

Energy and Resources

About the Energy and Resources Group

The mission of the Energy and Resources Group is research and teaching towards a sustainable environment and a just society. The Energy and Resources Group is a collaborative community of graduate students, core faculty, 200 affiliated faculty and researchers across the campus, and more than 600 alumni across the globe. The Energy and Resources Group provides advanced training in interdisciplinary analysis and research with the goal of creating transformative knowledge for the planet and its people.

As one of the first interdisciplinary programs in the field, Energy and Resources faculty and students have established an impressive track record of undertaking engaged, cutting-edge research and turning these ideas into effective actions from local to global levels.

Courses cover current developments in the field and emphasize a variety of disciplinary perspectives and methodologies: core areas include economics, social sciences, engineering, humanities, and environmental sciences.

Ph.D. in Energy and Resources

The Energy and Resources Group admits highly qualified applicants into the Ph.D. program, designed to support and empower doctoral students to pursue rigorous, interdisciplinary, and original research in the fields of energy, resources, and the environment. The Ph.D. Degree in Energy and Resources is typically completed four years beyond the Master's Degree.

Master's Degrees in Energy and Resources (M.A. or M.S.)

The Energy and Resources Master's Degree is a two-year program designed to educate the next generation of interdisciplinary leaders. The curriculum is intended to serve those students for whom the Master's Degree will be the final formal education in support of a professional career. It also serves as an interdisciplinary foundation for doctoral students preparing for dissertation research.

Students are taught the range of methods and subjects that they should be able to understand, advance, and critique, in order to address critical challenges stemming from the interaction of humans and the environment. To that end, the requirements for the Energy and Resources Master's Degree are both broad and deep, stressing analytic, theoretical, and practical approaches to problems in energy, resources, and the environment.

The course requirements provide for a substantive introduction to the disciplinary approaches that are employed in studying energy and resource issues. These approaches are codified as the A-F Breadth Requirements. For more detail on the A-F requirements please go to <https://erg.berkeley.edu/>

The program also ensures experience in interdisciplinary analysis applied to key resource concerns. The curriculum provides an opportunity, through a topical course cluster and an independent capstone project, to extend and deepen the areas of investigation and understanding to satisfy the intellectual interests of each student.

Concurrent Master's Degree of Public Policy and Energy and Resources

The Energy and Resources Group and The Goldman School of Public Policy offer a three-year concurrent Master's Degree program that integrates the strengths of public policy analytical tools with the interdisciplinary knowledge and expertise in energy and resources.

Undergraduate Minor in Energy and Resources

The ERG Minor offers knowledge and skills to enable students to address the complex and interdependent issues associated with the interaction of social, economic, political, technical, and environmental factors. Students in any major may add the ERG minor, which is composed of two core and three elective upper division courses. Several of these courses have prerequisites in mathematics or science.

Undergraduate Summer Minor / Certificate in Sustainability

This summer program offers a practical and relevant interdisciplinary approach at the intersection of environmental, economic, social, political, and cultural issues. It is open to matriculated UC Berkeley undergraduates, students from other institutions, and the general public. Upon completion, UC Berkeley undergraduates receive a Minor in Sustainability, while other participants receive a Certificate in Sustainability from UC Berkeley.

Admission to the University

Applying for Graduate Admission

Thank you for considering UC Berkeley for graduate study! UC Berkeley offers more than 120 graduate programs representing the breadth and depth of interdisciplinary scholarship. The Graduate Division hosts a complete list (<https://grad.berkeley.edu/admissions/choosing-your-program/list/>) of graduate academic programs, departments, degrees offered, and application deadlines can be found on the Graduate Division website.

Prospective students must submit an online application to be considered for admission, in addition to any supplemental materials specific to the program for which they are applying. The online application and steps to take to apply can be found on the Graduate Division website (<https://grad.berkeley.edu/admissions/steps-to-apply/>).

Admission Requirements

The minimum graduate admission requirements are:

1. A bachelor's degree or recognized equivalent from an accredited institution;
2. A satisfactory scholastic average, usually a minimum grade-point average (GPA) of 3.0 (B) on a 4.0 scale; and
3. Enough undergraduate training to do graduate work in your chosen field.

For a list of requirements to complete your graduate application, please see the Graduate Division's Admissions Requirements page (<https://grad.berkeley.edu/admissions/steps-to-apply/requirements/>). It is also important to check with the program or department of interest, as they may have additional requirements specific to their program of study

and degree. Department contact information can be found here (<https://guide.berkeley.edu/graduate/degree-programs/>).

Where to apply?

Visit the Berkeley Graduate Division application page (<http://grad.berkeley.edu/admissions/apply/>).

Admission to the Program

The Energy and Resources Group seeks students who have excelled academically, whatever their discipline; who show promise of ability to cross disciplinary boundaries; and who want not only to understand problems of energy, resources, and environment but to help solve them. ERG deliberately admits students with a wide variety of interests, perspectives, disciplines, research methods, and experience so that each can help the others see the whole picture.

Admission to ERG is highly competitive, with a class of approximately 20 students (Master's and Ph.D. combined) selected annually from approximately 300 applicants. Those admitted to the program have strong academic records and letters of recommendation and, where applicable, related work experience and publications. The statement of purpose, supplemented by the personal history statement, is vital in demonstrating an applicant's commitment to the program.

You may apply to the two-year Master's Degree (M.S. or M.A.), three-year ERG/Public Policy Concurrent Master's Degree, or the Ph.D. program.

Equity, Inclusion and Diversity at ERG

At ERG, we believe that diversity drives innovative research and discovery, expands our capacity for teaching and learning, and prepares our graduate students to be effective leaders in the transition towards a more sustainable environment and a just society. To learn how ERG actively promotes intellectual, racial, ethnic, and gender inclusion, visit our Equity, Inclusion, & Diversity (<https://erg.berkeley.edu/about/diversity/>) page.

Admission to the Master's Program, M.A. or M.S.

The minimum requirement for admission to the master's degree program is completion of a Bachelor's Degree or its equivalent at a fully accredited US institution of higher learning or international equivalent. Because the program is fundamentally interdisciplinary, there are no other formal requirements for consideration, although, as discussed above, successful candidates will demonstrate academic and intellectual excellence.

Admission to the Ph.D. Program

The first two years of the Ph.D. involve coursework, taught jointly with the Master's Degree students, and a Final Project in the second year. Please see the Master's Degree Curriculum (<https://erg.berkeley.edu/academics/program/masters-degree-curriculum-requirements/>) for further details. Doctoral students will receive a Master of Science or Master of Arts Degree in Energy and Resources upon completion of the first two years' requirements.

