

AC 2010-1484: INTRODUCTION TO RENEWABLE ENERGY: AN INTERDISCIPLINARY APPROACH

Christopher Simon, University of Nevada, Reno
Professor Political Science

Ted Batchman, University of Nevada-Reno
Professor, Electrical and Biomedical Engineering, Fellow ASEE, Life Fellow IEEE

Christine Taylor, Lewis and Clark University
Formerly at the University of Nevada, Reno and currently a law student at Lewis and Clark University in Portland, OR.

Introduction to Renewable Energy: An Interdisciplinary Approach

Abstract

Energy security and climate change issues have precipitated growing awareness of and interest in renewable energy. This paper assesses the impact of renewable energy education in a first-year offering of an introductory interdisciplinary renewable energy course employing a quasi-experimental evaluation design. Findings from the study indicate that the course has a significant impact on student knowledge.

Literature Review

Public policy and engineering are a critical part of any cogent response to growing pressure felt in higher education for new sustainable and “green” college curricula and campus physical plants. Students’ ‘green’ values often drive campus energy source and efficiency choices,^{4, 12} Students are proactive in demanding energy-efficient, small carbon footprint campuses.^{16, 18} Some survey evidence suggests that students may even be willing to pay increased fees for green buildings. College and university administrators—facing the prospect of high and constantly rising energy costs²—are cognizant of the need to tie green building initiatives to increases in student fees for energy consumption. Community colleges, in particular, are responding to students’ values by developing green campuses and incorporating energy education into campus design and operations, and into student orientation efforts.^{7, 9} The rapid movement towards green energy campuses, however, must be accomplished with a sense of the real costs and benefits of the specific green energy initiatives developed.^{18, 19}

Disciplinary change, student value shifts, and rising energy prices create a renewed opportunity to move U.S. public policy and engineering education in a mutually beneficial direction. Calls for change in the way energy education occurs are certainly not new, and earlier expressions of concern are a good source for our current reflection. Writing in 1973, the highly respected Republican legislator Howard Baker pondered the then-current oil supply shortage.⁴ He concluded that well-developed education programs linking environmental attitudes with energy use could have a strong and lasting impact on energy consumption behaviors in the country. In the 1970’s, President Jimmy Carter advocated the development of energy education programs to change students’ perceptions of energy and alter patterns of energy use among the youth.³ Energy price declines in the 1980’s reduced the intensity of the energy education dialogue, but price spikes in the early 1990’s gave rise to renewed calls to consider past awareness promotion initiatives.¹⁸ Energy education initiatives tend to parallel the ebb and flow of energy prices; but as Dias et al. concluded⁵—in much the same way as the Club of Rome report¹⁷ --human progression towards increased economic development aimed at raising the standard of living of people in all parts of the world almost surely means that energy crises will not solve themselves.

Broadly-inclusive energy education is central to the accomplishment of sustainable development.¹⁴ Traditionally, engineering economics and political economy would focus significant attention on costs factors present in policy choices, but such an “academic” approach in energy education might diminish its appeal and limit impacts on student behavioral change. A more qualitative public affairs and “social values” approach, combined with technical knowledge

and economic considerations, is perhaps more likely to lead to long-term impacts on students' energy behaviors in future citizen policymaker roles as voters, community leaders, and participants in "policy value forums."¹¹

Building on the many potential forms and roles of energy education, Kalkani et al. constructed an intriguing conception of interdisciplinary energy education.¹⁰ The authors developed a renewable energy course taught at the National Technical University in Athens, Greece that included four common pedagogical and curricular dimensions:

- conceptualization
- reflective observation
- concrete experience
- active experimentation

More specifically, Kalkani et al. "restructure the renewable energy engineering" to include three major education goals (402):

- "include modern technology on renewable energy applications;"
- "consider the present societal, environmental and legal issues;"
- "introduce business and entrepreneurial issues"

