: Letter grade. Alternative to final exam.

Instructor: ERG Faculty

Water and Development: Read Less [-]

ENE,RES C176 Climate Change Economics 4 Units

Terms offered: Fall 2018, Fall 2017, Fall 2016
This course is a self-contained introduction to the economics of climate change. Climate change is caused by a large variety of economic activities, and many of its impacts will have economic consequences. Economists have studied climate change for more than two decades, and economic arguments are often powerful in policy decisions. The course will familiarize students with these arguments and equip them with the tools to participate in discussions of climate change policy through an economic lens.
Climate Change Economics: Read More [+]
Objectives Outcomes

Course Objectives: The course will start with a brief review of the science of climate change, discuss scenarios of economic growth and the greenhouse gas emissions caused by economic activities and investigate various emission reduction opportunities and their economic costs. A significant amount of time will be spent on studying the impacts of climate change, their economic evaluation and how adaptation can lower the costs of climate damages.

We will then study various theoretical frameworks economists have developed that answer the question how estimates about the costs and benefits of climate policy can be combined to find “good” climate policies. We then study three more specialized topics that turn out to be of great importance when analyzing climate change policy: first, how do we compare costs and benefits of generations that live many centuries apart? Second, how do we design climate policy when our projections of both the costs and the benefits of climate policy are highly uncertain? And third, how can equity considerations be accounted for in an economic assessment of climate change policy? The course will close with a look at international cooperation on climate policy and why it has been so difficult to agree on effective treatises that implement climate change policy.

Student Learning Outcomes: Students will also have gained insight into the practical aspects of modeling the economics of climate change by building a simple integrated assessment model in Excel. They will be able to use that model to do simple analysis of climate change policy themselves.
Students will be familiar with the tools economists use to analyze climate change policy. They will have studied empirical estimates of the costs and benefits of climate policy and have an understanding of the analytical issues that drive research on the economics of climate change.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 2 hours of laboratory per week

Summer: 8 weeks - 6 hours of lecture and 4 hours of laboratory per week

Additional Details

Subject/Course Level: Energy and Resources Group/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Anthoff

Also listed as: ENVECON C176/IAS C176

Climate Change Economics: Read Less [-]

ENE,RES N176 Economics of Climate Change 3 Units

Terms offered: Summer 2018 8 Week Session
This course is a self-contained introduction to the economics of climate change. Climate change is caused by a large variety of economic activities, and many of its impacts will have economic consequences. Economists have studied climate change for more than two decades, and economic arguments are often powerful in policy decisions. The course will familiarize students with these arguments and equip them with the tools to participate in discussions of climate change policy through an economic lens. NOTE this summer course does NOT satisfy the EEP Major requirements that the 4-unit course ENERES C176/ ENVECON C176/IAS C176 that is offered in the regular academic spring/fall terms. Repeating this course under the C176 course number restricted.
Economics of Climate Change: Read More [+]
Objectives Outcomes

Student Learning Outcomes: Students will be familiar with the tools economists use to analyze climate change policy. They will have studied empirical estimates of the costs and benefits of climate policy and have an understanding of the analytical issues that drive research on the economics of climate change.

Rules & Requirements

Credit Restrictions: Not repeatable under this course number or ENERES C176, ENVECON C176, or IAS C176.

Hours & Format

Summer: 8 weeks - 6 hours of lecture per week

Additional Details

Subject/Course Level: Energy and Resources Group/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: TBA

Economics of Climate Change: Read Less [-]

ENE,RES 180 Ecological Economics in Historical Context 3 Units

Terms offered: Fall 2016
Economists through history have explored economic and environmental interactions, physical limits to growth, what constitutes the good life, and how economic justice can be assured. Yet economists continue to use measures and models that simplify these issues and promote bad outcomes. Ecological economics responds to this tension between the desire for simplicity and the multiple perspectives needed to understand complexity in order to move toward sustainable, fulfilling, and just economies.
Ecological Economics in Historical Context: Read More [+]
Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Summer:
6 weeks - 7.5 hours of lecture per week
8 weeks - 6 hours of lecture per week

Additional Details

Subject/Course Level: Energy and Resources Group/Undergraduate

Grading/Final exam status: Letter grade. Alternative to final exam.

Ecological Economics in Historical Context: Read Less [-]

ENE,RES 190 Seminar in Energy and Resources Issues 3 Units

Terms offered: Summer 2018 Second 6 Week Session, Spring 2018, Spring 2017
Critical, cross disciplinary analysis of specific issues or general problems of how people interact with environmental and resource systems.
More than one section may be given each semester on different topics depending on faculty and student interest.
Seminar in Energy and Resources Issues: Read More [+]
Rules & Requirements

Prerequisites: Upper division standing and consent of instructor

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1-3 hours of lecture per week

Summer:
6 weeks - 7.5 hours of lecture per week
8 weeks - 2-6 hours of lecture per week

Additional Details

Subject/Course Level: Energy and Resources Group/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Seminar in Energy and Resources Issues: Read Less [-]

ENE,RES 190C Energy and Environmental Issues 4 Units

Terms offered: Fall 2018
Critical, data-driven analysis of specific issues or general problems of how people interact with environmental and resource systems. This course will teach students to build, estimate and interpret models that describe phenomena in the broad area of energy and environmental decision-making. More than one section may be given each semester on different topics depending on faculty and student interest.
Energy and Environmental Issues: Read More [+]
Rules & Requirements

Prerequisites: 1. Foundations of Comp Sci:
COMPSCI C8 or STAT C8 or INFO C8: Foundations of Data Science

2. Computing:
COMPSCI 61A: The Structure and Interpretation of Computer Programs
or
COMPSCI 88: Computational Structures in Data Science

3. Math:
MATH 54: Linear Algebra and Differential Equations
or
ELENG 16A: Designing Information Devices and Systems I
or
STAT 89A: Linear Algebra for Data Science

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 2 hours of laboratory per week

Additional Details

Subject/Course Level: Energy and Resources Group/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Energy and Environmental Issues: Read Less [-]

ENE,RES 198 Directed Group Studies for Advanced Undergraduates 1 - 4 Units

Terms offered: Spring 2016, Fall 2015, Fall 2014
Group studies of selected topics.
Directed Group Studies for Advanced Undergraduates: Read More [+]
Rules & Requirements

Prerequisites: Upper division standing, plus particular courses to be specified by instructor

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1-4 hours of directed group study per week

Additional Details

Subject/Course Level: Energy and Resources Group/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

Directed Group Studies for Advanced Undergraduates: Read Less [-]

ENE,RES 199 Supervised Independent Study and Research 1 - 4 Units

Terms offered: Fall 2018, Fall 2017, Summer 2017 8 Week Session
Individual conferences.
Supervised Independent Study and Research: Read More [+]
Rules & Requirements

Prerequisites: Enrollment restricted by regulations in General Catalog

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1-4 hours of independent study per week

Summer: 8 weeks - 1.5-15 hours of independent study per week

Additional Details

Subject/Course Level: Energy and Resources Group/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

Supervised Independent Study and Research: Read Less [-]