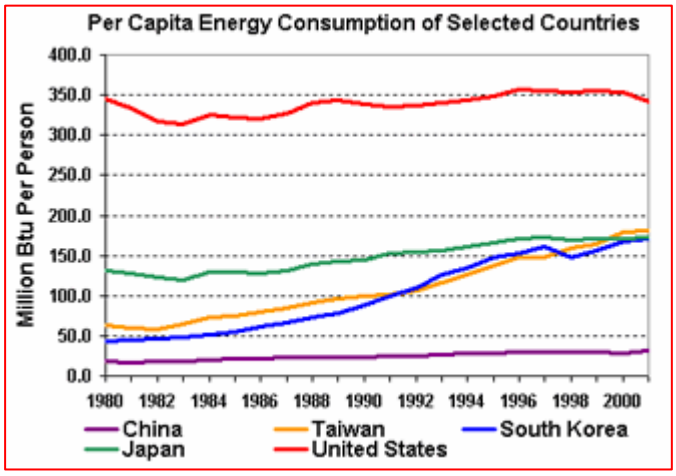
POLICY: Energy

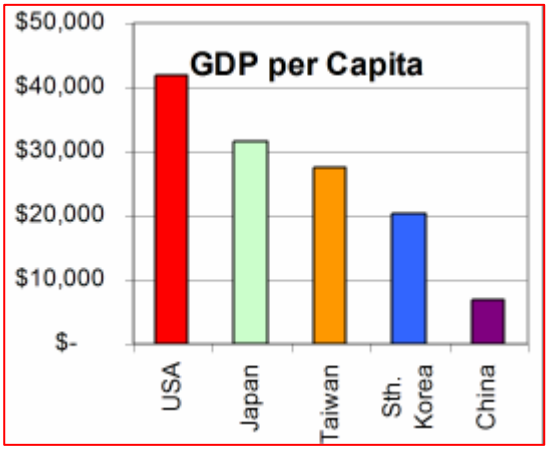
The energy slogan of the year is about curing "America's addiction to ***oil***". In the next breath there is always mention of what new form the addiction will take; akin to curing heroin addiction with opium. Just as China's economic "miracle" is yet to factor in apocalyptic ***environmental devastation*** wrought by China's industrial "miracle", so too much of US legendary ***productivity*** has rested on the salad days of wastefully-used under-priced energy. The "energy" issue is really two-fold – ***energy security***, and the ***environmental degradation*** associated with pursuit of that security. There is no single answer to energy security or to associated environmental issues; the real world offers a mix of compromises. Getting this mix right with a wise balance of ***short-term need*** and ***long-term results*** is the challenge for policy-makers.



The US consumes about ***one-quarter of all world energy***, about 100 quads (quadrillion BTU) of about 450 quad world total. Almost two-thirds of world energy consumption is by six industrial powers: **US** 23%, **China** 13%, **Russia** 7%, **Japan** 5%, **Germany** 3%, **India** 3%. Until recent years, the US used about one-third of world energy but with the breakneck industrialization of **China**, the **US** relative share has dropped. From all views, the **US** is a profligate energy user. Its energy consumption per capita is over twice that of industrialized nations such as **Japan**. Certainly the **US** is a power-house economy but ***per capita energy consumption*** is not proportionate to the ***GDP per capita*** of other productive nations. The US is simply wasteful or inefficient in its energy use and to date any attempt to make significant impact on this profligacy has been seen as tantamount to unpatriotic. However, the aggregate usage figures over time show that although the US is hooked on high energy use the addiction is not getting significantly worse (or better).

Greenhouse Gases (**GHG**)

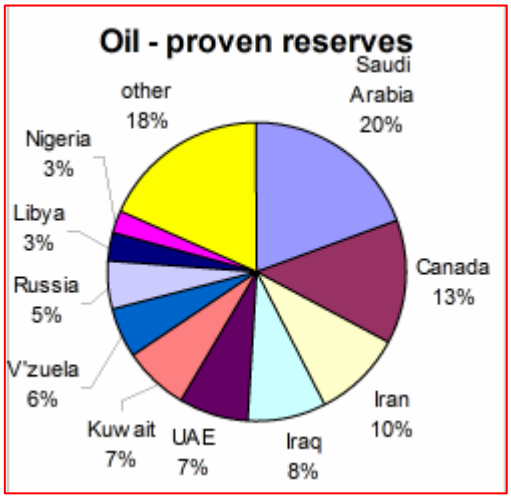
A key GHG goal of the Administration's 2002 ***Global Climate Change Initiative*** is to reduce US ***GHG intensity*** by 18% over the decade 2002 to 2012. *GHG intensity* is the ratio of GHG emissions to GDP. Thus, if the goal is met but GDP grows by 18% or more during the decade (which it will), the absolute quantity of GHG will still increase but at a rate less than GDP. DoE forecasts that, on its present assumptions, the GHG Intensity will be around 17%, slightly under target, and well under actual GDP growth of 30% to 40% over the decade.



US Energy Use

The sources of US energy are ***oil*** 40%, ***gas*** 23%, ***coal*** 23%, ***nuclear*** 8%, ***sustainable sources*** 6%. There are two distinct sub-plots in this. Almost 70% of ***oil*** is used (as ***gasoline*** and ***diesel***) for ***transportation*** and over 60% of all oil is ***imported***. Over 90% of ***coal***, over 1 billion tonne each year, is used for ***generation of electricity*** and at present all of this is mined in the US. These two – ***coal***

and ***oil***, both ***fossil fuels*** – are the superstars. If oil stops, the US stops moving; if coal stops, electricity stops and with it industry, commerce, PlayStations, Starbucks and chunks of the internet.



Electricity (generated from ***coal*** 50% ***gas*** 19%, ***nuclear*** 19%, ***hydro*** and other ***sustainable*** 9%) is used almost equally across sectors: ***residential*** (36%), ***commercial*** (33%), ***industrial*** (27%). A breakdown of residential consumption is instructive in figuring future trends: ***air-conditioning*** 16%, ***lighting*** 9% , ***water heating*** 9%, and a multitude of "other appliances" using 42% of total comprise *must-haves* such as ***clothes dryers*** 6%, ***color-TVs*** 3%, ***personal computers*** 1.5%. When some say a lump of coal is used each time an order is made on *Amazon*, they are exaggerating but are making an important point – 10% reduction in electricity use means 10% less generating fuels used, more than all contribution at present from "green" electricity. The projections for total US electricity sales in 2030 range from 4,828 million GWh to 5,854 million GWh. Slowing growth in electricity demand relative to GDP growth – due to greater efficiency in devices, better building insulation standards, and market saturation in white-goods – is expected to keep electricity prices at around 7.1 to 7.6 cents per kWh. All forecasts show an increase in ***coal*** consumption over future decades and that the US for the first time will become an <u>importer</u> of coal.

Gasoline (and **diesel**) are the lifeblood of the American road and the most politically-sensitive of all energy issues. About 40% of all US energy use is in the form of gasoline and diesel from largely imported oil. A naïve analysis of sources of world oil would conclude that the US would have (or would foster) good relations with **Canada**, **Iran**, **Iraq**, **UAE**, **Kuwait**, **Venezuela**, **Russia**, **Libya**, **Nigeria**. With the exception perhaps of **Canada**, US relations with all of these countries is either strained or problematic. In all forecasts, US domestic ***crude oil*** production declines in coming decades and import dependence increases. Prices are volatile, affected by world events and by policies of petroleum exporting countries. Retail prices can change rapidly by as much as 20% , unlike any other commodity. Fuel prices do <u>not</u> have a strong correlation with vehicle use but increases are felt in other parts of economy -- and by low-wage earners -- as cash is diverted from discretionary expenditure to gasoline. As most oil is imported, higher oil prices also add unfavorably to the international terms of trade. Despite gasoline prices being a raw electoral nerve, analysts claim that the US is no longer as vulnerable to "***oil shocks***" as it was in the 1970s, because the element of surprise is now lost and that much of the economic damage of the period was due to ***monetary policy***, not oil prices alone. Forecasts for crude oil prices in 2030 range between $28 per barrel and $96 per barrel (in 2004 dollars), showing that all that is certain is ***uncertainty***. This is one motivation for the current attention to "America's addiction to oil".

Irrespective of the resource used to produce energy, energy solutions generally are concerned with either of the two national energy systems***: reticulated energy*** (grid ***electricity*** and reticulated ***gas***) for industrial and domestic use and ***portable energy*** (***gasoline***, ***diesel***, tanked ***natural gas***). In each case, the energy issue is concerned with reducing **GHG**, and/or achieving greater output per unit input (efficiency), and/or blunting demand through frugality or better buildings and cars. Both of these energy systems are supported by ***infrastructures*** which need modification to accept new energy sources or new energy regimes.

Alternatives

Greener Electricity

Electricity generation by coal powered steam turbine is still the dominant method for electricity generation, as it was 100 years ago. The technology is mature and coal is relatively plentiful; however the US will start importing coal for the first time in coming years and CO_2 emissions from coal-fired power stations are the core of the **GHG** issue. Several broad-brush solutions to the electricity-CO_2 nexus have been on the table for some time: ***CO_2 sequestration*** (removal of CO_2 from coal-fired emissions); increasing use of "clean, green" ***alternative power generation*** (*wind* power, *solar* power,…); and increase in the use of *nuclear*-fired generation, which has no CO_2 emissions.

CO_2 Sequestration

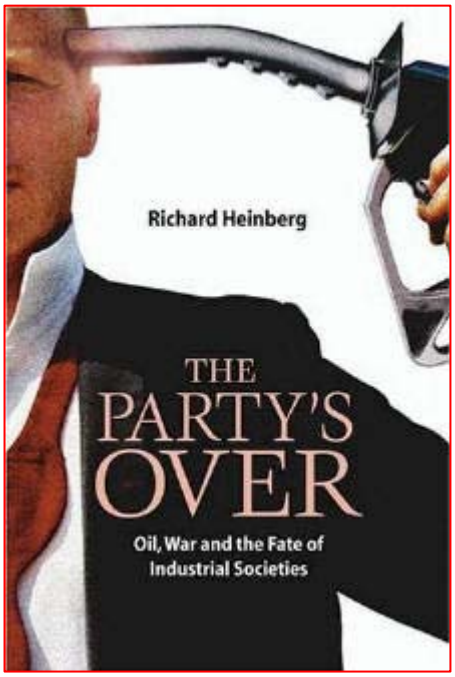
If CO_2 could be removed from coal-fired emissions, the energy-**GHG** nexus is broken in one step. Current ideas for this CO_2 capture – *carbon sequestration* – involves capturing the 3% to 12% CO_2 of smokestack gases, compressing the gas to liquid for transport and then sequestering it in some place where it will remain indefinitely. This seems like sweeping detritus under the rug because it is. Where to "hide" it is the issue – deep cold oceans where it will remain solid because of the high pressure, or in exhausted aquifers, coal mines or oil wells are the main suggestions. Norway has for some years been pumping one million tonne of liquefied CO_2 each year into depleted natural gas domes under the *North Sea*. An advantage of this or other emission capture processes is that SO_2 (*sulphur dioxide*, the cause of *acid rain*), *mercury* and other undesirable emissions apart from **GHG** CO_2 can also be removed. Sequestration, whatever the details and possible ecological hazards, will add cost to electricity generation. One way costs might be ameliorated is to sequester the CO_2 into *aging oil reserves* to increase the ***pressure*** and hence the yield. One elegant advance on this method is to capture the CO_2 before it gets to the smokestack. Following successful demonstrations in **Algeria** and **Norway**. **BP** and partners are building a 350MW power station in **Scotland** using this "decarbonised fuel"; *natural gas* is first "split" into ***hydrogen*** and CO_2. The hydrogen provides clean fuel for power generation and the CO_2 is piped directly for sequestration in *North Sea* oil reservoirs.

