Proposal for a Mixed Cluster General Education Learning Community:

Energy and the Environment

1. **Theme:** Perhaps no issues facing our global society right now are more pressing than the looming energy crisis and the serious environmental consequences of global warming. Due to modern society’s heavy reliance on fossil fuels, these two problems are directly linked, and require all of us to become informed enough to play a role in local, national, and global strategies for developing sound environmental policies and finding sustainable ways to meet energy needs. The impending exhaustion of fossil fuels coupled with the serious shift in the earth’s climate due to global warming is having and will continue to have dramatic social, political, and economic consequences for the entire world. For modern society to continue, scientific and technological development of new energy sources, as well as dramatic social, political, and economic measures, are required.

Achieving sustainability and thus meeting human energy needs while protecting our environment is a complex, interdisciplinary “Wicked Problem” that cannot be solved without a basic understanding of the laws of nature that constrain our scientific options and the moral, cultural, economic, and political principles that govern how humanity can and should respond to these issues.

The core theme of our proposed learning community is examining issues related to this wicked problem, i.e. **Energy and the Environment**, from the perspectives of science, policy, and ethics. Students will emerge from the learning community as informed citizens who understand the basic scientific and ethical problems related to energy and the environment.

**Importance of Issues to First Year Students:** People in America live a particularly energy-intensive lifestyle, and it is rapidly becoming clear that the collective impact of our behavior is having dramatic consequences for the world. There is certainly a connection between the rising price of gasoline and electricity of which first year students are acutely aware and the wars and instability in the Middle East, pollution, climate change, political upheaval in many parts of the world, and global economic trends. In a sense, energy and the environment are central issues that can be used to connect and explain a great deal of what is transpiring both globally and locally.

First year students can see how their individual choices, taken as part of an aggregate society, affect disparate elements of the global society. Because these problems will only become worse in coming years unless we change course, now is a critical time to become informed about energy and the environment.

2. **Courses:**

   Physics 2005: Science of Energy  
   Geology 1006: Earth Systems and Energy  
   Philosophy 1102: Issues in Environmental Ethics

3. **Integration of Course Content:** In order to facilitate integration of course content, we have decided that each course will share a common text [Out of Gas: The End of the Age of Oil, by David Goodstein (W.W. Norton and Co., London, 2004); $10.00 from Amazon]. Course content will be supplemented with handouts and additional texts as needed. In the final course in the sequence, the course will conclude with a “research presentations” on the subject of Energy and the Environment where students will give presentations combining knowledge and analysis from
all three courses. Professors and faculty from all the courses’ departments will be invited to the
corpus and share in the evaluation and/or discussion of the presentations.

Each of the courses will address the fundamental problem of how society can address human
energy needs in a sustainable way while protecting the environment. Each course will encourage
students to creatively engage this central question in different ways:

a) In *Physics 2005 (Science of Energy)*, students will first study the scientific facts concerning
energy. They will learn what energy is and the laws of physics that govern the creation, use,
and distribution of energy. Different means of energy production will be studied: fossil fuels,
nuclear, solar, geothermal, etc. Quantitative reasoning will be stressed as students will
analyze the impact of population growth, standard of living and economic issues, and
efficiency. Students will synthesize their knowledge by writing quantitative papers on how to
meet human energy needs in a sustainable way.

b) *Geology 1006 (Earth Systems and Energy)* will provide students with a broad survey of Earth
System Science with a focus on energy in the environment, energy resources (e.g., coal,
natural gas, petroleum geothermal, etc.), and the environmental implications of some energy
technologies (e.g., air pollution, acid rain, global warming, etc.). This course provides a
broad interdisciplinary (systems approach) introduction to energy and our environment.
GEOL 1006 will satisfy the Earth Science requirements of the Multiple Subject Preparation
Program (Liberal Studies) for elementary science teachers. In addition, students in this
cluster may elect to enroll in GEOL 1002 (Environmental Geology Lab) to satisfy the
General Education science lab requirement.

c) In *Philosophy 1102 (Issues in Environmental Ethics)*, students will become familiar with the
methodology of argument and how to apply this methodology to moral issues. They will be
required to take the information and skills developed in the other classes and use them to
provide informed answers to questions about how our behavior toward the environment is a
moral issue and what sort of behavior is correct.

