# E555 Renewable and Nuclear Energy
# Spring 2019

Class Meeting Time: 11:15 to 12:30 MW
Class Location: SPEA PV 163
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**Goal and Objectives:**
The impact of energy use by humankind on the surrounding environment has always existed. But now the impact of $7^{+}$ billion of inhabitants of the Earth is much greater and destructive to the life supporting ecosystems of our planet. A very important question is, can we continue to use energy and yet decrease the associated pollution and degradation of the natural systems? As we utilize various energy sources, are we able to have a smaller footprint… individually, nationally, and globally? Is it possible to address climate change problems? Can we sustainably develop and consume the energy we as a society require?

In this regard, utilizing renewable energy sources and their technologies could be seen as a part of the solution. They could, while not exclusively but, in several niches, offer significant contributions toward efficiently and effectively reaching positive goals. As in most all areas of life, there are no singular simple answers or solutions. Often in the field of environmental management no "good" solutions exist, only "bad" or "worse" ones. For every environmental solution, environmental friendly technology has its pro's and con's. As both renewable and nuclear energy sources have positive environmental benefits, these sources needs to be closely examined for their ability to positively contribute to environmental stewardship. While nuclear energy is not a renewable energy source, the pros and cons of the nuclear energy should be discussed in this context.

The integration of renewable and nuclear usage within the total energy portfolio of the nation and globe community will be explored. The environmental and climate consequences of these technologies as well as the dynamics of the global development of both will be highlighted. Considering holistically the technical and policy aspects about renewable energy and nuclear usage will be a key part of this course.

This course is fundamentally a science and technology course but will involve economic and policy components. An understanding of the complex interactivities of these factors are necessary for policymakers, analysts and scientists involved in making management decisions regarding this rapidly evolving renewable resource and development of new type of nuclear energy.

Assuming that most students upon graduation from SPEA will not be directly involved in working in the nuclear industry or in renewable energy sector but, as global citizens and future public policy makers, environmental regulators and business members it is incumbent upon them to know about what controls the viability of these energy resources and how they can be used. The goal is to help students make more informed decisions when parts of the question may involve renewable energy or nuclear development and use, along with the associated consequences. To be an informed decision-maker allows one to contribute to the better management of these important energy resource and to make a higher quality of life for the planet.

To accomplish this overall strategic goal of the course, a set of tangible objectives will be used. The course will be taught at a graduate level with major emphasis placed on information compilation, investigation, and critical analysis being performed by the individual student and by small groups. These analyses, whether as part of the student-led case studies, debates, discussions or as a part of the final research paper must be based on substantiated information. Based on the number of students in the class and inclination of the group, some investigations and analyses will be performed by groups, but the performance of each individual student will still be assessed.

**Prerequisites:**
The subjects presented and the evaluation of topics in this course will use both concepts and content from numerous disciplines including: physics, chemistry, geology, biology, environmental science, engineering/applied technologies, public policy and economics. Although there are no formal prerequisite courses for taking this course, students are expected to have the fundamental skills needed to: 1) read and comprehend technical issues on a fundamental level, 2) pursue individual research investigations, 3) write an analysis on a given topic and, 4) to present orally the findings of their own research as well as on the content from other published research papers.

**Participation:**
I am interested in investigating with the students, many of the interrelated complexities associated with these unique energy sources. In many cases, these lines of inquiry will be driven by the various interests of the individual students. I very much appreciate the interrogative, and at times, Socratic Method of teaching and learning. Plan to engage fully in this process. I intend to learn from the students as well as they learn from me through this process. And please attend all the class sessions. There will a variety of lecturers and activities and, all are important. The knowledge that will be gained is cumulative and toward the end of the class, when we debate, advocate for and, discuss issues, many of the basic principles and considerations discussed earlier in the course will be used to frame and bound operational and policy concepts.

