

International Conference
New Perspectives in Science Education
Florence, Italy
March 16, 2017

HIGHER WATTAGE

IMPROVING ENERGY LITERACY THROUGH EXPERIENTIAL LEARNING AT MULTIPLE LEVELS

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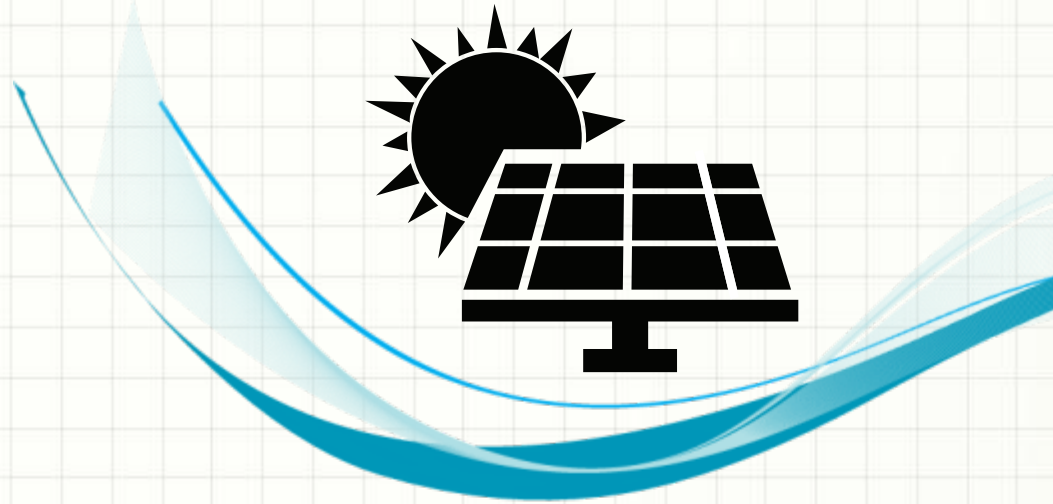


ENERGY EDUCATION LITERACY

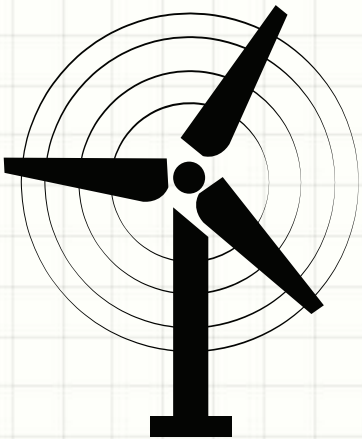
As we proceed through the 21st century, our ability to responsibly manage our energy resources will determine our future.

This will require that every human is literate about energy conversion and how our energy use is affecting the earth's energy balance.

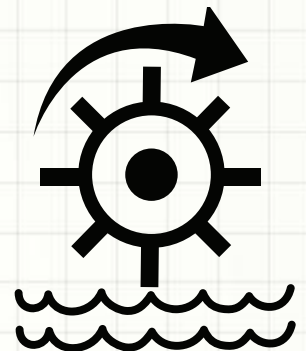
Many visionaries have charted a future energy system that is not reliant on the damaging emissions from burning fossil fuels.



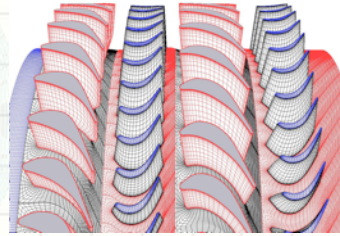
This revolution in our energy conversion strategies will not occur if there is not sufficient public will to promote these technologies on a large scale.



This choice can be fueled by clear education, including a dedication to ensure all college graduates have a firm understanding of the basic thermodynamics of climate science and energy conversion.



Energy conversion systems involve a highly complex set of scientific principles.

