Energy: Science, Technology & Society (chm 286/486 Phy 285)



Hot Discussion Points

- Does coal have a black outlook?
 - Is fracking freaking you out?
 - Is natural gas too volatile?
 - Are pipelines pipedreams?

Does solar have a sunny future?
Are wind farms overblown?
Is biofuel foolish?
Are new nukes a No-No?
Too many waves on hydropower?
Geothermal only for Icelanders?
Fearing geo-engineering?

• Is NIMBY an option?

Plenty of advocates, as well as opponents, for any course of action!

Goals of course:

Help to develop critical understanding of scientific issues, technical principles and potential of energy production, distribution and management,

benefits *vs.* environmental risks, public politics.

Today's Agenda

Introduction and Overview

Initial Info, Purpose

Topical outline

Reference texts

Potential research projects (Teams of 2, choose within a few weeks!)

Course web site

Precourse Opinionnaire

Next:

1-0: Sustainability (of Human Activity & Life on Earth)

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Initial Info

Lectures:

Prof. W. Udo Schröder Tuesdays/Thursdays 12:30 - 13:45, <u>Hylan</u>. Room 202

Office Hours

W. Udo Schröder: Mondays, 12:00 - 13:00 Hutchison Hall (<u>HH</u>) 466 or by appointment (275-8263), <u>schroeder@chem.rochester.edu</u> Zoom(<u>https://us02web.zoom.us/j/81169548612?pwd=LzY3YmNYZy9pdmJxakhPakpjWmd0Zz09</u> Meeting ID: 811 6954 8612),

Joshua Ruby, Teaching Assistant 441 Hutchison Hall (<u>HH</u>), Fridays, 2:00 - 3:30, or by appointment, <u>jruby3@ur.rochester.edu</u>

Prerequisites: Familiarity with basic calculus, principles of modern physics and chemistry, or by special permission

Assignments/Grades: Assignment include regular weekly homework problem sets and 2 research papers. The grades will be computed from homework (25%) and 2 project reports (75%), written and presentation. There are no written exams

Class Attendance (Covid protocol, in person/virtual)

Expected

Academic Honesty

Expected and enforced (<u>http://www.rochester.edu/college/honesty/</u>)

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Topical Outline

The Big Picture: Energy and the Environment

Sustainability, managing finite resources/policies (US), external costs of energy management (Illustrations) Climate factor: Atmospheric chemistry and physics, greenhouse effect, pollution and climate change

Energy Demand/Uses, Past and Outlook

History of energy technologies, current energy demand, outlook to 2050, fuel reserves, resource estimates

Energy Distribution and Storage Infrastructure

Fuel transport, electrical grid (dumb and smart), cyber security, energy storage technologies,

Energy Conversion, Science and Technology

Equivalent forms of work, energy, energy units , mechanics and basic thermodynamics, TD laws, electro-chemistry Heat engines, power plants, batteries and fuel cells, electricity, motors and generators, AC/DC Basic hydrodynamics, wind and hydro-power generation Physics and chemistry of solar cells, PV and thermo-solar generation Nuclear power fission, fusion Energy from biomass, carbon capture & sequestration

Energy Strategies: Potential and Risks

Risk factors for environment, health and climate, hydrocarbon fuel technologies (clean coal, CCS, shale, synfuels) Nuclear power (new nukes, fusion), development of renewable energy sources, energy efficiency, conservation

Energy Policies vs. Public Attitudes

Selective subsidies of energy technologies, energy conservation strategies Changing public attitudes through education

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Technical Reference Texts



Andrew & Jelley (3rd edition): Main reference textbook

"THIS BOOK IS A TOUR DE FORCE AS A WORK OF POPULAR SCIENCE IT IS EXEMPLART"

"THIS IS TO ENERGY AND CLIMATE WHAT FREAKONDMICS IS TO ECONOMICS."

SUSTAINABLE ENERGYwithout the hot air

David JC MacKay

Free e-copy down loadable at http://www.withouthotair.com/

Plus resources on specific topics, e.g., IPCC, NAS or IEA reports, statistics.

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Potential Research Projects

The research topics listed below are potential class assignments. However, it is currently assumed that only 2-3 of them will actually be assigned as projects to be researched by student teams. Project reports summarizing the findings are expected to be produced individually by each student utilizing the electronic (MS-Word) report template provided (Report template.doc). Logistics of class presentations are under consideration.

