Course Description:

This course will focus on energy sustainability with view to changing global energy availability and use, and addresses the objective of greatly reducing the dependence on the finite fossil energy sources and move to the environmentally benign sustainable energy. The emphasis will be on sustainability issues, discussion on supply, demand and storage, energy transmission, global warming and carbon management, biomass- resources, uses and production of biofuels, national energy policy discussion, carbon emission, energy security and economics to ensure future energy needs can be met without compromising the ability of future generation to meet their own needs.

Course Objectives

To provide an understanding of the concept of sustainable energy future, provide critical and thorough introduction to the subject of energy use, fate of fossil fuels, efficiency, costs and the environmental effects, global warming, understanding of the role of thermodynamic principles in energy conversion, energy transport and storage, and automotive fuel economy.

Course Outline

Part I. Sustainability
• Sustainable energy, supply, use, costs, efficiency, pollution and climate change
• Energy sustainability issues/discussion on sustainability issues
• Energy systems storage and transmission
• Energy analysis and life cycle assessment

Part II. Efficiency
• Thermodynamics and efficiency calculations
• Energy conversion methods, types of energy sources, conversion, power cycles and efficiency

Part III. Policy and Public Perception
• National energy policy discussion, carbon emission, energy security and economics
• Automotive technologies and fuel economy policy

Part IV. Emissions, global warming and carbon management
• Global warming and carbon management
• Regulations, penalties and emissions burden

Part V. Fossil fuels and biomass for sustainable energy
• Fossil fuels- why discuss fossil fuels in sustainable energy
• Biomass- resources, uses and production of biofuels
• Sustainable Technologies
**Grading:** The class will have home works (10%), lecture summaries (5%), 2 projects (20%) and a presentation (5%), one mid-term exam (25%), topic power point presentation (10%), and final exam (25%).

**Project I (Energy Demand Reduction):**

I. **Part A:**

Efficient energy use is one of the most important aspects of energy sustainability. Energy demand (usage) can be reduced by selecting high efficiency appliances and incorporating smart ideas in building designs along with change in operation behavior. **For this first project, the students shall find new ideas that can be incorporated in a household, either new or existing, that result in energy savings.** These savings can be realized through increased efficiency or by energy generation to reduce energy bills. **The students shall identify these idea and provide an estimate for the cost saving realized as opposed to the cost of these ideas. Each group shall provide three ideas and discuss the following:**

1. Are these ideas costly? Or are they going to break-even and result in energy savings that justify their initial cost? (life cycle cost analysis)
2. What are the government incentives to encourage such ideas? (Buy back excess electricity, subsidized solar systems, etc...)

**Examples:**
- Compact fluorescent lamps as compared to standard lamps (higher price but higher efficiency leading to lower energy bills)
- Think Solar Decathlon

II. **Part B:**

With the increased interest in electrical vehicles as an environmental friendly option, **it is required to identify the impact of adding an electrical vehicle to the findings in part A.** In other words, in part A, energy bill reduction has been realized either through energy use reduction or through electricity. **How would these savings change if an electric car is added to the household?** For example:

- If your suggested ideas in part A reduce electricity use, **Can the saved electricity be used to charge an electric car, leading to gas savings?** And how would that impact the cost/benefit of these suggested ideas (including the electric car cost)?
- If your suggested ideas revolve around incorporating electricity production (solar PV, wind...), how would adding an electric car impact the economics of the system. **Will the cost of saved fuel (by using electric car) be more than the capital and running cost of the suggested renewable technology (combined with the electric car cost)?**

Also how would these savings reflect on your CO₂ emissions?
**Project II (Carbon Footprint):**

I.  **Part A:**

Carbon footprint has been defined as "A measure of the total amount of carbon dioxide (CO\(_2\)) and methane (CH\(_4\)) emissions of a defined population, system or activity, considering all relevant sources, sinks and storage within the spatial and temporal boundary of the population, system or activity of interest."

Greenhouse gases can be emitted through transport, land clearance, and the production and consumption of food, fuels, manufactured goods, materials, wood, roads, buildings, and services. For simplicity of reporting, it is often expressed in terms of the amount of carbon dioxide, or its equivalent of other GHGs, emitted.

To have an idea of your own carbon footprint, BP Energy usage and carbon emission calculator can be used ([http://www.bp.com/en/global/corporate/sustainability/bp-energy-lab/calculator.html](http://www.bp.com/en/global/corporate/sustainability/bp-energy-lab/calculator.html)). You can evaluate your own performance based on that calculator.

Not only activities have their own carbon footprint, but also fuels and energy sources. For energy sources, the resultant emissions are only a portion of the total carbon footprint. The rest comes from material handling, transportation, construction, etc. Some energy sources have no pollutants emissions, yet they have a significant carbon footprint.

In this project, you are required to pick one electricity production method and find the carbon footprint of this technology. You shall identify and discuss the main contributors to this carbon footprint. Did any of the findings were unexpected?

- All figures and numbers used shall be referenced with full details.
- The U.S. National Renewable Energy Laboratory is a good starting point regarding carbon footprint.

II.  **Part B:**

Now as we know the carbon footprint of various electricity generation methods, how would that impact planning for future electricity installation? If we want to keep our total carbon release increase minimal and at the same time furnish electricity for the expected population increase, what are our technology options to furnish the required energy with minimal Carbon footprint change at an acceptable cost?