**Grading and Assignments:**
The assessment of performance in this course will be based on four principle elements:

1) Class participation: As this is a graduate class on a specific topic, I consider that the most effective manner to teach and learn in this case is discussion. Therefore I will use the method of asking and answering questions to stimulate critical thinking and to illuminate ideas. We are going to have some interesting guest speakers and we will be in the field with practitioners; talk with them about your concerns and questions. We will also have a series of three activities in which the members of the class will be divided into teams that will 1) debate (4/1), 2) advocate (4/3) and 3) discuss (4/8) aspects of renewable and nuclear energy development. Therefore, attendance to all class sessions and verbal engagement is highly valued. (15% of course grade)

2) Midterm examination: As the class will be roughly divided into two parts (investigation of topics and individual research), the content covered in the topical portion of the class will be need to be retained to be of value to the student in the research portion. The test will be comprised of short essays with possibly some short answer and perhaps multiple choice questions designed to assess your retention of the key concepts covered up to that time in the course. This material covered in the midterm will be from lectures, discussions and the review of technical papers by other students. (15% of course grade)

3) Case studies and discussion leadership: An important aspect developing a substantial understanding of technical and developmental issues associated with various energy sources is the ability to access and understand the information that is available in the media and technical literature. Following the instructor-led lecture on a given energy system, pairs of students will investigate an example of where this technology has been deployed, a case study. Presenters need to be systematic in their treatment of the case study, addressing the:

who, what, where, when, and how and lastly why of the development. This is necessary so that we can contrast developments of the various technologies. To cover each, a pair of students will **1)** choose an example of project where a given technology has been implemented, **2)** find and distribute to the class (three days ahead of time) a select group of technical papers (1-2) and media reports (2-3) that document the case, **3)** formulate and distribute (along with readings ahead of time) a set of questions about the development and **4)** make a short overview presentation outlining the positive and negatives of the development and then lead the class in discussion about the implications of developing this type of energy system, using the case study as an example. Part of the presentation will a single slide, using a standardized template that provides a succinct summary of the case study along with a critique of the papers and reports used to frame the study. A part of the grade for this assignment will be an assessment on how well students respond to the questions provided by the presenters. (20% of course grade)

4) Research project and presentation: in addition to the three performance metrics listed above, each student will need to conduct a research investigation, using existing sources of information, on a renewable energy related topic of their choosing. As graduate students, you need to demonstrate your ability to find, analyze, discuss, and interpret information that has been put forth by others in the literature. These 12-15 page research papers will provide a critical review of a topic that is proposed in one page proposal and agreed upon before starting the research for the paper. As these are to be critical assessments of a given topic, they will include a well-presented set of arguments that defend your position on the topic and a set of recommendations on alternative or additional actions that the world can undertake to accomplish your recommendations. (50% of course grade; Due - May 3, 2019)

At the end of this syllabus there is a schedule that shows when each assignment is to be received by myself and the other students. Please honor your colleagues in the class and me as the instructor by turning in all assignments when required. Life is complex and unpredictable; when you have a challenge that will keep you from meeting an obligation, please let me know as soon as possible and let's work together toward a solution. In fairness to others, makeup and replacement assignments will come at a cost; generally, a full grade penalty per day of lateness.

Collaboration is generally a good thing and I endorse it but, don't cheat. We will need to evaluate each of you on your individual performance so do your own work. In preparing for all of the assignments and obligations of the class, work with your colleagues, discuss the papers, compare impressions and solutions, but on the written assignments, do your own work. The expected academic performance and personal conduct of all students at Indiana University is defined by the IU Code of Student Ethics. Please be sure to abide by these policies.

**Resources:**

There is no formal text for this course. There are series of readings to accompany the lectures that will be drawn from a variety of sources including media stories, books, and technical papers. To complement the lectures, we will have seminar sessions. You will be asked to select readings for the class to read and then to lead the discussion of them. We will us Canvas as a locus for placing readings and distributing technical resources, as well as questions, responses to questions and critical reviews.