Electricity Consumption (kWh)		
1	**World**	**15,450,000,000,000**
2	United States	3,656,000,000,000
3	European Union	2,711,000,000,000
4	China	2,170,000,000,000
5	Japan	946,300,000,000
6	Russia	811,500,000,000
7	Canada	520,900,000,000
8	India	519,000,000,000
9	Germany	510,400,000,000
10	France	433,300,000,000
11	Brazil	359,600,000,000
12	United Kingdom	346,100,000,000
13	Korea, South	321,100,000,000
14	Italy	302,200,000,000
15	Spain	231,200,000,000
16	Australia	221,000,000,000
17	Taiwan	206,100,000,000
18	South Africa	197,400,000,000
19	Mexico	193,900,000,000
20	Ukraine	176,000,000,000

Sustainable ("Alternative") Electricity

A range of technologies that 30 years ago were known as "alternative" are now referred to as ***renewable*** or ***sustainable***. DoE adds a realistic note to this loose terminology by referring to resources that are ***nondepletable on a time scale of interest to society and tend to have low and stable operating costs***. Significantly, the qualification of ***negligible environmental impact*** is absent from the definition and must be added. This is why the term *sustainable* captures the idea better than *renewable*. Felling trees for wood-burning energy production is use of a "renewable" resource (trees grow) but it is not a sustainable resource. Strictly speaking, even the "greenest" of energy sources has some impact and intensive use can have intensive impacts. Damming of rivers for hydropower, huge wind farms, large tidal power schemes all impact the environment to varying degrees, changing and killing rivers in extreme cases, changing coastline sand deposition, killing or disturbing wildlife and natural processes. The ***low-impact*** quality of

truly sustainable resource use should be kept in mind in a critical examination of current proposals.



Wind-power electricity generation has grown twenty-times worldwide from 3.5GW in 1994 to 59 GW by 2006; and is now an accepted mainstream, albeit small, contributor to electricity generation in suitable areas, often offshore where the wind is not impeded by landscape. It is attractive for future applications in areas such as the *Great Lakes*, close to large energy markets. Work recently done by the **National Renewable Energy Laboratory** says many early ***wind energy*** models using single turbines are automatically a "worst-case scenario" and give unduly gloomy results. Multiple units better model the real-world "lumpy" nature of wind in an area. Mature technologies will including blade adjustment including feathering for dangerously high winds, and automatic mounting and demounting.

Hydro-electric power is a mature base-load power generation technology; in countries with the appropriate natural resources it provides the majority of electricity; in Brazil 75% of electricity is hydro. Research continues on other hydro technologies such as ***instream*** tethered turbines which exploit the force of fast-flowing rivers without large capital works such as dams. Similarly, in suitable places fixed turbines can exploit the force of ***tidal*** flow. In future, immense installations larger than the biggest modern oil rigs may be installed off-shore in permanent ***ocean currents***. In all of these cases, the natural force of ***wind*** or ***water*** is harnessed in the uncontroversial tradition of the centuries-old use of wind-mills and water-mills. A high-technology variant of these methods, ***ocean-thermal*** generation, exploits permanent temperature difference at two different ocean depths. Although presently obscure, technologies such as this may in the long-term warrant immense capital investment in large mid-ocean works that will provide "permanent" and "free" electricity on a continental scale.

Geothermal energy exploits the heat of the Earth's molten core. The quantity of energy available at the surface is estimated at over 40 Terawatt (million GW), around ten times the total electricity generation everywhere, but only about 9GW are used for electric generation and 16GW for direct heating (***hydrothermal***) mainly in **Iceland**, **New Zealand** and about 20 other countries. Geothermal could be of use in **Alaska** where it is not presently used. Although the earth's prodigious heat source is for practical purposes inexhaustible it is easily accessible only in places which, by definition, are geologically unstable and for that reason is often distant from high population areas. In future it may be possible to "package" geothermal energy into some ***portable*** energy-intensive form such as ***liquefied hydrogen*** but no demonstrations of this have yet been completed.

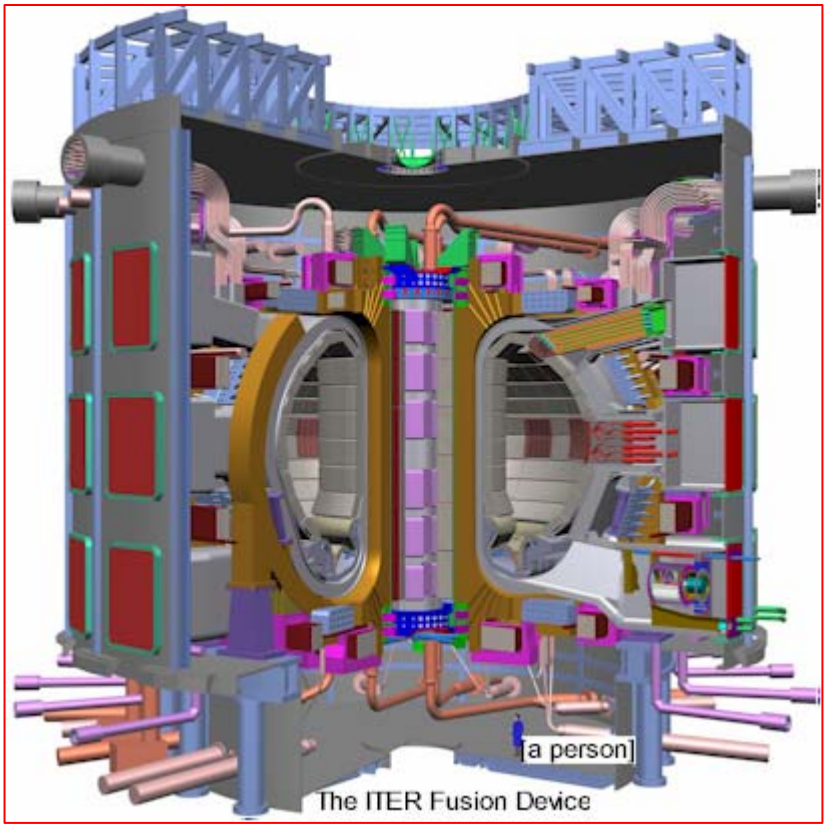
Solar-Power -- the costs of ***photo-voltaic*** (**PV**) cells **which convert sunlight directly to electricity** has dropped over the last 30 years from about $30 per Watt in 1970 to under $3 per Watt now and PVs are expected to continue dropping with research and economies of scale in manufacture. There is already over **2.5GW** generated by PVs worldwide, led by **Japan** where PV partly serves 160,000 homes. **Germany**, **Israel**, **Spain**, **Portugal** – and the **US** and **Australia** – are also investing in commercial-scale PV. Spain will bring 354MW more online within a year. Solar PV technology is solid-state (durable with no intrinsic moving parts) and, once installed, produces "free" electricity while the sun shines. It is ideal, for instance, when integrated into a larger grid as it performs at peak at precisely the time air-conditioning demand in hot sunny weather puts grid-crashing loads on the system. PV is likely to develop as both commercial-scale generators and as an energy augmentation measure at a household level. Almost certainly the "***zero-energy house***" idea will gather increasing interest and will prompt developments such as optional ***roof cladding*** sections integrating PV cells; rather than an additional structure covering an existing roof, the PV panel will be the roof itself which will reduce the nett cost. Isolated domestic PV is problematic

because of the cost of storage in some type of accumulator such as lead acid battery banks adds appreciably to cost, complexity, footprint, and maintenance. With the appropriate ***grid operating framework***, any domestic PV installation with the right black boxes can sell energy to the grid when it is not needed and draw from the grid when needed. The grid works like a ***virtual accumulator***. **Solar-thermal** is a related clean, green approach which uses focussed solar energy to drive conventional steam turbine power generation. Climate, capital cost, demand patterns and other issues determine whether solar-PV or solar-thermal is indicated in any particular case. A primitive yet highly effective use of solar heating is ***solar water heating*** which has been in use over several decades and continues to improve in efficiency. It is one of the most elegant of energy subsystems; water is heated directly by the sun with no intermediate processes, avoiding the very wasteful use of electricity to heat water.

All of these technologies have an optimum context. They are not a list from which one technology will eventually emerge as triumphant – ***all*** of these are part of the answer. The fact that the answer is complex – rather than simplistic – is one of the major indicators that will be needed in energy ***infrastructures***. **DoE** calculates current consumption from ***renewable*** energy sources in the US at around 6.1 quads, around 6% of total consumption, but along with the contributions of ***hydropower*** (45%), ***waste*** (9%), and ***wind*** and "*other*" (15%), is listed a 31% contribution from ***wood***. In most contexts, wood is <u>not</u> regarded a "renewable" fuel source. There will be many debates over what "renewable" should mean in coming years which is why "sustainable" predisposes a better perspective taking account of ***all inputs and all outputs***.

Nuclear

Since commissioning of the first commercial nuclear power station at Calder Hall (Sellafield, UK) in August 1956, nuclear (fission) power has had mixed fortunes and a mixed press. The "*nuclear debate*" has been given new life now because nuclear electricity generation offers savings in **GHG** emissions over coal-burning and other combustion power stations and some argue that *nuclear* is a valid clean, green alternative – it emits nothing (with luck) and waste can be safely handled using ***synroc*** storage technology (created in 1978 in Australia). Others argue it is the least green alternative conceivable because of radiation risks before, during and after use, and vulnerability to terrorist attack. The unique property that some nuclear power technologies can be produce ***weapons-grade*** materials puts nuclear in a separate category. Current dependence on nuclear varies significantly among countries -- **France** (79%), **Germany** (28%), **Japan** (28%), **UK** (20%), **US** (20%). Some countries such as **Sweden** are actively downscaling their dependence on nuclear generation, but during 2006 several countries announced their intention to implement or expand nuclear power – **Indonesia**, **Egypt**, **Belarus**, **Argentina**, **Nigeria**, **Iran**. There is now an array of "fourth generation" nuclear fission reactor



The ITER Fusion Device

designs addressing safety and cost issues, including the *Pebble Bed Modular Reactor* (**PBMR** - a **South African** initiative), the *Gas-Turbine Modular Helium* reactor (**GT-MH** – a **Russian** initiative partly aimed at consuming decommissioned weapons ***plutonium***) and the *International Reactor Innovative and Secure* project (**IRIS** - a multi-nation consortium formed by **Westinghouse**). Also, in September 2006, DoE granted $8M for research into engineering "pre-conceptual design", a full rethink of future nuclear plant design. Nuclear has a continued attraction as it offers small, self-contained power generation units that can be brought online and offline relatively quickly, ideal for cycling to meet daily peaks. Although safe nuclear-generated electricity may be more expensive than coal-fired stations, this ability to support peak demand – obviating the need to build more coal-fired capacity – is still attractive.

