Sabbatical Report

Lori Clark

Energy Resources and Conservation

Spring 2013

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Project Purpose and Meeting the College Mission

Purpose: The purpose of this sabbatical was to enhance and update materials to support the teachings in ENSC M-03 Energy Resources and Conservation. This class is required for all ENSC degree and certificate programs at Moorpark College and the most relevant textbook for this class had no data or updates past the year 2002. In the last 11 years, the global energy story has dramatically changed and an update to these materials was crucial to providing relevant information for students. In my original proposal I had been communicating with the editor of our outdated textbook who had expressed interest in bringing me on as a co-author of a new edition to the textbook. The authors chose a different co-author from among their colleagues and I altered my project to working on supplementary materials to accompany the textbook while I continue to work toward a new textbook.

College Mission: The sabbatical work will help students in the Environmental Science Majors to be better equipped members of the global community. They will have a broad national and international understanding of the advances and latest changes that are occurring in energy extraction, technology, and use. The ongoing changes in the field of energy have a powerful impact on economic and social interactions both within our country and the global community. The current information in this applied science will help direct the academic and career paths of our students. As they see the real time roll out of new energies, related technologies and environmental impacts, they will be able to assess their potential roles in areas such as leadership, science and technology, economics, and public policy. Our students will be prepared to enter academic and career pathways with the most cutting edge information in energy resources and conservation.

Proposal and Introduction to Research

My research was directed by my original proposal. The Proposal included enhancing texts for our current course textbook in the following ways:

Ch. 1 Energy Fundamentals, Energy Use in an Industrial Society *(update data and graphs for energy consumption and production, % use from various sectors, energy consumption per person from 2003 data, upgrade figures and include more relevant figures)*

Ch.2 The Fossil Fuels *(update estimates for undiscovered oil and natural gas, include recent findings globally and include changes in U.S. policy for offshore drilling, ANWR update, Alberta Tar Sand access/keystone pipeline, reference Deepwater Horizon Oilspill, update global natural gas and coal reserves, highlight growth of coal in China, include peak oil prices of 2008 and recession. Update OPEC nations and production.)*

Ch. 3 Heat Engines

Ch. 4 Renewable Energy Sources I: Solar Energy *(Update U.S. renewable energy consumption, discuss the factors that influence growth of solar in top growing states: irradiance, gov't incentives, cost of power, possibly include new diagram of earth's orbit highlighting the changing angle of the sun relative to the equator throughout the seasons)*

Ch. 5 Renewable Energy Sources II: Alternatives *(update U.S. status and plans for offshore wind projects, highlight European offshore wind, include update of largest hydroelectric projects, ex. Three gorges dam and environmental impacts, include ocean current energy systems, update biofuels to include US policies to increase ethanol production and impact on agriculture, highlight hydrogen fuel cell)*

Ch. 6 The Promise and Problems of Nuclear Energy *(Include recent accidents in Japan 2007 and 2011 Fukushima Daaichi and a description of level 7 accidents. Introduce the historic Rocketdyne meltdown. Include an update of new nuclear plants announced in the U.S. and the recent status of Yucca Mt. Discuss proposed growth in China and India and the status of phase out countries such as Sweden and Germany. Introduce new variations of nuclear plants.)*

Ch. 7 Energy Conservation *(Add LEED and U.S. Green Building Council standards and criteria, update Energy Star program)*

Ch. 8 Transportation *(Include new CAFE standards (mpg standards), add the reintroduction of diesel cars in CA, return of a new generation of electric cars and*

introduction of plug in hybrid models and hydrogen fuel cell cars by major dealerships, discuss the growth of the high speed rail system in China and emerging markets for autos projected growth and fuel consumption)

Ch. 9 Air Pollution *(update summary of air pollution from 2005 to 2012, include updates to smog tests, gas cap and pump designs to reduce VOC)*

Ch. 10 Global Effects *(Include information about cap and trade Carbon Dioxide program recently passed in CA, update climate change reports)*

Proposed New Chapters or Special Sections

Ch. 11 Water pollution: *Discuss contamination from fuel additives of the past- lead, MTBE. Discuss the impact of oil spills highlighting Deepwater Horizon and including a special interview with oil spill specialist. Include the impact of mining and improper nuclear waste disposal to rivers and lakes including Lake karachay in Russia.*