In some cases for highly qualified students, ERG may waive some course or project requirements for Ph.D. students who already hold a Master's Degree and who can demonstrate a strong interdisciplinary academic background.

Recommended Preparation

We recommend at least one term of college-level calculus, courses in fundamental science (e.g., physics, chemistry, and biology), as well as

[1] (p.) upper division social science (for example political science, sociology, or anthropology) and humanities courses.

Application Process

All applicants must use the online application system at <http://grad.berkeley.edu/admissions/apply/>. Applications open in the first week of September for the fall of the following year. There are no spring admissions at ERG. The application deadline is the first week of December.. All admissions are subject to approval by the UC Graduate Division. The following information will be requested in the application.

1. **Statement of Purpose and Personal History Statement:** ERG requires two essays and places considerable weight on the Statement of Purpose and the Personal History Statement. Each statement should be no longer than three pages (double spaced, 10–12 point font).
 - **The Statement of Purpose** should discuss your motivations for wanting to enter a graduate degree program, and specifically why you would like to study at ERG. This is an open-ended opportunity for you to tell us how you envision this degree furthering your plans and dreams for the future. We are not looking for a summary of your dissertation topic or master's focus, but a general statement of how this program fits into your goals.
 - **The Personal History Statement** should not be a narrative summary of your CV, but a more introspective look what has brought you to this point of wanting to pursue a degree at ERG. It can be a place to share formative experiences, inspiring influences, or personal challenges.
2. **Transcripts:** Unofficial copies of your transcripts will be accepted for the application. If you are admitted, you will be required to submit official transcripts for all college-level work. For coursework completed in the fall term of your admissions cycle, ERG will accept amended transcripts and late grade reports until the first Friday in January. There is a section of the application that will allow you to document coursework in progress.
3. **Letters of Recommendation:** ERG requires three letters of. You are welcome to use recommenders from your professional as well as your academic career, however at least one letter must be from a professor who is in a position to assess your potential for advanced academic work.

It is strongly preferred that your recommenders use the UC Berkeley online portal to upload letters to your application. On your application, you will find a section that asks you for name and email address for your recommenders. When you submit that information, the system will automatically send an email request to your recommenders with a link where they can upload their recommendation letter as a PDF. You should review your application periodically to see if the letters from your recommenders have been uploaded. You will have the option to electronically send a reminder request. If a recommender is unable or unwilling to upload a letter electronically, we will accept hard copies mailed in a sealed envelope (with signature over the seal) to: CONFIDENTIAL Admissions, Energy & Resources Group, 310 Social Sciences Buildingl #3050, Berkeley, CA 94720–3050. We will then upload the letter to your file for them.

1. **Language Proficiency Scores:** International applicants from countries in which the official language is not English must provide official evidence of English proficiency. There are two standardized tests you may take: the Test of English as a Foreign Language (TOEFL), and the International English Language Testing System (IELTS). To submit your TOEFL score, on your test registration

please list the institution code for Berkeley, **4833**. **You do not need a department code.** Scores more than two years old will not be accepted. For more information about language testing and scores, as well as applicants from which countries will be required to submit scores, please refer to the Graduate Division website.

Energy and Resources Ph.D.

The primary focus of the Ph.D. is the research and writing of the student's dissertation. After satisfying the first two years' course requirements, Ph.D. students will prepare for their Qualifying Examination and commence their Dissertation research.

Coursework

In most cases, entering Ph.D. students complete the ERG Master's Degree during their first two years. Please see the Master's Degree Curriculum (<https://erg.berkeley.edu/academics/program/masters-degree-curriculum-requirements/>) for further details. This is designed to ensure doctoral students possess sufficient breadth and foundational knowledge to begin their original research.

After completion of the Energy and Resources Master's Degree, Ph.D. students prepare for their Qualifying Examination and commence their dissertation research.

Faculty advisors, at their discretion, may waive some course or project requirements for Ph.D. students who have sufficient academic preparation. If an admitted Ph.D. student previously has completed a two-year Master's Degree in a program closely equivalent to the Energy and Resources Master's Degree, they may begin preparing immediately for their qualifying examination and dissertation research. In these cases, any additional coursework required to support the student's research plan will be identified in consultation with the student's primary faculty advisor.

Qualifying Exam

When the doctoral student and his or her faculty advisors have agreed on a subject for the dissertation, the student must defend in a three-hour oral examination the suitability of the topic and his/her preparation for conducting original research in it. This Qualifying Examination is conducted by a committee of four faculty members chosen by the student, in consultation with his/her faculty advisor and subject to the approval of the Graduate Dean.

Dissertation

The final requirement for the Ph.D. is the completion of the dissertation to the satisfaction of a committee consisting of three faculty advisors chosen by the student, subject to approval by the Graduate Dean. The Ph.D. degree in Energy and Resources is typically completed four years beyond the Master's Degree.

The course requirements provide for a substantive introduction to the disciplinary approaches that are employed in studying energy and resource issues. The requirements also ensure experience in interdisciplinary analysis applied to a key resource concern. The curriculum provides an opportunity — through a topical cluster and an independent project — to extend and deepen the areas of investigation and understanding to satisfy the intellectual interests of each student.

The curriculum is intended to serve those students for whom the Master's degree will be the final formal education in support of a professional

career and also those students who intend to continue their education, for example by pursuing a PhD in Energy and Resources.

To obtain a Master's degree from ERG, each student must meet the following requirements:

- Complete a minimum of 40 post-baccalaureate units.
- Complete a minimum of 18 units of graduate-level study in energy and resources, many of which can be fulfilled by courses from other departments and schools.
- Complete the ERG Masters Degree Series:
 - ENE,RES 293A – Interdisciplinary Analysis in Energy and Resources (3 units)
 - ENE,RES 293B – Master's Research Skills and Project Development (2 units)
 - ENE,RES 293C – Masters Project Development (2 units)
 - ENE,RES 293D – Masters Project Presentation (2 units)
 - ENE,RES 295 – ERG Colloquium (2 units) Two semesters are required to ensure exposure to a broad array of topics and approaches.
- The following limits and restrictions apply on credit toward the 40-unit requirement:
 - A maximum of 4 units of 299 (individual research) credits can be counted.
 - 298 units (group study) cannot be counted.