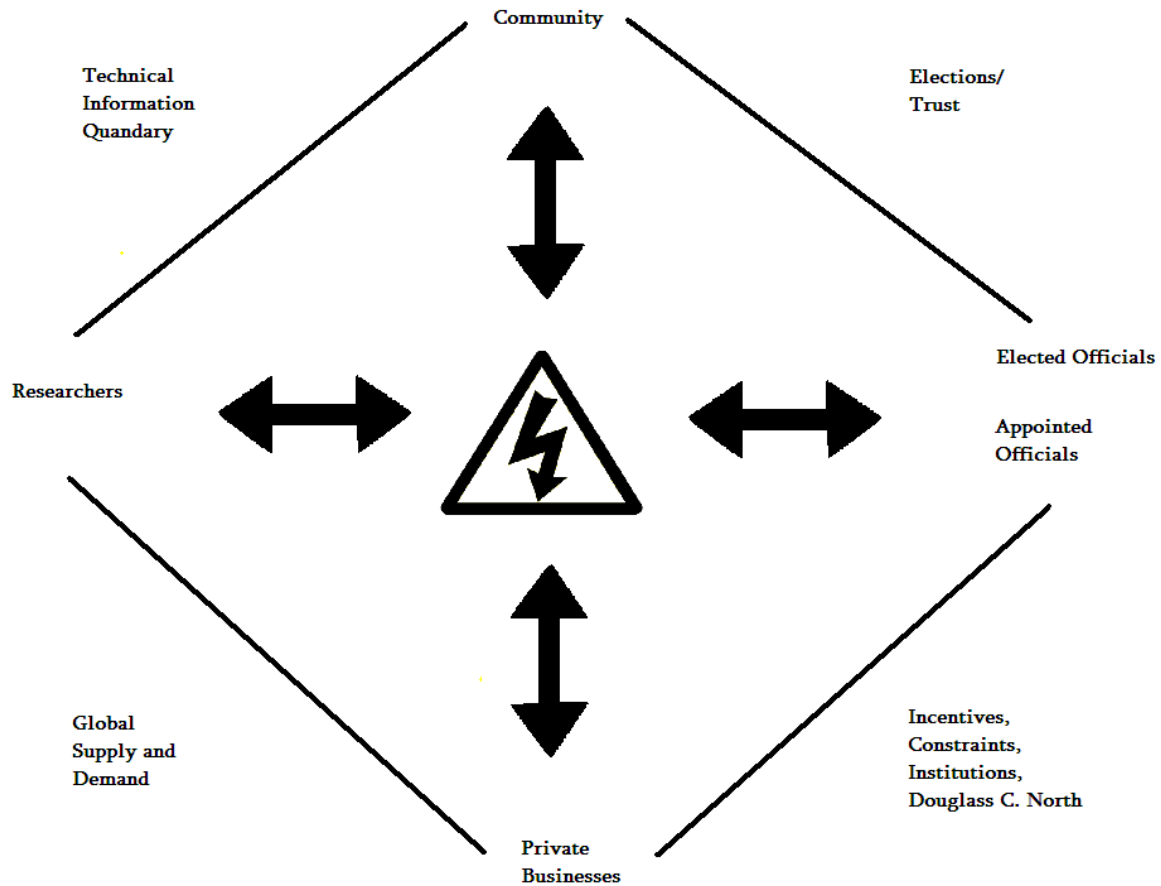
The renewable energy course analyzed in this study closely resembles the course described by Kalkani et al. It is different to the extent that it is an introductory (or freshman-level) course at a university in the U.S. Second, it does not have an active lab section, but rather uses computer simulation for the "hands on" learning aspects. Third, student enrollment is composed of both technical and non-technical students historically drawing students majoring in engineering, political science, business, general science, and education. Fourth, the course is team-taught by an engineering professor and a political scientist. The purpose of this paper is to describe the knowledge level, energy use behavior, and values of students enrolled in the renewable energy course compared to a comparable student cohort of individuals not enrolled in the renewable energy course in question. Documenting interdisciplinary course impacts in the way done here is intended to inform future programmatic and curricular development and inform similar institutional efforts elsewhere in higher education.