Nuclear Fusion

The ITER project (*International Thermonuclear Experimental Reactor*) comprising the **EU**'s EURATOM, **Japan**, **China**, **India**, **South Korea**, **Russia**, **USA** aims to demonstrate the scientific and technical feasibility of fusion power at the ITER device in Cadarache [**France**]. Fusion, if feasible in this application (a controlled hydrogen bomb), will provide benign and abundant electricity on a transcontinental scale. Nuclear ***fusion*** must be confused in no way with the ***fission reactors*** which have been in use since 1956.

Greener Portable Fuels

Oils Ain't Oils

"Oil" comes in many different forms and this accounts for the frequent contradictions in forecast of reserves. "Light sweet crude", low sulfur readily-refined oil has been the benchmark and most desired resource since the inception of the petroleum industry. This was the first class of oil to be exploited and it is now in shorter supply or has been exhausted in some places. The aggregate ***quality*** of crude oil is dropping. This coincides with the gradual tightening over decades in emission standards – of ***lead***, ***sulphur***, ***mercury*** – and both factors have put increasing obligations (and costs) on refiners Average ***sulphur*** content (the "sweet-sour" parameter) has increased from 0.9% to 1.4% over the last 20 years. Imported crudes are becoming ***heavier*** and more ***corrosive***. The anecdotal shortage of refining capacity in the US is due to this convergence of tighter output specification (often varying by state and season) and declining feedstock quality. Adaptation often requires capital-intensive upgrade, replacement or addition to refinery plant.

Synthetic Crude Oil (Syncrude)

Generous estimates of petroleum reserves still available generally include resources such as ***oil sands (bitumens)***, ***shale oil***, and ***extra heavy crude***. Much of **Canada**'s reserves are in the form of oil sands; Venezuela's estimated 1.36 trillion barrels petroleum deposits are largely ***Orinoco extra heavy crude***, a high-sulphur oil. As crude oil prices rise, known technologies will be applied to produce ***syncrude*** (synthetic crude oil) and traditional petroleum end-products from these resources. If crude oil prices remain above around $30 per barrel bitumens (oil sands) and extra-heavy crude will be economic to refine. The viability of ***shale oil*** is less certain. Shale oil is largely ***kerogen***, a "young" form of crude oil. It can be burned directly as a solid fuel in place of coal or can be processed into *syncrude* at the rate of about of 25 gallons (0.6 barrel) of *syncrude* per tonne of oil shale. There is an estimated 2.9 trillion barrels in *syncrude* in known shale oil deposits, about 750 billion barrels in the US – equivalent of about 100 years of current demand. Where's the catch? The processing cost of shale oil require a crude oil price of around $70 to $95 per barrel to be competitive. Also, a shale oil industry has apocalyptic environmental impacts. For each 1 million barrel per day of *syncrude* production, mining and remediation of 500 million tons of rock is needed each year, and 3 million barrels of ***water*** are required each day.

Non-crude Portable Fuels

Coal-to-Liquids (**CTL**) is a proven technology largely used in the **US** but is competitive only when

crude oil is above about $40 per barrel and the price for suitable quality coal is modest (about $1 to $2 per MBTU). The process is extremely dirty – there are challenges of waste disposal, water supply, and waste water disposal or recycling. CTL activity is sited in coal regions in the US mid-West and **DoE** forecasts the process will continue to be used, producing 1M to 2M barrel per day in 2030. **Gas-to-Liquids** (**GTL**) technology is more complex than oil refining; it converts natural gas into a range of petroleum fuels. The process is viable when the crude oil price is over about $25 per barrel and natural gas is in the range of $0.50 to $1.00 per MBTU.

Biomass-to-Liquids (BTL) originates from ***renewable*** sources, including ***wood waste***, ***straw*** and ***agricultural waste***, ***garbage***, and ***sewage sludge***. BTL fuels are several times more expensive to produce than gasoline or diesel with wholesale costs of around $3.35 per gallon now (a crude oil equivalent price of $80-$90 per barrel), but this is expected to drop to around $2.40 per gallon by 2020. There is no commercial BTL in the US but DOE commissioned some investigation from Bechtel in 1998. The world's first commercial BTL plant, with a capacity of 4,000 barrels per day. is scheduled to come on line in **Germany** around 2008, with others to follow. BTL front-end technology is new and evolving and has parallels with ***cellulose ethanol*** process in its use of sophisticated enzymatic technologies. BTL in the short-term is limited to use as fuel extenders rather than primary fuels. In the long-term, in the absence of a major energy breakthrough such as ***fusion*** power, BTL may become a mainstream source of portable fuels.

Renewable Portable Fuels (Biofuels)

Biofuels are seen as a certain hope on the energy horizon but partisan positions often put an overly optimistic or overly pessimistic view. In all cases, projected costs should take account of the ***energy*** used in the fuel-making process, as well as any catalysts, other chemicals, and labor. Making fuels of the future from straw and similar materials has a labor-intensive component absent from the petroleum industry and, with agriculture as the main source, only solid planning will ensure a year-round supply of raw materials. Those processes restricted to using "waste" are noble causes but will have a tough time ensuring continuity of materials supply in a local area, and those which use agricultural crops directly (***sugar cane***, ***corn***) are competing with food supply for land use and may produce unintended social consequences.

Ethanol -- Ethanol (ethyl alcohol, an intoxicant) is currently the most widely used biofuel. It is produced from plant sugars -- ***sugar beets*** in Europe, ***sugar cane*** in **Brazil**, and ***corn*** [wheat] in the **US**., and ***cassava*** experimentally in **China**. Production costs are generally low – around $0.75 per gallon in Brazil – but supply can be disrupted by drought or any adverse affect on the source crops. US **Department of Agriculture** expects ***corn***-based ***ethanol*** annual production to soon exceed 7 billion gallons per year (=167M 42-gal barrels) and forecasts 60 billion gallons per year by 2030, almost 4M barrels per day. Ethanol production uses only a small part of the plant; the residue which can not by recycled as a soil conditioner, an animal food or as a building material is an addition to the world's pile of agricultural "***waste***". With difficulty, ethanol can also be produced from this ***cellulosic*** plant waste. This a more complex (and expensive) process but does not detract from ***food supply*** in the way the common process does, and uses materials presently regarded as *waste*. **DuPont** has invested in a commercial-scale cellulosic ethanol plant suggesting there is some long-term business return in that industry. The Departments of **Agriculture** and **Energy** have recently awarded a further $17.5 million (a tiny amount) in grants for research into ***biomass*** research, and development and demonstration of commercially viable processes for converting agricultural waste into ethanol. Given the biochemistry involved in this, breakthroughs (and windfall profits) are certainly out there to be discovered, probably in the form of the right ***enzyme*** and heat-treatment processes. Ethanol can already be readily blended into gasoline up to 10% and there is pressure on manufacturers to produce engines that can use blends of up to 85% ethanol.

Biodiesel -- "Biodiesel" is one of the most-used terms in relation to current rethinking of energy sources. Biodiesel can be produced from a wide range of "sustainable sources" -- ***vegetable oils*** and ***animal fats;***

rapeseed and ***sunflower*** in Europe, ***soy oil*** in the US, and soy or ***palm oil*** in Asia. There have also been studies of this use for ***coconut oil***. The oil feedstock is put through a well-established catalytic process of ***esterification*** with an alcohol (methanol or ethanol) to produce methyl or ethyl esters, and ***glycerin*** and fatty acids as by-products. The by-products have some value but less than the *esterification* cost of around $200 per tonne. Biodiesel has been in reliable use for over a century – mainly in stationery large-plant applications and during times of diesel shortage – but it is a stronger solvent than conventional diesel and can destroy fuel lines and other components not designed for it. The oils used all have a long-standing value as human or animal ***food***. This and the cost of processing make biodiesel an expensive alternative to petroleum-based diesel oil. Although methyl esters have long been used as a component in soaps and detergents, it is only price competitive to diesel oil when oil prices are high. But the "renewable" nature of biodiesel rather than price has been a reason for interest. Governments may legislate use of some blend using biodiesel for import replacement reasons or green-motivated consumers may create increasing demand. Vehicle engines are now designed with the solvent properties of biodiesel in mind and to handle problems with quality variation and clogging that can cause damage to older engines. Typically a 20% biodiesel blend is the maximum recommended but some manufacturers now allow up to 100% biodiesel. Popular anecdotes that any vegetable oil will work in a diesel engine – such as filtered oil from deep fryers – is true to the extent that a wide range of substances will "burn" in the compression-ignition diesel but unprocessed oil wills eventually damage the engine.

Gas Fuels

Fossil gas fuels yield less GHG emissions (mainly CO_2), hydrocarbons, nitrous oxides, particulates, and sulphur. ***Liquefied Petroleum Gas*** (**LPG;** "***autogas***", "***bottled gas***") is best compatible with gasoline (spark ignition) engines, with about 75% of the energy density of gasoline. It is generally ***propane*** (C_3H_8) and/or ***butane*** (C_4H_{10}), and other hydrocarbons (depending on source) and can be liquefied at normal temperatures. In contrast ***Liquefied Natural Gas*** (**LNG**) is mainly ***methane*** (CH_4) which is best suited as a diesel substitute, but has an energy density of only about 60% of diesel. Where LPG can be compressed at normal temperature, LNG must be compressed (and stored) at around minus160°C and 8 bar pressure, a costly requirement and one limiting its use to heavy applications. The liquefaction process removes almost all impurities, producing almost 100% methane. The ratio of hydrogen to carbon in a ***hydrocarbon*** is a measure of how much CO_2 will be produced; the higher the H:C ratio the better – hence ***methane*** (CH_4) is a cleaner fuel than ***propane*** (C_3H_8) when fully combusted.