To ensure effective early planning and consultation, ERG Master's students are expected to submit a completed "Proposed Course of Study" form by the last day of class in their first semester. This form will indicate the courses that the student intends to take to meet the requirements given above. It will be completed by the student in consultation with the student's ERG core faculty advisor. The course of study may change as a student's interests and plans change. At the end of the second and third semesters, students are expected to submit a revised course of study. The final course of study must be approved early in the student's final semester to meet the requirements for graduation.

At the end of the third semester, students also are required to submit their proposed Master's Project title and abstract to their ERG core faculty advisor, who will provide feedback. Each student, in collaboration with the first faculty reader and the instructor(s) of the Master's seminar, will prepare a proposed project title and abstract for the Master's project by the end of the student's third semester.

The ERG Master's program can lead to either an MA or MS degree in Energy and Resources. In consultation with the advisor, each student makes a request of the MA or MS degree *based on the substantive content of coursework and Master's project*. The ERG core faculty advisor makes a final determination of the appropriateness of the MA/MS selection.

Area (A-F) requirement

Teaching and research in the Energy and Resources Group draws heavily on five academic traditions, as they are applied to the interactions of societies with resources and the natural environment. The ERG Master's curriculum ensures that each student is well acquainted with each of these academic spheres and also experiences how distinct approaches from these intellectual traditions are brought to bear in interdisciplinary resource analysis. Consequently, one of the cornerstone requirements of the ERG Master's curriculum is the A-F requirements.

- A. Interdisciplinary analysis**
B. Environmental science
C. Resource and environmental economics
D. Social science approaches to energy, resources and the environment
E. Engineering approaches to energy, resources and the environment
F. Humanities

Selecting Coursework

All Master's Degree students are required to complete Area A (Interdisciplinary Analysis) plus courses in four of the five areas B – F. Students select four areas in consultation with their ERG Core Faculty Academic Adviser. Students must choose to take the area, or at least one of the areas, of greatest deficiency in their academic or professional record. If there is more than one area gap in the student's record, the student and their adviser will come to an agreement about which four areas will fulfill ERG requirements.

The Berkeley Academic Guide catalog is always evolving, and not all courses are offered every term. Therefore alternate courses to those listed in the B-F Course List are allowed with permission of the designated responsible faculty.

The alternate course must meet the intent and prerequisites of the area requirement. Attributes that would normally be considered minimum requirements for an alternative course to be acceptable are these: 3+ units, taken for a letter grade, lecture or laboratory-based instruction (i.e., no seminar courses) with substantive intellectual content and topical relevance to the academic tradition of ERG. The purpose of these courses is to provide ERG students sufficient background in the physical and social constructions of the relevant systems to enable them to understand key issues and to begin to conduct research in that area.

A. Interdisciplinary Energy and Resource Analysis

Responsible Faculty: Daniel Kammen

The following courses satisfy this requirement:

- ENE,RES C200 – Energy and Society (Prerequisite: at least one course in college physics or chemistry)
- ENE,RES 275 – Water and Development (Prerequisite: at least one college-level development-focused or water-focused course)

B. Environmental Science

Responsible Faculty: Lara Kueppers

The ERG environmental science requirement teaches the analytical methods and the fundamental principles needed to understand and creatively engage with the biotic and abiotic environment. Topical content spans physics, biology, chemistry, and mathematics, with a focus on the cross-boundary subfields of biodiversity science, biogeochemistry, climatology, hydrology, toxicology, radiation and radioactivity, and demography. An emphasis is placed on developing the capacity to construct and use back-of-the-large-envelope modeling methods. We do not count courses that focus in on subsets of the above subfields, but you can make a case for substituting collections of courses for the core ERG course (ER 102), provided those courses emphasize quantitative tools comparable to those taught in ER 102.

The following course satisfies this requirement:

ENE,RES 102	Quantitative Aspects of Global Environmental Problems	4
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Prerequisites:

MATH 1A & MATH 1B	Course Not Available and Course Not Available	
OR		
MATH 16A & MATH 16B	Analytic Geometry and Calculus and Analytic Geometry and Calculus	
OR		
PHYSICS 7A & PHYSICS 7B	Physics for Scientists and Engineers and Physics for Scientists and Engineers	
OR		
PHYSICS 8A & PHYSICS 8B	Introductory Physics and Introductory Physics	4
OR		
CHEM 1A or CHEM 4A	General Chemistry and General Chemistry and Quantitative Analysis	3
OR		
BIOLOGY 1B	General Biology Lecture and Laboratory	4
OR		
course applied with consent of instructor		

C. Resource and Environmental Economics

Responsible Faculty: David Anthoff

The purpose of the economics requirement is for students to become acquainted with the tools and analytical methods used in economics. For students that have never taken an intermediate microeconomics course before, this requirement can only be fulfilled by an intermediate microeconomics course. For these students, the following courses satisfy this requirement:

- ENVECON 100 – Microeconomic Theory with Application to Natural Resources

Students who have taken an intermediate microeconomics course before can choose from a large number of economics courses from ERG, the departments of Agricultural & Resource Economics, Business, and Economics to fulfill this requirement. For these students, the following are some of the courses which satisfy this requirement:

- ENE,RES 276 – Climate Change Economics
- A,RESEC 212 – Econometrics: Multiple Equation Estimation
- ENVECON 162 – Economics of Water Resources
- ENVECON C101/ECON C125 – Environmental Economics
- ENVECON C151/ECON C171 – International Economic Development
- ENVECON C102/ECON C102 – Natural Resources Economics
- MBA 212 – Energy and Environmental Markets
- PUB POL 210A – The Economics of Public Policy Analysis

D. Social Science Approaches to Energy, Resources and the Environment

Responsible Faculty: Isha Ray

The ERG social science requirement aims to make students “see” the social world through methods and theories common to traditional social science fields such as: geography, political science, anthropology, sociology, and critical planning approaches. All classes should be 3 units, contain significant social science readings, but not be directed reading

seminars. These courses generally have as prerequisites undergraduate level courses in geography, sociology, anthropology or political science.

Some of the courses that satisfy this requirement:

- ENE,RES 273 – Research Methods in Social Sciences
- ESPM 155 – Sociology of Natural Resources
- ESPM 161 – Environmental Philosophy and Ethics
- ESPM 168 – Political Ecology
- ESPM 169 – International Environmental Politics
- CY PLAN 254 – Sustainable Communities
- ESPM 260 – Governance of Global Production
- GEOG 203 – Nature and Culture
- GEOG 215 – Seminar in Comparative and International Development

E. Engineering Approaches to Energy, Resources and the Environment

Responsible Faculty: Duncan Callaway

The purpose of this area is to provide all ERG students with exposure to and experience with the problem-solving, design-oriented approach of relevant engineering disciplines. Other courses may be allowed by petition, but must have substantive engineering content and topical relevance to the domain of ERG, and must be offered in the College of Engineering or in the Department of Chemical Engineering. Note: These courses will have various prerequisites.