Pedagogical Model

Currently, the introductory renewable energy course is the only course in which engineering and non-engineering students are required to enroll in a joint course offering. The course is designed to inform students of four major dimensions of renewable energy development (See Figure 1), with particular emphasis being placed on "bottom up" community-based energy production and demand-related choices. The four major actors studied are: a) citizens; b) political and administrative institutions; c) private businesses; and d) researchers. In a bottom up policy environment, all stakeholders must be able to participate as equals in the collective decision-making process. In the pedagogical model adopted for the course, "tensions" exists between these actors due to differing values and perspectives, and these "tensions" must be understood and addressed effectively if balanced participation is to be achieved. Citizens and political/administrative institutional interactions may be constrained by a lack of public confidence and trust in public institutions. Citizens may, for example feel that their social and environmental values are not being effectively addressed by elected and appointed officials.

Participation may be limited largely to the voting process, whereby citizens either re-elect their representatives or remove them from office.

Figure 1
Pedagogical Model for Course



An understanding of interaction between political/administrative institutions and private business is also important in developing the capacity for community renewable energy decision-making. The work of Douglass C. North plays a critical role in understanding the interaction between markets and the public sector. North's work offers a deeper understanding of the role of government policy in creating incentives for or imposing constraints upon markets.²⁰ Short and long term production costs and prices are impacted by public policy, as are the levels of demand for goods and services.

In bringing the private sector into the renewable energy policy making process, it is important to gauge citizen capacity to understand and accept the role of private sector solutions in the energy arena. If citizens are inclined to view government solutions as the optimal approach to the development of renewable energy, then private businesses may be viewed as being less relevant in the policymaking process. In the renewable energy course, considerable time is spent discussing the role of public-private partnerships; personal tax deductions; corporate tax breaks;

sales tax exemptions; property tax incentives; rebates; grants; loans; industry support; state bonds issuances; and production incentives.

Private business and researchers may also face stumbling blocks in communication. While private business leaders in the renewable energy market are generally aware of the technical attributes of marketable goods, they are not nearly as likely to be fully cognizant of current scientific research developments. As a consequence, business leaders are often frustrated by the lag-time between research discoveries and product development. From the standpoint of private business, renewable energy technology exists in the global marketplace and is therefore subject to the forces of supply and demand. In order to make informed economic choices, private businesses must be able to gauge the quality of current technology, future technology availability, and related prices. It is clear that researchers and private sector business must develop strong communication if equitable and effective energy choices are to be made.

Finally, researcher-citizen communication is critical to the development of community capacity for bottom-up renewable energy policy innovation. Communication is often limited due to the inability of citizens to understand the terminology of the researcher. Termed the “technical information quandary” by Pierce and Lovrich, the circumstance often vexes citizens and researchers alike.²¹ Literacy in technical issues may result in some citizens and interest groups having disproportionate say in the bottom-up policy making process, while less well-versed individuals are made to feel non-efficacious and unwelcome in the collective effort to develop effective public policy.

In addressing issues related to the four major social actors identified above, the introductory renewable energy course focuses on the following: the public policy process and policy developments; policy innovation in the energy area; technical feasibility and current research developments within the renewable energy realm; the economics of renewable energy, to include a discussion of opportunity costs associated with renewable energy development; public institutional capacity; and citizen capacity.

Design of Team Taught Introduction to Renewable Energy Course

The course was designed to begin with a series of lectures designed to introduce students Laws of Thermodynamics in application to renewable energy—it was called Thermo Clinic. Students participated in solving basic problems.

Following the thermodynamics lectures, lectures focus on “energy” as a politically defined concept discussed in statutes and administrative rules. The course moves to a more specific discussion of “what is renewable energy?” versus “what is alternative energy?” Special attention is given to the role of public policy in shaping energy markets and research. The intent is to show that technical and policy knowledge must be brought together to develop a clearer understanding of renewable energy.

Following a general discussion of energy definitions, the course focuses on the political economy of energy—in essence, a focus on the present fossil energy outlook, the state of renewable and alternative energy as it gains market-share. Additionally, the course emphasizes the role of

evolving political and social values and the impact of these values in shaping energy policy and outcomes.