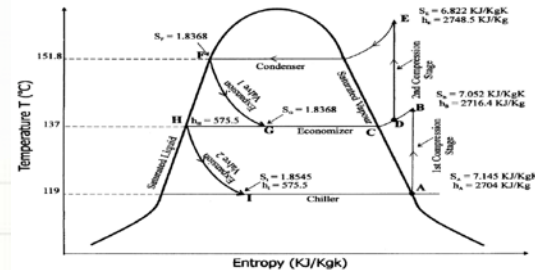


1st Law of Thermodynamics:

$$e_2 - e_1 + k_2 - k_1 = q - w_{sh} - p_2 v_2 + p_1 v_1$$

$$\Delta S = S_f - S_i = \int \frac{dq_{rev}}{T}$$

$$\Delta S = \frac{q_{rev}}{T}$$



However, the basic conceptual understanding of these technologies can be easily understood by the greater public if delivered in clear, uncomplicated vocabulary and conceptual explanations.

$$\Delta E = E_{in} - E_{out}$$



This case study presents the experiences of two faculty members and three classes.

All three classes contain:

- energy conversion content
- climate science understanding
- experiential project components



CASE STUDIES

Teaching Methods in Higher Education

These courses aim to *enhance student literacy and engage students in challenging problems encountered in mainstream energy conversion practices.*

MULTI-LEVEL APPROACH

1. Early Undergraduate
2. Middle to Late Undergraduate
3. Graduate Curriculum



CASE STUDY #1

Early Undergraduate,
First Year Seminar Course

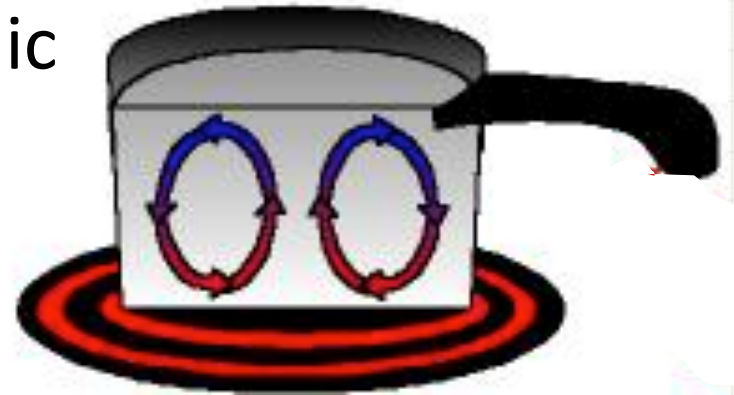
***“Know Watts Cooking – The Physics of
Energy Efficient Cooking”***



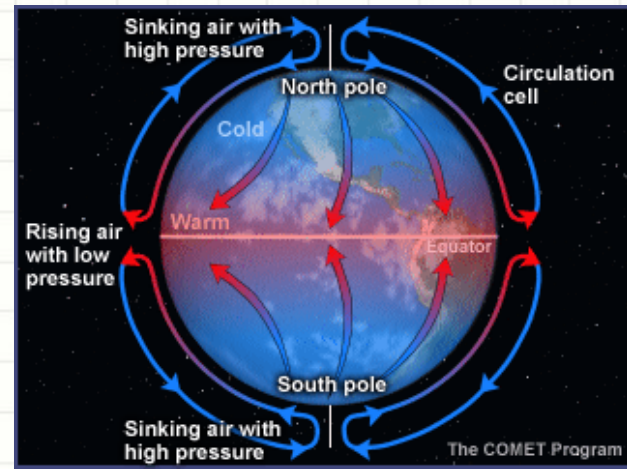
Goal of the first year seminar experience:

To apply critical thinking to examine a single issue
from multiple perspectives

Cooking provides the ideal topic for the understanding of basic thermodynamic concepts.



These concepts can then be applied to the earth's energy balance and the understanding of various energy conversions.



Student developed cooking laboratories allow for experiential learning and heightened engagement.



