Science in a Changing World
SCI 3000  3 Credit Hours  8:30 am - 12:00 noon
SCI 3000 fulfils the undergraduate, upper division, International Requirement (IR)
SCI 3000 is an ACCESS exclusive course

Course Description:
Explore the challenges associated with using a growing body of scientific knowledge to inform decisions pertaining to our understanding and use of energy. The curriculum in this “STEAM” (STEM with integration of arts and humanities) based course affords students with an opportunity to learn about contemporary research and the interplay between science, engineering, and society. Students engage in activities that complement instruction, foster a peer and campus community, and support academic success at the U. Research faculty and graduate students from the Colleges of Science, Mines & Earth Sciences, and Engineering, as well as an array of campus and community program representatives participate in instruction.

Science in a Changing World is a unique and transformative learning experience
Energy resources have been associated with human conflict and innovations. Modern civilization continues to rely, primarily, on fossil fuel combustion to service economic needs. While fossil fuel may be the most affordable resource, combustion comes at a significant human and environmental cost. A multidisciplinary approach, that extends beyond the STEM disciplines to collaborations with economists, educators, policy makers, global leaders, and communications experts is essential in addressing global demand for energy and a move to cleaner options. Science in a Changing World affords students with the opportunity to appreciate the value of collaboration, across STEM disciplines and beyond, in advancing solutions to a global challenge, energy.

ACCESS Program Core Competencies
Fostering academic success (year-long experience)
• Students will develop strategies for academic success
• Students will establish mentor and peer relationships that foster a sense of belonging in the scientific/engineering, academic and campus community at the University of Utah
• Students will acquire the skills needed to navigate educational and career opportunities in the sciences and/or engineering
Fostering success in STEM (year-long experience)
• Students will appreciate the process, and interdisciplinary nature, of scientific discovery and innovation in the fields of biology, chemistry, mathematics, physics, and engineering
• Students will have improved written and verbal scientific communication skills
• Students will appreciate the value of collaborative problem solving in the classroom and in a research laboratory
• Students will appreciate the challenges effectively communicating science to a general audience and the value of collaboration outside STEM disciplines.

Global Thinking (SCI 3000)
• Understand that fossil fuel dependence is a global issue tied to climate change and pollution
• Understand challenges to mitigating climate change for developing, developed, or an oil producing nation
• Understand the challenges associated with relying on innovation to address climate change
• Understand how energy use, pollution, and climate change can displace populations
• Appreciate the limitations and potential for adapting to heat waves and flooding associated with climate change
• Appreciate historic and contemporary efforts to mitigate or adapt to changes in climate
• Appreciate pollution and climate change are connected to fossil fuel dependence, economics, ecosystem sustainability, and health
• Appreciate the challenges of negotiating international agreements that are equitable (based on the equity principles of equality, responsibility, and capacity)
• Appreciate the challenges of shifting opinions about fossil fuels
• Appreciate the challenges of connecting science, and scientists, to policy efforts globally
ASSIGNMENTS. Assignments will be posted on Canvas and fall into one of two categories (no exams):

- **GLOBAL THINKING** connections
- **INSTRUCTOR ASSIGNED** (please reference section-V for topics explored)

**GLOBAL THINKING:** Assignment information and summary

- Global Thinking assignments will be posted each week. Please see Canvas assignments for details, dates, and submission requirements. For the most part, Global Thinking assignments will be presented in the order listed here. Student group composition will change weekly.
- These assignments foster informed dialogues between students and with course instructors. Many of the assignments are completed collaboratively, in small groups. The Global Thinking assignments are designed to facilitate the creation of a comprehensive primer for multidisciplinary thinking that connects science to policy, economics, and environmental issues globally, all in the context of energy and climate. These assignments ultimately serve as a journal of resources that will be used in the International Negotiations group capstone.