Some energy initiatives such as the use of ***landfill waste*** as an energy source have double benefits. ***Methane*** ("marsh gas") is emitted by all rotting organic waste. It is a major **GHG** and landfills are the largest source of US methane emissions. Capturing this gas displaces the use of other fuels and prevents the methane joining the **GHG** load. The City of Memphis has operated a landfill gas project since September of 2004, displacing the use of more than 67M gallons of gasoline in its first two years of operation, according to the EPA.

Natural gas hydrates (**NGH**) are a yet-untapped source of gaseous hydrocarbons. NHG is generally ***methane*** trapped in sponge-like structures of watery ice. The **US Geological Survey** estimates there is 320,000 trillion ft^3 of NGH in deep water offshore the US coast and around 600 trillion ft^3 in Alaska's *North Slope*. This NHG potential dwarfs US natural gas annual production of around 20 trillion ft^3, and reserves of around 200 trillion ft^3. Commercial exploitation of NGH has not been attempted and there is no pressure at present on the Alaska reserves while large natural gas deposits remain at *Prudhoe Bay* and elsewhere. Interest is likely to continue in the offshore deposits but all recovery methods presently envisaged (heating and/or pumping water into the deposit) are energy-intensive or problematic.

There has been a move to run vehicles on LPG in many countries because it is cheaper or has been made cheaper by government incentive towards slightly greener fuel. In the pattern of world energy usage it must be noted that LPG plays a crucial part in the lives of billions of people in the ***developing world*** as

the ultimate in ***portable*** energy used for ***cooking***, ***heating***, ***refrigeration***, and ***lighting***. Coupled with modern ***small turbines*** as ***generators*** and ***water pumps***, LPG is a strategic commodity on a global scale.

Greater Efficiency

Greener Buildings

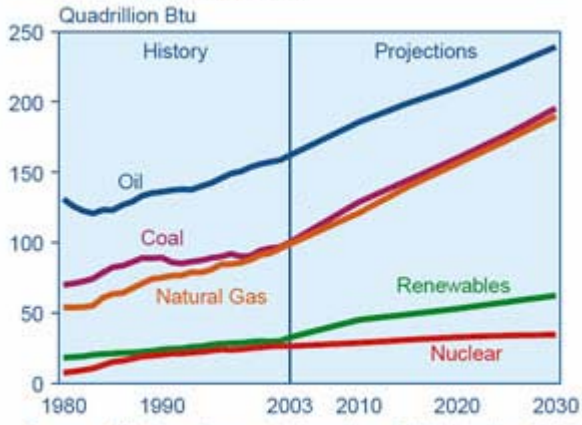
With 20% of electricity used for *heating and cooling* and 16% for *lighting*, significant improvement in efficiencies in just these two areas would have impact of many GWh across the country. Work in *solid-state lighting* (SSL) already offers possible 50% savings in energy costs for lighting and the impact of insulation and glazing on heating-cooling costs are already well known, but DOE's *Zero Energy Homes* (ZEH) program is attempting a "whole house" approach in systematic achievement of energy savings. Importantly, here as across the whole spectrum of energy issues, there is no "magic bullet", no single technology that will alone save the day. Already, ZEH prototypes have shown that an energy-efficient building shell, efficient appliances, and the appropriate ***mix*** of *solar water heating* and *photo-voltaic* (PV) can produce a dwelling with near zero net energy purchases.

Lighting (domestic and commercial) consumes around 16% of US electricity and is a good target for improved efficiencies that will have widespread impact with noticeable effect on the energy bottom line. Solid-state lighting (***SSL***) – using light-emitting diode (***LED***), organic LED (***OLED***), polymer (***PLED***) technologies - offers promise of over 50% reduction in power consumption for equivalent light output. SSL promises ***efficacies*** of 150 to 200 ***lumens per watt***, twice the efficacy of fluorescent lighting and 10 times the efficacy of incandescent lighting (the common Edison "globe"). Also, SSL units have typical lifetimes of 100,000 hours, the light is produced without heat and units can be incorporated architecturally in ways not possible with conventional lighting.

The AC/DC Problem

Electricity is electron flow -- ***direct current*** (**DC**) – and all early work in electricity such as Edison's work with electric illumination was concerned with these simple flows. But direct current does not travel well over significant distances and it was soon discovered that ***alternating current*** (**AC**), particularly in ***high voltages***, does travel without equivalent losses. So electricity is routinely distributed from power stations as high voltage AC and converted using transformers down to domestic voltages, between 110V and 250V in various parts of the world. But scores of electronic devices in every office and home use low voltage DC, which is why millions of little black transformers now litter the power outlets of the world. Some significant energy could be saved if buildings had a reticulated DC circuit. A standard may arise which pipes DC (perhaps 18V or 24V) from a single efficient large transformer in each building.

Figure 10. World Marketed Energy Use by Fuel Type, 1980-2030



Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, System for the Analysis of Global Energy Markets (2006).

Greener Transport

As vehicles account for 40% of US energy use mostly drawn from imported crude oil, any improvement in vehicle efficiency has a direct effect on the US bottom line. Much has been done by mandate to clean up ***vehicle emissions*** in the last few decades but little impact has been made on absolute fuel use. Vehicle innovation take two forms – incremental improvement in present designs, and radical rethinking of power-plant

(motor) and power-train (transmission) design. Over the last 20 years, motor vehicles have increased slightly in weight, have increased about 80% in power, and have improved fuel-consumption by about 20% to a typical 29 miles per gallon. There will be continuing incremental innovation in lightweight materials, aerodynamics, friction reduction, and low rolling-resistance tires. These improvements are marginal but they are independent of type of power-plant. Some innovation of conventional power-plant and power-train design are relatively low-tech and have been satisfactorily demonstrated in buses and ***heavy vehicles***. These include dynamic energy transfer to ***flywheels*** or to ***hydraulic pressure reservoirs*** – braking energy is transferred to the storage system and taken back again to assist with starting off, resulting in up to 50% in fuel economy.

The greatest single radical change to vehicle thinking is a range of ***electric-powered*** designs. The electric motor is a highly desirable power plant – it has a low-parts count, is intrinsically efficient, is compact, low-maintenance, and gives the highest torque at greatest load (when starting). Compared to the properties of the electric motor, the internal combustion ignition engine is one of the greatest mistakes in history. The efficiencies of ***electric rail*** and ***light rail*** (streetcars, trams) is legendary and has never been bettered. The first generation electric automobiles had almost 100 years of innovation, from the 1830s into the 1920s, when Henry Ford's mass production, and the availability of West Texas crude, killed them. Electric vehicles were still hand-made and were marketed to the well-to-do for town use; Ford's vehicles were one-third the price and could travel the highways appearing all over the US. Then as now, the energy efficiency of the electric motor was no match for the challenge of providing a portable high-endurance source of electricity. The challenge is two-fold – the cost, weight, and design-life of the electric source, and the vehicle range before recharge. Three answers have emerged – the ***all-electric*** vehicle with the cell technology available ideally suited to urban travel, the ***hybrid*** gasoline-electric vehicle (first implemented in 1916) that charges its battery while under gasoline power, and the ***fuel-cell*** that provides continuous electricity fuelled typically from a tank of ***hydrogen*** fuel. The fuel-cell is not a battery of electric cells; it is a ***catalytic electrochemical*** device that produces electricity while fuel is provided. All else being equal, the hydrogen fuel-cell electric vehicle – often called the ***hydrogen car*** -- has all the qualities of the vehicle of the future, and market penetration will certainly grow as fuel-cell costs drop and hydrogen filling stations spread. The first ***hydrogen filling station*** in the US was opened by **BP** in Michigan in October 2006; it manufacturers hydrogen on the premises using mains energy. DoE forecasts that the new vehicle sale of *hybrids* will grow from 0.5% now to around 9% by 2030, but sales of all-electric vehicles will continue to be almost non-existent at around 0**.**1% [sic] by 2030. Substantial decreases in the cost of electric vehicles may change those figures dramatically.

Futures

Infrastructure

The strategic plan of the *US Climate Change Technology Program* (**CCTP**) recognizes that transition away from GHG-emitting (and uncertain) fossil fuels to renewables will require "continued improvements in cost and performance of renewable technologies", which is obvious but, most significantly for real progress, the plan calls for "***shifts in the energy infrastructure*** *to allow a more diverse mix of technologies to be delivered efficiently to consumers in forms they can readily use*." This means two things – energy infrastructures must link to "a portfolio of renewable energy technologies" *in situ*, and – most radically – the grid must fully accommodate ***two-way energy flows*** to and from local areas and individual consumers. Energy corporations must not now be in the business of ***selling*** electricity (or gas) anymore; they now must sell ***connectedness*** to a dynamic and smart grid that is evolving every year (or every day) into a greener network of resources. **Reticulation itself is the new industry**.

It is the *mix* of a "portfolio" of new energy technologies that brings a new order of energy security. The distributed nature of DARPA's ***internet*** is the key to its ruggedness and distributed generation is the only possible answer for electricity grids of the future. Also, the distributed generation concept opens an

entirely obvious new possibility in world development. For instance, micro-turbines fed on biomass gases (or reciprocating engines fed on cow dung) could bring electricity to clusters of Indian villages now, rather than waiting for massive investment in huge central coal-fired power stations and high-voltage distributors.

In its simplest forms, local generation of energy is not new – elegantly simple s***olar hot-water*** technology has saved millions of GWh during its decades of history; ***solar powered remote telephone exchanges*** and satellite uplinks has also for decades brought communication to remote regions throughout the world.

Distributed Generation

One raft of clean, green solutions for distributed energy come from unexpected sources – the jet engine, and an engine design dating from 1816. The laws of physics allow the turbine ("jet") engine to scale very well from the very large to the very small, which is not possible with the internal combustion (gasoline or diesel) engine; hence, ***micro-turbines*** run from portable or fixed gas supply can generate electricity with high efficiency anywhere anytime. The ***Stirling external-combustion reciprocating engine*** is the Beta tape of the engine world. The whims of investment rather than technological supremacy allowed the gasoline engine to kill off not only the electric vehicle in the 1920s but proven mature technologies such as the reciprocating engine that is highly efficient, has few moving parts, and is open to a wide range of fuels.


A micro turbine commissioned by DARPA

Large scale gas turbines in commercial power generation waste around two-thirds of energy input through ***heat*** that is dissipated into the atmosphere. ***Cogeneration*** – that harnesses and delivers this heat as a valued service -- is an approach that more than doubles energy efficiency and halves GHG emissions. Some large institutions now use *cogeneration* to provide off-grid electricity and heating (or refrigeration). Large commercial power plants are generally distant from populations; cogeneration applications based on small turbines can be installed in a matter of days in the center of population centers where the electricity and heating/cooling services are used. Micro-turbines – with or without cogeneration – are quiet, have a ***higher power density*** (power to weight) than piston engines, extremely low emissions and very few moving parts (sometimes just one). Some are designed to be air-cooled and can operate without lubricants or coolants. They can use a range of fuels -- ***propane***, ***diesel***, ***kerosene***, ***methane***, or other ***biogases*** from landfills and sewage treatment plants. The ***transportable*** turbine generator can be brought to the source of the biogas and latched into the grid rather than needing the biogas to be somehow moved to a power plant. This cavalier fashion in which generators can be attached (and unattached) to the grid firstly depends on a ***regulatory framework*** that provides for that; there are no technical obstacles – modern power switching "black box" technology is highly sophisticated and inexpensive.