4. Fulfillment of General Education Learning Outcomes:


**Outcome 1:** Students will develop broad science content knowledge in the physical sciences by learning
about the physical laws pertaining to energy:

A. The scientific concept of energy will be introduced and discussed. Distinctions will be made
between scientific definitions and common usage. Important ways to classify energy will also be
introduced – classification itself being a central manner of organizing thought.

B. Conservation of energy is one of the most fundamental physics laws in the universe. The law of
conservation will be used to highlight the real issue of finite resources for energy production, and
to illustrate the fundamental nature of scientific theories and laws – and how they have stood the
test of time and multiple experiments.

C. The fundamentals of thermodynamics will be used to explain weather patterns, motors and
power generation. Thermodynamics is also critical to the idea that some forms of energy are
more useful than others, which ties nicely back to the second content point, conservation of
energy.

D. Basic mechanics will be introduced at a level necessary to connect mass and motion to energy,
and to understand why fuel efficiency goes down as speed increases.
E. Electricity and magnetism will be used to explain the entire electric grid, from how motion of water or steam is used to produce electricity to how it is delivered to households.

F. The structure of the nucleus and the concept of binding energy are critical to understanding how both fission (currently >22% of CA's energy supply) and fusion work/could work.

G. A conceptual understanding of atomic energy levels and the nature of semi-conductors is introduced in the discussion on photo-voltaics and fuel cells.

Outcome 2: Students will demonstrate the application of quantitative skills to physical science problems by making basic calculations and order-of-magnitude estimates concerning limits on the world's population, energy production by various sources (fossil fuels, nuclear, solar), future world energy needs, and the relationship between energy consumption and economic growth. Effort will also be made to make clear to students that in the scientific world many of our laws are still called "theories" based on convention, not any weakness on the part of the theory.

The focus on quantitative literacy begins on the very first day of class with a series of graphs that show the country and world's energy resources and uses in various manners. Students see how graphs change shape as energy consumption is plotted next to consumption per capita or consumption per GDP (gross domestic product). We discuss who would present data in which ways and why so often energy debates are not about who's right and who's wrong, but about perspectives, values and consequences.

Six problem sets throughout the quarter will give the students practice solving quantitative problems. These problems will require students to combine quantitative examples with their conceptual understanding of the basic science content listed in Outcome 1.

The papers will require students to seek out and obtain real-world data about various methods of power production. They will have to organize all the data they find, analyze, and discuss its significance.

Basic mathematical skills that will be covered in the class include arithmetic and algebra, ratios and percents, exponential growth, multiplicative growth, and statistical fluctuations and trends.

Outcome 3: Students will demonstrate a general understanding of the nature of science by evaluating scientific claims about energy production, learning about and applying the scientific method for addressing scientific questions about energy production and use, and differentiating between the scientific problems related to energy and the social, political, and cultural problems related to energy.

Since energy is such an interdisciplinary topic, there are numerous places to clarify where the science stops and the economics/politics/value judgments start. In early discussions we will work, as a class, to classify various passages in an article, distinguishing facts from assumptions from values. We will also look at where that facts or data are coming from, and discuss the scientific method of designing experiments - or even surveys.

In exploring how much oil is left we will examine data from various agencies, discuss how the data were collected, uncertainties in data collection, and how measurements can always be repeated. We can then discuss the various assumptions that have been made when interpreting the data.

The focus on the fundamental laws of thermodynamics as they relate to energy, will facilitate a discussion on how these concepts became accepted "laws" and the variety of experiments that have verified these relationships. A bit of historical context will be provided to provide an example of a scientific theory standing the test of time.

Pseudoscience will be touched on during a discussion of perpetual motion (or lack there-of).
**B5: Science Elective – GEOL 1006 Earth Systems and Energy**

**Outcome 1:** This course examines content in the four fundamental Earth Sciences: Geology, Atmospheric Science, Oceanography and Planetary Science. Students will gain knowledge in the following areas:

- Earth materials
- structure and composition of the Earth
- plate tectonics
- atmospheric structure
- weather and meteorology
- climate and global change
- physical and chemical oceanography
- solar science
- comparative planetology
- origin of the solar system (solar nebula hypothesis)

Students will demonstrate their understanding of the content of the course through examinations, homework exercises and web activities.

