ENERGY CONSIDERATIONS

Energy is the life blood of the economy. Those nations who have the highest energy consumptions have the highest gross national products. ***Our national goal should be to have more and cheaper energy available***. ***Our secondary goal should be to be self-sufficient and not have to buy energy from the rest of the world. It seems criminal that we have to send $400,000,000,000 per year to the rest of the world to buy oil, when we could simply allow drilling here at home. Imagine what $400 billion dollars spent in this country each year could do for the American people***.

We should not subsidize one form of energy over another, but let the market place decide the most economical and available energy. Anything else is counter-productive, wasteful, and down-right foolish.

It is energy that allows us to drive our cars, trucks, buses, trains, and fly airplanes. Energy allows us to run machinery, to heat furnaces to separate metals from ores and make alloys, such as steel. It is energy that allows us to heat our homes and to cool them in the summer. It is energy that allows us to turn on lights, to deliver goods, to refrigerate our foods, to farm our lands, and to dispose of wastes. The following is a breakdown of our energy use (2004):

Industrial--------- 33%
Transportation---28%
Commercial------17%
Residential -------21%
Other----------------1%

The World's energy sources in 2004 were:

	10^{15} BTU	or	10^{12} KWH
Oil	40		11.7
Gas	23		6.7
Coal	23		6.7
Hydroelectric	2.7		0.8
Nuclear	8		2.3
Geothermal, Wind, Solar, Wood	3.3		1.0
Total	100.0		29.2

The reason energy is included in the table as BTU's (British Thermal Units) and as KWH (Kilowatt Hours) is that some of the energy is used for furnaces and engines (BTU's) and some for generation of electricity (KWH's).

Some 4.28 trillion kilowatt hours of electricity were generated in the United States in the year 2007.

You can see that oil, coal, and gas comprise 86% of our fuel usage and these fuels obtain the majority of their energy by the combustion of carbon, resulting in CO_2 emissions. The only relatively emission-free energies are hydroelectric, nuclear, wind, and solar.

Electricity Generation

Electricity is generated in the United States at16, 883 "plants" by 15 different methods, such as wind, solar power, hydroelectric, coal and natural gas-fired turbines, Diesel generators, etc.

	% Electricity Generated
Coal fired boilers	49.1
Nuclear	19.4
Combined-cycle natural gas	12.4
Hydroelectric	7.0
Natural gas-fueled boilers	3.9
Biomass	1.3
Petroleum Coke Fueled Boilers	1.1
All others	5.8

Wind power is only 0.7% and **solar** power is 0.1% of US electrical generation. There are 341wind power sites and 31 solar generation sites in the US. The majority of wind power sites, 267, generate 50 MW or less. Only 3 are above 250 MW. Some 29 solar energy sites are below 50 MW and only two are in the 50-100 MW size range. Nuclear power stations range from 500-1250 MW in size.

While each of the types of electrical generation has its own unique problems, nuclear power is probably the best from a cost, size, and emission point of view for future facilities. A 1000MW plant operating for a full year will generate 8.76 million MWH of electricity or 8.76 billion KWH of electricity. To convert all electricity to 1000MW nuclear plants in this country would require building 342 new nuclear plants or one plant every month for 28.5 years (not counting the added growth in electricity usage). To convert our electrical power needs to 100MW solar facilities would require over 6,840 plants be built (based on the largest existing solar plants in existence). This assumes they all operate with the sun shining all day long (no clouds).

Conclusion: Obviously, we are going to have to live with carbon fuels for many years!

Costs per KWH

The average cost of residential electricity in US in March 2006 was 9.86 cents per KWH. In various states, the average costs ranged from 5.81cents in Tennessee to 16.63 cents per KWH in Hawaii. Comparing various sources of energy in Europe:

Source	Cost per KWh (euro cents)
Nuclear	0.4
Hydroelectric	0.4
Coal	4.1-7.3
Natural gas	1.3-2.3
Wind	0.1-0.2*

Cost projections in USA per KWH in 2010 are: nuclear=2.01cents, Coal=2.71 cents and natural gas=4.67 cents.

The true cost of wind power in the USA is not anywhere near that shown above for Europe. Initial costs were ~ 30 cents per KWH, but ***with governmental production subsidies***. With the newer 3.6 MW generators, the costs ***may*** be as low as 5 cents per KWH, ***if you believe the hype***.

True costs are complicated by US subsidies, the need for power lines from wind farms to residential users, the cost of the rental of lands, the replacement costs of windmills, etc. A small amount of electricity is produced by wind turbines, particularly due to their inherently low capacity factors. ***If all the thousands of windmills in the US, as of the end of 2002, operated with a typical 25% capacity factor, they would produce less electricity (10,260,150,000 kilowatt-hours) than two 750-megawatt (MW) gas-fired combined-cycle generating plants operating with a typical 80% capacity factor (10,512,000,000).***

The windmills are scattered over thousands of acres in 27 states (90% in CA, TX, IA, MN, WA and OR), while the two gas-fired plants would take up only a few acres. Also, gas-fired plants are available when needed, not just when the wind blows. An excellent report for those interested is found at: www.**mnforsustain.org**/windpower_schleede_**costs_of**_electricity.html

Energy Resources

No one really knows how much coal, oil, and natural gas exists on the Earth, however, today's best estimates are:

Coal-----------4000 BT of carbon
Oil---------------500 BT of carbon
Natural gas---- 500 BT of carbon

The world today burns 6.3 billion tons (BT) of carbon every year. Thus, there is at least an 800-year's supply and time for technology to solve the energy problems of our civilization. Our best hope may be nuclear fusion (the way the sun makes energy), and the fuel source is hydrogen, deuterium (a hydrogen isotope available from water), or helium. (See next section.)

