ENERGY ALTERNATIVES for Today and Tomorrow

A Report to Salt Lake League of Women Voters, Spring 2007.

A year ago global warming was an abstract concept to which most people paid little attention. Today it is widely perceived as a problem that threatens our way of life. Much like tackling the national obesity problem, concerns about global warming have met no "magic bullet" solution. We have, however, identified many partial measures that can be implemented in attempting to reverse our situation over time. This report undertakes to summarize a complex body of knowledge in process of rapid evolution.

A) **THE PROBLEM**: Greenhouse gases are increasing in the atmosphere while fossil fuels are being depleted.

For more than thirty years carbon dioxide and other greenhouse gases, along with noxious industrial gases, have been observed in ever-increasing amounts in our atmosphere.[1] The International Panel on Climate Change[2] declares that humans are largely to blame for climate change, owing to our accelerated burning of fossil fuels. Both rapid population growth and accelerated energy consumption are found to be depleting traditional nonrenewable energy sources.[3]

The best way to begin our energy "diet" is to rethink our own actions --driving, heating, lighting. This can be as hard as it is to reduce body mass, because old habits are hard to break. Yes, technology can be harnessed to create alternative fuels and improve energy efficiency. Yes, governments and individuals can find incentives to spur technological advances and promote their use. Yes, there will be financial costs (and gains).

Because of the large inertias in our systems (50-year lifetime for coal power plants, 15-year lifetime for autos/trucks, large infrastructures in factories and distribution systems, 100 year persistence of carbon dioxide in our atmosphere, for example), corrective measures taken immediately will not take full effect for many years. So much the greater then is our need to act decisively and soon. We can no longer "buy a larger size" and ignore the problem.

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[1] James Hansen testimony to Congressional Climate Warming Comm., 1988
"Earth in the Balance" by Al Gore, 1992
Film "An Inconvenient Truth" by Al Gore, 2006
"Phaeton's Reins" by K. Emanuel, Jan-Feb 2007 in Boston Review
www.bostonreview.net

[2] www.ipcc.ch/; "Science" 4/13/07, pp188-1990

[3] "Hubbert's Peak by K.S. Deffeyes, 2001, rev. 2003
"Peak Oil, the rise and fall of oil production" by Jean Arnold, "Catalyst" magazine, Oct. 2006

For those who still doubt the reality of global warming, please consider whether it would not be wiser to act now, when correction may still be possible, and before oil/gas/coal resources become so limited that our political interactions decay into conflict.

Fortunately, human ingenuity is up to the task of solving this "planetary emergency", as we shall see from many examples, outlined below, of new technologies, new agreements/legislative acts and new thinking on the parts of individuals, corporations and governments.

B**) TECHNOLOGICAL FIXES**: Saving existing energy, reducing greenhouse gas emissions and finding non-fossil-fuel energy alternatives

New efficiencies applied to our current systems could double the amount of energy now available without increasing pollutants. The major sources of carbon dioxide (CO_2) emissions are automotive motors (tailpipes) and coal-fired power plants (smokestacks); both are subject to significant reductions. In addition there exist valuable clean and renewable energy sources that are not (or little) based upon combustion, and are therefore sustainable over the long haul. Thus technology has present and potential means of solving the dual crisis of energy production and pollution reduction.

1) "Using energy more efficiently offers an economic bonanza...because saving fossil fuel is a lot cheaper than buying it".[4] The U.S. Environmental Protection Agency's Energy Star program offers voluntary energy efficiency solutions that conserve energy, reduce emissions and save big money as a result of reduced energy bills.[5] Other agencies are: American Council for an Energy-Efficient Economy,[6] Consortium for Energy Efficiency,[7] and Cool Cities.[8] Following are some examples of opportunities for energy efficiency.[9]

a) Improved building construction, both new and retrofit, to be governed by improved building codes with strict enforcement:[10] increased insulation, passive solar design, natural lighting, heat-exchange ground pumps for heating/cooling, insulated window construction, roof gardens for insulation (and for pleasure!).

b) More efficient appliances, particularly refrigerators, air conditioners, and furnaces. The EPA recently released its annual report summarizing the success of Energy Star and other voluntary climate protection programs. The report stated that Energy Star

