

ENVIR 202b Earth, Air Water**Winter 2003****Essay 1: assigned: Tues 1/14/03****draft by Thurs 1/23/03****final by Thurs 1/30/03**

The first of our three units, on Energy, has involved experiments on energy conversion (from one kind to another), concentration, transmission ('movement') including a simple engine and fuel cell. The science base includes understanding energy and power and the units describing them. In the essays you are encouraged to take a particular application of energy sources, transformation, or use and explore it, in the spirit of 'problem solving'. This is somewhat experimental, to see if the combination of lab experience, reading and literature searching will give you the ability to begin to address real problems. We know that this is early in the term, so you may not find the assignment clear or 'do-able'; if so just come and talk with us. There are lots of variants possible and lots of help available.

Length of essays: about 5 pages (with 1 ½ line spacing at font size 12), plus figures with captions.

Assignments: The idea is to take *either of your 1st two lab experiments in the Energy unit* experiment and use it as motivation for an energy essay. Suggestions are given below: keep to their general theme in each case, but you may develop some aspect of the problem that is not specifically described.

E1 Suns and Rainbows

Electric lighting is a major part of our personal environment. Using library and web resources, and from your observations in the lab, discuss the spectrum (color make-up) of several artificial light sources, for example fluorescent lights, incandescent (ordinary) light bulbs, sodium streetlights, halogen car headlights. In choosing lighting there are many issues: efficiency (how much 'waste' heat is produced compared to the useful visible light), cost to produce them, toxicity of components, possible damage to vision, subtle relationships with human health (winter in Seattle brings depression to some). There are even aesthetic questions about lighting worth thinking about. Develop some or all of these issues in your essay, aiming at a critical comparison of the value and environmental and health impacts of the lighting chosen. What new technologies are likely to change electric lighting in the future?

http://www.ge.com/en/commitment/ehs/technology/ehs_tech_lighting.htm

http://www.eren.doe.gov/buildings/purchs_lighting.html

<http://americanhistory.si.edu/lighting/energy1.htm>

E2 Lenses and Mirrors

Solar power is an alternative energy source of potentially great value. We have said that a key to its use is concentrating it focus its energy on a small area. Find out how modern solar power installations use concentrating devices (lenses, mirrors) and compare two particular schemes: first solar electric generation using photovoltaic solar panels and second, concentration of sunlight to produce heat, which is then used to generate electricity. At a more homely level, solar box cookers capture sunlight to cook food. Describe methods of concentrating sunlight for this application, including its cost versus its benefit. You may want to concentrate on a particular method, like the ‘Fresnel’ lens or mirror which is an unusual way to design a lens or reflector (www.solarcooking.org).

E3 A Model River

Hydropower is (together with burning biomass) the largest renewable energy source at present. In China the ‘Three Gorges’ project is to be one of the largest hydropower dam constructions ever carried out (their biggest construction project since the Great Wall). It involves flooding lands on the Yangtze River and displacing many people. Research the state of this project, and put it into the context of China’s energy and fresh-water supplies. The lab experiment has introduced you to the energy content of moving water, and is sort of hydropower in reverse. Provide some basic information about the flow of rivers, the power that can be extracted from them, and the negative side-effects of hydropower. Use this specific project and region for most of your discussion (we know that the salmon are suffering in Washington from damming of the rivers, but address such problems in the China case). To make best use of the ‘science core’ do some research into the kinds of geography and climate that make hydropower possible. It can’t be done everywhere: what makes the Three Gorges an effective hydropower site? Try to be as quantitative as possible, including geographical map information.

<http://www.cnn.com/SPECIALS/1999/china.50/asian.superpower/three.gorges>

E4 The Heat Engine

The *Stirling engine* in the lab works by heating air when it’s pressure is high and cooling it when the pressure is low (see 2d set of notes on energy experiments). It can have very high efficiency, yet is not widely used in practice. Yet, like photovoltaic solar cells, there may be some applications where it is especially suitable. Research this to find out what the efficiency of practical Stirling engines can be, and what factors have determined that it is not widely used: should it be? Note that many engines (like the internal combustion engine) have similarities, in heating a gas and then letting it expand to do work. Try to review the ‘pv diagram’ description of some of these engines.