Ch. 12 or special section Performing an Energy Audit: *Outline the process for performing an energy audit in the home or office including some of the methods to determine drafts and effectiveness of insulation, searching for inefficient use of energy and how to improve efficiency. Include exercises for students to perform.*

Ch. 13 or special topics in energy Agriculture, fossil fuels and biofuels: *Look at the relationships between food prices, food production and demand for fossil fuels and fertilizers. Discuss government programs to promote ethanol production and corn production in America.*

Introduction: In order to collect current and relevant data and information for the course texts I engaged in the following research:

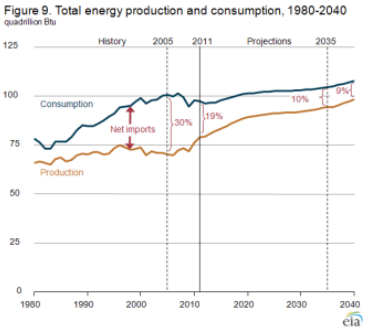
1. Extensive collection and study of data from Governmental and private organizations and journal reports
2. Conference attendance and networking
3. Interviews with staff members from various energy related companies and faculty members from University programs
4. Energy auditing and experiments
5. Photographing and documenting renewable energy across the country in several states

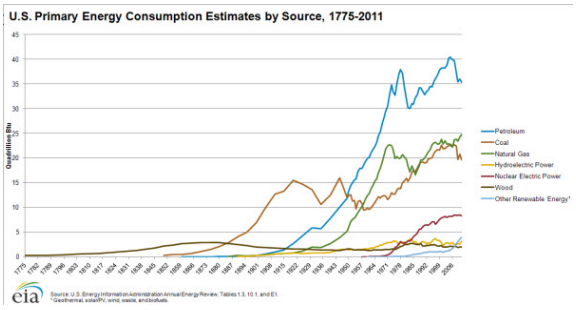
The following pages contain more detailed information about the research listed above.

Data Collection from Governmental and Private Sources

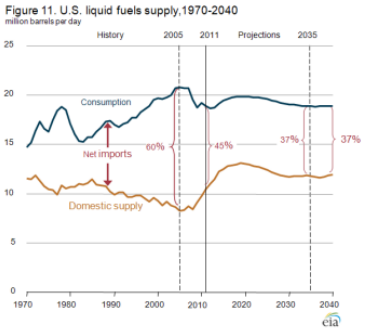
1. Data Collection: A large portion of my sabbatical was spent going through collected data on government websites and reading reports on various topics related to current energy trends, prices, methods of extraction, production changes, global consumption, and various related topics. Some examples can be found below:

A. U.S. Total Energy Production over time:



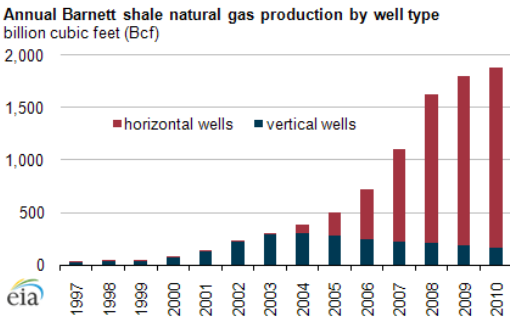


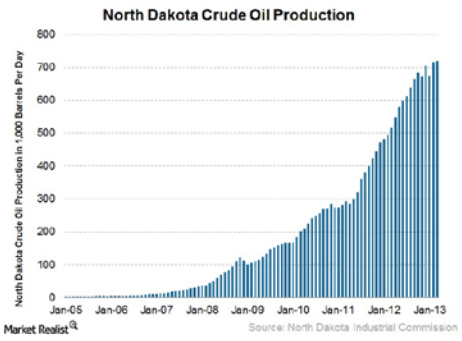
The gap between U.S. energy production and consumption has decreased significantly in the last decade. Prior to this sabbatical, our textbook information ended with data from 2002. The first graph shows how important new data collection is. After 2005, the graph illustrates how U.S. energy production rates are catching up with our consumption rates. This demonstrates the achievement of a concerted effort to become more energy independent which has potentially major economic and social implications. This has been achieved through work to increase U.S. energy production both in fossil fuels and renewable energy sources and programs to increase fuel efficiency standards and energy efficiency in homes and appliances. In the second graph we see the rise and temporary fall in Oil and natural gas production leading up till 2011. Since 2011, a change in production methods have altered this story.