The sun pours down more solar energy on the Earth in 1.5 hours than man uses in a year. The problem is that the energy is scattered over such a large area. The solar radiation that hits the Earth's surfaces each day averages168W/meter^2 or 15.6W per square foot per day. If you had 12 hours of daylight, that averages 1.3W per square foot per hour. The best solar cells are ~18% efficient, meaning you will get less than 0.25 Watt per square foot per hour. You can't run an air conditioner on that! If, however, you could cover the Sahara Desert with an efficient solar cell film, you might be able to make it more economical.

Fusion Power--^{3}He Isotope

Recent articles have been written on the ^{3}He isotope for future power generation. A kilogram (kg) of ^{3}He burned with 0.67 kilogram of deuterium (^{2}H) will generate about 19 Megawatt-years of energy output in an inherently safe reactor. A typical 1000 MW nuclear reactor will generate about 52.6 times that in a year.

There are two major problems. One is the supply of ^{3}He. As a by-product of the maintenance of nuclear weapons, a supply of 15kg per year could be made available. The moon, based on a paper by Kulcinski in 1988, holds over 1,000,000 metric tons of ^{3}He deposited in its regolith (sandy surface) by the solar winds. About 25 metric tons would power US for 1 year. (Internet reference---"The Artemis Project: Lunar Helium 3 as an Energy Source"). To extract it from the moon would require heating the regolith to about 1100F. Even at the cost of 3 billion dollar per metric ton, world-wide power could be supplied by 100 metric tons per year, and an income of $300 billion dollars could accrue. Russia, reportedly, plans to mine ^{3}He on the moon by the year 2020 and the British are also highly interested in it.

The second problem is how to extract this energy. It will require a ***fusion-type*** reactor. ***After many years, we have still not learned how to contain a fusion reaction.*** The first plant will cost a minimum of $6 billion. It may take years of development and may not be successful. It is a long shot! (Reference—Internet, Wikipedia, “Helium-3”)!

Conclusion: The ultimate solution to the energy crisis lies not in restricting carbon dioxide emissions, but in long-term technology development. None of us is willing to give up our furnaces, air conditioners, cars, refrigerators, airplane flights, manufactured goods, etc. Solutions will not come from Environmentalists or Politicians, but from the Scientists and Engineers.

Automotive Power

Fuel used in transportation is high in carbon content, because of its high thermal efficiency per pound of fuel. Diesel engines convert 50% of the energy burned into propelling the vehicle, whereas, the Carnot cycle used in the gas engine results in only a 27% maximum efficiency. When you consider that the average 160# person may use a 3000# car to take him to work, on vacation, or to the store, you see the “true payload” (the person) is only about 5% of the weight of the vehicle and person transported. Couple that with the 27% efficiency of the automobile engine, the loss due to friction of the engine, air, and road, the transmission conversion loss, and the energy lost to braking and acceleration, and you would be ***lucky*** to end up with a 1% efficiency in fuel usage. Can you imagine what it is in a heavy truck or SUV! We waste a tremendous amount of fuel for our automotive needs and desires. Our needs for gasoline are extensive. We used 141 billion gallons of gasoline in 2005 in this country last year.

Ethanol is certainly not the answer, for it has less energy than gasoline! The fuel economy drops 27% when using E85 (85% ethanol). Ethanol is subsidized by the government. Not only are subsidies given to farmers, but a 51¢ per gallon subsidy is given to blenders of ethanol and gasoline. Total subsidies run between $1.05 and $1.38 per gallon (paid by taxpayers). Some even claim there is a net energy loss in producing a gallon of ethanol; others dispute it. (Internet—Ecobrowser: Ethanol subsidies.) The economic values of the resources that are used to produce a gallon of ethanol are nearly 50% greater than the value of the product to the consumer. Add to that the devastating effect that raising corn for ethanol has had on food prices and the Mid-West water supplies and one concludes that ethanol production is an expensive miscalculation. As a result of the "Laws of Unintended Consequences", there is now a water crisis in these farm states, and the prices of corn, beef, milk, etc. continue to rise. Further, no one considers how badly we are depleting our soil or what the true net efficiency of making ethanol really is.

Biofuels are not new, nor the answer to replace gasoline. Rudolph Diesel, in 1900, powered his cars using peanut oil and expected future cars would all run on vegetable oil. (Recently, palm oil was blended with jet fuel and used on a commercial flight on Virgin Airlines.)

While the auto industry is comparing many alternatives (fuel cells, hydrogen, hybrids, etc.), the most likely solution in my mind is to have electric-powered hybrids that can be plugged in at home to recharge batteries each night. Because utilities can generate electricity so much cheaper, electrical power can compete with gasoline (eliminating the refining, distribution, and poor conversion efficiency of gasoline engines). An electric vehicle with an energy efficiency of 3 mi/KWH will cost 3cents per mile when electricity is 9 cents/KWH. You could travel 33+ miles for $1.00 versus paying $3.00 per gallon for gasoline for a compact car which gets 33 miles per gallon.