[4] Scientific American, Sept. 2005, "More Profit with Less Carbon" by Amory B. Lovins
[5] www.energystar.gov
[6] www.aceee.org
[7] www.cee1.org
[8] www.coolcities.com/
[9] Also see "Time" magazine, 4/9/07; www.usatoday.com.
[10] www.usgbc.org/LEED/

reduced greenhouse gas emissions equivalent to those from 23 million automobiles — up from 20 million in 2004 — while saving $12 billion on energy bills.

c) Substitution of fluorescent or LED lighting for incandescent light bulbs. Some say: "Banish incandescent."

d) Changes in lifestyle: reduced use of autos/trucks, development of low-sprawl communities, recycling of wastes, etc.

e) Expanded public transit, especially if powered by electricity that is derived from renewable sources.

f) Autos/trucks built smaller and lighter, made of lighter, stronger new materials and with gas-hybrid or diesel-hybrid motors. Gas-electric hybrid motors have already proven to be twice as efficient as the standard gas combustion engine. Autos with "plug-in" electric motors will prove to be better yet for many uses, and produce no CO_2, so long as they are recharged from a renewable electricity source, such as wind or solar.[11]

g) Use of alternative fuels. Autos propelled by hydrogen fuel cells are further into the future, but give promise of locomotion without oil/gas, and producing zero CO_2 so long as the hydrogen is generated by a sustainable electricity source. It is calculated that a compact, lightweight auto could carry enough hydrogen in safe tanks to travel 530 miles.[12] The National Renewable Energy Laboratory reported on a facility using electricity from wind turbines to produce and store pure hydrogen.[13] A variety of hydrogen powered vehicles are already being tested.[14]

2) Reducing greenhouse gas emissions per se is certainly all to the good, but it will not alleviate our dependence upon fossil fuels. Better, and probably less costly in the long run, would be to start now to increase efficiency and develop a set of sustainable alternatives (see 3, below).

a) Automotive vehicles cause a major part of our CO_2 problems, burning a large proportion (70%) of our imported oil/gasoline, while emitting a large portion (33%) of our CO_2 (as well as other pollutants). On the other hand, vehicles are a major component of our industrial base, and this, coupled with our long oil supply line, is proving a combination highly resistant to reform.

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[11] "Plug-in Hybrids" by Sherry Boschert, 2006
www.pluginamerica.com
www.greencarcongress.com
www.epriweb.com/public/000000000001009299.pdf

[12] www.eere.energy.gov/hydrogenandfuelcells/

[13] www.nrel.gov 12/14/06

[14] "On the road, hope for zero pollution car", Don Sherman, NYTimes, 4/29/07

Federal legislation has succeeded in achieving major reductions of exhausts from combustion motors: lead-out-of-gasoline, catalytic converters, 10% ethanol added to gasoline, removing 97% of sulfur from diesel fuels, diesel engines fitted with filters that reduce soot emissions by 90%. Further gains would result from switching from gas to diesel engines, since diesels run more efficiently and can even use bio-diesel fuels.[15]

b) Coal-burning power plants are our other major source of CO_2 emissions. Since coal is an abundant and cheap domestic fuel for which a large infrastructure is already in place, it will be difficult to wean ourselves from its use. But calculations of environmental and health impacts of coal mining and burning, plus impending legislative penalties, are already indicating that the costs of coal will increase, diminishing its future role.[16] Newly formed Utah Physicians for a Healthy Environment has recently highlighted the health crisis associated with Utah's air pollution.[17] In addition, a petition is being circulated in Utah to voice opposition to the construction of 3 more dirty coal-fired plants.[18]

For the present, research is pointing the way to new technologies that can make the burning of coal cleaner, although adding to costs and reducing efficiency. Standard burning of pulverized coal puts all of its contaminants (including sulphur-oxides (SOX), nitrogen-oxides(NOX), mercury and CO_2) out the smokestack; 'scrubbing' can reduce SOX and NOX by over 90%, and CO_2 can be partially captured at the terminus. A newer process, integrated gasification combined cycle (IGCC), gasifies the coal before combustion and is purported to reduce emissions as well as making the capture of CO_2 more efficient. Burning pulverized coal with added oxygen removes NOX, facilitating the capture of CO_2.

