**Benefit of Graduate Course in Energy Policy for Understanding Global Issues**

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**ABSTRACT**

In the fall of 2010, a new course entitled **Energy Policy Analysis and Modeling** was taught as a core course in the newly established Ph.D. in the Energy Science and Engineering (ENSciE) Track within the existing Environmental Science and Engineering (ESE) Ph.D. program. Course objectives were focused on implications of energy policies. However, as the significance of social factors became clearer, it was determined that the course had an unexpected and significant benefit: enhancement of understanding of global directions, interactions, differences, and difficulties. Future offerings of the course will make such outcomes a specific objective and define ways to measure this impact.

**Background**

In the fall of 2010, the author was tasked with teaching a new course entitled **Energy Policy Analysis and Modeling**. This course is a core course in the newly established Ph.D. in the Energy Science and Engineering (ENSciE) Track within the existing Environmental Science and Engineering (ESE) Ph.D. program. There were twenty four students in the class from numerous countries. As the course evolved, the author decided to take advantage of the desired course outcomes, coupled with diverse student backgrounds, to help students learn about circumstances in other countries.

**Course Objectives**

The course was intended to help students understand the results of various policies, including objectives, implementation, and monitoring. (In this context, it should be noted that absence of a policy is, *de facto*, a policy in itself.) Therefore, course content was designed to incorporate examples from numerous studies and have students read materials that had a global focus. The course was designed to culminate in group studies on energy policies within different countries, with each of nine countries studied by teams of from one-four students.

**Course Content**

Topics within the course included reviews of materials and studies within the following categories. As well, students were asked to present findings at several points within the course. Students were asked to break into groups of three –five for class discussions. In addition, they performed some of the analyses this way, e.g., use of scenario planning.

* Characteristics and objectives of policies
* Assessment of policies
* Scenario planning
* Policy organizations
* Energy return on investment
* Reviews of specific policies
* Modeling
* Inclusion of social factors
* Life cycle cost assessment and variants
* Uncertainty
* Sustainability dashboard use

While the scientific and engineering preparation was sound, and was being enhanced by other courses in the curriculum, understandings of social factors was lacking Therefore, inclusion of social justice was placed in a framework with the following dimensions:

* use of sustainability as an over arching principle that links protection of people (social justice), the planet (environment), and the economy through the so-called triple bottom line.
* understanding tools that are available to assess the social impact products and projects
* developing an understanding of other disciplines to define social issues and who may acquire data that are beneficial to the engineer
* developing an understanding and skills to enable communication with other disciplines and segments of society
* integrating social justice into a framework that facilitates development of new, sustainable societies

The use of sustainability as a framework has numerous advantages for the global emphasis. First, it forces students to include social justice issues in their analysis. Second, it reinforces the need to be sure that proposed plans and actions can be easily understood by the public and policymakers.

It is difficult to measure some social indicators possibly leading to the use of mitigation. Mitigation as it was first used some decades ago was intended to take some good action that was felt to offset negative environmental action. This was often done by input from not only agencies but also community organizations.

In some cases indicators of social factors may indeed be measured or estimated by disciplines other than engineering. This means that the engineer developing the science needs to be regularly in communications with other people in other fields. For example, health effects of certain contaminants and the impact of climate change are being regularly studied by professionals and health sciences. In addition, other factors that will create stress on certain parts of the environment are being studied by people in fields like economics, sociology, and urban planning. A part of the growth of an engineer to become an effective designer, as well as a future leader, is to not only begin the dialogue with these other disciplines but to be actively engaged and listen to workers in the field. This course presented an excellent laboratory for such activities due to the diverse backgrounds of class members.

In addition to preparing themselves to create better designs and solutions for climate change, engineering graduates exposed to these materials will be able to take a leadership role within their company, professional organizations, and their community. They can not only effectively communicate issues of climate change, but they can help provide opportunities for more proactive approaches to solution of these problems.

