# Syllabus

ESM 272: Energy and Resource Productivity
Instructor: Sangwon Suh
Instructor office and office hour: Bren Hall 3422, 12:00-12:30pm on Wednesdays, 1:00-1:30pm on Thursdays, or by appointment*
Meeting time: 2:30-3:45pm on Tuesdays and Thursdays
Meeting location: BH 1424

* Please use Google calendar 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) Key concepts and definitions of energy and resource productivity; (2) fundamentals of coal, oil, natural gas and renewable energy resources; (3) fundamentals of metal and mineral resources; (4) improving energy and resource productivity: case studies; and (5) repercussions of energy and resource productivity improvement. Throughout the course, the students will run a term project on personal energy consumption and its reduction strategies.

**Course objectives**

The objectives of the course are:

- Be able to understand fundamental concepts and principles of energy and resource productivity;
- Be able to understand the strategies, techniques, and policies for improving energy and resource productivity;
- Be able to conduct energy balance and develop a strategy to reduce energy consumption.

**Course format**

This course will be delivered by 50% lecture, 40% in-class discussion, and 10% student presentation. Student participation in the lecture and discussion is essential to this course.

**Assessment**

Midterm: 50%

Participation: 10% (based on contributions to in-class discussions)

Final presentation: 40% (based on clarity of the presentation, soundness of the methodology, and significance of the results)

**Term project description**

The term project is about (1) measuring / estimating the amount of weekly energy consumption of a student; (2) developing an intervention strategy to reduce energy consumption; (3) estimate the amount of energy and cost savings; (4) monitoring actual energy and cost savings after implementing interventions; (5) assessing the effectiveness of the strategies tested; and (6) drawing overall recommendations for personal energy saving strategies.

Form a group of 5 students, and identify the target student within the group whose personal energy consumption is to be measured / estimated. Use the materials provided to measure or otherwise estimate the amount of energy consumed over at least a week. Personal energy consumption includes (but not limited to) those for lighting, transportation, refrigeration, communication, computing. It will be often necessary to allocate collective energy consumption into individual level. Embodied energy in purchased goods and services may be excluded. Collect information and develop strategies to reduce energy consumption. Factor in the behavioral aspects and incentive structure. Estimate the potential energy and cost savings from implementing the strategies. Monitor the changes and discuss any discrepancy between the predicted savings and actual savings. Draw conclusions and recommendations.

Presentation time will be 15 mins per group.

**Class schedule by date**

| Date | Topic | Reading | Note |
|---|---|---|---|
| 4/4 | Introduction:<br>• Course overview/objectives<br>• Intro to reading materials and term project<br>• Why energy/resource efficiency/productivity? | | |
| 4/6 | Key definitions and concepts<br>• Energy/work<br>• Resource v.s. waste; recycling | http://www.npr.org/sections/money/2013/12/31/258687278/a-bet-five-metals-and-the-future-of-the-planet | |

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| | • Sources and sinks/ metabolism<br>• Efficiency and productivity | | |
| 4/11 | Key definitions and concepts<br>• Circular economy<br>• Recycling, reusing, remanufacturing<br>• Technology learning<br>• Jevon's paradox/ Khazoom-Brookes postulate | http://ec.europa.eu/environment/circular-economy/pdf/AnalysisEUtarget.pdf<br><br>http://www.sciencedirect.com/science/article/pii/S0306261916301362 | Useful resources:<br>http://ec.europa.eu/environment/circular-economy/index_en.htm<br><br>http://www.theguardian.com/sustainable-business/series/circular-economy<br><br>https://www.youtube.com/watch?v=zCRKvDyyHml |
| 4/13 | Key definitions and concepts<br>• Supply Cost-curve/ abatement cost-curve<br>• Efficiency gap<br>• Source reduction/ pollution prevention | http://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/pathways-to-a-low-carbon-economy | Not expected to read from the beginning to the end. Use the material as a resource. |
| 4/18 | Understanding energy and resources<br>• Global energy systems<br>• Fossil energy<br>• Renewable energy<br>• Emerging energy technologies | http://www.pnas.org/content/112/20/6277.full.pdf | Useful resource:<br>http://www.eia.gov/forecasts/aeo/pdf/0383(2015).pdf |
| 4/20 | Understanding energy and resources<br>• Energy efficiency<br>• Natural resource landscape<br>• Bulk material resources | http://www.pnas.org/content/112/20/6271.full.pdf | |
| 4/25 | Understanding energy and resources<br>• Exotic/critical materials<br>• eWaste<br>• Land use<br>• Water<br>• Natural capital | https://www.youtube.com/watch?v=dd_ZttK3PuM | |

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| 4/27 | How to improve energy/resource efficiency/productivity: case studies<br>• Technological approaches<br>○ Motor vehicles<br>○ Paints | http://www.unep.org/resourcepanel/Portals/24102/PDFs/IRP_DECOUPLING_2_REPORT.pdf<br><br>Used throughout the second half of the class. | |
| 5/2 | How to improve energy/resource efficiency/productivity: case studies<br>• Technological approaches<br>○ Barrel Painting<br>○ Calendar Process<br>○ Electroplating | | |
| 5/4 | How to improve energy/resource efficiency/productivity: case studies<br>• Technological approaches<br>○ Drip irrigation and partial root-zone irrigation<br>○ Passive housing Steel industry<br>○ Food and hospitality | | Useful resource: http://vancouver.ca/files/cov/passive-ome-design.pdf |
| 5/9 | Mid Term | | SW out of town for a UNEP mission |
| 5/11 | No Class | | SW out of town for a UNEP mission |
| 5/16 | How to improve energy/resource efficiency/productivity: case studies<br>• Economic approaches<br>○ Pricing<br>○ Tax/incentives<br>○ Sustainable Purchasing | | |
| 5/18 | How to improve energy/resource efficiency/productivity: case studies<br>• Regulatory/planning approaches<br>○ Densification<br>○ Building codes<br>○ RFP/RFS<br>○ Efficiency targets | http://pubs.acs.org/doi/pdf/10.1021/es4040792 | |

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| 5/23 | How to improve energy/resource efficiency/productivity: case studies<br>• Closing the knowledge gaps, information dissemination | | |
| 5/25 | Repercussions of efficiency and productivity improvement: case studies<br>• Rebound effects<br>• Productivity-growth dilemma<br>• Design v.s. practice gaps | http://www.sciencedirect.com/science/article/pii/S0301421508007131 | |
| 5/30 | Strategies for implementation: discussion | | |
| 6/1 | Final presentations | | |