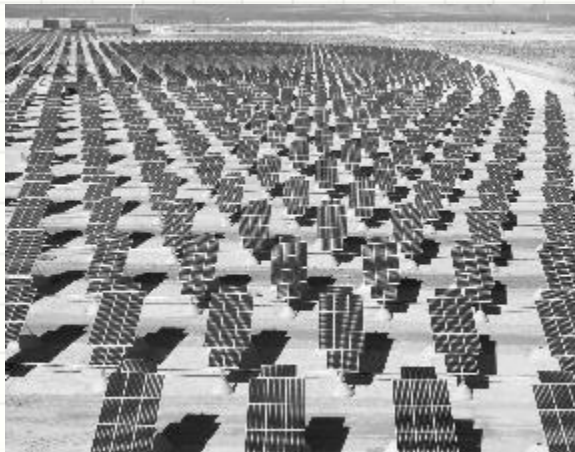
In-class case studies and farm field trip allow for further understanding of the complexity of the interdependencies of these issues.



CASE STUDY #2

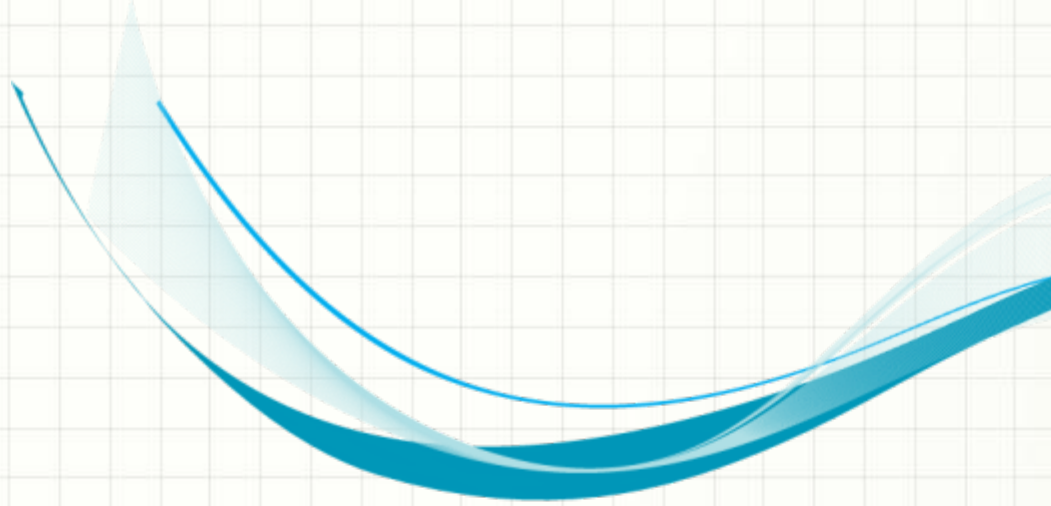
Mid to Late Undergraduate,
General Education Course

“The Physical Principles of Energy and Sustainability”