The course curriculum moves on to discuss a series of renewable and alternative energy developments (e.g., solar, wind, geothermal, natural gas, electric vehicles, and next-generation nuclear power). For nearly all of these topical areas, the course offers guest lectures from professors in engineering and political science/public policy, as well as individuals working in private industry. The guest lectures are supplemented with discussions of current technology as well as issues associated with economic and political feasibility.

A final in-class portion of the course uses small group seminar-style discussions of current “great books” in renewable and/or alternative energy. To facilitate the seminar approach, the combined engineering and political science section enrollment of 40+ students is randomly assigned to two smaller seminar groups which meet on different class days when seminar-style discussions are held. (See Exhibit 1)

In terms of team-building outside of the in-class portion, students are formed into teams of two or three students and conduct computer simulations for residential renewable energy systems using a shareware program known as HOMER™. HOMER™ brings together economics, engineering, and political value concepts into the design of a renewable energy system to meet the energy needs of a residential home. Working together, students prioritize their imaginary residence’s energy needs and then try to meet those needs using site-appropriate renewable energy technology. HOMER™ conducts an economic analysis and creates optimum system designs. The student dialogues build student knowledge and mutual understanding—in short, the students discover that they need each other to arrive at a solution that is technically feasible and accepted by consumers.

At the conclusion of the course, a second “Thermo Clinic” is offered in the final two course lectures. The basic laws of thermodynamics are reviewed to reinforce basic energy concepts.

Outcomes: Is the Course Producing a Positive Impact on Students?

In order to measure course impacts, students in the first two iterations of the course were given a pre- and post-course survey (See Exhibit 2). We are primarily interested in seeing if the course leads to positive outcomes on student knowledge controlling for student energy use behavior, environmental and social values, policy attitudes, and general knowledge of fossil energy prices.

Hypotheses

H1: Individuals enrolled in the alternative energy course will experience a significant increase in their level of knowledge about alternative energy policy over the course of the semester-long course exposure when compared to the control group course.

It is expected that students having a semester-long exposure to alternative energy policy and technical issues will experience an increase in their level of knowledge and understanding of alternative energy.

H2: Energy use and energy/material conservation behaviors are positively associated with knowledge of renewable energy policy.

A basic assumption of the alternative energy course is that exposure to policy and technical knowledge is critical to the adoption of alternative energy systems at the individual and community level. While course exposure will likely increase student knowledge and awareness, it is likely that behaviors independent of course material might lead to increased personal awareness of energy policies. In the case of longer driving commutes, informal interviews with students indicate that long distance driving is often explained by trips to Lake Tahoe for recreational purposes. Enjoying the outdoors and natural settings might lead to increased student interest in the relationship between energy policy and environmental impacts. Student recycling behaviors are likely to also shape interest in alternative energy as part of the pursuit of sustainability.

H3: Individuals who express post-materialist values and support the New Environmental Paradigm (NEP) tend to command more knowledge of renewable energy than individuals who are more materialistic and less supportive of NEP principles.

Post-materialists tend to value the aesthetic qualities of life and frequently value equality, broadly-defined. Values more specific to environmental protection and human impacts on ecosystems are captured by NEP indicators. Based on the work of Ronald Inglehart and others, postmaterialism and NEP support are expected to be related to higher levels of alternative energy policy knowledge, which relate back to the course pedagogical model emphasis on citizen values being related to policy outcomes and policy knowledge.^{6, 8}

H4: Individuals who support government control of energy markets and prices are significantly less knowledgeable about alternative energy policy.

Individuals who envision government as a solution to social and economic problems may be less concerned with policy specifics and more focused on outcomes. In the case of energy supply and prices, individuals who support government control of related markets would likely gauge policy success in terms of lower energy prices and increased supply — and policy specifics would be of less interest to them. Greater support of government control as a solution to energy prices and supply issues might also reflect a limited and stereotyped understanding of the complexities of energy markets.