<table>
<thead>
<tr>
<th>GLOBAL THINKING Connections Assignment Summary</th>
<th>Individual or group assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Getting started, priming assignments</strong></td>
<td></td>
</tr>
<tr>
<td>Essential terms and definitions</td>
<td></td>
</tr>
<tr>
<td>Climate Change Quiz- Test your knowledge</td>
<td></td>
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<tr>
<td>Compare energy options available to power the global economy</td>
<td></td>
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<tr>
<td>Carbon Cycle Connections (mitigation strategies and policy)</td>
<td></td>
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<tr>
<td>Ecosystem Services (economic stability and population vulnerability)</td>
<td>individual</td>
</tr>
<tr>
<td>Anthropocene, a new epoch?</td>
<td></td>
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<tr>
<td><strong>Exploratory assignments</strong></td>
<td></td>
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<tr>
<td>What happens if we lose the permafrost?</td>
<td>groups</td>
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<tr>
<td>What happens if we lose the polar ice (Arctic and/or Antarctic)?</td>
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<tr>
<td>Adaptation: Heat, Flooding</td>
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<tr>
<td>Adaptation: Historical lessons</td>
<td></td>
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<tr>
<td>Adapting, What’s your climate change personality?</td>
<td>individual</td>
</tr>
<tr>
<td>Comparing GHG and potential for mitigation in U.S. and India</td>
<td>groups</td>
</tr>
<tr>
<td>Graphic Organizer: GHG emissions in developing, developed, and oil producing nations</td>
<td>groups</td>
</tr>
<tr>
<td>Energy: Upstream environmental costs and mitigation</td>
<td>groups</td>
</tr>
<tr>
<td>Reading: Pollution is a global, not a local problem</td>
<td>individual</td>
</tr>
<tr>
<td>Exploring fossil fuel combustion: Benefits and consequences</td>
<td>groups</td>
</tr>
<tr>
<td>History and progress: Create an energy policy timeline</td>
<td>groups</td>
</tr>
<tr>
<td>Readings: Consider the limitations and potential for global collaboration to inform policies that drive the change needed to address the environmental challenges posed by a fossil fuel economy.</td>
<td>individual</td>
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**Capstone group project**

- International negotiations on fossil fuel reliance and action on climate (UN moderated debate). Incorporates principles of equity in climate change decision making. | groups |

**Pending schedule and availability** *(see section-V for more details)*

- Laura Nelson, Ph.D., Energy Advisor, Director, Utah Governor’s Office of Energy Development
- **SKYPE:** Michael Roberts, Professor of Economics, University of Hawaii
- **SKYPE:** Pulitzer Center journalist (NY Times, Guardian, Nat.Geo., NBC, and others)

**Pending confirmation: Film screening**

- Anote’s Ark, World premiere at the 2018 Sundance Film Festival *(see section-V for more details)*
INTRODUCTION TO COURSE MODULES
A team of research faculty, graduate students, and community representatives, with expertise specific to the various modules, lead instruction of this unique course offering. Thus, students are afforded the opportunity to learn from, and engage, with experts across the STEM disciplines.

A. College of Science

Student Success
Learn about campus resources and prime your success at the U. Students will receive information about general advising, university services, research opportunities, and strategies for undergraduate success.

Physics Show
Physics is a seminal scientific discipline, providing the principles and tools that guide our understanding of the physical world. The Physics show launches the summer with a survey of principles in this discipline and connections across STEM, industry, and society. Through demonstrations, the physics show also introduces our most fundamental understanding of energy, providing women with a primer to the energy theme and summer curriculum.

Chemistry, Sustainable/Renewable Energy: Electrochemical Conversion & Storage
Students will be introduced to the alternative energy grand challenges with a focus on solar energy conversion and electrochemical energy storage (batteries). Population growth, infrastructure, and socioeconomic challenges in the U.S., as well as in developing nations, are integral to translating innovations into globally available and accessible energy solutions. In China and India, a lack of regulation and fossil fuel dependence have been a recipe for unprecedented pollution and a simultaneous decline in health. What are the potential solutions that can be offered through science and innovation? How will humanity be impacted, and the planet change, if we do not address the energy issue? How costly and feasible is it to shift from fossil fuel to sustainable and renewable models? This module will train students on the challenges and potential scientific solutions to both sustainable, renewable energy and energy storage, while they learn the basics of electrochemistry. Students will construct both solar cells and batteries.

Energy, Dark Matter, and the Hadron Collider
Particle physics is the study of elementary particles, like electrons and quarks, and the forces that control their behavior at the most basic level. In order to learn about these tiniest and most fundamental building blocks of nature, extremely large and powerful experiments are necessary. The Large Hadron Collider (LHC), located near Geneva, Switzerland, accelerates protons to nearly the speed of light, then smashes them together in fantastically energetic collisions. Thousands of particle physicists around the world scrutinize the wreckage of these collisions in the hopes of learning more about the elementary particles and their interactions. Recently, the LHC discovered a brand-new elementary particle, never before observed (though particle physicists had suspected its existence for decades): the Higgs boson. We will explore past, present, and future collaborations at the CERN laboratories (which involve 600 institutes and universities from around the world), including the potential for supplying the world with energy through fusion. Fundamental principles that include collision energy, Einstein's mass-energy equivalence, and how all this might be related to the identity of dark matter in the Universe will also be considered. After discussing particle collisions and how elementary particles are detected at the LHC, we'll try our hand at analyzing some data collected by the LHC experiments ATLAS and CMS. Maybe we'll even discover new particles!

