Physics 9 – February 12, 2008

- Return assignment #1, pass out #3.
- Power Plant visit: 3/13/08, 8:30AM.
- Co-gen: Brassord, 4/29/08, 10 AM.
- Energy headlines review.
- Thermal energy.

	gal/min	comment
Allar, Neal	1.875	?
Bookman, Adam	1.875	?
Bruno, Evan	1.875	?
King, Hayden		
Landman, Michael	1.849	
Lennox, Shane	1.71	
Nishimoto, Jeanne	1.03	
Platzbecker, Ryan	1.91	
Reinhardt, David	1	measured?
Rhone, Matthew	1.54	
Shashy, Stephen	1.89	
Slater, Robert	1.46	
Smith, Lisa	0.5	measured?
Sullivan, Claire	1.321	
average	1.53	

The Energy Challenge

Utilities Turn From Coal to Gas, Raising Risk of Price Increase

By MATTHEW L. WALD , NY Times, Feb5, 2008

WASHINGTON — Stymied in their plans to build coal-burning power plants, American utilities are turning to natural gas to meet expected growth in demand, risking a new upward spiral in the price of that fuel.

Utility executives say they have little choice. With opposition to coal plants rising across the country — including a statement by three investment banks Monday saying they are wary of financing new ones — the executives see plants fired by natural gas as the only kind that can be constructed quickly and can supply reliable power day and night.

But North American supplies of natural gas will be flat or declining in coming years, according to the Energy Information Administration. The United States already has high natural gas prices, a problem for homeowners and many industries, like chemical and fertilizer producers. Some experts fear a boom in gas demand for electricity generation will send prices even higher.

It has happened before: The price of natural gas tripled in the late 1990s and early in this decade, partly because so many companies built generators to use the fuel. In some places, the power plants became white elephants as higher gas prices made them too expensive to operate, compared with coal plants.

Now, with many coal plants being canceled and demand for electricity rising by 2 percent or so a year, the prospect is that utilities will be forced to build and use a new generation of gas-fired plants regardless of the operating cost — and consumers will bear the burden of higher electricity rates.

“Coal has been removed in many places as an option,” said Art Holland, a vice president of Pace Global Energy Services, a consulting firm in Washington that advises utilities. New nuclear plants are on the drawing board but will take at least a decade. Sun and wind power, though growing, remain a small part of the nation’s electricity mix, and they provide only intermittent power.

“We’re having by default to fall back on gas, as though we learned no lesson from the gas-fired boom,” Mr. Holland said.

Study Suggests That, Unlike in the '70s, Energy Lessons Will Last

By CLIFFORD KRAUSS, NY Times, February 5, 2008

The oil shocks of the 1970s produced a flurry of attention to alternative sources of energy, but it faded once prices dropped in the mid-1980s. Now, with oil prices again high and climate change moving up the list of public concerns, interest in alternative energy is once again at fever pitch.

Is history about to repeat itself?

Not likely, according to a leading energy consulting firm. In a report scheduled for release Tuesday, the firm, Cambridge Energy Research Associates, concludes that multiple factors will continue pushing the world toward greater use of alternative energy sources like sun and wind power, regardless of what happens to oil prices.

“The focus today on clean energy is not a bubble or passing phenomenon,” the report says. “Unconventional clean energy is now poised to cross the divide and move from the fringes of the energy sector to the mainstream.”

What makes today different from the 1970s is growing apprehension about global warming as a threat to political security and the environment, according to the report. That is pushing governments to demand, and subsidize, greater use of alternative energy.

Science, Published Online February 7, 2008, Reports

Land Clearing and the Biofuel Carbon Debt

Joseph Fargione, Jason Hill, David Tilman, Stephen Polasky, Peter Hawthorne

Increasing energy use, climate change, and carbon dioxide (CO2) emissions from fossil fuels make switching to low-carbon fuels a high priority. Biofuels are a potential low-carbon energy source, but whether biofuels offer carbon savings depends on how they are produced. Converting rainforests, peatlands, savannas, or grasslands to produce food-based biofuels in Brazil, Southeast Asia, and the United States creates a 'biofuel carbon debt' by releasing 17 to 420 times more CO2 than the annual greenhouse gas (GHG) reductions these biofuels provide by displacing fossil fuels. In contrast, biofuels made from waste biomass or from biomass grown on abandoned agricultural lands planted with perennials incur little or no carbon debt and offer immediate and sustained GHG advantages.