Very long-term "sinks" for CO_2 include reduction to organic material by biological photosynthesis, absorption by oceans and conversion to insoluble carbonates or mineralization into such compounds as magnesium carbonate. These processes are far too slow, however, relative to the amounts of CO_2 being produced, to compensate for current energy consumption.

Therefore, 'Carbon Capture and Sequestration' (CC&S) is under heavy investigation, by the U.S. National Energy Technology Laboratory,[19] Canadian Natural Resources,[20] and at private labs such as that of Prof. Brian McPherson, University of Utah. CC&S seeks to remove CO_2 from point-sources such as coal-burning plants, by chemically fixing it or

[15] Carmakers Aim Diesels at U.S. Market, J.R. Healey, USA Today, 4/19/07
[16] http://web.mit.edu/coal/
[17] SLTrib, 3/31/07
[18] www.lesscoal.com
[19] www.netl.doe.gov/
[20] www.nrcan.gc.ca/

permanently trapping it underground, thus removing it from the atmosphere and reducing its potential for global warming.

Professor McPherson's current efforts, in collaboration with his Southwest Regional Partnership on Carbon Sequestration, are directed towards identifying underground spaces with storage capacity to hold large amounts of CO_2 without leakage, i.e.: natural geologic domes, spaces between sedimentary rock layers or old mines/oil wells from which methane and residual oil may be released as an added benefit. The U.S. FutureGen project[21] plans to build, before 2012, a commercial scale IGCC coal plant with integrated sequestration, aiming for zero-emissions.[22] American Electric Power Co. has announced the construction of a different demonstration coal plant with integrated CC&S, but using an improved carbon capture method, "a sign that American Electric, which relies on coal for fuel, is expecting carbon emission limits of some kind."[23]

3) Developing New Sources of Energy that are Renewable/Sustainable, non-polluting over their full life-cycle AND cost-competitive with fossil fuels.

One advantage to dispersed renewable energy sources is their 'local' potential: points of harvest close to points of consumption. This provides some energy autonomy to communities and nations, reduces costs of long transit, enhances energy security and liberates local entrepreneurship.[24]

a) Wind power makes electricity which can be transmitted or stored locally by generating hydrogen, charging batteries, etc. Both onshore and offshore wind can be exploited to generate significant contributions of electricity, perhaps 20% of our total needs, although the inconsistency inherent in wind makes necessary some source of back- up power, such as fast-responding natural gas-burning plants, hydroelectric dams from which water can be held back, or compressed air. Wind power is free and safe, has low operating costs and can be sited on arid or mountainous lands (or on farm lands with benefits to farmers), but there are problems of transmission and inconsistency to be solved. Nonetheless, capture of wind energy is expanding rapidly.

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[21] (www.futuregenalliance.org)
[22] "Burying greenhouses gases will be key" http://www.csmonitor.com/2007/0315/p02s01-sten.html?page=1
[23] The New York Times, by M.L. Wald, 3/15/07
[24] "Busting Myths, Leading Transition", H. Scheer, in "Solar Today" May-June, 2007

In Perth, Australia, wind energizes the desalination of ocean water, critical to this desert climate.[25]

b) Our abundant sunlight can be captured as heat or directly converted to electricity using semiconductor materials, in a process called photovoltaics. The size of our solar potential is told as $5X10^{13}$ Kilowatt-hours/day of total incident solar energy on the land area of continental U.S., to be compared with $1X10^{10}$ Kwh per day of average electricity consumption in 2004. This great potential is reduced, however, by intermittency (i.e. clouds or darkness, in the absence of storage), need for conversion of DC to AC, transmission constraints, the area of deployed photovoltaic surfaces and the efficiency of the photovoltaic conversion. The efficiency has increased from 4% for the first solar cells (1950) to as much as 20% at present, depending upon the semiconductor recipient, which is subject to further improvement. One projection is that total harvested photovoltaic electricity could reach 7% of total U.S. electricity by 2030, with costs being reduced as volume increases. Stimulus is being provided by the California Solar Initiative and the proposed federal Solar America Initiative. In Salt Lake City, roof-top solar panels are sprouting, as part of a much more inclusive "SLC Green" initiative.[26] Near Las Vegas, a massive photoelectric array, able to track the sun for maximum incidence of sunlight, is being planned to power 30% of Nellis Air Force Base, funded by the Air Force, three private entities and a mix of federal and state incentives and subsidies.[27]