Engineers expect that existing or proposed policies will act as a design constraint. In addition, engineers exposed to material from this course will be in a position to do more thorough analyses and hence to provide evidence-based policies that help forward social initiatives. They were given an opportunity to see existing and proposed policies and to assess implications including social factors. This included reviews of analyses (Resources For the Future/National Energy Policy Institute) (2010). Of particular emphasis in studying any such analyses will be developing an understanding of their impact on climate change. There are numerous tools that were discussed, with special study of life cycle assessment (LCA) (2006). Guidelines were extracted from a thorough study on including social factors (sLCA) (2009), the UN Global Compact (2010), and the new ISO 26000 – Social Responsibility (2010). Further, students reviewed data on indicators such as the GINI coefficient (CIA, 2011) to describe inequality of wealth, the Human Development Index (HDI) to describe various dimensions of social conditions (UN Development Programme, 2010), and others.

Methods to enhance communications, including listening, will be presented to students to enable their use later. These will include scenario planning (2002), as well as simplified indices that can be used to better inform decision makers, such as the sustainability dashboard (2010), already in use in Minnesota (2010) and elsewhere. In this role, the engineer can also work to identify meaningful, easily understood metrics that will enable consumers to make informed, accurate decisions on purchases that will indeed help solve the climate change problem. Goleman (2009 ), among others, argues that many consumers would like to help but find it confusing to interpret what they see on product labels.

Students were also brought into contact with design and engineering work related to climate change. For example, New York City and the United States Navy are among entities beginning to plan for sea level rise under continued climate change scenarios. Students were able to experience the benefit of interfacing with others working in the field. In this dimension, social factors provide a common area for discussions as well.

**Country Projects**

The final project was presented to the entire class, and a written paper was submitted by each team. The paper was to discuss at least the following for the country being studied:

* Demographics of country, including political climate, energy profile, and environmental issues
* Identification of energy policies and objectives (or non-policies)
* Balancing of economic, environmental, and social factors
* Identification of implementation of policies and monitoring of results
* Other factors peculiar to that country
* Lessons from that country potentially applicable to other countries.
* Likely future directions

Students were split into teams, and each team prepared a presentation and paper on a particular country. The countries studied were as follows:

* Brazil
* China
* Denmark
* Germany
* India
* Japan
* Mexico
* South Africa
* Ukraine

The United States could not be chosen for this project. This decision was made in part to allow studying of other counties and to allow students from various countries to interact. The students in the class included students from a number of countries, as follows:

* Bangladesh
* India
* Libya
* Malayasia
* Mexico
* United States

Backgrounds of the students varied widely. Disciplines represented include engineering (chemical, civil, manufacturing, mechanical), environmental science, biology, chemistry, physics, geology, and geography. One student was concurrently completing a Masters of Fine Arts in creative writing.

**Findings**

Student understanding of the situations in other countries grew significantly, while at the same time, they learned of the complex interactions between science and other issues in creating and successfully implementing energy policies. Due to the emphasis of this conference, the focus here has been on the impact on engineers within the class. It should be recalled that this was not originally an emphasis or objective for the course, so this grew as the semester proceeded.

Students had opportunities to exchange thoughts during several phases of the course. As various assessments and tools were reviewed and used, they talked with others in their discussion groups (which were switched often to encourage experiencing different points of view). There were also discussions by the whole class. These included sharing from group conversations, with yet additional thoughts presented. Interestingly, students began to introduce their own experiences and questions. Several independently mentioned corruption as an issue that was difficult to quantify but could not be neglected in many countries.

In addition, although the United States could not be studied for the country projects, it was frequently discussed in both groups and the entire class. In part, this was because some of the models and assessment plans studied activities and/or potential policies in the US. Increasingly, the class began to contrast behavior in the US to robust policies developed elsewhere, and they began to ask more pointed questions. This was fruitful, because it introduced the complex of strong economic, political, social, and historical factors that compete with each other. As country presentations were made, this created an enhanced ability to review competing influences.

There are numerous areas in which students expressed thoughts suggesting they were coming to grips with global issues.

