Term Project
10.391J/1.818J/2.65J/11.371J/22.811J/ESD.166J Spring 2007 Part B

We would like you to write a term paper analyzing a topic related to energy.

Term Paper Guidelines

Rule #1 for these papers is quality over quantity. Take the space you need to say what you need to make your argument. Beyond that, some general *formatting* guidelines are

- About 20-30 pages, including figures and references
- A *space and a half* between lines
- 12-point type
- 1-inch margins

Topic Selection

Please choose two topics that are of interest for a term paper. Do not pick a topic that you are working on or have worked on as a project already – we want you to look into something outside of your main expertise. For ideas of possible topics and papers, please see the pages at the end of this document.

We will return your topic selection forms with the topic for you to work on (we will try to give first choices, but may not be able to if people choose the same topic), with any relevant comments on SES #11.

Paper Outline

You should submit an outline of your paper on SES #13 – we will comment on it and help you get a good start! Please include an abstract, an introduction to the problem, and citations of references that will provide a starting point for the assessment. Each paper is expected to review the state of the art on the topic and do some independent analysis and assessment that add insight to the topic.

Final Paper

Final papers are due 19 days after SES #17 by 5 pm and there will be no extensions. Papers will be reviewed and returned with feedback prior to your preparation of a PowerPoint oral presentation.

Term Paper Presentations

The term paper presentations will take place 29 days after SES #17 from 3:00 pm to 8:00 pm and continue the next day from 9:00 am to 4:30 pm.

You will have 20 minutes to present your term project with 10 additional minutes for questions and discussion. You are *strongly* encouraged to practice beforehand to ensure that your presentation does

not extend past the allotted 20 minutes as you will be stopped if it does.

The use of personal laptops will not be allowed. **Please bring your presentation on a USB stick.** We will provide a laptop, laser pointer, and projector. Also, to avoid issues with different versions of PowerPoint, please be sure to bring a backup Adobe PDF copy of your presentation.

All students taking 10.393 for credit are required to attend all of the presentations. We will provide food on both days.

You will have the opportunity to select a time that you wish to present on SES #16 in class. If you are not attending the Nuclear module or do not attend class that day, you will receive an email with the remaining time slots open. If you have any scheduling conflicts, please discuss this with the TA.

Writing Resources

For those of you who need some help with anything from organization to content, there are a variety of resources that might turn what you have from a good paper into a great paper (or maybe an outline to a paper, depending on your schedule). The Mayfield Handbook of Technical and Scientific Writing by Leslie C. Perelman, James Paradis, and Edward Barrett covers all kinds of things from turning outlines to papers, writing references, working with figures, and the nitty gritty of punctuation and mechanics.

The MIT Writing and Communication Center has lists of online resources but more importantly, they have real people whose job it is to help go over papers. You can schedule an appointment online to discuss specific or general issues about writing your paper. It's a resource for everyone, and what you get out of it depends on the type of attention your project needs.

Possible Topics

Regional Energy Choices and Options

1. Analysis of the feasibility –including economics, environmental issues, policies needed, etc. -- for a specific energy technology or technologies to make a difference in supplying energy for a country, province, or state of your choice.
2. National energy strategy for a nation of your choice (China, India, Ireland,…).
3. Is a sustainable hydrogen economy possible for the US, Iceland or developed countries in Europe
4. Examination and comparison of large corporations that have committed on some scale to "sustainability", e.g., Interface, Ford, GE, BP, etc.
5. Can India meet its energy needs to support a developing industrial economy?

Conventional and Unconventional Fossil Fuels and Power Generation

6. Assessment of oil (or coal or natural gas) resources/reserves and sustainable production

trajectories. Impact of technology and non-conventional sources. Related Hubbert's Peak analyses. Inclusion of economic, environmental and geopolitical issues.
7. Oil sand recovery: technologies, net energy gain, environmental consequences, economic considerations.
8. Shale oil recovery: technologies, net energy gain, environmental consequences, economic considerations
9. State-of-the-art of super-critical and ultra super-critical coal-fired power plants. Improvements in efficiency, technical barriers, costs.
10. Assessment of oxy-combustion or IGCC coal-fired power plants with carbon separation. Status of the technology and opportunities for advancement. Related penalties.
11. Solid Oxide Fuel Cells (SOFC): Potential for distributed power production or enhancement of IGCC power.
12. Clathrates (methane hydrates): potential fuel source or accelerator of global climate change.
13. Alaskan oil exploration and production from the Arctic National Wildlife Refuge (ANWR): Is it worth it?
14. Can methane be recovered from marine or permafrost based hydrates?
15. Can fossil energy from Mexico help the US in a sustainable fashion?
16. Can western Canadian natural gas help eastern US consumers?
17. How much oil is there in the world?
18. Inclusion of externalities in stationary power generation from coal

Nuclear Energy

19. Is there a next generation for nuclear power in the US?
20. Third generation nuclear fission reactors: How viable, how safe, and how soon?
21. What would be the scale and barriers to creation of a nuclear power economy large enough to displace fossil fuel consumption substantially?
22. What are the safety improvements of proposed advanced reactor designs?
23. Is nuclear power suitable for use in developing countries?
24. How might substantial contributions by nuclear power to alleviating global warming affect public attitudes toward the technology?
25. What can be done in using nuclear power to ensure that it does not contribute to nuclear weapons proliferation?
26. Is high level nuclear waste a serious public health hazard?
27. Does creation of a nuclear waste disposal fund internalize the costs of creating nuclear wastes? What other energy technologies have similar internalization mechanisms?