Critical to the development of photovoltaics is the "net-metering" agreement that allows individual solar collectors to feed electricity back into the electric grid, compensating individual collectors for their energy harvest and allowing the grid to behave as a sort of overall battery. In Germany solar feedback to the grid earns eight times the electricity cost charged by the power company, prompting a great surge in demand for solar installations. A net metering bill passed the Utah legislature in 2002, under guidance from the State Energy Office and Utah Clean Energy. Its cap of 25 kilowatts per unit could now well be enlarged to 12 megawatts.

Concentrated solar uses sunlight concentrated by mirrors to heat oil and thence water, turning generators to make electricity. Seven Solar Electric Generating Systems (SEGS) facilities were built 1986- 1990 in the Mojave Desert, at Barstow, CA, constituting the largest solar plants in the world, producing 350 megawatts at peak periods. A natural gas boiler serves as back-up when the sun is off. (Wind power can also be coupled with

[25] Utah Wind Working Group, Jason Berry, Renewable Energy Coordinator, Utah State Energy Program

[26] www.SLCgov.com/environment

[27] "Air force embraces solar power", USA Today, 4/18/07
American Solar Energy Society: http://ases.org/climate

solar for more consistent energy flow.) Major new concentrated solar plants are under construction outside of Las Vegas and Tucson.

c) Geothermal energy provides heating and electricity. Geologists believe Utah sits on one of the prime reservoirs of geothermal energy in the United States, an energy resource that is clean, renewable, reliable, and, to date, almost entirely untapped. Geothermal steam and hot water are now routinely utilized for the generation of electric power with the gentlest of environmental impacts. Thermal waters piped directly from the ground support greenhouses, fish farms, and municipal heating systems. Logan, Utah, has opted to build a new geothermal electric plant, rather than renewing their contract for coal- generated electricity.[28]

d) Ground-source heat pumps provide warmth and cooling to buildings.

e) Tidal energy makes electricity, based upon the constant powerful flows of ocean waves, tides and currents. Water turbines are moored to the sea bed and convey the energy back to the electric grid by cable.[29]

f) Small hydro power makes electricity.

g) Methane, a bad greenhouse gas that is combustible and that can also be converted to electricity, can be recovered from decomposing bio-materials in garbage dumps.

h) Nuclear power makes electricity. Technically, nuclear power is not a renewable energy source, since it depends upon a depleting mineral source, uranium. Neither can it be considered cost effective, nor non-polluting, except in the context of CO_2. Because nuclear power plants replace combustion with radioactive decay to generate the heat to boil water, there is very little release of CO_2 from the power plant per se. Furthermore, a nuclear power plant produces a strong and steady yield of electricity, for a lifetime of 25-50 years. There is a strong drive in the U.S. moving us towards expansion of our nuclear energy.[30] President Bush has proposed a major program called the Global Nuclear Energy Partnership[31] that would foster nuclear power throughout the world. The nuclear power industry also supports this approach.[32] Energy Solutions purchased three new nuclear entities last year, expanding their industry from nuclear waste storage to nuclear fuel and to nuclear reprocessing.

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[28] Utah Clean Energy; "Renewable geothermal energy holds promise, but it gets little attention", by Robert Gehrke The Salt Lake Tribune, 2/11/07.

[29] "Catch a wave, throw a switch", USA Today, 4/19/7

[30] "Spinning a nuclear comeback" "Science" 3/30/07, pg1782

[31] www.GNEP.energy.gov

[32] www.nei.org

Reprocessing refers to the chemical extraction from spent nuclear fuel rods of plutonium (and many other 'hot' products). In theory, plutonium can be used as fuel in a new generation of "breeder" nuclear power plants, cooled by liquid sodium and known to have unresolved technical problems; no breeder plant is functional at present.