Some of the courses that satisfy this requirement:

- ENE,RES 254 – Electric Power Systems
- CIV ENG C103N – Introduction to Hydrology
- CIV ENG 111 – Environmental Engineering
- CIV ENG 218A – Air Quality Engineering
- CIV ENG 268E – Civil Systems and the Environment
- MEC ENG C105B / BIO ENG C105B – Thermodynamics and Biothermodynamics

F. Environmental Humanities

Responsible Faculty: Isha Ray

Humanities courses introduce students to historical, philosophical, textual, and interpretive methodologies and epistemologies, which are distinct from the mainstream methods taught or used within the social sciences. The humanities deal with history, philosophy, languages, religion, literature and even art — with what makes us human. Conversely, the social sciences deal with sociology, anthropology, politics, economics, urban planning — with what makes us social.

Some of the courses that satisfy this requirement:

- ESPM 161 – Environmental Philosophy and Ethics
- GEOG 203 – Nature and Culture
- PHILOS 128 – Philosophy of Science
- RHETOR 155 – Discourses of Colonialism and Postcoloniality
- HISTORY C187 – The History and Practice of Human Rights

The ERG Master's Degree Seminar Series

Semester I – Fall

- ENE,RES 293A – Interdisciplinary Analysis in Energy and Resources 3 units, graded. Required for all Masters students in their first semester. Introduction to the Masters final project process; survey of previous Masters final projects; survey of energy and resources classic texts; external funding searches and proposal writing skills; introduction of ERG faculty research topics; interactive group research projects.
- ENE,RES 292A – Tools of the Trade 2 units, S/U. Recommended for all new Masters students who want to refresh their quantitative skills; students with substantial remedial needs may need to take some undergraduate coursework. Quantitative methods for energy and resource analysis. Topics include linear algebra, differential equations, statistical methods, chemical equilibrium theory and thermodynamics.

Semester II – Spring

- ENE,RES 293B – Master's Seminar: Research Skills 2 units, graded. Critical reading and analysis of research papers; development and discussion of project ideas. Students begin to identify and solicit faculty readers for their projects. Human subject research issues, ethics and protocols introduced.

Semester III – Fall

- ENE,RES 293C – Master's Seminar: Research Project Development 2 units, graded. Final Development of research project ideas; final solicitation of faculty readers; critical feedback from cohort on projects.

Semester IV – Spring

- ENE,RES 293D – Master's Seminar: Final Project Presentations 2 units, graded. Students meet as needed with faculty readers and advisors; following Spring Break students meet as a group for practice presentations. End of semester all students do a final 15-minute presentation of their project.

Sample Master's Degree Program of Study

ERG students take classes in departments all over campus, and have many choices to satisfy the A-F and other requirements. The below is a sample of what a student's plan might look like. Master's students may elect to drop one of the B-F requirement areas, but may not drop the area in which they have the least strong background.

Minimum enrollment requirement for all graduate students is 12 units per semester.

Semester I (Fall)

- ENE,RES 293A – Master's Seminar: Interdisciplinary Analysis in Energy and Resources (3 units). Required for all entering students.
- ENE,RES C200 — Energy and Society (4 units): Satisfies Area A (Interdisciplinary Energy and Resource Analysis) requirement
- ENE,RES 295 — Colloquium (1 unit): Required in two of four semesters
- ENE,RES 276 – Climate Change Economics (4 units) satisfies Area C requirement (Research and Environmental Economics)

Semester II (Spring)

- ENE,RES 293B – Master's Seminar (2 units). Required for all first-year Master's students.

- ENE,RES 295 – Colloquium (1 unit): Required in two of four semesters
- ENE,RES 102 – Quantitative Aspects of Global Environmental Problems (4 units): Satisfies Area B requirement (Environmental Science).
- ENE,RES 273 – Social Science Research Methods (3 units): Satisfies Area D requirement (Social Science Approaches).
- Elective Cluster Course #1 (3 units)

Semester III (Fall)

- ENE,RES 293C: Master's Seminar (2 units): Required for all second-year Master's students
- ESPM 161: Environmental Philosophy and Ethics (3 units): satisfies Area F requirement (Humanities).
- Elective Cluster Course #2 (3 units)
- Elective Cluster Course #3 (3 units)

Semester IV (Spring)

- ENE,RES 293C – Master's Seminar (2 units). Required for all second-year Master's students.
- ENE,RES 254: Electric Power Systems (3 units) Satisfies Area E requirement (Engineering).
- Elective Course
- Elective course
- Independent Study

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.

Rules & Requirements

Repeat rules: 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 To be decided by the instructor when the class is offered.

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.

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 To be decided by the instructor when the class is offered.

Instructor: John Harte

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

Terms offered: Fall 2017, Fall 2016, Spring 2016

Lectures and small group discussions focusing on topics of interest that vary from semester to semester.

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.

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.

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

Terms offered: Spring 2023, Spring 2022, Fall 2021

Supervised research on specific topics related to energy and resources.

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.

ENE,RES C100 Energy and Society 4 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022

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.

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

ENE,RES W100 Energy and Society 4 Units

Terms offered: Summer 2024 8 Week Session, Summer 2023 8 Week Session, Summer 2022 8 Week Session

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.

Hours & Format

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

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

Online: This is an online course.

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 W184

ENE,RES 101 Ecology and Society 3 Units

Terms offered: Summer 2024 Second 6 Week Session, Summer 2023 8 Week Session, Summer 2022 8 Week Session

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.

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

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

Terms offered: Spring 2025, Spring 2024, Spring 2023

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.

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

ENE,RES C124 Gender and Environment 4 Units

Terms offered: Spring 2025, Spring 2024, Fall 2023, Spring 2023

This course examines the centrality of gender and intersectionality in understanding nature-society relations across time and space. During the first half of the semester, students will become familiar with key feminist theoretical approaches to studying environmental problems, including ecofeminism, feminist environmentalism, feminist critiques of science, feminist political ecology, and queer and more-than-human ecologies. In the remainder of the semester, students will apply the theories learned to explore contemporary feminist environmental movements and analyze key topics, such as resource politics, pollution and toxins, environmental and reproductive justice, climate change, and the ethics of care.

Objectives & Outcomes

Student Learning Outcomes: Upon taking this course, students will be able to: 1) explain different approaches to theorizing the gender-environment nexus; and 2) apply theoretical and conceptual tools to engage with, reflect on, and critique contemporary local and global environmental issues from an intersectional feminist perspective.