Dumb Grids and Smart Networks

> ***In just 13 minutes the power grid of the 80,000-square-mile Canada-US Eastern Interconnection area was toast.***
>
> - Steve Silberman, "The Energy Web"

The electricity distribution network – heavy-duty copper cable terminating in every home and office in the developed world – offers a high-technology ***convergence*** that is yet to get the attention it warrants. ***Broadband Over Power Lines*** (**BPL**) has been demonstrated for some years in places such as **Australia** and in April 2006 a regulatory framework was approved in **California**. BPL exploits very basic physics. For many decades, consumers have been able to opt to have electric water heating turned off during peak demand for a lower tariff. The signal switching heating circuits on and off is the crudest and earliest

application using signaling over power lines. BPL at speeds of 12Mbps have already been commissioned and the theoretical maximum bandwidth for each consumer is many times higher. BPL will allow remote customers beyond ADSL telephone service or cable to have broadband services. In areas already serviced, BPL will provide a "third pipe" ensuring even keener ***competition*** for broadband services.

More importantly, BPL enables ***smart grid*** technologies that have been the subject a very detailed theoretical development. A smart-grid would allow domestic devices to *talk back* to the power grid; the consumer could set simple equipment, probably from their existing PC, to negotiate prices and qualities of electricity supply. Doubtless a deluge of BPL interfaces and software will appear once penetration reaches a critical point and will give the term "smart building" a real meaning. A new activity, hobby, obsession of "energy tuning" will emerge that will not only switch electrical devices but will decide which should be adjusted based on the prevailing tariff. If tariffs soar during peak load, BPL-based controllers may switch a device such as an air-conditioner off, or adjust its temperature setting. Conversely if a grid supplier sees demand slipping, they could tout for extra demand from controllers that are allowed to switch suppliers. When critical mass is reached, the presently dumb electricity grid starts to become a smart web-like (or *web-based*) network. BPL offers obvious price advantages to consumers but it also gives electricity suppliers the opportunity to smooth peaks and troughs in demand through real-time price "negotiation". This would lead to the second generation use of the "smart grid". Obviously, the consumer does not get just those electrons their chosen supplier sends to them but in aggregate the system does work like that. If enough consumers specify 60% of their requirement must come from green sources, the system will warn household controllers (or simply start switching things off) when the network aggregate demand reaches the level of supply. The market would become "perfect".

Another issue concerns ***quality***. For crude electric uses such as heating and lighting, the quality of the supply is secondary to continuity – dim lights are better than no lights – but there are an increasing range of manufacturing processes, and home-office requirements that are greatly inconvenienced by as few as one or two blackouts or brownouts each year. A growing demand for power conditioning is certain. Whether this will be manifested in sophisticated (and expensive) home-office systems or local / neighborhood systems remains to be seen. What is certain is that vast electric grids stepping high-voltage AC down to districts and then down again within each local area is simply unable to guarantee the level of quality that high-tech equipment needs. Lightning events, storms, or a road accident bringing down lines, all threaten the *Goliath* hub-and-spokes model of electric grid. Traditionally, electricity suppliers have had a supply goal of 99.9%, ("three-9s") representing an outage of about nine hours in a year. In India, Iraq, and all of the developing world that goal is a distant dream; in the middle of Manhattan, or Tokyo, nine hours over two or three incidents a year is no longer tolerable. More importantly the quality of this supply is below specification for far less than 99.9% of the time. New goals in the electricity industry – and the high-tech equipment lobby – speak of "nine-9s" (99.9999999%) as the new reliability and quality standard. For practical purposes this is impossible to meet without a systematic decentralization of the grid. To achieve the next generation, electricity sub-stations and transformer points throughout the grid must be able to disentangle themselves from a grid crisis and continue to serve local areas with acceptable quality for a practical period of time. All of these possibilities need just one more "***black box***" in each building's meter box, where the grid meets the consumer. This would be the intelligent junction for any or all of the following:

Some Energy Statistics - USA

Electricity - production:	3,900	billion kWh
Electricity - consumption:	3,700	
Electricity - exports:	24	
Electricity - imports:	30	
Oil - production:	8	million barrel /day
Oil - consumption:	20	
Oil - exports:	1	
Oil - imports:	13	
Oil - proved reserves:	22,450	million barrel
Natural gas – production:	539	billion m^3 /year
Natural gas – consumption:	634	
Natural gas – exports:	24	
Natural gas – imports:	114	
Natural gas - proved reserves:	5,353	billion m^3

CIA, DoE data (estimates) rounded / OSS.NET

- Tail-end from any local photovoltaics, wind power (DC probably 12V);
- tail-end from any local mains voltage generation;
- head end of building mains power circuits;
- head end for building DC circuit/s;
- head end for vehicle charging circuit;
- tail-end from the electricity grid (the "supply").

But, above all, policy-makers must create ***regulatory framework*** that permits the nation's grids to join the digital age and mandates standards and installation safety.

…/ Forecast

Near-Term	Mid-Term	Long-Term
Just as "climate change" in a few years has moved from an assertion of the lunatic fringe to scientific fact, just so the realization that there is something very wrong with public energy policy will soon enter common discourse. Much data about the relative virtues of various energy initiatives is ***misleading*** (by accident or intent) because it does not take into account all the costs (cradle-to-grave) of each technology. Now that ***water*** security is more precarious than even energy security, technologies that consume or render water unusable should be seen as high-cost. ***Grain ethanol*** technology – the shining star of the moment – is certain to come to tears at some stage as it competes directly with the ***food supply*** for ***land***. ***Broadband Over Power Lines*** (**BPL**) is within reach now and awaits only sound ***policy frameworks***. The opportunity to provide basic broadband services over an existing link will attract third parties to invest in the line and head-end infrastructure which will achieve most that is required for an intelligent two-way decentralized (internet-like) energy grid. To start now is the key.	**Allah** has been most merciful with distribution of oil reserves, to **Arab** nations and to non-Arab Muslim nations such as **Iran**. It seems it will be ultimately a ***political*** imperative rather than green consciousness that will put a brake on crude oil usage. ***Crude oil***, the source of a vast array of unique ***plastics***, is a resource to valuable to burn while there are alternatives. Fifty years ago, rail supporters said policy-makers would rue the day they neglected ***rail*** in favor of ***road transport*** – that day may be here now. Energy prices for portable fuels are certain to cause even more pain to road transport as rail lines sit growing weeds. In the mid-term, critical mass may arrive in the ***fuel cell*** market and ***lead-acid batteries*** and many of their modern counterparts can be consigned to recycling centers along with the ***internal combustion*** engine. With the right ***regulatory framework***, and regime for safe, authorized connection to the grid, the smart grid can get started. Architects in droves will join their cutting edge colleagues who now design buildings for efficiency (or even self-sufficiency). Cities in windy areas will have tasteful wind generators; sunlit cities will have integrated photovoltaic roofs. Home energy enthusiasts in their millions will drive rapid innovation in gadgets, gizmos all aimed at "energy tuning".	***Hydrogen*** probably is the terminal point for all energy endeavors in search of a clean, green, portable energy source but the takeup rate will depend on the numbers of early-adopters willing to pay a premium while the price is still high. Within a few years nuclear fusion may appear, *deus ex machina*, to solve the world's energy problems forever. Or not. In all events, if **China**, **India**, and the **US** continue as now, the next major wars may be not over ***ideology***, or ***water***, but energy. After some experimentation, the "***energyplex"*** or **"**eco-industry park" concept will mature – suites of co-located industries will use "waste" energy (often heat) and "waste" output material of one operation will be an input for another; process water will be recycled. This will not motivated by clean, green sentiments but by cost savings. Energy ***reticulation*** itself is the new industry.

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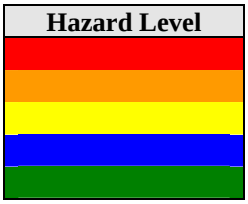

Change Codes	
↓	Deteriorated
•	Steady
↑	Improved
↗	Alert

week-ended	*See daily list of news items*
2007 Jul 01	• *Why Nuclear Energy Isn't the Great Green Hope* -- "*There's a better solution: energy efficiency….*". Nomadic ***rebels*** have launched a string of attacks in northern **Niger's** *Sahara* desert, demanding greater stake in ***uranium*** and ***oil*** reserves being sold off to **Chinese** and other foreign firms. *Researchers Find Way to Safely Store Hydrogen for Use in Future Cars* -- "*high surface areas that soak up hydrogen at much higher densities than previously possible, and without the need for extreme cooling or* ***pressurisation***." "*There may be ways to use* ***microbial communities*** *to improve the* ***quality*** *of the oil while still in the subsurface. So we'll look at microbes that live in* ***coal beds*** *or* ***oil fields*** *and* ***oil sands***" -- *Building a Bug to Harvest Oil*. *How Might China's Soft Power Impact Central Asia?* -- "*The reason* ***Central Asia*** *is so attractive to* ***oilmen*** *is that it is not* ***Arab***". The world's first ***floating wind turbine*** could be generating ***electricity*** in the ***North Sea*** in 2009. **DOE** has named 13 "***Solar America***" cities -- "*The new DOE program will provide* ***technical and financial assistance*** *to the cities that were chosen because of the commitment they demonstrate to a comprehensive, citywide approach to the deployment of* ***solar technologies***." • "*How wars of the future may be fought just to run the machines that fight them*" -- *The Pentagon v. Peak Oil*. If the situation in **Nigeria** worsens, oil markets will have yet another worry; "*an indefinite stoppage is expected to cut supplies from the world's eighth largest oil exporter*" -- *World oil threatened by Nigeria strike*. "*When I was the boss of an oil company I would never tell the truth. It's not part of the game.*" -- *Clock Ticking On Global Oil Supply*. *Iran says won't rule out using oil as a weapon* -- "*When the Americans say that* ***military action*** *in regard to the nuclear issue has not been put aside,* ***Iran*** *can also say that it will not put aside* ***oil*** *as a tool*." Senate passage of the bill that mandates 40% increase in ***fuel economy*** standards by 2020 revealed "*deep partisan and regional divides over the nation's energy future*". ***Dimethylfuran*** (DMF), produced using a combination of conventional biological and new chemical methods, has a 40% higher energy density than ***ethanol*** -- *Better Biofuel Uses Best of Both Worlds*. Research into new alloys as ***hydrogen storage media*** will obviate problematic hydrogen ***pressure tanks*** -- *Light years ahead*.
2007 Jun 17	• An example of solutions that can and will arrive: *Bio-latrine Cleans Up Kenyan Slum and the Environment* -- "*the latrine that uses human waste to produce* ***gas*** *to burn to*