Biological Connections

- Conserving Wildlife in a Human-Dominated World
  Humans are drastically altering Earth’s ecosystems through habitat destruction, species persecution, and anthropogenic climate change. Conservation biology seeks to understand how humans are impacting wildlife and works to develop ways to preserve biodiversity. To see conservation studies first-hand, we will walk the Red Butte Canyon (RBC), a “research natural area” behind the university, where only researchers are allowed. More broadly, our conversation and the fieldwork demonstrated in the RBC will be used to introduce the challenges wildlife biologists face working with governments and communities around the world to study biodiversity and collaborate on conservation projects. The project provides insight into global collaborations and input, which is essential to gathering data on species diversity and environmental change.

  - Introduction to Climate Change & Fossil Fuel Combustion
    A comprehensive introduction to climate change that incorporates the role governments, individuals, and policy play in advancing solutions to address this global challenge.

Mathematics of Climate & Energy
Mathematics is the platform upon which which quantitative descriptions of the natural world are built. It was, and is, the foundation for many discoveries. From approximating Earth’s average surface temperature to finding the optimal placement of wind turbines, and even predicting when the Arctic may be iceless, mathematics gives us the framework, tools, and ideas to formulate, examine, and solve interesting and relevant problems. During the Mathematics week in ACCESS, we explore how math is being used to study Earth’s climate system and rapid changes, as well as how math
can help shape the future landscape for energy resources and usage on a global scale. One topic of particular interest that arises naturally in our discussions will be fractals, or objects which have a non-integer dimension and look very similar no matter on what scale we view them. Examples include clouds, snowflakes, the sea ice pack, Brownian motion, and even cauliflower! In addition to seeing how they arise in nature, we will also explore their underlying mathematical properties which make them so interesting, pervasive, and beautiful. Our investigations will help us develop a deeper understanding of the earth’s climate, and also the importance of describing complex processes with mathematics – the universal language of the sciences and engineering.

B. Engineering Colleges

The direct and indirect environmental challenges associated with fuel and resource extraction are explored. Hands-on activities and demonstrations highlight the limits and potential of energy from biofuels, wind turbines, water wheels and other sources. Students are introduced to engineers, geoscientists, and representatives from industry who highlight the importance of collaboration and research. When possible global companies, with a local presence, offer engineer guided fieldtrips (Rio Tinto, Andeavor).

*College of Mines and Earth Sciences*

Introduction to Urban Landform and Emission.

Students consider geologic challenges extracting energy during outdoor lectures where data from drones and the U of U seismographic stations are explored. Environmental challenges associated with land use, water, and air pollution are also explored during laboratory tours and discussions. Environmental considerations associated with the extraction of minerals and fuels extend far beyond science and engineering, into social, economic, and political issues that are relevant on a local and global scale. The extraction of these resources must be managed in order to prevent environmental degradation and potential harm to various communities. Economic benefits complicate mining and energy extraction in developing nations. Issues of social justice, environmental management, and collaborations with stakeholders from industry (such as Rio Tinto and Andeavor/Tesoro) will also be considered. Additionally, Atmospheric scientists in the CMES consider the local and global implications of pollution from fossil fuel combustion. Exploration of this topic includes the consideration of global variation in pollution distribution, such as geographic variables and atmospheric conditions, in places like Beijing and Salt Lake, that exacerbate or improve pollution. Utah specific air quality challenges will serve as the model for considering efforts to study and affect change globally.

*College of Engineering*

College of Engineering week includes two projects associated with alternative energy, an introduction to disciplines and majors in the college, and lab tours. Students will design, build, and test devices and systems relating to biofuels & wind energy. The engineering grand challenges will be discussed and considered throughout this week. Students will learn to appreciate the transformative potential of engineering and the challenges engineers face in funding their research. Practical implementation of the energy projects explored in this module have positive and negative considerations that relate to cost, environmental issues, and longevity. Furthermore, access to these innovations can be limited to people, communities, and or governments that can invest in these new technologies. Students will start to appreciate the broader perspective of the topics explored during the summer in terms of global challenges working with stakeholders outside STEM disciplines to address our energy demand and pollution.

