

ENMG698

Strategic Energy Scenarios, a multi-disciplinary project course

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Summary:

In a post fossil fuel environment how will we get electricity, or fuel our cars? Planning starts with a purpose, a goal, an end state such as large carbon emission reduction. Given the goal, the next step is strategic scenarios, simple system or architectural models to estimate and compare cost and performance of feasible alternatives. In this project course students will start with a blank sheet of paper and imagine what energy systems might look like in 2050. The focus is on feasibility, the numbers, ignoring legacy systems and current policy. Students will learn strategic thinking, systems thinking, and discover opportunities for projects, theses and careers. Students will be encouraged to publish final reports as appropriate.

Course description

Engineering is driven by a purpose, a goal. For Clean Energy Systems, President Obama established a goal of an 83% reduction in CO₂ emissions below 2005 levels by 2050. This is a good strategic goal (end state) because it is widely accepted that controlling climate change will require large emission reductions in a 2050 time frame.

Given the goal, the next step is strategic scenario tradeoffs, a common practice in strategic planning.. Based on known technology, students will develop simple models of what various low carbon systems could look like in a 2050 time frame. The key is to put numbers to the models to assess feasibility.

Strategic scenarios ignore legacy systems and current policy. They use common metrics so that different scenarios can be compared. Once the scenarios are complete policymakers have a factual basis to make value judgments and decide which paths to pursue. After policy choices, engineers can then develop classic engineering development plans.

Method

The course begins with students choosing a topic and setting a goal. A project candidate list offers suggestions, though the topic need not be chosen from this list.

Upon approval, students will research the literature then think through feasible 2050 system configurations characterizing performance (CO₂ emission reduction) and cost. This may involve models and simulations, particularly for intermittent renewables. A nuclear scenario would involve evaluation of fuel cycle options, waste disposal and safety.

After selecting a scenario, the class shifts to bi weekly meetings and students report on their progress every other week. Other class members will provide a critical review, offering suggestions on how the team can improve its work. The product will be an oral presentation and

a 10 page scholarly report. The report may lead to a publication in the peer reviewed literature.

Students are wholly responsible for the execution of each phase of scenario development including the final report that shall be prepared in a format of a professional report. The course advisor is wholly responsible for the approval of the final report designating a satisfactory grade for the course and individual student grades for the members of the project team.

Learning objectives

- ◆ Strategic thinking - How to develop and compare strategic scenarios; how much detail is necessary to capture the essence of the concept; how much detail is too much.
- ◆ Systems thinking - How to create system architecture for a non IT environment.
- ◆ How to think outside the box - Develop original concepts that can be used for subsequent projects, papers, theses, and careers.

Prerequisites

This is intended to be a graduate level multi-disciplinary course. While the primary emphasis is engineering, students with a passion for some aspect of clean energy are invited. This would include students with a background in engineering finance (e.g. life cycle costing), engineering management, physics and policy.

Grades will consist of three parts:

- ◆ 10% attendance, full attendance at every class is expected.
- ◆ 20% participation in class, to what extent does the student contribute to new ideas and support other student projects.
- ◆ 70% the originality, intellectual quality and substance of final report. Students are encouraged to reach and take on high-risk topics. This is one semester project, not a thesis and a positive outcome is not required. Evaluation is based on how the student handles the dilemma of a difficult goal.

Classes, traditional 13 weekly classes

Week 1 - Lecture, overview and list of scenario choices. Teams form between lectures 1 & 2.

Week 2 - Students propose projects.

Weeks 3-11 – Student progress reports on scenario development.

Week 12 – Oral presentations

Week 13.- Deliver final report.

Reference: Pavlak, A., [Strategy vs Evolution](#), *American Scientist* **98**, pp. 448-450, 11-12/2010.