	heat up water *that can be purchased by slum dwellers.*" More nails in the coffin of the glib ***corn ethanol*** fix -- *Maize of Deception: How Corn-Based Ethanol Can Lead To Disaster*. *Stockholm International Peace Research Institute* says the ***Middle East***, ***Africa***, ***Central Asia***, ***South America*** and ***SE Asia*** will be areas of potential ***energy conflict*** -- *SIPRI warns against oil shortage in Africa, Mideast*.
2007 Jun 10	• **DoE** has awarded $8M [petty cash] for "***fundamental research*** into ***biomass genomics*** that will facilitate and accelerate the use of ***woody plant tissue*** for ***bioenergy*** and bi" -- *$8.3 million awarded for biofuels research*. Over 60% of current **US *wind*** generation of over 7.3GW has been installed in the last six years -- *America is full of wind*. In **Burundi**, the better of some bad options takes some pressure off a ***tree-denuded*** land, ***burning refuse*** -- *Urban Waste Becomes Urban Fuel*.
2007 Jun 03	• In **Burundi**, the lesser of some bad options takes some pressure off a tree-denuded land -- *Urban Waste Becomes Urban Fuel*. An update on attacks in the ***oil-rich*** *Christian* and *pagan* ***southern delta*** of **Nigeria** -- *Nigerian militant attacks on oil industry [Chronology]*. A new agreement will bring **Algerian *gas*** to **Brazil** -- "*Algerian gas … would be used in terminals that the company is implementing in Pecém Port … and in Guanabara Bay*". A technology involving ***starch***, ***enzymes*** and ***water*** to produce ***hydrogen*** fuel joins the growing array of "basic research" technologies that offer the only real future promise -- *Researchers study organic enzymes as future car fuel*. Also: A ***lithium*** compound "*could be a major step towards the breakthrough that the fuel cell industry and the transport sector have waited for*" -- *Hydrogen Breakthrough Could Open the Road to Carbon-Free Cars*. The first generation of ***LED*** (*Light-Emitting-Diode*) lighting technologies bring 60% energy-saving without the downsides of complex and ***ecologically-unsound compact fluorescents***. [As predicted …] "*The rush to produce* ***biofuels*** *… is exerting* ***price pressure*** *on* ***staple foods*** *in South Africa ...*" -- *Biofuel making staple food more expensive*.
2007 May 27	↑ **GE**, **BP** and **Rio Tinto** have committed to developing a full-scale process that will produce ***hydrogen*** and captured ***carbon dioxide*** from ***fossil fuel***.
2007 May 20	↑ A **Perdue *Eureka*** moment that may be truly revolutionary -- *New fuel for 21st century -- aluminum pellets?*. **DoE** has awarded $11M in ***research grants*** in ***hydrogen fuel cells***. ***Solar*** and ***wind*** powered ***cellular phone*** systems are being deployed in **Namibia** -- "*a feasible option for operators instead of utilising costly* ***fuel generators*** *or waiting long periods for a* ***mains grid connection***." ***Ethanol*** diplomacy settles into two camps – "*taking corn away from people and the food chain to feed automobiles is a terrible thing*" Chávez said -- *Why Chávez, Castro bash U.S. ethanol plan*.
2007 May 13	• *see also*: **India** Driving "passive" collectors more energetically with ***concentrated light*** is now the new direction -- *Solar Power at Half the Cost*. More on the ***cost/benefit*** approach to ***bio-fuels*** from *Christian Science Monitor* --

	Biofuels show promise, but also present problems. *Africa faces energy crisis - report* -- "*most of the commercial energy it produces is consumed elsewhere*." A 14 meter (46 foot) twin-hull boat has completed a ***fuel-free*** crossing of the ***Atlantic*** -- 2,000 kilowatt hours of ***solar energy*** during a journey of six months and some 13,000 kilometers. A **US Senate** panel has set a 35 miles-per-gallon auto ***fuel consumption*** target by 2020 -- "*But senior Republicans said the plan was unfair to struggling U.S.-based auto companies that depend on sales of less efficient* ***sport utility vehicles*** *and* ***pickups***." [Your point being …?] **Russia's** involvement with the **Iran-Pakistan-India** ***gas pipeline***, with its **Gazprom** expertise, may see the pipeline extended on to **China**. Daniel **Nocera**, professor of chemistry at MIT, says that basic research into the chemical processes of ***photosynthesis*** could lead to a society powered by ***water*** and ***sunlight*** -- *Supplying the World's Energy Needs with Light and Water*.
2007 May 06	• A look at some of the ***strategic pipelines*** of ***Central Asia*** -- *Energy-Central Asia: Wrangling Over Pipelines Wrecks Early Prospects [Analysis]*. "*About 80 percent of all material transported on the battlefield is* ***fuel***" -- as a strategic imperative the **US** ***military*** is reviewing its ***energy assumptions and practices***.
2007 Apr 29	• The *Bujagali* ***hydroelectric*** project near the ***Nile's*** source will double **Uganda's** grid capacity but will have ecological consequences. Using ***food crops*** to fuel ***vehicles*** [***biofuels***] is a dilemma with particular clarity in ***developing countries*** -- *Combustion Or Consumption? Balancing Food And Biofuel Production*. A primer and resource on ***wind power*** by *National Center for Policy Analysis* -- *Wind Power*. Work-in-progress -- *Making Gasoline from Carbon Dioxide* -- is cutting-edge science yet unproven but certainly a better direction than the limp-wristed efforts to hide [***sequester***] ***carbon-dioxide*** in some deep orifice.
2007 Apr 22	**US DOE** is now funding a ***cellulosic ethanol*** project -- "*One of our goals is to reduce the cost of the process and make it applicable for commercial production.*" **Imperial College London** has been granted $8.5M to research ***hydrogen*** energy systems. A breakthrough in ***solar cell design*** proves again the power of applying ***natural*** designs; "*similar to the veins in tree leaves*" -- *Plastic solar cell efficiency breaks record*. The largest ***solar power*** plant in North America will soon be providing electricity to **Nellis Air Force Base** in Nevada. The ***South American oil and gas summit*** opened in **Venezuela** -- "*The presidents will tackle other projects, such as a* ***gas pipeline*** *between* ***Venezuela*** *and the Pacific Coasts of* ***Colombia*** *and* ***Panama*** *...*" In a clash with President **Lula** of **Brazil**, President **Chavez** continues to argue against a vapid faith in ***non-cellulosic ethanol***.
2007 Apr 15	• A $30B barrage harnessing the ***tidal flow*** of the *Severn Estuary* may supply 5% of the **UK's** energy needs but may destroy ***unique habitats***. A quick overview on ***hybrids*** from *locomotives* to *tugboats* -- *Hybrid vehicle technology goes commercial*.

	A new design for ***solar panels*** improves *efficiency – "an array of nano-towers, like microscopic blades of grass, that add surface area and trap more sunlight*". Fears of a world ***gas cartel*** eased after major gas producers **Iran**, **Qatar**, **Russia**, **Venezuela** had met, but they took the necessary first step towards such a cartel by establishing the **Gas Exporting Countries Forum**.
2007 Apr 08	↑ ***Renewable energy*** projects in the ***developing world*** have an astounding efficiency; they obviate the need (and impossible cost) of ***regional electrification*** -- *Loans fund renewables for poor*. ↑ The only real future for "biofuels" will involve ***enzymes*** and a new alchemy of ***microbes*** -- *A Better Biofuel*. The **World Bank** says **Iran** gas is **India's** best energy option -- "*the proposed pipeline from Iran could bring gas to Mumbai at a cost one-third cheaper than the closest alternative ...*" [The **US** opposes the project for political reasons.] "*Mechanisms Count, Not Targets…. The **U.S**. could learn a lot from **Europe**, if we would only look.*" [and more on the **Gore** version of the "***intelligent grid***".] -- *Energy from Hot Air*.
2007 Apr 01	• **Canada** looks to double its output from ***oil sands*** but nearby ***uranium*** rather than natural ***gas*** may be used to power *energy-intensive* (and *water-intensive*) extraction from its vast reserves. The first ***solar-powered transatlantic crossing*** saved around 8,000 litre of fuel. At last some good sense from **DOE** in questioning the place of ***corn ethanol*** in the energy future -- "*I'm not going to predict what the price of corn is going to do, but I will tell you the future of biofuels is not based on corn.*" DOE says ***coal liquefaction*** technology has been around for 60 years but successful commercial implementation may still be a while in coming. [It is no magic bullet.] The $7B ***gas pipeline*** from **Iran** to **India** via **Pakistan** looks set to proceed -- energy imperatives win against the **US** desire to isolate Iran by stopping the project. A "bio-cell" may offer mid-term promise for ***fuel cells***; it uses ***enzymes*** from an ancient bacterium, one of the first forms of life on Earth, when there was no oxygen in Earth's atmosphere -- *New 'biofuel cell' produces electricity from hydrogen in plain air*. Another off-the-wall possibility is "*a fuel cell battery powered by sugars found in anything from sweet drinks to tree sap*" -- *New Batteries Get Their Buzz From Sugar*.
2007 Mar 26	• **Kazakhstan** and **Turkmenistan** want to ensure they are have options in the new energy world order by bypassing **Russian *pipeline*** routes. Separately, there is talk of constructing ***pipelines*** that would bring Gulf ***oil*** beyond the ***Strait of Hormuz*** to **Oman** or **Yemen**. The idea of a ***global natural gas cartel*** is gaining clarity --"the consortium reportedly will initially include **Russia**, **Iran**, **Qatar**, **Venezuela**, and **Algeria**…", 70% of the world's natural gas reserves. **US** presidential candidate Senator **Edwards** has announced an "aggressive" energy plan that hits all the right words -- "… strengthen the ***family farm*** ... replace some of the ***manufacturing jobs*** that we've lost in America." In the **UK** an 8MW ***tidal stream*** power project in the sea off the west coast of Britain is proposed. **Oak Ridge National Laboratory** has developed a ***nanonfilter*** that may replace an expensive, dirty, water-greedy diesel refining process. A paper-like, polymer based ***rechargeable battery*** developed by Japanese scientists may be a technology with long-term promise -- "*The power rate performance is strikingly high*