1. 4 >> Potential of Wind Energy in NW New York

Consider a Vestas or Siemens 2-or 3- MW (nominal) wind tower Collect one week of data provided by NOAA on wind speeds (web site) Calculate statistical averages and variances of wind speed and actual turbine power output over the period considered and scale to 1 GW nominal output. Estimate additional stand-by energy for 95% or 99% safety margin on voltage. Materials; Published daily NOAA record, generator manufacturer's information.

2. 4 >> Solar Power Generation in NW New York

Retrieve generation data from an actual installation of solar panels on the roof of Rochester Public Library Arnett branch. Calculate mean power generated per day and its variance, for several months in different seasons (Summer vs. Autumn). Compare production cost in \$/kWh (20 years amortization) and compare to utility charge. Discuss backup and storage options/requirements to satisfy 80% of demand.

3. 4 >> Risks and Benefits of Hydro-Fracking

Retrieve the material safety data sheets (MSDS) for fracking fluids published by Haliburton. Classify the chemicals used in fracking and describe their respective functions. Identify potentially hazardous chemicals and describe their possible health effects. Utilize environmental "event" reports published by government agencies.

4. 4 > Electrification of Transport

Outline current modes and utilization of commercial, mass and personal transport in the USA. Study and discuss recent proposals to replace internal combustion engines by electromagnetic engines, fuel cells, or hybrid combinations. Perform a detailed cost analysis for the case of personal electro-mobility by automobiles and the required technical infrastructure. Consider international electrification efforts.

5. U Prospects of Geo-Engineering

Study and discuss recent proposals to reduce solar insolation (effective albedo) with atmospheric seeding, carbon capture via oceanic algae cultivation, etc.

6. US Algae Based Biofuel Development in the US

Study and summarize the NAS report (download pdf from NAS website) on the potential of algae for biofuels in the U.S.

Outline basic principles, land grown or ocean fertilization. Discuss experimental setups (Florida).

Project 7: Liquid-Fluoride Salt Thorium Nuclear Reactor/Processing Facility

Study and summarize the nuclear and actinide chemistry making the LFTR a unique, advanced nuclear reactor with in-situ, simultaneous reprocessing. Materials: Extensive ORNL report, several new papers.

Project 8: Carbon Capture and Sequestration Technologies

Discuss chemical and geological methods for CO2 sequestration, potential for leakage, monitoring.

Materials: Book on carbon capture technologies, experiences reported in Sleipner capture and sequestration project, FutureGen project report, CO2 sequestration test results.

Project 9: Smart Grid and Cyber Security

Discuss main features suggested for smart grid implementation, recent incidents of cyber security breaks.

Materials: Book on System Failure, journal articles on hacking of Iran's nuclear industry.

Project 10: Major Accidents in the Global Energy Industry

List and describe briefly industrial accidents since 1950 with fatalities, casualties, habitat destruction (fossil fuel production, distribution, nuclear industry, hydropower). Quote cost estimates given in literature/media. Materials: PSI report, monographs on nuclear accidents, chapters of several books, Mueller's Fukushima analysis.

Project 11: Issues for a Green Economy

Discuss issues of energy density and environmental impact of renewable (minus hydro-electric) energy technologies, as well as support by federal and state policies. Summarize and evaluate common criticisms towards a green economy. Materials: Book "False Promises of a Green Economy."

Project 12: Economic Impact of New Energy Policy in Germany

Discuss the decision to discontinue electricity generation from nuclear power in Germany, factors for GDP, electricity costs, CO2 emission standards. Summarize reports by energy institute, European Physical Society. Materials: Report by European Physical Society, ERI special study report.

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Course Website: http://www2.chem.rochester.edu/courses/chm286_486/index.html

Energy: Science, Technology and Society W. Udo Schröder

CHM 286/486 Introduction to energy issues

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General Info

This is the web site for the science course Chm286/486. Additional pages are accessible via the navigation bar on top..

The goal of course is to help students to develop a sophisticated and critical understanding of scientific principles, technological processes of energy conversion, as well as an appreciation of environmental and societal impact of energy consumption, the management of energy technologies and aspects of sustainable energy policies.