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. Alternate method of final assessment during regularly scheduled final exam group (e.g., presentation, final project, etc.).

Instructor: Chung

Also listed as: ESPM C124

ENE,RES 131 Data, Environment and Society 4 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022

This course will teach students to build, estimate and interpret models that describe phenomena in the broad area of energy and environmental decision-making. Students leave the course as both critical consumers and responsible producers of data-driven analysis. The effort will be divided between (i) learning a suite of data-driven modeling and prediction tools (including linear model selection methods, classification and regression trees and support vector machines) (ii) building programming and computing expertise and (iii) developing capacity to formulate and answer resource allocation questions within energy and environment contexts.

Rules & Requirements

Prerequisites: Required: Foundations of Data Science (Computer Science C8/Information Systems C8/ Statistics C8) and high school or college calculus Recommended: An introductory computer programming course (Computer Science 61A or Computer Science 88) and Linear Algebra (Mathematics 54, Electrical Engineering and Computer Science 16A, or Statistics 89A)

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. Alternative to final exam.

Instructor: Callaway

ENE,RES C160 CLIMATE JUSTICE 4 Units

Terms offered: Fall 2023, Fall 2022

Climate change is transforming our world in ways we are only beginning to understand, and in many ways we cannot yet imagine. The emerging theoretical and practical lenses of social and environmental justice (EJ) provide tools with which to examine and understand this new world. Using literature, media, and engaged field experiences, this course brings together the scholarship, scientific and engineering innovation, policy, literature and media, and activism around the interacting themes of climate change and social justice.

Rules & Requirements

Credit Restrictions: Students will receive no credit for ENE,RES C160 after completing ENE,RES 160, or ARCH 153. A deficient grade in ENE,RES C160 may be removed by taking ENE,RES 160, or ARCH 153.

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: Mills-Novoa

Also listed as: ESPM C176

ENE,RES 170 Environmental Classics 3 Units

Terms offered: Summer 2023 8 Week Session, Summer 2022 8 Week Session, Summer 2021 8 Week Session

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.

Objectives & Outcomes

Course Objectives: This 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 - 7.5 hours of seminar per week

8 weeks - 4 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.

ENE,RES 171 California Water 3 Units

Terms offered: Summer 2024 First 6 Week Session, Summer 2023 First 6 Week Session, Summer 2022 First 6 Week Session

The story of water development in California provides compelling examples of water politics, the social and environmental consequences of redistributing water, and the relationships between water uses, energy, and climate. This course provides the historical, scientific, legal, institutional, and economic background needed to understand the social and ecological challenges of providing water for California's growing population, agricultural economy, and other uses - all of which are made more complex by climate change.

Objectives & Outcomes

Course Objectives: Students will grasp the historical, scientific, legal, institutional, and economic background needed to understand the social and ecological challenges of providing water for California's growing population, agricultural economy, and other uses - all of which are made more complex by climate change.

Hours & Format

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

Summer:

6 weeks - 6 hours of lecture per week

8 weeks - 4 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.

ENE,RES 174W Water and Sanitation Justice 3 Units

Terms offered: Summer 2024 First 6 Week Session

This course will explore the many manifestations of water and sanitation justice and injustice on interlocking scales (i.e. local, national, transnational) while illustrating analytical ideas connecting to a range of social processes including claims for human rights, deprivation and exclusion, urbanization and infrastructure development, and privatization of land and water. We will look at various case studies in high-income and low-income countries and use key technical and social concepts to examine rights, equity, and justice with respect to water and sanitation. This course partially satisfies requirements for the ERG Summer Minor/Certificate in Sustainability.

Objectives & Outcomes

Course Objectives: This course will acquaint you with theoretical and practical knowledge about water and sanitation justice.

Student Learning Outcomes: Analyze water and sanitation through a variety of disciplinary perspectives: Arts, Engineering, Humanities, and in the social sciences of Sociology, Geography, Environmental Studies, Politics, Economics, Anthropology

Compare issues at local to global scales

Explain key issues of water and sanitation justice

Explain water and sanitation policy and governance historical examples, locally and globally

Identify factors influencing water and sanitation justice and injustice

Seriously consider strategies for addressing water and sanitation injustice

Understand impacts of water and sanitation injustice on quality of life

Rules & Requirements

Credit Restrictions: Students will receive no credit for ENE,RES W174 after completing ENE,RES 174. A deficient grade in ENE,RES W174 may be removed by taking ENE,RES 174.

Hours & Format

Summer:

6 weeks - 3.5 hours of lecture and 8 hours of discussion per week

8 weeks - 2.5 hours of lecture and 6 hours 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: Ray

Formerly known as: Energy and Resources Group W174

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."

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

ENE,RES C176 Climate Change Economics 4 Units

Terms offered: Fall 2024, Summer 2024 Second 6 Week Session, Fall 2023

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.

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 treaties 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:

6 weeks - 9 hours of lecture and 6 hours of laboratory per week
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

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.

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.

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

Terms offered: Summer 2020 8 Week Session, Spring 2019, Summer 2018 Second 6 Week Session

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.

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.

ENE,RES 190B Energy and Environmental Issues 4 Units

Terms offered: Spring 2022, Spring 2021

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.

Rules & Requirements

Repeat rules: Course may be repeated for credit when topic changes. Students may enroll in multiple sections of this course within the same semester.

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. Final exam required.

ENE,RES 190C Energy and Environmental Issues 4 Units

Terms offered: Fall 2020, 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.

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.

ENE,RES C192 Business, Sustainability, and Society 3 Units

Terms offered: Summer 2024 Second 6 Week Session, Summer 2022 8 Week Session, Summer 2021 8 Week Session

As corporations have grown in influence, concerns over their impact on people and the planet have also grown, pushing sustainability, corporate social responsibility, and the wider impact of business into the spotlight. This course focuses on business ethics, supply chains, resource constraints, labor issues, innovation, and environmental externalities, as well as the internal challenges, competitive pressures, external stakeholders, and other issues that businesses must consider while trying to act responsibly.

Hours & Format

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, with common exam group.

Instructor: Rochlin

Also listed as: UGBA C192R

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

Terms offered: Fall 2020, Fall 2019, Spring 2016

Group studies of selected topics.

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.

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

Terms offered: Spring 2025, Fall 2024, Spring 2024

Individual conferences.

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.