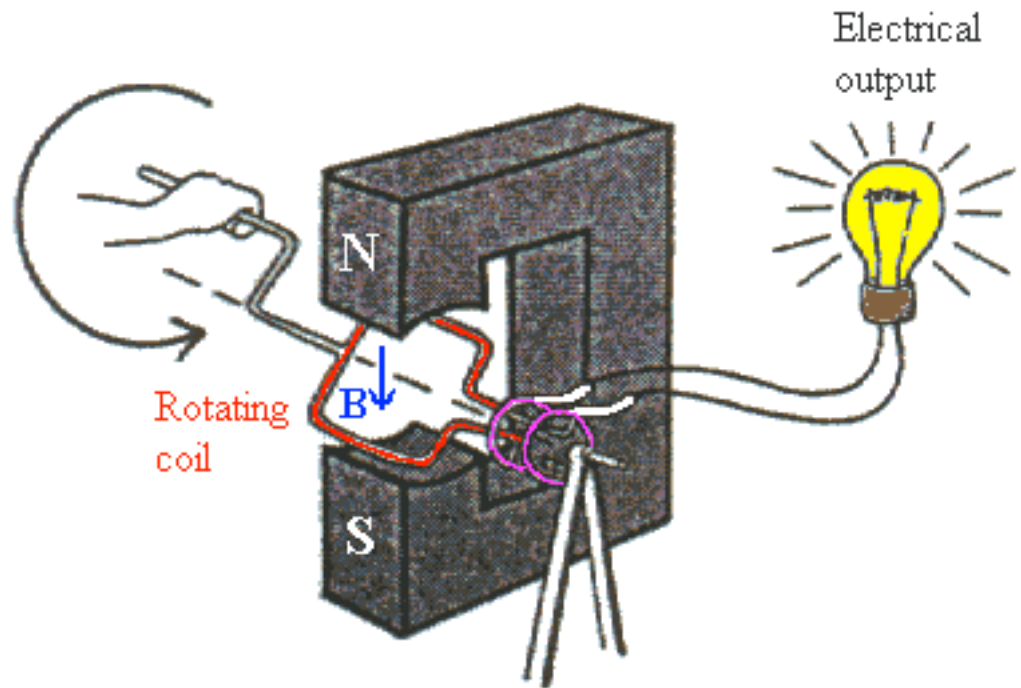


General Education course open to all students

Allows for students from a wide range of disciplines, many of whom have very little knowledge of physics, climate change, or renewable energy at the start of the class.



Energy conversion technologies are presented using conceptual science strategies and basic schematics and demonstrations.



Students realize that many methods used to convert various forms of energy to electricity are similar and not beyond their comprehension.

Individual student project presentations allow for deeper exploration into a single topic.



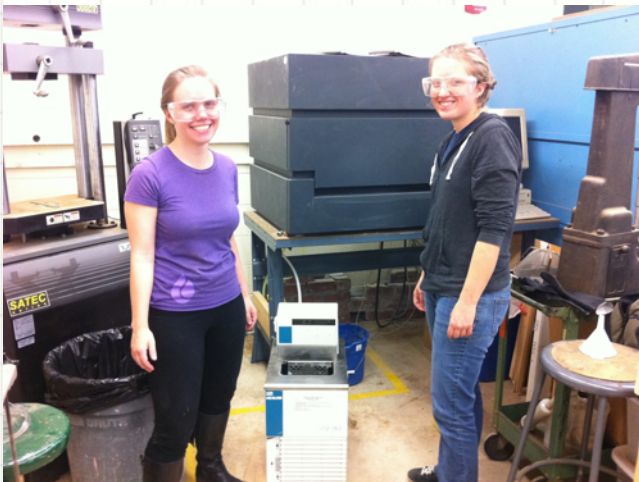
Based on students' responses to basic questions about energy conversions and climate science on the first day of class as compared to the final exam day, there is a notable improvement in literacy of these important topics.

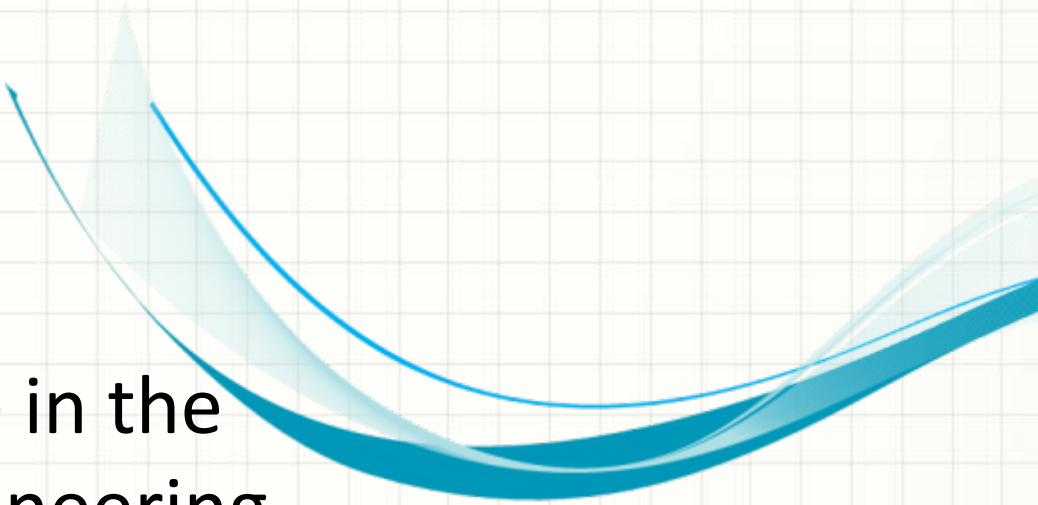


CASE STUDY #3

Graduate Curriculum in
Renewable Energy Engineering

***“Theory and Practice of Engineering
Thermodynamics”***





Core curriculum course in the Renewable Energy Engineering concentration of the Master of Science in program

Most students in this concentration have a bachelor's degree in engineering but want to focus more in the practical application of the fundamental knowledge they have obtained.