Findings

A univariate generalized linear model (GLM) is reported in Table 1. The model explains approximately 48 percent of the variance in the dependent variable. A Levene's test for equality of variance was insignificant ($F=1.65, p \leq 0.14$), which means that the model does not violate a basic modeling assumption required for use of this statistical procedure.

Table 1
Univariate GLM Analysis

Dependent Variable: Renewable Energy Knowledge Score ¹	B	s.e.	t	Partial η	Obs. Power
Time of Survey					
Post-Test	15.07	3.97	3.80*	0.24	0.96
Experimental Grp.	9.81	4.35	2.25*	0.10	0.60
Driving Habits ²	2.99	1.24	2.41*	0.11	0.65
Recycling Habits ³	5.07	1.97	2.68*	0.13	0.71
Government Control of Energy ⁴	0.81	1.74	0.47	0.01	0.07
New Environmental Paradigm ⁴	-4.35	1.76	2.48*	0.12	0.68
Post Materialist Values	10.07	3.48	2.90*	0.15	0.81
Gender					
Female	-15.45	3.87	4.00*	0.26	0.97
Estimated Current Price of Petroleum (\$/bbl.)	-0.52	0.22	2.37*	0.11	0.64
Estimated Current Price of Petroleum (\$/bbl.) [quadratic]	0.003	0.001	2.34*	0.11	0.63
Estimated Current Price of Petroleum (\$/bbl.) [cubic]	-3.71×10 ⁻⁶	1.54×10 ⁻⁶	2.41*	0.11	0.66
Intercept	66.53	16.74	3.97*	0.26	0.97

Levene's Test F=1.65 (p≤0.14)

Adj. R-Square: 0.48

N=58 *p<0.05

¹ Additive Index of Correct Responses. See Appendix A

² Additive Index Constructed Using Section IVa-c indicators

³ Additive Index Constructed Using Section IVd-g indicators

⁴ Scaled Index. See Appendix B

Controlling for effects of other explanatory variables in the model, knowledge levels for both control and experimental groups increased by 15 percent when compared to pre-test scores—probably due to history effects associated with petroleum price spikes—the experimental course knowledge levels rose at a rate significantly greater than the control group course. While history-related incidents impacted knowledge levels, curriculum had a marked impact. *Ceteris paribus*, the experimental group—alternative energy course—knowledge-level increased by nearly 25 percent on average.

As expected, energy and resource use behaviors were significantly related to alternative energy knowledge levels. Individuals who drove longer distances and individuals who reported recycling habits were more knowledgeable about alternative energy. In both cases, however, the model coefficients were statistically significant but the relative power of the coefficients in the models was of only moderate strength.

The results indicate that individuals who are post-materialist in general value orientation tend to be more knowledgeable about alternative energy policy than their materialist counterparts. The model coefficient is statistically significant, and its observed power is fairly high. A high level of support for more specific environmental values (that is, the NEP value statements posed) is unexpectedly associated with lower levels of knowledge about alternative energy, while a post-materialist outlook tends to be associated with more knowledge as expected. Further study is clearly required before any definitive conclusions can be drawn on the connection between knowledge holding and environmental and political culture values. The findings reported here, however, suggest the need to draw a clear distinction between more global post-materialist values and the environmentally-specific NEP values that should be teased out through pedagogical and curricular adaptation in classroom instruction.

Controlling for the effects of other explanatory variables, the model indicates that female students are significantly less knowledgeable about renewable energy than male students. The finding is noteworthy in terms of equity in curricular offering and general pedagogy. A greater effort must be made to promote equal access to science and policy information—curriculum and pedagogy must be complimentary. The knowledge gap is present prior to course exposure, which would indicate that the course does not create the equity issue; but it remains an issue that must be addressed.

A final control variable was knowledge about energy prices. The finding reported indicates that a curvilinear relationship exists in the data. While cubic relationships might seem odd, in this case the result tends to look more typically parabolic in graphic form. Students who underestimate energy prices tend to be slightly more knowledgeable than students who correctly estimate energy prices. Students who overestimate fossil energy prices tend to be more knowledgeable about alternative energy policy. While statistically significant, the observed power of the energy price variables are moderate, requiring further study using larger sample sizes.