<http://www.bekkoame.ne.jp/~khirata/english/others.htm>

E5 My Candle Burns at Both Ends...

Fossil fuel helped make possible the prosperity of the last century. Yet its byproduct of carbon (soot and carbon dioxide) is causing problems to the environment. One answer is to go toward fuels with fewer carbon atoms per hydrogen atom, like natural gas. Methane (CH₄) is an idealized version of natural gas. Consider the problem of distributing *natural gas* (in tanks, pipelines), first of all outlining how it is done (and at what rates), then researching the problems, costs, dangers and benefits. A few years ago a natural gas pipeline leaked in the town of Everett, north of Seattle, and killed some children when it exploded. In this situation try to figure out where the leaking gas would go based on its properties. You should introduce the essay with some basics of energy content of natural gas, comparing with other fossil fuels, and the sources and the quantity of 'proven reserves' in the ground. If possible make a schematic map of the natural gas distribution system.

<http://www.oilcrisis.com/gas/primer/>

E6 Conduction and Convection

Transmission of energy is carried out many ways, and this lab illustrates the conduction and convection of heat... which produce very different energy flow. For your essay, consider how animals of various sizes use heat conduction and convection to do 'natural ventilation': that is, to control their body temperature. Air and water act differently for 'great' and small creatures: the fluids act very viscous for the small ones. In this case 'convection' or movement of heat by the flowing fluid, may be hard to achieve. Does this affect the way a very small animal like a zooplankton or a mosquito works? Not only heat but dissolved gases like oxygen and nutrients like glucose are carried by the respiratory and arterial (blood-flow) systems of the body: the same issues arise, where conduction ('diffusion') of these chemical substances occurs with the aid of 'convection' (fluid flow).

<http://nzoomwebchallenge.co.nz/westlake/>

book: Life in Moving Fluids, S. Vogel, Princeton Univ Press, 1994.

E7 Solar Pond

Solar ponds have been built in Israel and India. Research these projects, and try to decide why there have not been more such energy collectors built. How much energy can they produce in practice, and what is an estimate of their construction and running costs? Describe the climate needed for a successful solar pond in as much detail as you can. What regions of the US would be most suitable for this technology?

<http://www.soilwater.com.au/solar/>

E8 Your Next Car? The Fuel Cell

We read that the ‘hydrogen economy’ is coming. What does this mean and why is it desirable. If hydrogen is used to power automobiles research the problem of producing the hydrogen; at first sight it seems that we have the same old problem of burning fossil fuel to produce hydrogen fuel. What measures can be taken to make this a winning situation?

<http://www.eren.doe.gov/hydrogen/basics.html>

E10 The World’s Simplest Electric Motor

Review the basic ideas behind simple electric motors and then use web and literature resources to learn how electric motors are used to ventilate large buildings. As part of the review consider that electric motors use up about 64% of the electricity produced in the US (<http://www.psnh.com/Business/SmallBusiness/Motor.asp>): a significant fraction of our total electricity supply. Find out the statistics on this, and the typical efficiency of motors (large and small) in a variety of applications, and what new technologies may improve them. [Ships are now often driven by electric motors, with fuel oil used to generate electricity: why is this done, instead of simply driving the propeller with a diesel oil-driven engine?]

The particular aim is to assess the energy cost of ventilating buildings and consider how ‘green buildings’ can improve upon this (imagine that you are an architect-apprentice). You may want to include ideas that reduce the need for ventilation in the first place.

<http://www.scitoys.com/scitoys/scitoys/electro/electro.html>

http://www.edcmag.com/edc/cda/articleinformation/features/bnp_features_item/0,4120,70793,00.html