B. Fossil Fuels: Oil, Natural Gas, and Coal

The story of oil and natural gas production in the U.S. has changed from one of depletion toward a story of abundance. The image above shows a sharp rise in liquid fuel production in the U.S. beginning just a couple of years ago. This follows a consistent decline since 1970. Previous textbooks still were recounting the story the U.S. hitting "peak oil" production around 1970 and the world hitting peak oil somewhere between 2000 and 2012. These estimates did not account for newer methods of extraction such as off shore production and Hydraulic Fracturing or "fracking". With fracking alone, our reserves are now estimated at more than twice what we were counting in 2011 (just 2 years ago!) as long as oil prices remain over $60.00 per barrel. Horizontal drilling and hydraulic fracturing have changed the way we access oil and natural gas by opening up regions that were once considered too difficult to be profitable. The diagrams below depict the rise in production through horizontal drilling and fracking. Based on the increase in production, policy makers are beginning to suggest that we may become either North American or American (including all of the Americas) oil independent in coming decades. North American Imports are expected to drop from more than 9 million barrels a day (mbd) in 2005 to about 5 mbd in 2020.



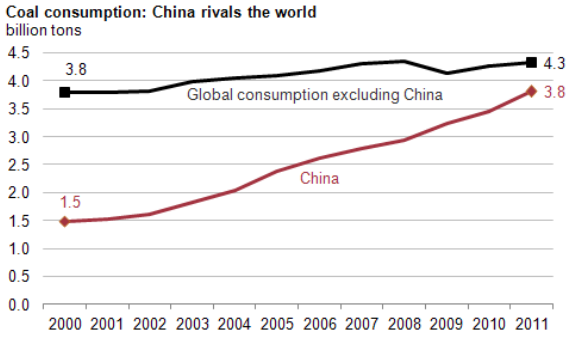


Certainly, our textbooks did not include the accompanying environmental concerns with newer extraction technologies such as the Deep Wells Horizon oil blow out (now the world's worst accidental oil spill) as well as environmental concerns with fracking chemicals, leaks, and trucking pollution.

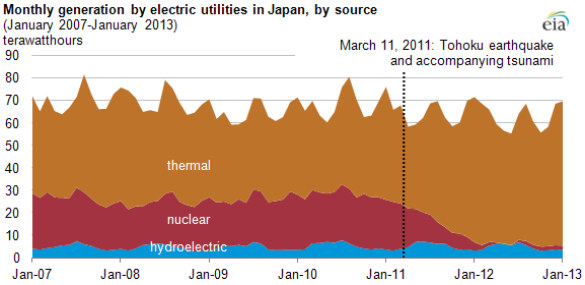
With oil production from within the U.S. and Canada rising, the delivery of oil has been under pressure. The Keystone pipeline has not been approved and as an alternative, Canada is seeking to move it by ship from Vancouver to the U.S. west coast. California's largest refinery is receiving North Dakota oil by rail.

With Natural Gas production on the rise, coal burning in the U.S. is declining. In fact the combination of NG and renewables on the rise seem to be a growing replacement for coal which is on the decline. Coal accounted for about 50% of the U.S. primary energy source for electricity production from 1990-2008. Since 2008 it's been declining and is expected to drop to 35% by 2040.

China has been going through a major manufacturing and urbanization explosion. Coal has provided the primary source for electricity demands associated with the growth. In 2011, reports estimate that 2 new coal power plants have been going online every week. Since 2000, China has seen a 200% increase in coal production, it accounts for 47% of world coal consumption today. This has become a source for severe air pollution in its major cities.



C. Nuclear energy has great potential as a cleaner high potential energy source making it desirable in countries fighting air pollution and carbon emissions. Accidents, waste disposal issues and public fears have led to closures over time. The most recent level 7 accident at Fukushima in 2011 has forced a shift in electric energy primary sources for Japan.