There is also a current rush to mine uranium, the price of which is now more than ten times its 2002 price.[33] The mining of uranium has inflicted a large negative toll on human health due to its radioactive nature, and uranium refinement consumes large amounts of energy. The concrete structuring of nuclear energy plants do emit CO_2, although less than coal burning power plants.[34] The vast costs of nuclear energy, which have always been heavily subsidized by governments, are out of line with costs projected for other energy sources which are renewable and free from health consequences. Furthermore, no solution has been found to the problem of how nuclear waste can safely be disposed of, since it will remain hazardously radioactive for thousands of years. There still remain, 30-some years after the Cold War, many radioactive sites in the U.S. that were never remediated.[35]

i) At present, the only renewables able to replace combustible oil/gasoline are plant and animal oils which can be chemically converted to bio-diesel, and plant sugars or cellulose convertible to ethanol by microbial fermentation. Such harvests of plant substances are just one-step removed from the harvest of sunlight itself, since only plants have the capacity to reduce atmospheric carbon dioxide to organic matter, using sunlight for energy. Note that this plant attribute is also unique for the natural sequestering of carbon dioxide, making all plant culture of benefit in our fight against carbon dioxide.[36]

Glucose sugar from sugar cane and starch from corn grain are readily converted to ethanol by microbial fermentation. Since sugar cane and corn are important food sources, a more desirable source for energy would be plant cellulose, the structural plant fiber that is not digestible as food except by ungulate animals (and termites). Cellulose, a long polymer of glucose, comes in complexes with poly-xylose and crosslinked with lignan, a robust structure that is difficult to unpack.

Chemical dissolution has recently been improved. And genetic engineering has succeeded in the building of artificial microbes able to convert efficiently both glucose

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[33] "Uranium ignites 'Gold Rush' in the West", S. Moran & A. Raup, NYTimes, 3/28/07

[34] "The green minefield" by A. Vasislath. 3/5/07 in "The Age" newspaper of Australia; www.theage.com.au

[35] 4 articles about uranium mining on the Navaho reservation, by Judy Pasternak, Los Angeles Times 11/22/06.

[36] "Is ethanol for the Long Haul?" by M.L. Wald, "Scientific American" January 2007, pp 42-49.

and xylose to ethanol in high concentrations. The net result of these manipulations may be ethanol at $2 per gallon, or less, with a potential yield of 60 billion gallons per year, or 30% of present transportation usage.[37]

Such plant ethanol is now widely added to gasoline at 10% to allow cleaner burning (replacing the toxic MTBT). It can also be provided as an 85% mix with gasoline for specially adjusted motors. "Flex-fuel" vehicles have been developed in Brazil to use either gasoline or ethanol. It should be noted, however, that the shift from gasoline to ethanol for automobiles is a small cost and a small benefit, compared to the gains that could be made by increasing motor/automobile efficiency.

There are big advantages to "cellulosic" ethanol over corn grain ethanol, the latter preempted from a major food source grown under prime agricultural conditions, and actually yielding less energy as ethanol than is used to grow it. "Cellulosic" ethanol can be made from plant debris (corn cobs, wood chips, wheat straw) which has little other utility, or it can be extracted from perennial grasses that grow on marginal prairie lands, needing no cultivation, no fertilizer and little water. Such perennial grasses, like forests, do double service by sequestering large amounts of carbon dioxide in their deep root systems.[38]

Professor Byard Wood at Utah State University has been researching the generation of bio-diesel fuel from oil-rich algae grown on extended surfaces using elevated CO_2 from a nearby coal plant and sunlight intensified by fiber-optic cables.

C) **VOLUNTARY and LEGISLATIVE ACTIONS:** There seems to be some agreement that we (and the whole world) can work toward renewable energy in a stepwise fashion, gaining experience and economic confidence while reducing our dependence upon fossil fuels gradually, but 'with all deliberate speed'.[39] In a recent decision (4/3/07), the U.S. Supreme court found that our EPA does have the authority to regulate greenhouse gas emissions.

1) Already several renewable-energy advocacy groups have been formed to provide information and advice, e.g.: Intergovernmental Panel on Climate Change[40]; Pew

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[37] "Biofuel researchers prepare to reap a new harvest", by R.F. Service, "Science" 3/16/07, pp 1488-91.

[38] "Carbon-negative biofuels from low-input high-diversity grassland biomass" by D. Tilman, J. Hill & C. Lehman, "Science" 12/8/06, pp 1598.