Conclusion

The analysis of alternative energy course instruction yields interesting results. The role of values is clearly an important factor in energy knowledge development. History effects associated with fossil energy price spikes likely impact general student knowledge about alternative energy, but alternative energy education produces a demonstrable positive impact on student learning above and beyond any possible history effect (in this case, the rising price of petroleum occurring in Spring, 2008) — students did learn on their own, but the impact of curricular offerings adds importantly to that learning. Values and gender play a significant role in explaining student knowledge. The findings indicate that greater awareness must be placed on these critical components of effective alternative energy education.

Exhibit 1 Abbreviated Course Syllabus

ENGR I10/PSC I10 Introduction to Renewable Energy
Instructors: Professors Batchman and Simon

Class Information

Welcome to Introduction to Renewable Energy. We assume that you have no previous knowledge of renewable energy systems and policy; however, the fact that you are here means that you have an interest in the subject. The course will inter-weave the technological, political, and economic feasibility of alternative energy, which includes renewable energy—the latter being a subset of alternative energy.

Unique class procedures/structures

- Guest presentations from industry leaders and policymakers—renewable energy is changing so quickly, that it is important for students to gain information from “top name” leaders in the renewable energy marketplace as well as from national and state policymakers who make rules that govern markets and create incentives.
- Team-based problem solving. Students will work together to create optimal energy system designs for sustainable communities. The students will use a web-based free shareware program known as HOMER™, which is available for download from the National Renewable Energy Laboratory (NREL)-- <http://www.nrel.gov/homer/>.
- Class discussion. We will use the assigned texts, guest presentations and lectures as opportunities to discuss renewable energy issues.

Course Objectives

- Familiarize students with scientific terms and concepts related to energy. Students will understand what terms and concepts mean and learn how to apply concepts to real world energy applications.
- Familiarize students with the role of energy in modern society and trends in demand and supply. Students will learn about current estimates of energy inventories and the current and future need to pursue renewable energy and other alternative energies.
- Familiarize students with major national and state policy initiatives related to renewable energy. Student will develop a substantial understanding of how energy policy creates incentives for renewable energy development.

Course Books

Cravens, Gwyneth 2007. *Power to Save the World: The Truth About Nuclear Energy*. New York: Knopf. [Cravens]
Holland, Geoffrey and Provenzano, James. 2007. *The Hydrogen Age: Empowering a Clean Energy Future*. Layton, UT: Gibbs Smith Publishing. [HP]
Simon, Christopher A. 2007. *Alternative Energy: Political, Economic, and Social Feasibility*. Lanham, MD: Rowman & Littlefield. [Simon]

Williams, Wendy and Whitcomb, Robert. 2008. *Cape Wind: Money, Celebrity, Energy, Class, Politics, and the Battle for Our Energy Future*. New York: Public Affairs Publishing. [WW]

Evaluation Tools

Midterm	25%	Team Assignments	10%
Class Participation	20%	Final Examination	30%
Book Reviews	15%		

Participation: Class participation will be evaluated on the basis of random attendance taking as well as instructor and peer-group evaluations of your performance in class and in small group exercises.

Book Reviews: For *Cape Wind*, *The Hydrogen Age*, and *Power to Save the World*, you will need to write book reviews, due at the time you attend the assigned discussion day.

Team assignments: Team assignments will involve problem solving, using course material to brainstorm solutions to real energy problems affecting us today and very likely to affect us well into the future.