ENE,RES 199S Sponsored Projects for Undergraduate Research (SPUR) 1 - 4 Units

Terms offered: Not yet offered

The Sponsored Projects for Undergraduate Research (SPUR) program helps students get involved in research projects with world renowned faculty and staff researchers in the Rausser College of Natural Resource

Rules & Requirements

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

Hours & Format

Fall and/or spring: 15 weeks - 3-12 hours of independent study per week

Summer: 12 weeks - 5-18 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. Alternative to final exam.

ENE,RES C200 Energy and Society 4 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022

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 international perspective, origins, and character of energy crisis.

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/Graduate

Grading: Letter grade.

Instructor: Kammen

Also listed as: PUB POL C284

ENE,RES W200 Energy and Society 4 Units

Terms offered: Summer 2024 8 Week Session, Summer 2023 8 Week Session, Summer 2022 8 Week Session, Summer 2021 8 Week Session, Fall 2020

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.

Hours & Format

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

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

Online: This is an online course.

Additional Details

Subject/Course Level: Energy and Resources Group/Graduate

Grading: Letter grade.

Instructor: Kammen

Also listed as: PUB POL W284

ENE,RES C202 Modeling Ecological and Meteorological Phenomena 3 Units

Terms offered: Fall 2015, Fall 2014, Fall 2013

Modeling methods in ecology and meteorology; stability analysis; effects of anthropogenic stress on natural systems. Offered alternate years.

Rules & Requirements

Prerequisites: Integrative Biology 102 or consent of instructor

Hours & Format

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

Additional Details

Subject/Course Level: Energy and Resources Group/Graduate

Grading: Letter grade.

Instructor: Harte

Also listed as: ESPM C211

ENE,RES C205 Quantitative Methods for Ecological and Environmental Modeling 3 Units

Terms offered: Fall 2015, Fall 2013, Fall 2012, Fall 2011, Fall 2009

This course will review the background mathematical and statistical tools necessary for students interested in pursuing ecological and environmental modeling. Topics include linear algebra; difference equation, ordinary differential equation, and partial differential equation models; stochastic processes; parameter estimation; and a number of statistical techniques. This course will be recommended as a prerequisite for advanced modeling courses in Integrative Biology, Energy and Resources Group, and Environmental Science, Policy, and Management.

Rules & Requirements

Prerequisites: Consent of instructor

Hours & Format

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

Additional Details

Subject/Course Level: Energy and Resources Group/Graduate

Grading: Letter grade.

Also listed as: ESPM C205/INTEG BI C205

ENE,RES C221 Climate, Energy and Development 3 Units

Terms offered: Fall 2019, Fall 2018, Fall 2017

Graduate seminar examining the role of energy science, technology, and policy in

international development. The course will look at how changes in the theory and practice

of energy systems and of international development have co-evolved over the past half-

century, and what opportunities exist going forward.

A focus will be on rural and decentralized energy use, and the issues of technology, culture,

and politics that are raised by both current trajectories, and potential alternative energy

choices. We will explore the frequently divergent ideas about energy and development that

have emerged from civil society, academia, multinational development agencies, and the

private and industrial sector.

Rules & Requirements

Prerequisites: Graduate student standing or consent of instructor

Hours & Format

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

Additional Details

Subject/Course Level: Energy and Resources Group/Graduate

Grading: Letter grade.

Instructor: Kammen

Also listed as: DEVP C221/PUB POL C221

ENE,RES C223 Agrarian Questions 4 Units

Terms offered: Spring 2024

The seminar offers an introduction to the interdisciplinary field of critical

agrarian and food studies, which brings together Marxian agrarian

political economy, historical and political sociology, postcolonial and

subaltern studies, post structural feminist theory, critical development

studies, and political ecology. Students should come out of this class with

a genealogical understanding of key debates and emergent issues in the

field. Our goal is to think theoretically and empirically about the social

relations of land, labor, and livelihoods and how these relations articulate

with broader political economic processes.

Rules & Requirements

Credit Restrictions: Students will receive no credit for ENE,RES C223 after completing ESPM 223. A deficient grade in ENE,RES C223 may be removed by taking ESPM 223.

Hours & Format

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

Additional Details

Subject/Course Level: Energy and Resources Group/Graduate

Grading: Letter grade.

Instructor: Chung

Also listed as: ESPM C223

ENE,RES C226 Photovoltaic Materials; Modern Technologies in the Context of a Growing Renewable Energy Market 3 Units

Terms offered: Fall 2015, Spring 2013, Spring 2011

This technical course focuses on the fundamentals of photovoltaic

energy conversion with respect to the physical principals of operation and

design of efficient semiconductor solar cell devices. This course aims

to equip students with the concepts and analytical skills necessary to

assess the utility and viability of various modern photovoltaic technologies

in the context of a growing global renewable energy market.

Rules & Requirements

Prerequisites: Material Science and Mineral Engineering 111 or 123 or equivalent. Should have a firm foundation in electronic and optical props of semiconductors and basic semiconductor device physics

Hours & Format

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

Additional Details

Subject/Course Level: Energy and Resources Group/Graduate

Grading: Letter grade.

Also listed as: MAT SCI C226

ENE,RES 254 Electric Power Systems 4 Units

Terms offered: Spring 2025, Spring 2023, Spring 2020

Provides an understanding of concepts in the design and operation of electric power systems, including generation, transmission, and consumption. Covers basic electromechanical physics, reactive power, circuit and load analysis, reliability, planning, dispatch, organizational design, regulations, environment, end-use efficiency, and new technologies.

Rules & Requirements

Prerequisites: Physics 7B or 8B or equivalent

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/Graduate

Grading: Letter grade.

Instructor: Callaway

ENE,RES C266 Political Ecologies of Climate Change Adaptation 3 Units

Terms offered: Fall 2023

As the climate crisis escalates and mitigation efforts stagnate, adaptation has come to the forefront of public debates and funding priorities. This course will explore the varied political ecologies of climate change adaptation. By drawing on political ecology, this course will include both foundational and emerging scholarship that explores how climate change adaptation is shaping and being shaped by the material impacts of climate change, the political economy of climate governance and finance, and the agency of experts, funders, promoters, and the individuals and collectives adapting to climate change. We will examine the history of climate change adaptation concepts and governance while also exploring emerging frontiers in the field.

Hours & Format

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

Additional Details

Subject/Course Level: Energy and Resources Group/Graduate

Grading: Letter grade.