[39] S.Pacala & R.Socolow, "Stabilization wedges: solving the climate problem for the next 50 years with current technologies", "Science" 12/13/04, pp968-72
R.Shinar & F.Citro, "A road map to U.S. decarbonization", "Science", 9/1/06, pp1243-4.)

[40] www.ipcc.ch

Center on Global Climate Change;[41] Center for Energy and Climate Solutions;[42] U.S. Climate Action Network (USCAN);[43] American Council for an Energy Efficient Economy[44] (about Industries and environmentalists together crafting legislation to reduce U.S. global warming pollution); Council for Environmental Education (CEE);[45] Southwest Energy Efficiency Project (SWEEP)[46] (for Arizona, Colorado, Nevada, New Mexico, Utah and Wyoming).

Coalition for Environmentally Responsible Economies (CERES) is a coalition of investors, public pension trustees, foundations, labor unions, and environmental, religious, and public interest groups: www.ceres.org/, The Energy Foundation: www.ef.org/home.cfm Western Resource Advocates: www.westernresourceadvocates.org/, and Utah Clean Energy: www.utahcleanenergy.org

2) Voluntary compromise agreements between corporations and environmental advocates. There have been reports during the past few months of 'settlements' regarding disputed coal plant projects. On 12/13/06, in Springfield IL, opposition by the Sierra Club to Renfros Power's proposal to construct a new coal-burning plant was assuaged by Renfros' agreement to take down two dirty outdated coal plants, purchase a good slug of local wind power and educate its constituents about renewable energy vs. CO_2 pollution from coal.

In March of 2007, TXU Corp., the largest utility in Texas, under pressure from local citizens and such organizations as Public Citizen, Environmental Defense and NRDC, agreed not to build eleven new coal-fired plants of standard polluting design, but rather two IGCC plants designed to capture CO_2 exhaust and inject it underground, rather than allowing it to escape into the atmosphere.

On March 19, 2007 Kansas City Power and Light, under pressure from the Sierra Club, agreed to buy wind energy and generate energy conservation sufficient to offset the CO_2 output of its planned new coal plant.

3) Legislated mandates and incentives are being devised by local, federal as well as international governments to spur the development of alternative energy sources. Such goal-setting, backed by legislated financing, is quickly appreciated by the private

[41] www.pewclimate.org
[42] www.energyandclimate.org
[43] www.usclimatenetwork.org
[44] www.aceee.org
[45] www.cee.org.uk
[46] www.swenergy.org

investment sector (stock markets, venture capitalists), augmenting the government action.[47]

a) Corporate Average Fuel Economy (CAFÉ) Standards mandate energy efficiency standards in automobiles. First used by the federal government during the gasoline shortages of the mid-seventies, CAFE standards proved effective in directing automobile design towards greater efficiency. When the oil import crisis ended, however, auto design went towards larger 'SUV' vehicles, not covered by CAFE. California's 2005 Pavley Act reinstated CAFE standards for a broad spectrum of auto types. Utah adopted State Fleet Efficiency Requirements in 2007.

b) De-coupling the consumer's cost for energy from the income guaranteed to energy providers, so that measures for efficiency do not incur disincentives. The standard financial model is that the utilities recoup their fixed costs through volumetric energy sales; therefore it is generally not in their financial interest to help consumers use less energy. Decoupling helps to align the interest of the utility with the interests of the consumer. It eliminates the disincentive to the utility to promote and provide incentives to save energy. For example, Questar Energy was granted permission 1/6/07 by Utah Public Service Commission to institute a new demand-side management program, "Thermwise", to promote energy efficiency, including rebates for installation of energy-efficient appliances, rebates for weatherization, etc. Questar is a willing partner because it is now permitted to account separately for its fixed infrastructure costs and the volume of gas sold, so that the amount of gas purchased by consumers is no longer a determinant of Questar's profits. The community as a whole benefits from the economies of reduced gas consumption. Individuals who use less save more.