Tentative Course Outline

Topic	Reading
1. What is energy?	
2. Thermo Clinic	
3. Industry Perspective/Guest Speaker	
4. What is the fossil energy paradigm?	www.eia.doe.gov/ www.eere.energy.gov/
5. How the grid works	
6. The grid and democracy	
7. Why alternative energy? Why now?	Simon, Ch 1
8. The Nature of Goods and basic economic principles and tools	Simon, Ch. 11
9. What is renewable energy?	Simon, Ch 3
10. Energy as a public policy innovation	Simon, Chs. 2 & 4
11. Solar Energy	Simon, Ch 5
12. Wind Energy	Simon, Ch 6
13. Class discussion of <i>Cape Wind</i>	
14. Geothermal Energy	Simon, Ch. 7
15. How Fuels Work: New Century Fuels	Simon, Ch. 8
16 Class discussion of <i>The Hydrogen Age</i>	
17. Transportation and Energy	
18. Technical Feasibility, Political Consent, Institutions, and Legitimacy Issues	Simon, Chs. 9-10
19. Class discussion of <i>Power to Save the World</i>	
20. Thermo Clinic Review/ Review for Final Examination	

Exhibit 2
Select Survey Questions

Section I: Your Views
Please indicate your level of agreement or disagreement with the following statements

	Strongly Agree		Neither Agree Nor Disagree			Strongly Disagree	
	1	2	3	4	5	6	7
a) Climate change is related to human-made greenhouse gas emissions.	1	2	3	4	5	6	7
b) Regardless of the price of petroleum, renewable energy should be promoted through public policy.	1	2	3	4	5	6	7
c) Human beings are but one species among the many that are interdependently involved in the biotic communities that shape our social life.	1	2	3	4	5	6	7
d) Intricate linkages of cause and effect and feedback in the web of nature produce many unintended consequences from purposive human action.	1	2	3	4	5	6	7
e) The world is finite, so there are potent physical and biological limits constraining economic growth, social progress, and other societal phenomena.	1	2	3	4	5	6	7
f) Energy supplies should be controlled by government.	1	2	3	4	5	6	7
g) Energy prices should be controlled by government.	1	2	3	4	5	6	7
h) Energy use should be controlled by government	1	2	3	4	5	6	7
i) Energy is private good that should be bought and sold in the free market.	1	2	3	4	5	6	7

Section II: General Knowledge
Please answer the following questions.

- a) What is the current price of a barrel of intermediate grade crude petroleum? \$_____
- b) What is the current Sierra Pacific Power Company base price of residential electricity in kWh terms? \$_____
- c) The average home uses how much electricity on an annual basis (circle your answer below)?
1) 80 kWh; 2) 8 MWH; 3) 80 MWH; 4) 8 kWh
- d) In your own words, what is the difference between energy and power?

Section III: Renewable Energy Knowledge

Please circle your response to each statement below.

- | | |
|--|---|
| <p>a) Photovoltaic cells are generally designed to produce thermal energy.</p> <p style="text-align: center;">TRUE FALSE</p> | <p>g) Nevada is behind most other states and local governments in promoting renewable energy.</p> <p style="text-align: center;">TRUE FALSE</p> |
| <p>b) Alternative energy may not be renewable, but renewable is a form of alternative energy.</p> <p style="text-align: center;">TRUE FALSE</p> | <p>h) All forms of renewable energy require public subsidies to make their use cost effective.</p> <p style="text-align: center;">TRUE FALSE</p> |
| <p>c) Wind turbines are designed to produce AC electricity.</p> <p style="text-align: center;">TRUE FALSE</p> | <p>i) Solar energy is about the same price as commercially available energy.</p> <p style="text-align: center;">TRUE FALSE</p> |
| <p>d) An optimum electricity producing geothermal resource is between 50 and 100 degrees Celsius.</p> <p style="text-align: center;">TRUE FALSE</p> | <p>j) Ethanol is made from high-sugar feedstock.</p> <p style="text-align: center;">TRUE FALSE</p> |
| <p>e) Public policy promoting renewable energy first began with the Energy Policy Act of 1992:</p> <p style="text-align: center;">TRUE FALSE</p> | <p>k) Natural gas is a hydrocarbon.</p> <p style="text-align: center;">TRUE FALSE</p> |
| <p>f) Green tags are sold with renewable energy generation systems and can in turn be sold by the owner of renewable energy technology.</p> | |

Section IV: Energy Use Behaviors

Please indicate your level of agreement or disagreement with the following statements regarding the use by your instructors of the following methods.