	– it only takes one minute to fully charge the battery. And it has a long cycle life, often exceeding 1,000 cycles." [It is for small device applications at present but the technology is theoretically extensible to ***vehicle*** applications.]
2007 Mar 19	• Using the village bull to generate ***electricity*** is a no-brainer … once it's been perfected – an Indian engineer has designed a village power system that uses ***draught animals*** to charge a ***battery*** bank. The world is not running out of ***oil*** -- to be accurate, there are "unlimited" petroleum reserves but the cost of ***extraction*** and ***processing*** will inexorably increase to $100 (or $1,000) per barrel as the best and most profitable reserves are exhausted. There are so many unknowns about ***CO_2 sequestration*** that no-one should crack the champagne yet – *Scientific American* examines the issue: *Future of 'Clean Coal' Power Tied to (Uncertain) Success of Carbon Capture and Storage*. ***Microbes***, the majority of life on Earth, will almost certainly be the only rational answer to ***CO_2 sequestration***. [Converting CO_2 into ***ocean fish*** is more sensible than hiding it.]
2007 Mar 12	• A new **nanoscale** engineering breakthrough may lead to dramatic cost reductions in hydrogen-powered vehicles, "*will bring* ***polymer electrolyte membrane fuel cells*** *for hydrogen-powered vehicles closer to massive commercialization*." DOE has proposed a range of grants with the policy goal of reducing ***photovoltaics*** from 18c-23c per kWh now to 5c - 10c per kWh by 2015. A new **Los Alamos** ***thermo-acoustic gas liquefaction technology*** may turn the 100B m3 of natural gas wasted every year into fuel. Another advance in cheap ***nano solar cells*** may be used to make ***hydrogen*** for fuel cells *directly from water* or for producing electricity. **Brazil**, as the world's top **ethanol** producer, is a key member of a new forum with **India**, **China**, **US**, **EU** on ***biofuels***. But the critics of the ***ethanol*** frenzy are gathering. "*Strong demand for* ***corn*** *from ethanol plants is driving up the cost of livestock and will raise prices for beef, pork and chicken*" The new "ethanol diplomacy" is called a hoax by some -- "*the US government is more interested in protecting US* ***farmers*** *than strengthening ties with* ***Brazil***."
2007 Mar 05	• The much delayed report by the **White House Council on Environmental Quality** shows an unacceptable medium-term situation, a 19% growth in **US** ***emissions*** by 2020. **India** notes "*many countries*" are against the proposed ***India-Pakistan-Iran pipeline*** due to their "vested interests" and urges formation of ***Asian energy consortiums***. The meeting of major ***south Asian*** nations on 05 March hosted by **India** will examine potential for cooperation in the energy sector. **Japanese** interests will soon start drilling in **Canada's** ***permafrost*** for ***methyl hydrate***, a controversial energy source that needs significant energy input to recover. Malaysia is clearing 1,000ha of [ecologically important] ***mangrove swamp*** to make way for ***palm oil*** industrial zones -- the darker side of palm oil, until now a darling of alternative fuel possibilities. ***Cellulosic alcohol*** (fuel from *grass* and *wood chips*) could be big in the next 10 years -- if the government helps at first. A team at **Arizona State University** is working to improve ***fuel cell*** fundamentals such as *membrane* design and *operating temperature*. In early demonstration … a promise-filled technology that uses ***sunlight*** to produce ***hydrogen*** from ***water*** -- *U.S. funds hydrogen experiment.* **Cuba** has opened an experimental ***wind farm*** -- the six 180-foot windmills produce about 1.8GW. Waste ***rice husk*** in Sri Lanka could produce 20MW of electricity and reduce pressure on

		forests for ***firewood***. Fact-boxes by *Reuters*: Comparing renewable and fossil fuel prices Selected national biofuels targets Some national renewable energy targets
2007 Feb 26	•	The long lead-time of oil ***infrastructure investment***, price ***volatility***, manipulation of ***supply***, and rumors of ***alternatives*** will combine to bring a prolonged energy crunch. The U.S. share of global ***solar panel*** construction has fallen from 20-25% about four years ago to about 8% now. "*US researchers have successfully demonstrated the* ***thermoelectric effect*** *in an* ***organic molecule***." -- *Organic electricity generator is hot stuff* Glib confidence in an ***ethanol*** energy future is quite unjustified -- *Ethanol`s critics doubt results* A tale of necessity and invention; a home ***hydroelectric*** generator for around $1,400 -- *Homemade Hydro Power Lights Up Tajikistan* **Sri Lanka** is building a large ***garbage-driven*** thermal power plant -- "*the power plant expects to generate electricity using 1000 metric tonne of garbage a day*." **Egypt** has plans to build a 150 MW combined ***solar*** and ***gas-powered*** electric plant near Cairo using concentrated solar technology. ***Thin photo-voltaic film*** will be the future of solar and **China** is at the front of development that will drive prices down. **Cuba** is on the verge of tapping its own ***oil*** deposit in the ***Gulf of Mexico***-- "*we are going to continue with our programs — with American companies or without American companies.*"
2007 Feb 19	•	***Oil sands*** are plentiful but refining them is a costly and dirty business -- "*influencing the price and cost of oils sands product is the price of* ***natural gas****, which is needed to provide the energy to extract the oil*." *Increasing oil sands production* **Portugal** is proposing to build a ***wind-powered*** electricity plant in ***Maluku***, eastern **Indonesia** -- *"… the region possessed great wind-power potential which could be utilized to produce electricity*." A developer proposes solid-state ***methanol*** for ***fuel cells*** -- "*In a clathrate compound technology, a guest compound is trapped in a solid state host compound. In this case, methanol is the guest compound*." [This may be an important development.] Global Warming: It's All About Energy A nice thesis: ***global warming*** is not an "***environmental***" problem like ***pesticides*** … it is an ENERGY problem.
2007 Feb 12	•	**Brazil** and the **US** are join forces to create an ***ethanol standard*** -- "Both countries want to create ***standard certifications*** for the product to become a ***commodity*** and be traded on the ***futures market***." Closer review of the ***budget*** shows that the healthy ***R&D*** component is mainly ***weapons*** systems, with little devoted to ***energy*** futures. The new **US** ***budget*** proposal does relatively little for ***wind*** energy -- "*overall funding for wind power was decreased to $40 million.*" **Russia** and **Qatar** – who dominate the world ***gas*** market -- are said to be discussing, along with **Iran**, a ***gas version of OPEC*** -- but they deny this. The theoretical potential is clear -- ***algae*** can produce far more fuel per acre than ***soybeans***.
2007 Feb 05	•	In the **US** further funds have been awarded in the $38.6M of ***Nuclear Energy Research Initiative*** funds granted since 2005. **India** will construct four more ***breeder reactors*** -- "*The new breeders would first use* ***mixed uranium-plutonium oxide*** *as*

		fuel and later switch over to ***metallic fuel***.". **European *wind*** market growth is up -- the total wind power capacity in the EU is now a not inconsiderable 48GW. Researchers have developed a ***portable generator*** that turns many types of ***refuse*** into electricity -- "*The* ***biorefinery*** *generator initially runs on diesel oil for several hours until the gasifier and the bioreactor begin to produce fuel…*". Continuing research may see the ***roof cladding*** itself turned into a ***photo-voltaic collector***. The **World Bank** published an account of its involvement in ***renewable energy*** initiatives -- World Bank Group Progress on Renewable Energy and Energy Efficiency
2007 Jan 29	•	President **Bush's *State of the Union*** address remarks on energy mirrors ***public opinion*** that ***biofuels*** -- somehow -- hold the answer. What happened to the President's call in 2006 for ***switch grass*** as a ***biofuel*** source? – it did a lot for switch grass futures but not for ***cellulosic technologies***. President **Bush** wants to double **US *emergency oil stockpile*** -- "*the move would give U.S. consumers an insurance policy equivalent to about 97 days worth of imports …*" ***Wind*** provides only 1% of **US** energy but is growing faster than any other form [from this very low base] -- ***biofuels*** are ***transport*** energy sources and a distraction from the need to develop ***base-load*** sources. President **Putin** calls for global ***nuclear energy*** based on centralized (secure) ***enrichment*** -- "*it is necessary to establish a network of international centers for nuclear fuel enrichment under the control of international organizations.*" **Brazil** will export 3 billion litre of ***sugar-cane ethanol*** this year -- **Sudan** has expressed interest in Brazilian equipment and technology for alcohol production at the ***International Ethanol Workshop*** in Sudan.
2007 Jan 22	•	Whether **Turkmenistan's *oil and gas pipelines*** head "east" or "west" is of global strategic importance. The new Congress will probably see ***solar*** turn from an idea into an industry. **BP** is to build five US ***windfarms***, in ***California***, ***Colorado***, ***North Dakota*** and ***Texas***, that will deliver a total generation capacity of 550MW. ***Corn-based alcohol*** will ultimately be a wasteful, possible immoral, sidetrack -- but ***enzymes*** may save the day with ***cellulosic*** ethanol. The ***Cebu Declaration*** by 16 ***East Asian*** nations on ***energy security*** aims at expanded use of ***renewable energy*** and development of ***clean coal*** technologies. **Australia** and **China** announced a "partnership" for "***clean coal***" – but the handshake between one of the world's biggest suppliers and one of the biggest users signifies nothing consequential. **Venezuelan** state ***oil*** firm PDVSA had talks with **India's** Oil and Natural Gas Corp. to supply more oil to India.
2007 Jan 15	↓	Experiments with ***biofuel*** production in **Senegal** has raised concern; as a local energy source the technologies are sound; as a massive ***monoculture crop*** for base-load energy it would devastate the country -- "*When we are talking about using it as a major energy source, it is a wrong direction.*" The **US** will remain vulnerable to oil supply -- *"... the idea of 'energy independence' is a myth...*". An analysis concluded the *Anglo-American* "empire" is losing the "Great Energy Game" --"While **China** and **Russia** continue to 'win' in ***Central Asia***, the ***West*** continues to lose political and economic clout everywhere."