**Outcome 2:** Students will have the opportunity, in both the lecture and laboratory sections, to interpret graphical data and perform simple numerical calculations. In this course, we will stress the connection between mathematics and science. It is important that students understand that science is a way of understanding the physical world around us and that we can achieve a deeper understanding through quantitative skills. As an example:

If the speed of light is 299,792,458 meter/second and the Earth is 149,598,000,000 meters from the Sun, how long does it take for sunlight to reach the Earth?

\[
\frac{149,598,000,000 \text{ m}}{299,792,458 \text{ m/s}} = 499 \text{ seconds}
\]

This simple problem gives us the ability to gain a deeper appreciation of the Earth-Sun relationship through a very simple calculation. In addition, this problem reinforces mathematical skills (e.g., dimensional analysis, unit conversion) and science content such as the speed of light and the definition of the astronomical unit.

Students will have the opportunity to interpret graphical data that describe the physical world. In the figure, the thermal structure of the Earth’s atmosphere is presented. Students will interpret graphical data in terms of mathematical relationships. As an example, students will recognize that the temperature of the stratosphere increases with altitude from these data. In addition, students will be able to explain that the temperature of the stratosphere increases with altitude due to the absorption of solar ultraviolet radiation by ozone molecules.
Students will demonstrate their understanding of this learning outcome through examinations, homework exercises, and/or web activities.

**Outcome 3:** The content of this course includes some of the most important historical advances in the natural sciences such as our understanding of the heliocentric solar system, geologic time, evolution and plate tectonics. These examples (and others) will be used to demonstrate the nature of science, empiricism and experimentation. Through this course, students will begin to evaluate scientific data and claims. Lastly, the contrast between astronomy and astrology serves as an excellent example of the differences between science and pseudoscience.

Students will demonstrate their understanding of this learning outcome through examinations, homework exercises, web activities and/or a local fieldtrip.

**C2: Letters – Philosophy 1102: Issues in Environmental Ethics**

**Outcome 1:** The body of literature that relates to human interaction with the environment is vast and diverse. It covers both developments in science as well as social issues such as attitudes toward our environment. Students will be required to address a variety of works across a variety of fields.

**Outcome 2:** Students will be required to study writing and ideas about the environment both historical and modern. Students will realize how certain concerns are persistent (like the difference between intrinsic and instrumental value) while other concerns are contemporary (like concerns based on recent science).

**Outcome 3:** Critical reflection is the theme of the class. Students will be required to develop a detailed understanding of the arguments, but they will also be required to evaluate the arguments in such a way so that they are aware of their strengths and weaknesses and can identify what would qualify as support or criticisms of those arguments.

**Outcome 4:** Students will discover that the obvious arguments are rarely the best because they fail to demonstrate a thorough understanding or relevant skills related to the detailed study of environmental ethics. Students will come to appreciate the value of interesting thoughtful studies and arguments.

5. **Course Outlines:** (see attached pages).
Energy & Environment Cluster Proposal

Approved by Department Chairs:

[Signature]

Physical
Date: 4/2/2014

Earth & Environ. Sci.
Date: 4/2/2014

PHIL
Date: 3/1/14

Approved by College Dean/Associate Dean from each participating college:

[Signature]

CLASS A.D.
Date: 4/4/2014

For Dean
Roundtree
Date

Signatures of three faculty members: Ideally, the person who will teach the courses will participate in the cluster planning. However, recognizing the staffing difficulties departments face, the faculty member who plans the cluster must agree to provide a thorough orientation to the expectations and methods developed for the learning community to the actual instructor. We each agree, if selected, to meet on for six hours during the following three days for an end-of-Spring workshop on interdisciplinary curriculum, pedagogy and course integration.

[Signature]

Calvin Lee (chair, EESC)
Date: 4/3/2014

[Signature]

Date: 3/1/14

[Signature]

Date

[Note]: While Colleges do not approve courses for GE, College approval assures support for departmental participation.