- | | Never | 1 | 2 | 3 | Sometimes | 4 | 5 | 6 | Always | 7 |
|---|-------|---|---|---|-----------|---|---|---|--------|---|
| a) I drive more than 100 miles per day. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | | |
| b) I drive more than 100 miles per week. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | | |
| c) I use public transportation. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | | |
| d) I use low wattage light bulbs in my residence. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | | |
| e) I recycle paper, plastics, and metals. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | | |
| f) I use green energy in my home/residence | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | | |
| g) At any given time, I have fewer than ten lightbulbs turned on in my residence. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | | |
| h) I take long showers (more than ten minutes). | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | | |
| i) Other _____. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | | |
| j) Are you the person responsible for paying the energy bills in your home? | | | | | | | | | | |
| a) yes | | | | | | | | | | |
| b) no | | | | | | | | | | |

Section V: Social Views

Please circle the response that best approximates your views

Rank the following issues [1= Most Important; 2=Second Most Important; 3=Third Most Important; 4= Least Important]:

____ Maintaining order in the nation.

____ Fighting rising prices.

____ Giving people more say in important political decisions.

____ Protecting freedom of speech

p) Circle the number that best represents your political ideology:

Very

Moderate

Very

Liberal

Conservative

1

2

3

4

5

6

7

Section VI: Background Information

We are collecting demographic information to determine if we have obtained a representative sample of the student population. Please provide accurate information so that the study's results are most helpful to students, faculty and administrators. Thanks!

1. Please indicate gender (circle one):

a) Female b) Male

2. How many credits are you currently taking? _____ credit hours

3. Please indicate your year of birth: 19____

4. What semester and year did you begin your coursework at the university? (circle term and fill in year)

Fall Spring Summer Year: _____

5. Expected graduation date?

Fall Spring Summer 20____

6. Please indicate your current academic standing.

a) Freshman

d) Senior

b) Sophomore

e) Graduate student

c) Junior

Thank you for taking the time to complete this survey. Please use the space below to write any comments that you feel would be helpful to us.

Appendix A

Renewable Energy Knowledge Questions (response: true/false)

1. Photovoltaic cells are generally designed to produce thermal energy.
2. Alternative energy may not be renewable, but renewable is a form of alternative energy.
3. Wind turbines are designed to produce AC electricity.
4. An optimum electricity-producing geothermal resource is between 50 and 100 degrees Celsius.
5. Public policy promoting renewable energy first began with the Energy Policy Act of 1992:
6. Green tags are sold with renewable energy generation systems and can in turn be sold by the owner of renewable energy technology.
7. Nevada is behind most other states and local governments in promoting renewable energy.
8. All forms of renewable energy require public subsidies to make their use cost effective.
9. Solar energy is about the same price as commercially available energy.
10. Ethanol is made from high-sugar feedstock.
11. Natural gas is a hydrocarbon.

Appendix B

Factor Analysis

Energy as a Public Good and New Environmental Paradigm

Indicator

	Energy as a Public Good	New Environ- mental Paradigm
[1=Strongly Disagree 7=Strongly Agree]		
Climate change is related to human-made greenhouse gas emissions.		0.63
Regardless of the price of petroleum, renewable energy should be promoted through public policy.		0.84
Human beings are but one species among many that are interdependently involved in the biotic communities that shape our social life.		0.77
Intricate linkages of cause and effect and feedback in the web of nature produce many unintended consequences from purposive human action.		0.82
The world is finite, so there are potent physical and biological limits constraining economic growth, social progress, and other societal phenomena.		0.60
Energy supplies should be controlled by government.	0.90	
Energy prices should be controlled by government.	0.91	
Energy use should be controlled by government	0.87	
Energy is private good that should be bought and sold in the free market.	-0.72	

	Eigenvalue	% of Variance Explained
Factor 1	3.05	33.94
Factor 2	2.68	29.79
Total		63.72
Varimax Rotation		

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