Instructor: Mills-Novoa

Also listed as: ESPM C266

ENE,RES 270 Environmental Classics 3 Units

Terms offered: Fall 2013, Fall 2011, Fall 2009

Motivation: What is the history and evolution of environmental thinking and writing? How have certain "environmental classics" shaped the way in which we think about nature, society, and development? This course will use a selection of 20th-century books and papers that have had a major impact on academic and wider public thinking about the environment and development to probe these issues. The selection includes works and commentaries related to these works that have influenced environmental politics and policy in the U.S. as well as in the developing world. Through the classics and their critiques, reviews, and commentaries, the class will explore the evolution of thought on these transforming ideas.

Rules & Requirements

Prerequisites: Graduate standing

Hours & Format

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

Additional Details

Subject/Course Level: Energy and Resources Group/Graduate

Grading: Letter grade.

Instructors: Kammen, Ray

ENE,RES C271 Energy and Development 3 Units

Terms offered: Spring 2016

This advanced graduate seminar will examine the theoretical frames and models used to examine the linkages between energy and development, and the impacts of one on the other.

Rules & Requirements

Prerequisites: Energy and Resources ENE,RES C100 or C200 or Public Policy PUB POL C184 or C284 Energy and Resources ENE,RES 102 Environmental Economics and Policy ENVECON C151 or ECON C171 or equivalent Economics course

Hours & Format

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

Additional Details

Subject/Course Level: Energy and Resources Group/Graduate

Grading: Letter grade.

Instructor: Kammen

Also listed as: PUB POL C271

ENE,RES 273 Research Methods in Social Sciences 3 Units

Terms offered: Spring 2025, Fall 2023, Fall 2021

This course aims to introduce graduate students to the rich diversity of research methods that social scientists have developed for the empirical aspects of their work. Its primary goal is to encourage critical thinking about the research process: how we "know," how we match research methods to research questions, how we design and conduct our information/data collection, what we assume explicitly and implicitly, and the ethical dilemmas raised by fieldwork-oriented studies.

Rules & Requirements

Prerequisites: Graduate standing or consent of instructor

Hours & Format

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

Additional Details

Subject/Course Level: Energy and Resources Group/Graduate

Grading: Letter grade.

Instructor: Ray

ENE,RES 275 Water and Development 4 Units

Terms offered: Spring 2025, Spring 2024, Spring 2023

This class is an interdisciplinary graduate seminar for students of water policy in developing countries. It is not a seminar on theories and practices of development through the "lens" of water. Rather, it is a seminar motivated by the fact that over 1 billion people in developing countries have no access to safe drinking water, 3 billion don't 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 and assumptions behind some of today's popular "solutions."

Hours & Format

Fall and/or spring: 15 weeks - 4 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Energy and Resources Group/Graduate

Grading: Letter grade.

Instructor: Ray

ENE,RES 276 Climate Change Economics 4 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022

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.

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 treaties 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 a scientific programming language of their choice. 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/Graduate

Grading: Letter grade.

Instructor: David Anthoff

ENE,RES 280 Energy Economics 3 Units

Terms offered: Fall 2016, Fall 2015, Spring 2015

Input-output and cost benefit analysis applied to energy; exhaustion theory and economics of energy supply; patterns of energy use; trade-offs in energy conservation; the effect of energy policy on supply and demand; projecting future energy and resource supply and use.

Rules & Requirements

Prerequisites: Economics 100A or equivalent; basic calculus or linear algebra

Hours & Format

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

Summer: 6 weeks - 7.5 hours of lecture per week

Additional Details

Subject/Course Level: Energy and Resources Group/Graduate

Grading: Letter grade.

ENE,RES 290 Seminar in Energy and Resources 1 - 4 Units

Terms offered: Spring 2025, Fall 2024, Fall 2023

Graduate student presentations and faculty-student discussions of advanced topics in energy and resources. Specific topics vary according to faculty and student interest.

Rules & Requirements

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

Hours & Format

Fall and/or spring: 15 weeks - 2-3 hours of seminar and 0-1 hours of discussion per week

Additional Details

Subject/Course Level: Energy and Resources Group/Graduate

Grading: Letter grade.

ENE,RES 290A Seminar in Energy and Resources 3 Units

Terms offered: Fall 2021, Spring 2021, Fall 2020

Graduate student presentations and faculty-student discussions of advanced topics in energy and resources. Specific topics vary according to faculty and student interest.

Rules & Requirements

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

Hours & Format

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

Summer: 8 weeks - 6 hours of seminar per week

Additional Details

Subject/Course Level: Energy and Resources Group/Graduate

Grading: Letter grade.

ENE,RES 291 Special Topics in Energy and Resources 1 - 3 Units

Terms offered: Fall 2016, Spring 2012, Spring 2011

Study and critical analysis of advanced topics in energy and resources using interdisciplinary approaches. Specific topics vary according to faculty and student interest.

Rules & Requirements

Prerequisites: Graduate standing or 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

Additional Details

Subject/Course Level: Energy and Resources Group/Graduate

Grading: Letter grade.

ENE,RES 292A Tools of the Trade 2 Units

Terms offered: Fall 2018, Fall 2017, Fall 2016

Quantitative methods for energy and resource analysis. Topics include linear algebra, differential equations, statistical methods, chemical equilibrium theory, and thermodynamics.

Rules & Requirements

Prerequisites: Consent of instructor

Hours & Format

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

Additional Details

Subject/Course Level: Energy and Resources Group/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

ENE,RES 293A Master's Seminar I: Interdisciplinary Analysis and the Environment 3 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022

ENERES 293A is the first of 4 required seminars of the ERG Masters' sequence. It provides an intellectual and practical orientation to the Energy and Resources Group and to what makes us "ERG". It's at once an understanding interdisciplinary approaches class and a cohort-building class. ERG is a community of scholars and researchers who are actively engaged in academic research, policy design, and engagement with civil society. ENERES 293A provides a space in which interdisciplinary approaches to domains, methods / tools and worldviews are explored, individually and collaboratively, for the fields that comprise energy and resources research.

Objectives & Outcomes

Course Objectives: 1.

Develop a cohort among incoming students and connect with the larger ERG community.

2.

Explore the foundations of the environmental field by reading seminal papers and books in the space.

3.

Introduce interdisciplinary thinking and problem-solving frameworks through a unifying topic throughout the semester.

Rules & Requirements

Prerequisites: Open to ERG graduate students only

Hours & Format

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

Additional Details

Subject/Course Level: Energy and Resources Group/Graduate

Grading: Letter grade.

