Syllabus

ESM 272 Energy and Resource Productivity

Classroom:  BH 1424  
Class hours:  10:00 – 11:15  (Mon / Wed)  
Instructor:  Sangwon Suh  
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Office:  3422 Bren Hall  
Office hours:  Mon/Wed 11:15am – 12:15pm or by appointment*

* Please use the Corporate Time (or its successor, when it becomes available) for any and all appointments outside the office hours. Email confirmations are not necessary.

Course description

In this course, fundamental concepts, principles, key trends, policy and tools in energy and resource productivity will be discussed. Topics to be discussed include: (1) Definition of energy and resource productivity; (2) Global context and background of energy and resource issue; (3) basic economics of energy and resource efficiency; (4) fundamentals of coal, oil, natural gas and renewable energy resources; (6) fundamentals of metal and mineral resources; (7) energy and resource productivity in business; and (8) measuring materials and energy flows and efficiency.

Course objectives

The objectives of the course are:

- Understanding fundamental concepts and principles of energy and resource productivity;
- Understanding how coal, oil, natural gas and other energy resources are extracted, used and disposed of;
- Understanding how metals and mineral resources are extracted, used and disposed of;
- Understanding key trends and policy in energy and resources;
- Understanding the process and activities by business to improve energy and resource productivity;
- Be able to conduct materials and energy flow analysis.

Course format

This course will be delivered by 70% lecture and 30% in-class discussion. Student participation in the lecture and discussion is essential to this course.

Active learning principles: your participation is the key to success

Active learning principles will be adopted as much as practicable in this course. Active learning principles are based on the simple fact that students tend to learn more efficiently and effectively when they are actively engaged in the thought process as opposed to the situation
where they are passively receiving instructor’s unidirectional lecture. Conversation for example is an example of bidirectional, interactive thought and communication process requiring all parties actively participate in the process. During the class, students are invited to the collective thought process and team learning Wedough various interactions including in-class discussions, which is an invitation to the collective thought process and team learning. Students will often be asked open questions. Sometimes, there is no right or wrong answers to the question: it can be simply an invitation. Students will also be asked to give presentations on some reading materials. Such student participations in the collective thought process is absolutely essential to the active learning. Feel free to be creative in your interaction during the class and, most of all, stay active!

**Weekly reading materials and group presentation**

This class did not require a textbook. The reason is not only that they are expensive but also that any one of them may not cover the divers topics that will be discussed during the course. Instead, students will be given contemporary literature on various topics in energy and resource productivity. Each week, *all* students are expected to study the reading material of the week prior to the class on Monday. Students may form a reading group (2 - 6 students per group; 1 student per every 30 pages of a reading material) and pick out a reading from the list provided. Each week, the group that is assigned to the reading material of the week is expected to prepare 5 quiz questions, and give a presentation on their reading material. The presentation may include—but does not have to be limited to—overview of the reading material; key findings; any discussion points; any questions arose; any other related materials outside the reading. Each presentation should be no more than 20min long.

**Assessment**

- Quizzes (30%): each week about the reading materials (5% X 6 weeks)
- Presentation and quiz preparation on reading material (5%)
- Homework (30%): 15% X 2
- Midterm (20%)
- Final (20%)

There will be 7-8 quizzes (see the course schedule later in this syllabus) from which 6 best quizzes will be taken for the final grading. Quizzes will be during each Wednesday (except for no-class Wednesday, if any) and will be about the reading material of the week. Students who prepared the presentation for the week’s reading material will prepare the quiz for the week. Students are not expected to master and memorize everything about the reading materials to take quizzes. Questions for the quizzes should be designed to check that students have understood the key points of the material of the week.