Science, Published Online February 7, 2008

Use of U.S. Croplands for Biofuels Increases Greenhouse Gases Through Emissions from Land Use Change

Timothy Searchinger, Ralph Heimlich, R. A. Houghton, Fengxia Dong, Amani Elobeid, Jacinto Fabiosa, Simla Tokgoz, Dermot Hayes, Tun-Hsiang Yu

Most prior studies have found that substituting biofuels for gasoline will reduce greenhouse gases because biofuels sequester carbon through the growth of the feedstock. These analyses have failed to count the carbon emissions that occur as farmers worldwide respond to higher prices and convert forest and grassland to new cropland to replace the grain (or cropland) diverted to biofuels. Using a worldwide agricultural model to estimate emissions from land use change, we found that corn-based ethanol, instead of producing a 20% savings, nearly doubles greenhouse emissions over 30 years and increases greenhouse gases for 167 years. Biofuels from switchgrass, if grown on U.S. corn lands, increase emissions by 50%. This result raises concerns about large biofuel mandates and highlights the value of using waste products.

Biofuels Deemed a Greenhouse Threat

By ELISABETH ROSENTHAL, February 8, 2008, NY Times

Almost all biofuels used today cause more greenhouse gas emissions than conventional fuels if the full emissions costs of producing these “green” fuels are taken into account, two studies being published Thursday have concluded.

These studies for the first time take a detailed, comprehensive look at the emissions effects of the huge amount of natural land that is being converted to cropland globally to support biofuels development.

The destruction of natural ecosystems — whether rain forest in the tropics or grasslands in South America — not only releases greenhouse gases into the atmosphere when they are burned and plowed, but also deprives the planet of natural sponges to absorb carbon emissions. Cropland also absorbs far less carbon than the rain forests or even scrubland that it replaces.

Together the two studies offer sweeping conclusions: It does not matter if it is rain forest or scrubland that is cleared, the greenhouse gas contribution is significant. More important, they discovered that, taken globally, the production of almost all biofuels resulted, directly or indirectly, intentionally or not, in new lands being cleared, either for food or fuel.

“When you take this into account, most of the biofuel that people are using or planning to use would probably increase greenhouse gasses substantially,” said Timothy Searchinger, lead author of one of the studies and a researcher in environment and economics at Princeton University. “Previously there’s been an accounting error: land use change has been left out of prior analysis.”

The clearance of grassland releases 93 times the amount of greenhouse gas that would be saved by the fuel made annually on that land, said Joseph Fargione, lead author of the second paper, and a scientist at the Nature Conservancy. “So for the next 93 years you’re making climate change worse, just at the time when we need to be bringing down carbon emissions.”

The Intergovernment Panel on Climate Change has said that the world has to reverse the increase of greenhouse gas emissions by 2020 to avert disastrous environment consequences.

In the wake of the new studies, a group of 10 of the United States’s most eminent ecologists and environmental biologists today sent a letter to President Bush and the speaker of the House, Nancy Pelosi, urging a reform of biofuels policies. “We write to call your attention to recent research indicating that many anticipated biofuels will actually exacerbate global warming,” the letter said.

February 10, 2008

NY Times Editorial

Clean Power or Dirty Coal?

Opposition to new coal-fired power plants built without new technology — that is, without the capacity to capture greenhouse gas emissions — is rising on both Wall Street and Main Street. Citizen opposition has led companies to cancel some high-profile projects, including a proposed plant near the Florida Everglades. Pressure from environmental organizations has persuaded major banks to begin weighing the risks of global warming when deciding whether to finance new plants.

This is good news. Coal-fired power plants are big contributors to global warming. In the United States alone, they generate half the country’s electricity and nearly a third of its emissions. Meanwhile, scientists have left no doubt that the world has just a few years to make deep cuts in emissions or begin to suffer the worst consequences of rising temperatures. This means that scientists will have to figure out a way to capture carbon dioxide from coal plants, or coal will have to be replaced with cleaner fuels.

Given that task, the failure — by both the Bush administration and Congress — to encourage alternative sources of power is distressing. Bowing to veto threats from the White House, Congress stripped from an otherwise admirable energy bill two important provisions on alternative fuels.

One would have required states to generate an increasing share of their power from renewable sources like wind and solar energy. The other would have rolled back about $12 billion in wholly unnecessary tax breaks for the oil industry and used the proceeds to develop cleaner fuels and new energy technologies.

As we have said before, the surest and probably the only way to encourage meaningful and swift commercial development of cleaner fuels and energy sources is to put a stiff price on carbon emissions. That, in turn, would inspire — indeed require — industry to invest heavily in energy efficiency and low-carbon fuels.