Balancing - They often reflected on the balancing required as decisions were made to allocate resources. This included the need to consider whether social factors were more positively impacted by direct investment or through environmental or economic investment with the potential for elevating the lives of people.

Varying maturity levels – Many reflected that there seemed to be a certain maturity of countries and their governments to attain before they made decisions based strongly on sustainability. As noted elsewhere, corruption was cited as an issue by several students.

Relation to availability of own energy sources – Students clearly recognized that countries with their own sources of energy (e.g., coal in South Africa) might behave very differently from those mostly dependent upon other sources (e.g., Germany).

Commitment to people – While this surfaced in many forms, many students observed differences they perceived in how various governments included people in their decisions and policy implementations. In some cases, it was obvious that deeper study will be required to understand fully all the factors in individual countries, as well as the impact of various global organizations.

Complex issues – It was clear that the populations, even if the most economically strong and well-educated countries, are often misinformed about issues. Students observed that competing influences often cloud the issues through public statements, advertising campaigns, and sometimes through scare tactics. Considerable time was spent reinforcing the need to be very critical in assessment of any materials, even those with apparent scientific bases. Examples were drawn from the methanol industry, among other industry segments. The concept of energy return on investment was helpful to student understanding. Further, life cycle assessment was very informative, especially for students with the backgrounds represented in this course. Analyses were identified from the literature for a number of cases where not all impacts were included, skewing the results. As an example which proved to be enlightening, nuclear power is considered completely free of greenhouse gas emissions during operations, but lifecycle emissions do occur through plant construction, uranium mining and milling, and plant decommissioning. (Sovacool, 2008) Students seemed to benefit from application of life cycle assessment tools in these conversations. Climate change was often referenced due to both its obvious relationship to energy issues and the politicization of this topic that has evolved, with many misleading statements made. This further brought up conversations about the need to help work to assure that communications have a strong engineering and scientific basis, while also being easily understood.

Another helpful tool for increasing student dialogue centered around various energy models. Of particular importance in this context was the National Energy Modeling System (NEMS), developed by the United States Department of Energy. (U.S. Department of Energy, 2009) Unfortunately, the class did not have direct access to the model itself for comparative studies. However, there is considerable information available in their publications and from other users. Each member of the class was asked to review one of the available modules, and the entire class discussed considerations in integration of the various modules and their interactions to create a realistic view of the results expected from various energy strategies. One of particular importance to this conversation is the International Energy Module. Students began to understand the system implication of interactions of large-scale phenomena, including economic and political conditions.

**Improvements for Future**

Several changes will be made next fall (2011), when the course is next taught.

* Students will select the countries they will study much earlier in the semester.
* This earlier selection will enable more brief updates presented by each team to the class, increasing interaction and dialogue about global differences
* The first time, all presentations were made on the same day. This made the effort burdensome, and time for questions and answers was too limited. Presentations will be spread over several periods, with significantly more time for student inquiries and review of differences between countries.
* All teams will have a minimum of three members, with most having four. For example, the first time, a two-student team studied and reported on India, and it was obvious there was too much material for them to effectively deal with complex issues in India.
* Course materials are placed on the Blackboard Management System. Students will be asked to place updates on their projects there for all other students to see, and each student will be asked to post comments on one or more of the submissions. Special emphasis will be placed on global implications of the projects.
* An instrument will be developed to assess changes and student attitudes and awareness of global issues during the course of the semester. Specific comment will be sought from students to help identify benefits, as well as suggestions for further enhancement in the future.

**Conclusions**

A doctoral course on Energy Policy Analysis and Modeling had the unexpected benefit of creating extended dialogue and understanding of global issues. Students from diverse backgrounds and nationalities were able to explore linkages through course emphasis on social factors and studies of other countries. Success was sufficient to encourage changes for the next course offering that will enhance study of global implications while at the same time accomplishing the original course objectives. Use of sustainability concepts to frame the discussion insured that social factors were included. As a result, engineers in the course were subjected to numerous social factors. These were especially useful when incorporated within elements of life cycle assessment, energy models, scenario planning, and effective communications strategies.

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