Thermodynamic principles are applied to renewable energy and building energy situations through experiential methods, including industry-based projects.

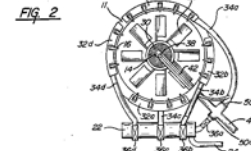
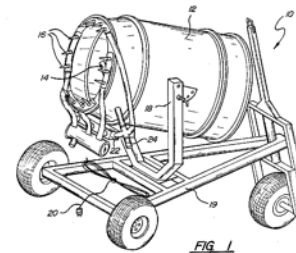


These projects immerse the students in a real project with real clients, real budget and time constraints, allowing them to tie the fundamentals to an actual need and solution.

A recent class worked as engineering consultants to a regional ski resort to perform an energy audit of the operation, as well as a design of an energy efficiency upgrade and a renewable energy system installation



U.S. Patent Apr. 24, 1999 Sheet 1 of 3 4,919,331



U.S. Patent Apr. 24, 1999 Sheet 3 of 3 4,919,331

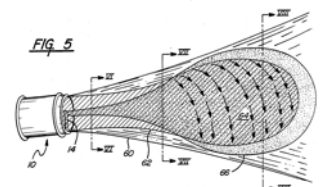
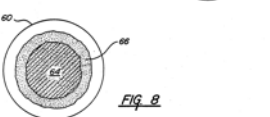


FIG. 7



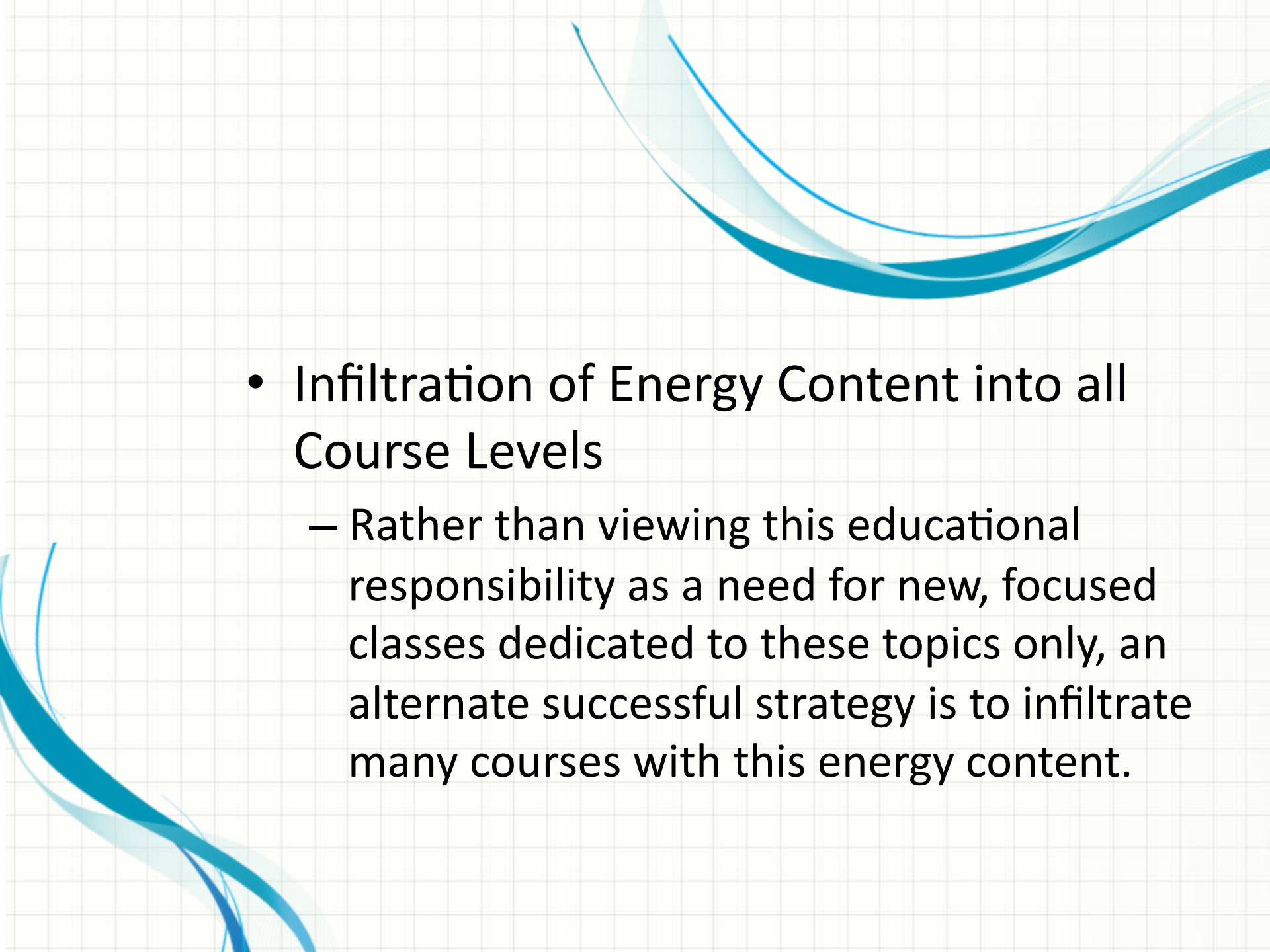
This project provided a uniquely effective learning opportunity through the study of the thermodynamics of the snow making process and the energy intensive nature of the ski resort industry.