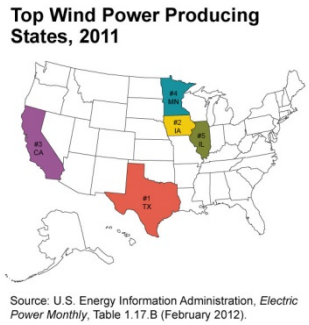
California has significant nuclear stories that go completely undocumented in course texts. Our local community (Moorpark) is the first U.S. city to run on nuclear energy, though temporarily, and we live in the region of the U.S. worst nuclear accident. The site of the experimental sodium reactor that lost nearly a

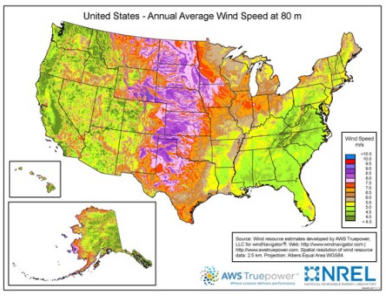
third of its fuel to a meltdown in 1959 was set in the Simi Hills (Santa Susana Field Laboratories). Unfortunately, the site was set up to vent radiation and it is believed to have released up to 459 times the radioactive gases released at Three Mile Island in 1979. Our two official reactor sites in California struggle with controversy. The San Onofre plant was recently closed and the Diablo Canyon site was built on coastal cliffs above 7 fault lines. The western U.S. has few nuclear energy sites, however the U.S. houses nearly ¼ of worldwide reactors.

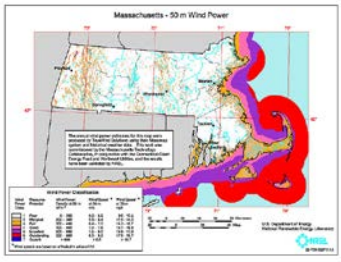
At the start of the Obama administration, the Yucca Mountain nuclear waste receptacle (Nevada) was stopped from receiving waste. This left our country with no permanent nuclear waste site, further halting the closing of the nuclear fuel loop. Two new reactors were approved during this administration in Georgia which will be the first new reactors ordered in the U.S. (that haven't been shut down) since the 1970s.

D. Renewables: Wind

Wind is the second fastest growing of our renewable energies in the U.S. The department of energy has set goals to raise our production to 20% of electricity production. Midwestern states have enough wind resources to power the lower 48 states.







The offshore wind project in Nantucket Sound, Massachusetts will potentially provide 75% of the electricity needs for the region.

This section provides a sampling of the updated information that could not be found in previous texts for the ENSC M-03 course. The currency of this information is invaluable.

Conference Attendance and Networking

2. Conference Attendance: I attended the following conferences which were chock full of current and powerful data trends and stories of energy use, production and impact. The conferences covered detailed information about the biofuels industry, the impacts of extreme weather and climate change to energy systems and security, and the oil and natural gas boom occurring with hydraulic fracturing as well as total energy production and projections around the world. They were very exciting conferences to be a part of!

A. **Department of Energy Biofuels Conference** – Hosted by Howard Gruenspecht Deputy Administrator EIA March 2013

- Michael Cole, Office of Petroleum, Natural Gas and Biofuels Analysis "Modeling of Biofuels in the Annual Energy Outlook"
- John Maples, Office of Energy Consumption and Energy Analysis "Flex fuel vehicle Modeling in the AEO"
- David Greene, Oak Ridge National Lab, Modeling E85 use
- Kristi Moriarty, Energy Analysis National Renewable Energy Lab, "E85 Retail Station Growth"

B. **2013 NYIT Energy Conference** – Hosted by Professor Rahmat Shoureski

- Dr. Nada Anid, NYIT School of Engineering and Computer Science (Microgrid systems)
- Dr. Rosenzweig, Barnard College, Lead author for IPCC "Climate Risk Information 2013" an NPCC1 report
- Louis Uccellini, Director National Weather Service, "Trends in Extreme Weather"
- Panel speakers on microgrid integration and disaster energy and social response