Lectures:

Professor W. Udo Schröder Lectures on Tuesdays/Thursdays 12:30 - 13:45h, Hylan. Room 202 (or on ZOOM) First Lecture : Thursday, August 26, 2021 12:30-13:45, Hylan. Room 202.(or on ZOOM)

This course is intended to be conducted in terms of 2 per week in-person meetings. Wearing a properly fitted face mask is required for all. However, as Campus health concerns arise, it will be given in a virtual format, with 2 per week on-line lectures on the ZOOM platform.

A decision for virtual meetings for this course will be announced by August 24. It will be made contingent upon prevailing status of general and Campus safety and in compliance with health protocols.

Zoom Link for Class Meetings ("Tritium") Zoom Link for WUS Office Hours ("Tritium")

On-line Zoom lectures will be recorded and made available for asynchronous view via BlackBoard and Panopto platforms. In addition, contents of the lecture materials and presentations will be available for downloading and preparation by students prior to class meetings. Direct visual and audio communication between students and instructor will occur via webcam, microphone and other virtual communication devices such as touch screens, tablets, document cameras, etc.

In any case, students are encouraged to familiarize themselves with, and practice, the use of features of the Zoom platform, including handwriting on the Zoom Whiteboard.

Assignments: Home works/quizzes (25%), 2-3 research papers (75%)

Class Presentations & Materials

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Course Syllabus Class Venue/Times

links on this page:

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- Energy Demand/Outlook
- Science and Technology
- Energy Conversion/Distribution
- Strategic Issues
- Realistic Policies

Lecture Notes

This is the web site for energy science and technology course Chm286/486. Additional pages are accessible via the navigation bar on top...

The topics discussed in this course, Energy: Science, Technology and Society, have been categorized in the Synopsis. They are tentatively rearranged below for practical and didactical reasons but may have to be updated in time.

ASSIGNMENTS

CONTACT WUS

Electronic lecture presentations can be downloaded in various formats if marked by colored links. .pdf is the recommended form. Videos and animations are available in avi, mpeg or wmv formats. Audio cuts of lectures are not available.

The format .mcd indicates a MathCad program file, which can be viewed with the original programming software or a free MathCad viewer.

Disclaimer (Please read before using the presentations on this site)

0. Course introduction (pdf), Opinionnaire (pdf)

1. The Big Picture: Energy and Environment

- 1. Eco-footprint and sustainability of human society (pdf1, pdf2)
- 2. Summary of public policies (pdf)
- 3. External factors: pollution and climate change (pdf1, pdf2)
-Tutorial: Radiation interaction with matter I (pdf) & II (pdf)
- 4. Tools and fuels in human history (pdf1, pdf2)

.....Materials

.....NAS Climate Report 2010 (web, loc)

.....IPCC Executive Summary (pdf)

.....NAS Policy GHG Mitigation report (web)

Society

Weekly Assignments & Project Tasks

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- Solar Power Generation
- Chemistry of Fracking
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- rtGrid Cyber Securi
- iquid-Salt Th Reactor
- lean Coal
- No Nukes in Germany Accidents in Energy Industry

Homework and Research Projects

This is the web site for energy science and technology course Chm286/486. Additional pages are accessible via

ASSIGNMENTS

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Homework Assignments

1. Statistical Data Analysis, Greenhouse Gases

Reading assignments for week of August 30:Andrew&Jelley Ch. 1, 12.1-12.2,12.6, MacKay I.1NAS_Climate_Report-2010 (pdf),IPCC Summary (pdf)

2. Blackbody Radiation, GHG Geo-Engineering

Download HW file (pdf)

Reading assignments for week of September 5:Andrew&Jelley Ch. 11.1, 11.5-6.

......NAS Report Policy Implications of GH Warming:Mitigation, Adaptation & Science Base, Ch. 28 (pdf)(free down load from NAS site)

Potential Research Projects

Society

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Energy: Science Technology

Links To Useful Energy Relevant Websites



International Energy Agency https://iea.blob.core.windows.net/assets/d0031107-401d-4a2f-a48b-9eed19457335/GlobalEnergyReview2021.pdf



US Energy Information Administration https://www.eia.gov/environment/emissions/carbon/archive/2014/index.php



US Environmental Protection Agency https://www.epa.gov/web-policies-and-procedures/free-viewers-and-readers-readand-print-epa-information



Climate Data: "Copernicus" Applications and Tools https://cds.climate.copernicus.eu/toolbox/doc/gallery/index.html

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