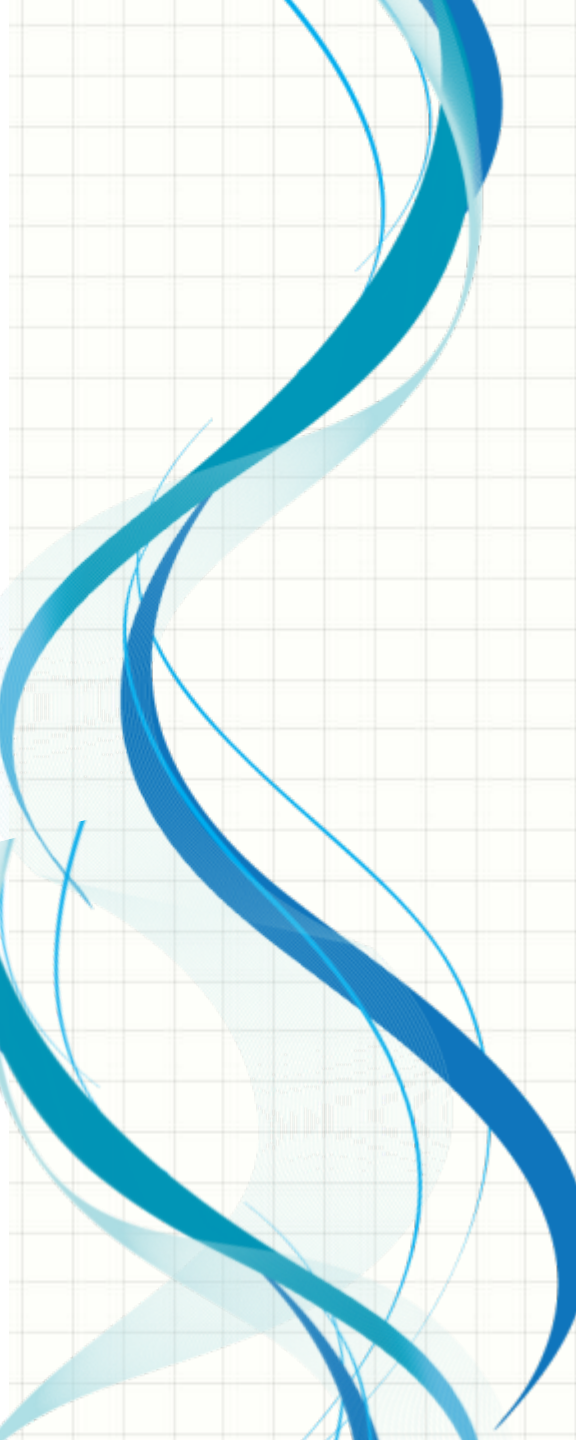


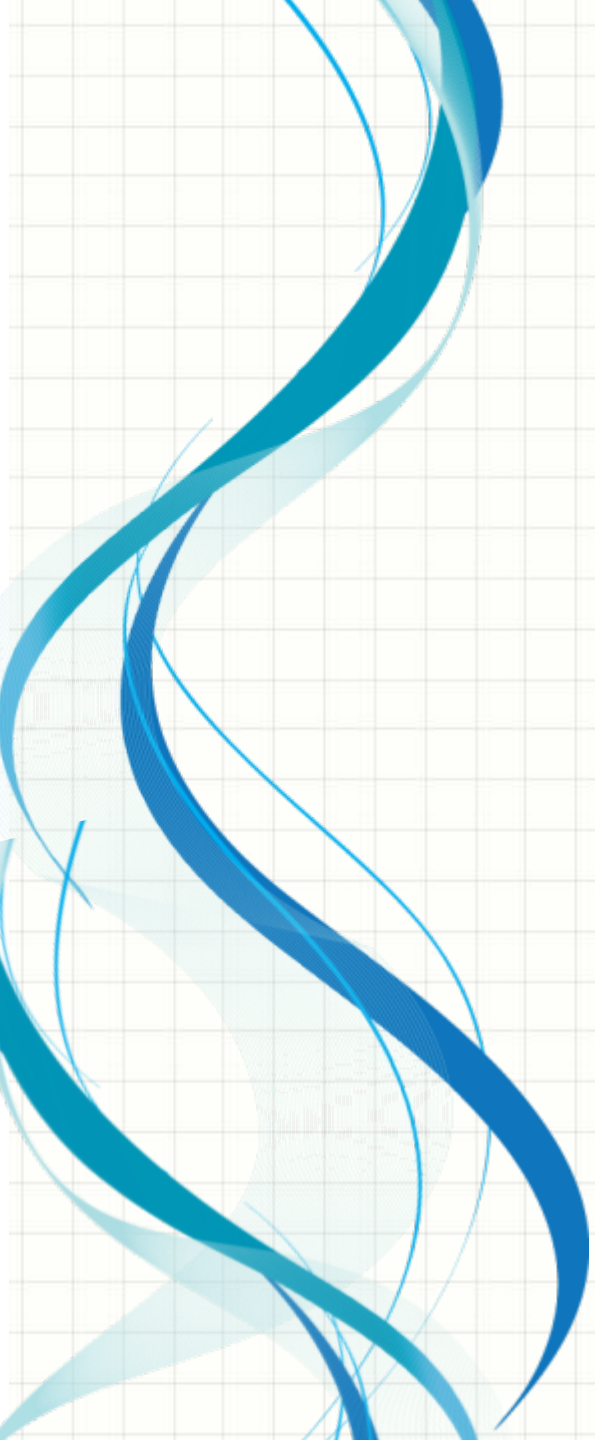
Many graduate students have commented on their lack of understanding of how to apply their knowledge until participating in these projects.

Conclusions



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- Infiltration of Energy Content into all Course Levels
 - Rather than viewing this educational responsibility as a need for new, focused classes dedicated to these topics only, an alternate successful strategy is to infiltrate many courses with this energy content.

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- Implement project-based learning to further enhance the retention
 - Individual Projects allow for deep exploration into one area for enhanced understanding
 - Group Projects allow for collaboration across disciplines

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- This repeated, continual exposure to these energy conversion concepts will maximize students' long-term retention and true understanding.
 - These educational opportunities can help to develop the literacy necessary to transition to an alternative, responsible energy future by making these students **agents of change** in their professions.



QUESTIONS?