C. EIA 2013 Energy Conference

- Plenary Speakers:
  Adam Sieminski, Administrator, U.S. Energy Information Administration
  Dr. Ernest Moniz, U.S. Secretary of Energy
  Thomas Fanning, Chairman, President and CEO, Southern Company
  Aldo Flores-Quiroga, Secretary General, International Energy Forum
  Lisa Murkowski, U.S. Senator (Alaska) and Ranking Member, Senate Energy and Natural Resources Committee

- Sessions attended: Plenary sessions

- Global Natural Gas Outlook

- Hans Rossling-population and consumption new normal

- World Hydrocarbon Resources

- Energy in the Americas

- U.S. Natural Gas Production Growth and its Implications

- U.S. Oil Production Growth and its Implications

- Portions of Coal and Nuclear: World Domestic Outlook and Alternatives to Oil in Transportation

Personal Interviews and Networking

3. Interviews: I was able to meet with many individuals directly involved in the delivery and management of various energy sources for heating, transportation, and manufacturing. The energy sources varied from #6 heating oil, to renewable wood heating, to cogeneration at corn product plants in the Midwest. I was also able to interview various faculty members that work with energy engineering as well as planning for climate change as a result of fossil fuel emissions. Those individuals are listed below:

A. Several Employees from North Shore Fuel, Heating Oil company, Long Island, NY

B. Ronald Schmitt, Energy Manager for Roquette America – Cogeneration plants throughout Iowa

C. John Graham from "Real Green" subcontractor for CMC Energy Services, NY

D. Dr. Stanley Greenwald– Founder of Department of Environmental Tech at NYIT and former engineer at Diablo Canyon Nuclear Power Plant, San Luis Obispo County, CA

E. Dr. Malcolm Bowman – Physical Oceanographer, coastal flooding specialist and coordinator of "Storm Surge Group" modeling storm surge threats and protections for NYC, Stony Brook University

F. Ed Bradshaw- Director EES Engineering and Services, designing systems for Nuclear Power Plants

G. Julia Hryvniak- Land Use Ecological services, Inc.

H. Owner-King of Hearths wood and pellet burning stoves and fireplace inserts, Port Jefferson, NY

Energy Auditing and Conservation Experiments

4. Energy Auditing and Energy Conservation Experiments: During my sabbatical I was engaged in ongoing projects that allowed for direct experience with energy conservation. These included experiments in whole house energy efficiency, reliance on renewable heating and cooking energy sources, and documenting the savings of food delivery related energy consumption.

A. Home energy auditing

- Worked alongside home energy auditor, John Graham testing electricity run major appliances for efficiency and ventilation.
- Tested emissions of water heater and oil heater.
- Ran through shut down process of burners releasing excessive CO emissions.
- Reviewed insulation requirements and weaknesses.
- Replaced light bulbs with CFLs

B. Renewable energy heating experiment

- Replaced oil heating with high efficiency wood burning fireplace insert.
- Kept continuous fires going in two units day and night
- Tracked the change in fuel consumption over 8 weeks of heating season in the North East winter.
- Tracked fuel and cost savings.

C. Renewable energy cooking experiment

- Built Solar Oven
- Tracked internal and outdoor temperature changes
- Baked cornbread in both solar and conventional ovens comparing times

D. Compost and Gardening

- Planned and maintained high variety garden (30'x40')
- Collected yield mass and value equivalent at grocery store prices
- Documented import distances for grocery store produce
- Planning energy cost problems/solutions for buying/growing local in-season produce compared to buying imported and out of season produce

Documenting Alternative Energy Production

5. Documenting Alternative Energy

I traveled along Route I-10, I-40, I-80, and I-70 across the U.S. and photographed Solar Fields, Wind turbine fields, and hydro-electric power plants in several states including: CA, TX, IL, IO, OK, KS.

Resources

Data Collection

Annual Energy Review

Intergovernmental Panel on Climate Change

Mothers for peace

National Oceanic and Atmospheric Association

National Renewable Energy Laboratories

Oil and Gas Journal

OPEC

Statistical Abstracts of the United States

U.S. Bureau of Transportation Statistics

U.S. Department of Commerce, Bureau of the Census

U.S. Department of Energy

U.S. Energy Information Administration

U.S. EPA, Office of Air Quality Planning and Standards