C. Department of Communications

*The Science of Science Communication* (Department of Communications, College of Humanities)

We will focus on the importance of science communication research for scientists, members of publics, and policymakers, both nationally and globally. Communication offers a framework for better understanding the complex relationship between science and society, including connections with publics, policy makers, and media practitioners. While most people in STEM fields recognize that communication is an important element of disseminating scientific findings, there is not a widespread awareness of academic research on science communication. By highlighting the science of science communication, this session will bring the beginning foundation in the theories and methods of science communication and highlight research that informs skills for engaging in effective science communication. This unit will include an introduction to science communication, a field activity, and an examination of high-level nuclear waste siting as a case study in science communication. Historic and contemporary examples of the critical need for accurate and accessible science communication will be thread throughout the lessons and will emphasize the value of the humanities in bridging this communication gap.

D. Summer capstone. Introduction to approaches to international negotiation and action on climate

Students advocate for one of 6-groups (groups= developing or developed nations, and climate refugees) in international negotiations on fossil fuel reliance and action on climate. Knowledge gained during the course, and a climate negotiation equity framework, provide the foundation and structure for creating presentations and supporting arguments. The General Assembly of the United Nations will be represented by the Hinckley and anonymous voting (clickers) from students.
E. Guest Presentations (pending availability and alignment with the summer course schedule)

Michael Roberts, Professor of Economics, University of Hawaii
Aloha! I am a Professor in the Department of Economics, University of Hawaii Economic Research Organization (UHERO), and Sea Grant at UH Manoa. My research focuses on effects of agricultural policies, impacts of climate change on agriculture, and commodity pricing, and I’ve recently started new research and outreach program on renewable energy and water. I enjoy interdisciplinary research and publish in both science and economics journals. I have served on several other editorial boards for leading agricultural, environmental and resource economics journals, and currently a Co-Editor at the Journal of Association of Environmental and Resource Economics. Before coming to Hawaii I was an Assistant and then Associate Professor at North Carolina State University from Fall 2008 through Spring 2012. Before that I worked for USDA’s Economic Research Service. I grew up in California, went to UCSD to swim and study, Montana State to ski and earn an MS, and obtained an MA in Statistics and PhD in Agricultural and Resource Economics at UC Berkeley.

Laura Nelson, Ph.D., Energy Advisor, Director, Utah Governor’s Office of Energy Development
Governor Gary R. Herbert appointed Dr. Laura Nelson as his energy advisor in May 2016. She also continues to serve as the executive director for the Governor’s Office of Energy Development, a position she has held since 2014. Prior, Dr. Nelson served as the vice president of government and regulatory affairs for Potash Ridge, Corp., the vice president of energy and environmental development for Red Leaf Resources, and the energy advisor for Utah Governor Jon M. Huntsman. For two decades, Dr. Nelson has been proactive in defining and supporting balanced and sustainable energy solutions, including providing Congressional testimony, participating in regional collaborations, working with counties and cities, and coordinating across diverse stakeholders to deliver positive policy, regulatory and commercial results. Dr. Nelson holds a Ph.D. in Economics from the University of Utah and resides with her family in Salt Lake City.

Pulitzer Center journalist (NY Times, The Guardian, National Geographic, NBC News, and others)
A print, radio, or documentary journalist, who is recognized for their reporting in the area of climate and energy, presents about experiences reporting in this topic area. A Q and A, with students, follows the presentation.

Film Screening: Anote’s Ark, World premiere at the 2018 Sundance Film Festival
Official Trailer: https://vimeo.com/244728466
What if your country was swallowed by the sea? The Pacific Island nation of Kiribati (population: 100,000) is one of the most remote places on the planet, seemingly far-removed from the pressures of modern life. Yet it is one of the first countries that must confront the main existential dilemma of our time: imminent annihilation from sea-level rise. While Kiribati’s President Anote Tong races to find a way to protect his nation’s people and maintain their dignity, many Kiribati are already seeking safe harbour overseas. Set against the backdrop of international climate and human rights negotiations, Anote’s struggle to save his nation is intertwined with the extraordinary fate of Sermay, a young mother of six, who fights to migrate her family to New Zealand. At stake is the survival of Sermay’s family, the Kiribati people, and 4,000 years of Kiribati culture.