

HW1, EE 590F, Power System Planning
August 27, 2008, Dr. McCalley, Due Monday 5:00 pm, September 8

There is a great deal of talking going on these days about energy. Some samples:

Barack Obama (senator and presidential candidate), ABC News, August 4, 2008, <http://blogs.abcnews.com/politicalradar/2008/08/the-long-short.html>.

“As part of Obama’s long term plan he calls for:

-A goal of having one million 150 miles-per-gallon plug in hybrids on the roads by 2015

-A requirement that 10% of energy comes from renewable sources by the end of his first term, including extending the Production Tax credit for 5 years to encourage the production of renewable energy resources

-A goal to reduce the demand for electricity by 15% by the end of the next decade by implementing energy efficient programs”

John McCain (senator and presidential candidate), Biofuel Digest, June 19, 2008, www.biofuelsdigest.com/blog2/2008/06/19/john-mccain-outlines-new-energy-policy-focused-on-45-nuclear-plants-and-clean-coal-technology-support/.

“In Missouri, Senator John McCain of Arizona outlined the centerpiece of his new energy policy by calling for the construction of 45 new nuclear reactors by 2030 and said he would earmark \$2 billion for the development of clean coal technology. McCain said “Perhaps no advancement in energy technology could mean more to America than the clean burning of coal and the capture and storage of carbon emissions.” McCain expressed support for offshore drilling earlier this week.”

Robert F. Kennedy Jr, (son of Robert F. Kennedy), CNN Article, August 25, 2008, www.cnn.com/2008/POLITICS/08/25/kennedy.energy/index.html.

“The United States has far greater domestic energy resources than Iceland or Sweden. We sit atop the second-largest geothermal resources in the world. The American Midwest is the Saudi Arabia of wind. Solar installations across just 19 percent of the most barren desert land in the Southwest could supply nearly all of our nation's electricity needs even if every American owned an electric car. Obama's vision of de-carbonizing our economy begins with a market-based carbon cap-and-trade system designed to put downward pressure on carbon emissions. He will invest billions to revamp the nation's antiquated high-voltage power transmission system and press for cost-saving building and appliance standards that would cut our energy demand by half. For a tiny fraction of the projected cost of the Iraq war, we could completely wean the country from carbon. Homes and businesses will become power plants as people cash in by installing solar panels and wind turbines on their buildings, and selling the stored energy in their plug-in hybrids back to the grid at peak hours. By kicking its carbon addiction, America will increase its national wealth. Everyone will profit from the green gold rush.”

T. Boone Pickens (founder of Mesa Petroleum), Business Wire, July 8, 2008,
<http://biz.yahoo.com/bw/080708/20080708005799.html?.v=1>.

“Step #1: Using the United States’ wind corridor, private industry will fund the installation of thousands of wind turbines in the wind belt, generating enough power to provide 20 percent or more of our electricity supply

Step #2: Again funded by the private sector, electric power transmission lines will be built, connecting these wind power generating sites with power plants providing energy to the population centers in the Midwest, South and Western regions of the country.

Step #3: With the energy from wind now available to operate power plants serving the large population centers in key areas of the country, the natural gas that was historically utilized to fuel these power plants can be redirected and used to replace imported gasoline and diesel as a fuel for thousands of vehicles in our transportation system.”

John Hofmeister (recently retired president of Shell Oil Company), Houston Chronicle, Aug. 21, 2008, www.chron.com/disp/story.mpl/business/steffy/5959086.html.

“His plan is based on what he calls the "four mores": 1. More supply of all kinds of energy. "There should be no barriers to developing energy supplies in this country," he said. We've done that for too long because when imports were cheap, nobody cared. 2. More pursuit of technology and innovation to more effectively use all forms of energy. That means everything from better conservation to better land use. "Technology represents the best form of conservation," he said. 3. More environmental stewardship. Technology works in our favor in finding ways to reduce emissions of all kinds. We've been able to effectively reduce physical and liquid pollutants, and we need to take a similar approach to gaseous waste. Hofmeister also returned to a favorite theme from his Shell days: Climate change is an ideological argument that won't be won. Instead, we should have practical discussions about how to reduce airborne pollutants economically. 4. More infrastructure — from pipelines to refineries to power plants — to match supply with consumption. Use the capital markets to fund improvements, but ensure that reasonable regulations are adopted. We're trying to meet tomorrow's energy needs with yesterday's planning and rules, he said. We also must ensure that regulations don't change in midstream, otherwise private companies won't take the investment risk.”