2007 Jan 08	• The Russian gas giant **Gazrom** is exchanging some resource assets for a strategic position in European ***energy distribution***. The Council on Foreign Relations published a briefing on the new energy politics of Europe -- Russia's Energy Disputes. [Analysis: Ideology politics is rapidly being sidelined everywhere by "energy politics".]
2007 Jan 01	• More compelling documentation emerges that the best use of solar power is as ***concentrated solar power*** (using mirrors/lenses to focus the suns energy onto high-efficiency collectors). About a fifth of ***Europe's gas*** imports from Russia are threatened by a price dispute between **Russia** and **Belarus**. California's governor is seeking $95M for ***green research*** -- importantly much of the investment is in ***"basic" research***, the riskiest and most rewarding. **Algeria** has become the sixth biggest provider of **US *oil***.
2006 Dec 25	• ***Ethanol*** will not be a long-term savior -- "*even if 100% of the US **corn** supply was distilled into ethanol it would supply only a small fraction of the fuel consumed by the nation's vehicles.*" **Britain** has approved construction of the world's biggest ***offshore wind farm*** -- the 341-turbine *London Array* and 100-turbine *Thanet* wind farm will supply **1.3GW** of electricity, the first of a number of large-scale offshore wind farms in the UK. **Argentina** is facing a severe energy shortage that many experts blame on the lack of ***investment*** since the 2001-2002 economy crisis.
2006 Dec 18	• A scientist notes the inconvenient truth that a ***hydrogen*** economy doesn't make -- "More energy is needed to isolate hydrogen from natural compounds than can ever be recovered from its use." [*Analysis*: But wait. The truth is unaffected that hydrogen is an excellent ***portable fuel*** if made using "free" energy such as ***solar*** and ***hydro***; it is silly as a ***base load*** fuel.] An **Indian** state has made ***solar water heating*** mandatory for most buildings, an obvious measure in a sunny climate with energy shortfalls. **Indonesia** is actively investigating the ***jatropha*** shrub, which grows prodigiously as a weed in the area, as ***biofuel*** source. [The plant referred to is probably *Jatropha curcas*.] **China** assures **India** it will work for ensuring energy security of the region [not just China] -- the Chinese Premier says "energy efficiency is a ***strategic*** issue in China's economic development" and also recommends an Asian strategic oil reserve. **Nigerian** President **Obasanjo** makes what may prove to an historic suggestion, that **OPEC** exploits all sectors of its own **oil** resources [upstream and downstream], and cooperates in non-oil activities. **Egypt** says it is ready to strengthen ***energy cooperation*** among ***African*** states -- "Egypt is keen on gaining access to African markets by providing technical aid in the ***oil services*** domain." The *International Herald Tribune* observes what is obvious from these items -- "Now, the ***oil*** market has a new force to reckon with: ***nationalism***."
2006 Dec 11	↑ Congress approved offshore ***petroleum drilling*** in the ***Gulf of Mexico*** ending a 25-year ban on drilling in some ***deep waters***, but extends a moratorium on drilling in other Florida waters until 2022. President **Chavez** arrived in **Brazil** for energy discussions, to promote his vision of "the ***energy matrix*** of **Brazil**, **Argentina**, **Paraguay**, **Uruguay** and all of ***South America***." **Russia** seeks to deflect pressure it is receiving from ***Europe*** on energy issues by allying with **SCO** to the East, but SCO may not need Russia. The head of the ***European Commission*** said "**Kazakhstan** will play an important part in the EU's evolving ***energy security*** strategy". With **DoE** funding, *Boeing-Spectrolab* has demonstrated a concentrator ***solar cell*** with a record-breaking 40.7% ***efficiency*** rating.
2006 Dec 04	• A case study shows ***methane digesters*** can have a significant effect on the economics of a ***dairy farm***, the quality of life of its neighbors and on the pollutants a farm

		produces. **Angola**, with output of 1. 4 million barrels a day, joins 11-nation **OPEC**. The **USAF** has reduced its energy use by 30% since 1985 and is the top purchaser in the US of ***renewable energy***.
2006 Nov 27	↑	Now 20 states and DC have some form of policy goal for ***renewable energy***. Showing what ***energy politics*** of the future will look like, **Russia** has threatened to cut ***electricity*** to **Azerbaijan**. A government report has found that development of ***nuclear power*** in **Australia** is viable; Australia has 40% of the world's known ***uranium reserves***. A ***cellulosic ethanol*** plant is planned in Iowa -- the process yields 27% more ethanol from an acre of ***corn*** because it uses the cellulosic corn stalks and leaves, the first such commercial plant in the US.
2006 Nov 20	•	The NATO chief said NATO's brief could extend to ***energy security*** -- "the free flow of energy" is "an important element in NATO's strategic concept". It's all good news for the first retail release of a ***hydrogen car*** in 2008 by *Honda*; California Governor **Schwarzenegger** promotes a *'Hydrogen Highway'* to fuel it. **DoE** has been forced by a NY District Court decision to improve ***energy efficiency*** standards for key household electrical devices. **Rand** says "***Renewable resources*** could produce 25% of US electricity and motor vehicle fuel by 2025 at little or no additional cost".
2006 Nov 13	•	The **International Energy Agency**'s (IEA) *World Energy Outlook (WEO) 2006* has echoed the findings of a recent **UK** [*Stern*] report – the world risks a 'dirty' energy future at its peril.
2006 Nov 06	•	Long-discussed, little-implemented, ***tidal energy*** companies are starting to move -- "Water's greater density means fewer and smaller turbines are needed to produce the same amount of electricity as wind turbines." DoE has announced grants to add 15 to the one ***85% ethanol*** station in California where there are already 300,000 "***flex-fuel***" cars. **Russia**, **Turkmenistan**, **Kazakhstan**, **Uzbekistan**, **Ukraine**, **Belarus** may become members of a ***Gas Alliance*** that would control 50% of the world's gas reserves. A ***storm*** took out ***electricity*** supply to 100,000 customers in Northeast and Mid-Atlantic States.
2006 Oct 30	↑	**Australia** announced a ***solar electricity*** site that will serve 45,000 homes. The **Appropriate Rural Technology Institute** in Puna [**India**] has designed a system that requires ***cow-dung*** paste, a second-hand generator, and ***household waste*** to give endless ***electricity***. This is the first ***hydrogen*** retail filling station in the **US** has been opened by **BP** and partners in southeast Michigan.
2006 Oct 23	↓	**OPEC** has cut production by 1.2 million barrels per day to support the ***crude oil*** price. All indications are that an **Australian** Prime Ministerial task force investigating ***nuclear power*** in Australia will favor that solution.
2006 Oct 16	!!!	The head of **Germany**'s security intelligence agency, the Bundesnachrichtendienst (**BND**) says terrorists have a definite goal of destroying Western ***energy infrastructure*** and supply -- "Questions of ***energy security*** will fundamentally help

		determine the security agenda of the 21st century". The **National Renewable Energy Laboratory** says ***single turbine*** models of wind farm projects are a "worst-case scenario" and give an unduly gloomy picture of ***wind energy***. US DoE says ***renewables*** have a considerable way to go to yield acceptable ***cost*** and ***performance***. All indications are that an **Australian** Prime Ministerial task force investigating ***nuclear power*** will favor that solution for the first time in the country.
2006 Oct 09		• [nothing significant to report]
2006 Oct 02		• **DOE** is spending $8M on engineering "pre-conceptual design" for future ***nuclear power*** plants.
2006 Sep 25		• [nothing significant to report]
2006 Sep 18		• The US ***nuclear waste*** issue is still far from resolved; 2,000 tons are produced each year; *Yucca Mountain* is still at least 10 years away. Big Oil told consumers to quit buying as much ***gasoline***.
2006 Sep 11		↑ A newly-proven ***oil*** field 270 miles southwest of New Orleans could yield 11% of U.S. output by 2012-14
2006 Sep 04		• [nothing significant to report]
2006 Aug 28		• The scales are starting to tip in favor of ***hybrid*** motor vehicles — **India**, **Russia**, **China**, **France**, **Japan**, **South Korea**, **Ukraine** (representing half the world's population) have mounted a project to design the "perfect" ***reactor***.
2006 Aug 21		↑ ***Biofuels*** have given new life to agribusiness.
2006 Aug 14		↑ BP shut down the Prudhoe Bay ***oil*** field in Alaska, the largest in the US, to repair leaks in the pipeline.
2006 Aug 07		• The **US Energy Agency** will invest $250M for research into cellulosic ***ethanol*** and other fuels derived from plant byproducts — the ***natural gas*** price rose 35% in July reflecting increased demand — **Venezuela** will send ***gasoline*** to **Iran** which has much oil but little refining capacity.
2006 Jul 31		↓ **China** advanced experiments into ***nuclear fusion***, a blue-sky hope for the world's future energy needs [this is separate to the international **ITER** project]. *$3 a gallon and we're still standing* – some say the shocks are yet to strike. If **Cuba** proves oil deposits that are probably there, what then of the US embargo?
2006 Jul 24		↓ Most wars in history were about resources – now they will be about *energy*. With infrastructure damage caused by the demand for cooling, parts of New York City continued into its sixth day without *electricity*.
2006 Jul 17		• A study says soy oil as *biodiesel* is more efficient than *ethanol* additives but – in an obvious *gotcha* -- neither can significantly supplant petroleum without impacting food-growing capacity; **DARPA** is seeking new biofuels for military use; the **EU** reported a 66% increase year-on-year in use of biofuels, but this is still far short of the 2005 target of 2% total biofuels.
2006 Jul 10		↓ The search for energy sources has rapidly become an immodest scramble – **China** is spending hugely to ensure future supply, the **US** says the world should see the coming crisis as a matter on international partnerships; it is rumored the upcoming **G8** meeting will embrace **nuclear** power as never before.
2006 Jul 03		• Much of the alternative energy debate is over – it has moved from an obsession of

fringe groups to a main-stream imperative.

Commencement of Service

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Energy Units and Conversions

No other domain is so confused by mixed systems of measurement (*barrel*, *cord*, *British Thermal Unit*) -- this reference allows conversion back to sensible units such as *Watt*.)

A BTU (British Thermal Unit) - amount of heat necessary to raise one pound of water by 1 degree Farenheit (F).

1 Joule (J) is the MKS unit of energy, equal to the force of one Newton acting through one meter.
1 British Thermal Unit (BTU) = 1055 J (The Mechanical Equivalent of Heat Relation)
Power = Current x Voltage (P = I V)
1 Watt is the power from a current of 1 Ampere flowing through 1 Volt.
1 kilowatt is a thousand Watts.
1 kilowatt-hour is the energy of one kilowatt power flowing for one hour. (E = P t).
1 kilowatt-hour (kwh) = 3.6 x 10^6 J = 3.6 million Joules
1 calorie of heat is the amount needed to raise 1 gram of water 1 degree Centigrade.
1 calorie (cal) = 4.184 J (the Calories in food ratings are actually kilocalories.)
1 BTU = 252 cal
1 Quad = 10^{15} BTU (World energy usage is about 300 Quads/year, US is about 100 Quads/year in 1996.)
1 therm = 100,000 BTU

Power Conversion

1 horsepower (hp) = 745.7 watts

Gas Volume to Energy Conversion

One thousand cubic feet of gas (Mcf) -> 1.027 million BTU = 1.083 billion J = 301 kwh
One therm = 100,000 BTU
1 Mcf -> 10.27 therms

BTU Equivalents

1 bbl crude oil: 5.8 million Btu; 1 Mcf gas: 1.03 million Btu;
1 kWh electric: 3.4 thousand Btu; 1 ton coal: ~21 million Btu

Energy Content of Fuels

Coal 25 million BTU/ton
Crude Oil 5.6 million BTU/barrel
Oil 5.78 million BTU/barrel = 1700 kWh
Gasoline 5.6 million BTU/barrel (a barrel is 42 gallons)
Natural gas liquids 4.2 million BTU/barrel
Natural gas 1030 BTU/cubic foot
Wood 20 million BTU/cord (1 cord = 128 cubic foot)

http://www.physics.uci.edu/~silverma/units.html

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