I am happy to talk with you should you have a question or a concern about this complex subject. Please contact me (email is best) to set up a time when we can meet either one on one or with a group as part of a topic that you are interested in understanding. We also encourage you to polish your professional skills by contacting some of the guest speakers (in a professional manner befitting of their positions) to find out more information from their particular positions or disciplines.

**Logistics:**

This class is formally scheduled at 11:15 to 12:30 on Mondays and Wednesdays. Additionally, we would like to go into the field to visit a couple of operations where renewable energy systems are being deployed and operated. These will be essentially all day fieldtrips that we would like to hold on a couple of Saturdays.

**Activities:**

*Debate*: We will have a debate in this course. We will organize the students into opposing teams of debaters to present and defend ideas associated with renewable and nuclear energy systems and the consequences of their utilization. We will work up the questions to be used before the debate.

*Advocacy Meeting*: in this class session, we will emulate a meeting in which: 1) part of the students will advocate for the implementation of a renewable portfolio standard (RPS) to a state utility regulatory commission, 2) part will serve as opposition/modification to the proposed RPS and, 3) part will serve as the decision-makers.

*Favorite Renewable or Nuclear Development Project Discussion*: in this session, each student will present a short overview of their favorite renewable or nuclear project development, anywhere in the world. Students should select a paper or media story that outlines the development that will be loaded onto Canvas so that the student can access key diagrams or findings for discussion.

**Schedule**

(R = Rupp, M = Meretsky, C = Carley, G = Graham, P= pair of student presenters/discussion leaders)

| Date, Day | Topic | Activity |
|---|---|---|
| January 7, M | Organizational discussions | Lecture – R |
| January 9, W | Climate change, pollution and renewables | Lecture – R |
| January 14, M | Basic overview of low carbon energy systems | Lecture - R |
| January 16, W | Hydroelectric dams and pumped storage | Lecture – R |
| January 23, W | Hydroelectric energy case study | Discussion - Colin, Thomas |
| January 28, M | Wind energy: turbines | Lecture - R |
| January 30, W | Wind energy case study (Indiana?) | Discussion – Jonathan, Tianyu |
| February 4, M | Solar energy: Photovoltaic cells, thermal panels, | Lecture - R |
| February 6, W | Solar energy case study | Discussion – Reena, Austin |
| February 11, M | Geothermal energy | Lecture - R |
| February 13, W | Geothermal energy case study | Discussion – Sean, me |
| February 18, M | Biofuels energy | Lecture - M |
| February 20, W | Biofuels energy case study | Discussion – Jennifer, Sonja |
| February 25, M | Impacts of biofuel utilization on climate change | Lecture - M |
| February 27, W | RPSs to encourage renewables | Lecture- C |
| March 4, M | Midterm (take home – no class) | |
| March 6, W | E vehicles/green power policy implications | Lecture - G |
| March 18, M | Nuclear energy: generation | Lecture - R |
| March 20, W | Nuclear energy case study I (France or US) | Discussion – Michael, Jin An |
| March 25, M | Nuclear energy: international relations and waste | Lecture - R |
| March 27, W | Nuclear energy case study II (Savannah River MOX) | Discuss – Savannah, Derek |
| April 1, M | Nuclear vs. renewables vs. some of these | Debate-Teams |
| April 3, W | Recommendations to states for RPSs | Meeting-Teams |
| April 8, M | Favorite R and N energy international development | Discussion-Ind. |

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| April 10, W | Student Research Project Presentations |
| April 15, M | Student Research Project Presentations |
| April 17, W | Student Research Project Presentations |
| April 22, M | Student Research Project Presentations |
| April 24, W | Summary Discussions |

Fieldtrips

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| April 5, Friday | 9:00 – 1:00 | Electricity Storage – IPL – Indianapolis IN |
| April 6, Saturday | 9:00 - 12:00 | Solar array - Hoosier Energy – Bloomington IN |