Demand-side efficiency programs have also been introduced by Rocky Mountain Power. These are financed by a small add-on charge to each customer. The Rocky Mountain Power program is a result of Senate Bill 152, passed in 2002. The Public Service Commission approved.

c) Caps on particular pollutants are mandated limits fixed by law. Caps are more effective if the cap is enforceable and becomes more stringent with time. Examples:

- Catalytic converters on autos 1981
- Ozone-depleting gases phased out by Montreal Protocol of 1987
- Lead out of gasoline 1996
- Following Kyoto Accords against greenhouse gas emissions 1997

[47] Wall Street Journal, "Energy Report", 2/12/07

- Mercury limited in coal power plant exhausts by Clean Air Act 2005
- California passed Global Warming Solutions Act, 8/2006
- Sulfates out of diesel fuel 12/2006
- California drafted major carbon cap on its gasoline usage, 1/11/07
- European Union passed carbon cap on gasoline usage, 3/9/07
- Great Britain drafts legislation to cap carbon, 3/14/07

d) Cap-and-Trade (C&T) market mechanism: sets a price upon the pollutant being regulated, so that trading of deficits and excesses can proceed, and invention is spurred towards pollution reduction. C&T can be developed privately (as the Chicago Carbon Exchange, 2003), or under legislative regulations developed in conjunction with Caps. Although a carbon tax/cap is simpler than Cap-and-Trade, there seems to be growing agreement among both industrial and environmental interests that C&T offers more flexibility and incentives for innovation. The basic premise, according to Professor Richard Collins, is to design an economic model that forces the issue, allows for long term benefits and for incentivising industry to make it profitable.[48]

A choice example of a successful C&T program was the reduction of sulphur dioxide emissions from U.S. mid-west coal-burning power plants, with the objective of reducing the 'acid-rain' that was killing eastern forests. Under a 1990 amendment to the Clean Air Act, the Environmental Protection Agency (EPA) issued a fixed number of tradable permits to utilities for sulfur dioxide production, and monitored the amount of SO_2 produced. Each permit allowed for a ton of SO_2 emitted, and permits not 'spent' could be traded to other facilities or banked. The incentive to reduce emissions had a clear impact: SO_2 was reduced ahead of anticipated schedule and cost.

The situation with CO_2 is far more complicated. Because this pollutant readily distributes itself world-wide, an international effort is required, involving the trade of permits world-wide. For example, CO_2 emissions in the U.S. can be offset by preventing deforestation of tropical rainforests, thus preserving a valuable ecosystem. Clearly, "ensuring the integrity of such a system will require rigorous monitoring, auditing and registration", but methods to manage such problems are considered to be available.[49]

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[48] See also "Moving to Markets in Environmental Regulation", by J. Freeman & C.D. Kolstad, Oxford Univ. Press, 2007.

[49] "Carbon trading over taxes", W. Chameides & M. Oppenheimer, "Science" magazine, 3/23/07, pg 1670.

The complexities of international Cap and Trade are daunting, however. In Europe, bad management has caused large swings in the price of power and CO_2, with impacts on production and employment: revisions are under way.[50] Payments for CO_2 ameliorations in the developing world, such as China, have resulted in large money transfers to owners of high-emitting factories and deal-makers.[51] Current discussions on the Lehrer News Hour of the Public Broadcast System are broadening the discussion. The Carbon Tax Center of New York City advocates a simple tax on the carbon content of fuel, imposed at the top of the supply chain and passed through to the ultimate customers; customers paying more at the pump become motivated to use energy more sparingly, although the tax itself is 'revenue neutral' since all proceeds are rebated to all citizens.

Increasing the cost of polluting energy, by whatever program, will cause a decrease in the amount of that energy used and thence of pollutants produced. By having fixed in place, as soon as possible, a long term program of increasing taxes on carbon, business markets can find long term stability in the predictability of their situation.

e) Renewable Portfolio Standards (RPS) is the terminology for governments setting a target percentage of electricity that must come from renewable sources. Over 22 states have now passed RPS legislation --- but not Utah. A national renewable energy standard is now being introduced in the U.S. Senate.

f) City contracts for electrical power. In November, 2006, a move started in California cities to not renew their long-term contracts for electricity with standard polluting coal-fired plants, such as those in Utah. Those cities will have until 2027, when their current contracts expire, to develop alternative energy sources. Logan, Utah, is now joining this move, by refusing a 30-year contract with a standard coal-fired plant proposed to be built by Intermountain Power near Delta. Instead, Logan will develop a clean, renewable geothermal project. Hopefully, other power provides will build new plants with the new emissions cleaning technologies.

g) Feed-In Tariffs: Danish government required utility companies to buy electricity from clean-energy sources at a premium price set by the government. Costs are passed on to consumers, increasing their utility rates. This is similar to Rocky Mountain Power's 'Blue Sky' program, allowing consumers to invest voluntarily in new wind power and other renewable energy facilities.