But until Congress sets such a price, through a carbon tax or a cap-and-trade program — and it is a long way from doing so — every effort should be made to encourage the development of alternative energy sources. The first step is to extend the tax credits for alternative sources like wind and solar power.

Battle Pits Solar Energy Against Trees

- http://www.npr.org/templates/story/story.php?storyId=18905405

Thermal Energy

What is thermal energy? - Energy associated with the rapid random motions of atoms and molecules.

Disorderly, microscopic kinetic energy.

Temperature

- A number that tells us how hot something is. (Formally, the thermal energy/degree of freedom).
- When two objects are in thermal contact, heat will flow from the warmer object to the cooler.
- If two objects are in thermal contact and they have the same temperature, there will be no further net flow of heat.

Scales of Temperature

- Fahrenheit – the temperature scale used in the US with the boiling and freezing points of water defined to be 212 F and 32 F degrees respectively.
- Centigrade – the temperature scale used by most of the world with these points defined to be 100 C and 0 C respectively.
- Kelvin – absolute scale, important for science – 0 K is an absolute minimum temperature. T(Kelvin) = T(Centigrade) + 273.15

TABLE C.4. Values of various temperatures on the Fahrenheit, Celsius and Kelvin scales.

	°F	°C	°K
Absolute zero	−460	−273	0
Liquid helium	−452	−269	4.2
Liquid hydrogen	−423	−253	20
Liquid nitrogen	−320	−196	77
Liquid oxygen	−297	−183	90
Lowest recorded weather temperature	−125	−87	186
"Dry ice" (solid CO_2)	−110	−79	194
Mercury freezes	−38	−39	234
Water freezes	32	0	273
Room temperature	70	21	294
Body temperature	98.6	37	310
Highest recorded weather temperature	136	58	331
Water boils	212	100	373
Lead melts	621	327	600
Steam temperature in a nuclear power plant	660	350	620
Steam temperature in a fossil-fuel power plant	930	500	770
Uranium fuel rod (interior temperature)	4000	2200	2500
Light bulb filament	4600	2500	2800
Tungsten melts	6170	3410	3683
Sun—surface	10,000	5500	5800
Sun—interior	2.7×10^7	1.5×10^7	1.5×10^7
Deuterium-Tritium fusion (ignition temperature)	7×10^7	4×10^7	4×10^7
Deuterium-Deuterium fusion (ignition temperature)	7×10^8	4×10^8	4×10^8

Units of Thermal Energy

- 1 Calorie = amount of energy required to heat a Kg of water one degree Centigrade.
- 1 BTU = amount of energy required to heat a pound of water one degree Fahrenheit.

The difference between Heat and Thermal Energy

Thermal Energy refers to the energy that an object has.

Heat refers to energy that “flows”. It is in transit from one place to another.

How does heat flow?

Conduction – the flow of heat through something

e.g. – a tea spoon in coffee, a solar hot water heat exchanger, an iron skillet

Convection – the flow of heat due to the motion of a liquid or a gas

e.g. – ethylene glycol in your automobile radiator or as a transfer medium for a solar hot water heater.

Radiation – emission of electromagnetic waves (can be visible, can propagate through vacuum)

e.g. – energy from the sun, light from a light bulb

Relationship between heat transfer and temperature change

$$H = C\, m\, \Delta T$$

m = mass

H = heat

ΔT = change in temperature

C = heat capacity [units of Cal/(kg-^{0}C)]

a characteristic of a particular substance

What is C for water?

An Experiment: What is the specific heat of Brass?

Heat out of brass = heat into water

$$c_B \, m_B \, \Delta T_B = c_W \, m_W \, \Delta T_W$$

$$c_B = c_W \, m_W \, \Delta T_W \, / \, m_B \, \Delta T_B$$

Note: 1 cal/(g - ^{0}C) = 1 Cal/(kg - ^{0}C)

TABLE C.6. Specific heat capacities (at constant pressure) of various substances, near room temperature.

	cal/g-°C	J/kg-°C
Water	1.0	4184
Ice	0.5	2100
Aluminum	0.22	903
Iron	0.11	449
Copper	0.092	385
Lead	0.031	129
Gold	0.031	129
Brass	0.09	375
Brick	0.2	800
Cement	0.15	600
Rocks	0.2	800
Dirt (dry)	0.2	800
Wood	0.3-0.6	1200-2500
Glass	0.1-0.2	400-800
Bakelite	0.35	1400
Paper	0.3	1300
Gasoline	0.5	2100
Oxygen	0.22	918
Nitrogen	0.25	1040
Air (dry)	0.24	1000
Hydrogen	3.42	14175
Helium	1.24	5200