Renewable Energy

28. What can policy instruments do for increasing the deployment of renewable energy in the US (or the world)?
29. Geothermal energy – how can universal heat mining be achieved?
30. Wind energy technology: Lessons learned from Altamont Pass, California, and Nantucket

Sound, Massachusetts.
31. PURPA: Lessons learned in the promotion of alternative energy.
32. Feasibility of incorporation of intermittent wind or solar renewable energy technologies into the electric grid at significant market penetration
    a. Is it necessary to have fossil-fuel based backup systems for significant market penetration of intermittent renewables?
33. Hydropower from Quebec – Is this a sustainable approach?
34. Solar photovoltaics or concentrating solar power – Can they really make a difference as a major alternative energy supply?
35. Will the technology of modern biology enable the production of competitive fuels?
36. Technologies for low-head, run of river hydropower energy recovery – what are they and what will it take to develop and deploy them?
37. Geothermal energy development in central America, Indonesia and the Philippines – a blueprint for the future?
38. Geothermal heat pumps – what are the impacts and deployment schedule be in the US?
39. Survey of Renewable Portfolio Standards in multiple states: what works? What doesn't? From this can one recommend a national policy for an RPS?
40. LCA comparison of thin film and crystalline silicon PV; examination of the differences in manufacturing technologies, energy requirements, environmental impacts, etc.
41. Use of renewable energy technologies for desalination
42. Feasibility, scale, economics, and GHG issues with use of landfill gas
43. LCA issues for converting biomass energy crops to biofuels
44. Options for supplying energy or fuels from biomass waste from industrial animal farms

Energy Efficiency

45. LCA of large-scale use of compact fluorescent light bulbs (e.g., Australia, recent Wal-Mart announcement); economics, feasibility, consumer attitudes, recycling, etc.
46. Use of "fee-bates" by governments to encourage energy efficiency and shift consumer choices in purchasing automobiles, appliances, etc.
47. Survey of high efficiency stationary power generation: why aren't more being built?

Crosscutting Technologies: Storage, Transmission, etc.

48. Energy storage: Technology opportunities and their integration into interruptible renewable energy sources.
49. Assessment and evaluation of a specific energy storage technology, e.g.
    a. Compressed air energy storage: feasibility, economics, siting issues.
    b. Battery technology: review of recent breakthrough technologies, feasibility of using all-electric vehicles to improve urban air-quality, etc.
50. Survey of the electricity grids of the future, e.g. hybrid distributed-centralized grids to prevent large-scale rolling blackouts such as in Eastern part of US in 2003.
51. Room temperature superconductivity for enabling electricity transmission and storage: is it possible?

52. Fundamental issues facing widespread deployment of fuel cells in either stationary or transport applications.
53. Will the California energy shortage "virus" of 2001 reappear and possibly spread to the other 49 states?
54. Can CO_2 be successfully sequestered in the deep ocean (or in the depleted oil and gas wells or in aquifers)?

Buildings

55. Is a zero net energy building a realistic sustainable goal?
56. How much more efficient can we be in energy use in homes or offices in the US –
    a. Analysis of the economics and feasibility of sustainable homes: what can an average citizen in a specific country afford to do to retro-fit a house to have a more sustainable home with little or no sacrifice of comfort?
    b. Specific, small-scale technologies to increase efficiency in homes (e.g., geothermal heat pumps)
    c. Impact of current and revised LEED standards

Transportation

57. Hybrid vehicles for transportation.
58. Electric vehicles for transportation.
59. Two billion by 2050: what kind of automobiles will be driven and how will they be fueled?
60. PEM fuel cells and prospects for powering automobiles of the future.
61. Potential for reducing annual automotive mileage and fuel consumption through development of modern urban/suburban mass transit systems. Relationship to land development. Barriers to implementation.
62. Energy use in the military: tanks, planes, Humvees, etc.
63. Alternative, sustainable fuels and/or improved airplane design for more sustainable air travel.
64. Improved ship designs, improved heavy freight vehicle design, intelligent highway systems and technology.
65. Advanced, lightweight materials development and technology for increasing efficiency in transportation applications.

Industrial Energy Use

66. Survey of current fertilizer production and options for a more sustainable future for the industry.
67. Carbothermic reactions that dominate our production of primary metals and materials: energy use trajectories and opportunities.