In other words, it is required to reduce the average CO\(_2\) release of 1216.18 lb/Mwh by 10% to about 1094.56 lb/Mwh while the electricity generation increases by 20%, what will be the technologies of choice that can be installed to furnish 20% increase electricity generation, and at what costs.

- The price per kwh of each technology can be found through the US Energy Information Administration
Project III (Energy Supply):

I. Part A:

As the demand for electric energy increases in the United States, it is required to install a new power plant for sustainable electricity production for the next 20 years in a chosen location.

In this project, the students shall choose one of the energy generation technologies and assess the cost of this technology. The students shall account for the different costs ($/kW), including capital, operation and maintenance, and fuel costs. The electricity generation efficiency shall also be evaluated.

The students shall account for the change in fuel prices and how they affect the cost of energy production ($/kW). At the end of this project, the students shall be able to suggest a power generation technology, identify the expected efficiency and the associated costs. A comparison with electricity price shall outline the feasibility and sustainability of this technology.

Remarks:

- There is no penalty if the suggested technology does not turn out to be sustainable. The project will be graded on calculations and assumptions involved.
- All figures and numbers used shall be referenced in full detail and any assumption made shall be logical and justifiable.
- The U.S. Energy Information Administration is suggested to be a good starting point for different costs and trends.
- The U.S. Environmental Protection Agency is also a good starting point regarding federal regulations on emissions.

II. Part B:

As an incentive for environmentally green operation, and to encourage sustainable energy systems, additional costs for pollutants emission and tax breaks for green technologies are being discussed to be introduced. These incentives are expected to affect the feasibility of the suggested power plant. In this project, the students shall evaluate the impact of these incentives on the costs of the energy production of a selected energy production technology. The students shall identify these incentives relating to the technology they chose and then re-assess the sustainability and feasibility of their chosen (suggested) technology of Part A. The students may suggest other regulations and incentives that they deem necessary and how they affect their proposed power plant sustainability.
**Topic (Power Point) Presentation:**

Each group of students shall prepare a presentation (equivalent to one lecture) covering one of the following topics given below. The presentation shall be informative, comprehensive, detailed and appealing. The presentation shall be about 60 slides and it *should not be a duplicate of the course lectures*. The topics are as follow:

1. Sustainable energy, energy availability and use, and related issues
2. Energy conversion methods and efficiency
3. Policies affecting energy production, fuel economy, emissions and costs
4. Global warming and carbon footprint
5. CO2 emission, capture and storage (CCS)
6. Regulations governing energy production and the associated penalties for emissions
7. Fossil fuel in a sustainable energy system
8. Biomass and biofuels
9. Fuel economy, energy storage and transmission for sustainability

*Draft presentations will be due on 5th week, final power point presentation due on 8th week (see table below).*

**Timeline for assignments**

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<td>Task</td>
<td>Form groups</td>
<td>Submit draft Topic Presentation</td>
<td>Turn in Project I</td>
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<td>Task</td>
<td>Midterm</td>
<td>Submit Final Topic Presentation</td>
<td>Turn in Project II</td>
<td>Thanksgiving break</td>
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<td>Task</td>
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<td>Module 1 + David MacKay Video</td>
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<td>Module 2-1: Energy use, demand and supply</td>
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<td>Module 4: Life cycle cost analysis</td>
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<td>Module 9: Regulations and CCS</td>
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<td>Guest Lecture, Module 10: Fossil fuel</td>
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<td>Module 11: Biofuel</td>
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<td>14</td>
<td>12/3</td>
<td>Module 12: open discussion about sustainable technologies based on Project I</td>
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<tr>
<td>15</td>
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<td>Group presentations for Project II</td>
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**Other Notes**

**Students with Disabilities**
Students wishing to request academic accommodations for a disability should notify the professor at the beginning of the semester. The student should also register with Disability Support Services (DSS) [http://www.counseling.umd.edu/DSS/](http://www.counseling.umd.edu/DSS/) (301-314-7682).

**Attendance Policies**
University policy excuses the absences of students for illness (self or dependent), religious observances, participation in University activities at the request of University authorities, and compelling circumstances beyond the student's control. Students must submit the request in writing and supply appropriate documentation, e.g. medical documentation. Except in the cases mentioned above, students are expected to attend all sessions since class participation will be graded. For more information, see the University's Attendance and Assessment Policy. Students will not be penalized in any way for participation in religious observances and they be allowed to make up academic assignments that are missed due to such absences. However, it is the student’s responsibility to inform the instructor of any intended absences for religious observances in advance of the projected absence within two weeks of the start of the semester and with a written notification. The request should not include travel time.

**Inclement Weather**
Assignments will be rescheduled if necessary due to inclement weather and campus emergencies. Official closures and delays are announced on the campus website and snow phone line (301-405-SNOW) as well as local radio and TV stations.

**Policy on Academic Integrity**
Must abide by the University of Maryland’s Code of Academic Integrity ([http://www.president.umd.edu/policies/docs/III-100A.pdf](http://www.president.umd.edu/policies/docs/III-100A.pdf)). No academic dishonesty on
homework and major grading events. Procedure will be followed for any student suspected of any incidents.