Assignment:

1. Answer the following questions. I suggest you initially use the data in my notes. If you can not find a particular data item in my notes, then provide your own estimate (i.e., guess). Attempt to do a “first-pass” on this, answering all questions, in a very limited amount of time. There is a reading assignment below which will help you refine these data.
 - a. Existing annual US electric energy production:
 - i. What is total annual electric energy production?
 - ii. What percent does each existing generation technology contribute to the annual electric energy production?
 - b. Existing annual US CO₂ emissions:
 - i. What is the total annual CO₂ emissions from all sources?
 - ii. What percent of total CO₂ emissions is from electric energy production? What percent is from transportation?
 - iii. What percent of total CO₂ emissions is from each of the following generation technologies: Pulverized coal and natural gas (combustion turbines or combined cycle units).
 - c. What are typical efficiencies for pulverized coal-fired units, combustion turbines, and combined cycle units?
 - d. What is a reasonable assumption for annual US load growth over the next 40 years?
 - e. What are reasonable assumptions regarding generation technology data, in terms of investment cost (\$/MW), O&M cost (\$/MWhr), emissions per unit energy (MMTCO₂e/MWhr) for each of the following generation technologies:
 - i. Pulverized coal with & without carbon capture & sequestration (CCS)
 - ii. IGCC with and without CCS
 - iii. Natural gas combined cycle with and without CCS
 - iv. Nuclear (O&M should include waste storage)
 - v. Wind
 - vi. Solar

The investment cost for each generation technology should include not only the cost of building the generation but also the cost of any transmission necessary to move the energy to the load source. Clearly you do not have enough information to do any kind of transmission study, so your estimates for transmission costs must be very approximate, based on very rough, high level observations. Since solar and wind are location-constrained, their transmission investment cost should be higher than for fossil or nuclear plants.
 - f. Make an assumption regarding what carbon tax level, in \$/MMTCO₂e will be implemented. Assume this tax level is implemented beginning 2010.
 - g. Make assumption regarding what percent of existing generation fleet will need to be retired by 2050?
2. After obtaining, or estimating, all of the above data, read (or watch) the following. The reports need not be read in detail – some parts of each document may be skipped or very quickly scanned. There are three things to look for in performing this reading.

First, look for support or refutation of the viability for the statements made at the top of this page. Second, look for refinements on the data you provided in responding to question 1 above. Third, look for (and bookmark) description on the *study process* that was used or is being proposed (this last effort is mainly applicable to items c-f below).

- a. Data at the US DOE Energy Information Administration (EIA) website <http://www.eia.doe.gov/>, particularly the one on electricity, at <http://www.eia.doe.gov/fuelelectric.html>.
 - b. US Department of Energy, Energy Information Administration, “Emissions of Greenhouse Gases in the United States 2006,” November 2007, available at <http://www.eia.doe.gov/oiaf/1605/ggrpt/index.html>.
 - c. US DOE Energy Efficiency and Renewable Office, “20% Wind Energy by 2030: Increasing Wind Energy’s Contribution to U.S. Electricity Supply,” May 2008, available at <http://www1.eere.energy.gov/windandhydro/pdfs/41869.pdf>.
 - d. NERC 2007 Long-Term Reliability Assessment, <http://www.nerc.com/files/LTRA2007.pdf>.
 - e. The MISO 2007 Expansion Plan Report, called “MTEP 2007: Growing the Grid,” http://www.midwestiso.org/publish/Document/5d42c1_1165e2e15f2_7ba40a48324a?rev=1.
 - f. Generation Technologies in a Carbon Constrained World, EPRI, http://www.epriweb.com/public/EPRI_GenTechCarbon.html (this is a videostreamed recording – note the bottom buttons that allow you to pause the stream).
3. Develop a spreadsheet calculation that provides the total emissions together with the present worth on total cost (investment and O&M) for a US generation investment portfolio from 2010 and 2050. You should be able to represent the portfolio in terms of the existing generation fleet (a fixed input) together with input data that can be easily changed that characterizes retirements and additional investments. Use the spreadsheet calculator to identify and recommend a generation investment strategy that most effectively achieves emissions reduction at least cost.
4. What to turn in (by e-mail):
- a. A summary of all data you used and the corresponding data sources
 - b. A copy of your spreadsheet calculator
 - c. A plot of annual load from 2010 to 2050, a summary of your recommended generation investment strategy in terms of what to invest in and when, total cost and emissions, and a comparison/contrasting of that strategy with the comments from the various individuals included at the top of this assignment.
 - d. You have now developed a generation expansion model, and you have completed your first generation expansion study ☺. Provide some brief comments on how your analysis should be improved; in developing this response, consider material on “study process” in the reports that read.