Instructor: Ray

Formerly known as: Energy and Resources Group 201

ENE,RES 293B Master's Seminar II: Methods for Interdisciplinary Analysis 3 Units

Terms offered: Spring 2025, Spring 2024, Spring 2023

This is the second semester of the ENERES 293 sequence for all ERG Master's Degree students. The primary purpose of the sequence is to support students in the process of doing independent interdisciplinary research. ENERES 293B is designed to help students learn to identify and develop tractable and impactful interdisciplinary research projects.

Objectives & Outcomes

Course Objectives: 1.

Discuss career paths and research with experts in students' area(s) of interest – some of whom are eligible to be a reader of the students' capstone Master's Project.

2.

Develop and refine an individual development plan.

3.

Read and discuss several frameworks for the process of doing interdisciplinary research, and interpret existing research in the context of those frameworks.

4.

Complete group activities to identify and argue for research in a new area.

5.

Encourage students to think carefully about their mentoring needs and how they will fulfill those needs.

6.

Develop a refined research question for the ERG capstone Master's Project, as well as a supporting annotated bibliography, a list of anticipated methods and data to be used, and a plan for obtaining them.

Rules & Requirements

Prerequisites: Energy and Resources ENERES 293A

Credit Restrictions: Students will receive no credit for ENE,RES 293B after completing ENE,RES 292B. A deficient grade in ENE,RES 293B may be removed by taking ENE,RES 292B, or ENE,RES 292B.

Hours & Format

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

Additional Details

Subject/Course Level: Energy and Resources Group/Graduate

Grading: Letter grade.

Instructors: ERG Faculty, Callaway

Formerly known as: Energy and Resources Group 292B

ENE,RES 293C Master's Seminar III - Master's Project Development for Interdisciplinary Analysis, Part 1 3 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022

This is the third semester of the ERG master's seminar series. This semester shifts from a focus on intellectual exploration to the design and execution of the master's project. While some students may have already started their projects through summer research and/or fieldwork experiences, others may be starting fresh. This semester is designed to meet students wherever they are in the process of developing their research. It will also focus on building communication/translation skills and continuing the professional development work started in ENERES 293B.

Objectives & Outcomes

Course Objectives: 1.

Develop verbal and written communication skills and techniques

- a. Project pitches
- b. Peer presentations
- c. Individual presentations
- d. Optional presentation to lab group
- e. Writing workshop
- f. Written outline of Master's project

2.

Network with people in and outside of the ERG community

- a. Determine the appropriate scope and focus for a Master's project
- b. Begin to plan for a career beyond the Master's degree

3.

Develop project management and leadership skills

- a. Practice managing and executing a research plan
- b. Lead discussions on individual research
- c. Provide constructive feedback on peers' research
- d. Ask for specific types of guidance and mentorship from advisors and readers

4.

Define the scope of a Master's project that can answer an interdisciplinary question

- a. Identify a gap in existing literature and/or a field of research
- b. Develop a question that is actionable under the timeline of the master's project
- c. Bound the project with a defined literature search and analysis

5.

Complete the initial steps of the Master's project

ENE,RES 293D Master's Seminar IV: Master's Project Development for Interdisciplinary Analysis Part II 3 Units

Terms offered: Spring 2025, Spring 2024, Spring 2023

Required of, and open only to, fourth-semester Energy and Resources Master's Degree students. Topics include structuring and writing a research paper, crafting and delivering a clear, engaging presentation on the Master's project, supporting classmates with these goals, and professional development. In addition to whole-class sessions, students will work in small groups throughout the semester and conduct individual professional way-finding exercises. Students will apply the interdisciplinary approaches and perspectives learned in the core curriculum and previous courses in this series.

Objectives & Outcomes

Course Objectives: Complete and file the masters project paper.

Develop and deliver a clear and engaging presentation on their master's project.

Prepare for post-graduation activities.

Rules & Requirements

Prerequisites: Energy and Resources ENERES 293A, ENERES 293B, ENERES 293C

Hours & Format

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

Additional Details

Subject/Course Level: Energy and Resources Group/Graduate

Grading: Letter grade.

Instructor: ERG Faculty

Formerly known as: Energy and Resources Group 292D

ENE,RES 295 Special Topics in Energy and Resources 1 Unit

Terms offered: Spring 2025, Fall 2024, Spring 2024

Presentations of research in energy issues by faculty, students, and visiting lecturers. Master's degree students required to enroll for two semesters.

Rules & Requirements

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

Hours & Format

Fall and/or spring: 15 weeks - 1.5 hours of colloquium per week

Additional Details

Subject/Course Level: Energy and Resources Group/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

ENE,RES 296 Doctoral Seminar 2 Units

Terms offered: Spring 2025, Fall 2024, Spring 2024

Lectures, reports, and discussions on current research in energy and resources. Particular emphasis on topics of research interest for current Ph.D. students in the Energy and Resources Group.

Rules & Requirements

Prerequisites: Consent of instructor

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

Hours & Format

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

Additional Details

Subject/Course Level: Energy and Resources Group/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

Formerly known as: 298

ENE,RES 298 Doctoral Seminar 2 Units

Terms offered: Spring 2025, Fall 2024, Spring 2024

Lectures, reports, and discussions on current research in energy and resources. Sections are operated independently and under direction of different staff.

Rules & Requirements

Prerequisites: Consent of instructor

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

Hours & Format

Fall and/or spring: 15 weeks - 0 hours of independent study per week

Additional Details

Subject/Course Level: Energy and Resources Group/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

ENE,RES 298N Directed Group Study 1 - 3 Units

Terms offered: Fall 2016, Spring 2016, Fall 2015

Informal group studies of special problems in energy and resources.

Rules & Requirements

Prerequisites: Graduate 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 directed group study per week

Additional Details

Subject/Course Level: Energy and Resources Group/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

ENE,RES 299 Individual Research in Energy and Resources 1 - 12 Units

Terms offered: Spring 2025, Fall 2024, Summer 2024 10 Week Session

Investigation of problems in energy and resources from an interdisciplinary perspective.

Rules & Requirements

Prerequisites: Graduate standing

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

Hours & Format

Fall and/or spring: 15 weeks - 1-12 hours of independent study per week

Additional Details

Subject/Course Level: Energy and Resources Group/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

ENE,RES 301 Graduate Student Instructor Practicum 3 Units

Terms offered: Spring 2013, Fall 2012, Spring 2012

Course credit for experience gained in academic teaching through employment as a graduate student instructor.

Rules & Requirements

Prerequisites: Appointment as a graduate student instructor in the Group and permission of the graduate advisor

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

Hours & Format

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

Additional Details

Subject/Course Level: Energy and Resources Group/Professional course for teachers or prospective teachers

Grading: Offered for satisfactory/unsatisfactory grade only.