[50] "Europe's Problems Curbing Carbon" by S. Mufson, 4/9/07 Wash. Post

[51] "Outsize Profits and Questions", by K. Bradsher, 12/21/06, NY Times

h) Government Investment in companies that harvest renewable energy, providing capital grants and research, e.g. in Denmark such investments are funded by a "public service obligation" tax on total energy consumed: 3% by homes, 9% by businesses.

i) Incentives to consumers who install clean energy. Utah has Renewable Energy Tax Incentives for residential customers who install renewable energy at their homes.

j) Tax credits to businesses that produce renewable energy: must be dependably long-term to inspire private investment. Federal tax credits for solar and geothermal installations are provided by Energy Policy Act of 2005.[52] Utah's Renewable Energy Tax Credit (2007) provides corporate and individual tax credit incentives for commercial and residential renewable energy systems.

k) Incentives for research, education, technical assistance, and liability coverage.

l) Prize Monies offered by private entities: The Doris Duke Charitable Foundation announced 4/9/07 a $100 million program to support research towards Reducing the Threat of Global Warming.

4) Citizens' Advocacy Organizations:

George Monbiot: "Here's the Plan". In Guardian, 10/31/06: www.monbiot.com

Bill McKibben: "How to Build a Mass Movement to Halt Climate Change": www.commondreams.org/views07/0321-22.htm

"Energizing America", SierraClubMagazine, Jan/Feb 2007

D) **CONCLUSIONS**: We still need to diet and exercise judgment, to achieve our goals. We cannot wait for the magic bullet. Increasing the efficiency of our energy systems while diversifying our energy sources will not be easy, but it is possible. First, we must accept the reality of climate change and acknowledge our part in contributing to it. Next, we must choose to take action and demand that our leaders do the same! If we do, the world's energy would become sustainable, as our atmosphere becomes ever more life enhancing. The costs of alternative fuels are coming down, thanks to technological advances, while the costs of fossil fuels increase, especially as their true costs are fully calculated (hazards, health impacts, costs of transit and political conflicts).[53] A new long-term security will result from the recognition of our true energy capacity and its efficient utilization from diversified and dispersed sources. We are most fortunate to have been sent the signal of climate change!!!

[52] www.dsireusa.org

[53] "Energy Report", 2/12/7, Wall St. Journal

E) **CONTEMPORARY REPORTS**

"2006 Energy Resources Policy", National Sierra Club, 10/9/06.

"Tackling Climate Change in the U.S.", American Solar Energy Society, 2007.

"Deep Economy", Bill McKibben, 2007.

"Utah Energy Efficiency Strategies", report to Gov. J. Huntsman by Utah Clean Energy, April 2007. www.utahcleanenergy.org

Follow progress of Gov. Huntsman's Blue Ribbon Advisory Council on Climate Change. www.deq.utah.gov

"Sustainable Industries" (monthly magazine) www.sijournal.com

"Solar Today" (bi-monthly magazine www.solartoday.org

"Energy Autonomy: The Economic, Social and Technical Case for Renewable Energy", Hermann Scheer, 2006 : www.hermannscheer.de/en

Contributors to this study: Jean Binyon, Naomi Franklin, Marie Fulmer, Polly Hough, Sandra McIntyre, Mary Schultz, Doug Stark, Kathy van Dame, LeeAnne Whitaker, Carol Withrow, Marelynn Zipser.

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Professor of Engineering Brian McPherson, Univ. of Utah

Professor of Economics Richard Collins, Westminster College

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F) **DISCUSSION QUESTIONS**

1) Since the program of studying 'Energy Alternatives' was accepted in April, 2007, as a statewide issue for LWV of Utah, might we arrive at a statewide resolution of commitment towards energy reform?

2) What goals would we prioritize?

3) What actions can we exert in Utah?