**Course schedule**

Regular class hours are 10am – 11:15am on Mon and Wed. No class dates are marked with red background. There will be one makeup class, which will be offered during the evening with Pizza and drinks (2hr).
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<thead>
<tr>
<th>Week</th>
<th>Dates</th>
<th>Remark</th>
<th>Homework</th>
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<tr>
<td>1</td>
<td>Jan 6 (Mon), Jan 8 (Wed)</td>
<td>Introduction/Interplay between P,A, and T</td>
<td>HW 1 due Jan 30</td>
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<td>2</td>
<td>Jan 13 (Mon), Jan 15 (Wed)</td>
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<td>3</td>
<td>Jan 20 (Mon), Jan 22 (Wed)</td>
<td>Improving E&amp;R efficiency at a facility level</td>
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<td>4</td>
<td>Jan 27 (Mon), Jan 30 (Wed)</td>
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<td>5</td>
<td>Feb 3 (Mon), Feb 5 (Wed)</td>
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<td>6</td>
<td>Feb 10 (Mon), Feb 12 (Wed)</td>
<td>Metals and Minerals / Feb 12 (Midterm);</td>
<td>HW 3 due Mar 3</td>
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<td>7</td>
<td>Feb 17 (Mon), Feb 19 (Wed)</td>
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<td>8</td>
<td>Feb 24 (Mon), Feb 26 (Wed)</td>
<td>Materials and Energy nexus</td>
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<td>9</td>
<td>Mar 3 (Mon), Mar 5 (Wed)</td>
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<td>10</td>
<td>Mar 10 (Mon), Mar 12 (Wed)</td>
<td>Energy</td>
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<td>11</td>
<td>Mar 17 (Mon)</td>
<td>Final</td>
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**Homework instruction**

Each homework assignment shall be submitted on the date noted in the course schedule by 10am. Late submission can be accepted with good reasons. Each homework submission should be prepared as a report no more than 5 pages in letter size with 1 inch margin on each side and 12 font size in Times New Roman (my favorite!). Depending on the homework, you may also attach supplementary files such as MS excel file for background calculation. Please use SI units whenever practicable.

Homework will be graded based on the following criteria:

1. Completeness of the answer
2. Level of research for the background data and literature
3. Ability to assess the quality and credibility of the data used
4. Ability to draw conclusions based on the evidences and scientific reasoning

**HW1: Shale oil and shale gas reserves, past production and future potential**

Objectives:

- Help develop skills to find relevant statistics and to extract data from statistics;
- Be able to process data to derive meaningful results that allow insights;
- Interpret analytical results critically.
Using any readily available statistics and analyses on the web or in the library, find the following data:

(a) Historical data for shale oil and shale gas extraction by country by year.
(b) Data on technological and economic reserves of shale oil and shale gas by country or by state.
(c) Analyses on future projections of shale oil and shale gas production.
(d) Analyses on potential impact of shale oil and shale gas production on oil and gas price, energy consumption and greenhouse gas emissions.

Using these data and analyses that you gathered, present the following information as succinctly as possible. You may use any means of presentation that you think is suitable including table, bar chart, line graph, pie chart, scatter chart. You may also use any regression analysis, draw trend line, analyze the correlation, etc.:

(e) Overall trends of global shale oil and shale gas extraction relative to conventional oil and tar sand oil productions;
(f) Per capita oil and gas availability with and without shale oil and shale gas by country and for the world;
(g) Total amount of CO2 that can be generated from current technological and economic reserves of shale oil, shale gas, tar sand and conventional oil and gas;
(h) Comparison of (g) with annual and historical total GHG emissions of the world.

Using the analysis above, discuss the following issues:

(i) What are the implications of shale oil and shale gas on future energy price and consumption?
(j) What are the GHG implications of shale oil and shale gas development?
(k) How (un) certain are your analyses?

HW3: Materials requirement for future energy provision

Objectives

- Develop skills to use projections and scenarios;
- Be able to assemble disparate data for meaningful analysis;
- Acquire experience of addressing clients’ needs;
- Understand the dynamics between energy, resources and technology change;
- Understand the supply-security issues.

Suppose that you are writing a final report to a consulting project commissioned by DOE. DOE’s concern is whether there will be enough material resources to support future renewable energy in the U.S. 2050. The particular renewable energy and storage technologies that DOE is concerned about are:

- Wind power
- PV
Battery

The elements of concern include:

- Neodymium
- Indium
- Gallium
- Tellurium
- Lithium

Write the final report to DOE addressing the following issues:

(a) The amount of these materials used by the technologies of DOE’s concern per unit energy production or storage;
(b) Projections of technology improvement and material efficiency changes in the future;
(c) The amount of energy produced or stored by these technologies (using existing scenarios);
(d) Estimation of the cumulative amount of these materials needed considering the amount of materials per unit production or storage, technology change and future energy demand from these technologies;
(e) Analysis on the reserves of these materials and the countries that currently supply these materials to the U.S.;
(f) Any advices/recommendations to DOE having done the research.

Please feel free to use available analyses by DOE and others on the similar issue. But make sure that you perform your own quantitative analysis.