We Can Live With a Fossil Fuel Future: Oil, Gas, Coal & Shale Oil

By Gerald T. Westbrook*

In an earlier version of this essay, an analogy was developed between our energy situation and that of 11 survivors in a movie of a plane crash in the Sahara. Both situations could be described as desperate. Both situations would exhibit entrenched opinions, zero tolerance for other views, little information and much confusion. Their crucial resource was water, ours is oil.

For the Saharan survivors, it was not until all other options proved futile that the remaining survivors—very gradually, and reluctantly—were able to coalesce around the one option that would save them, namely to re-build a plane from the wreckage. Initially most saw this as an insane idea. Our challenge is similar, to re-build our energy system.

Price Stability. When the price of crude oil sky-rocketed from $95 to $147 per barrel, it was easy to see the danger of such a situation. Less clear is the impact of a retrenchment from $147 to $35 per barrel. In this situation energy planning and implementation for areas such as alternative energy (AE) gasification becomes impossible.

Our country is still in a serious energy situation. Perhaps no one has stated it stronger than Matthew R. Simmons, a Houston investment banker. "It is sick", he concludes. This theme was continued in the *NY Times*. The writers wonder if the market is broken in some way creating a bubble of artificially expensive oil. While the price at $147 may look like such a bubble, Simmons thinks not. He notes that much of the supply is from fields that are old and getting older ─ "the era of cheap oil is over."

One can see three main pathways into the future. These widely disparate pathways or areas of concentration are AE, fleet electrification/nuclear power, and fossil fuels.

The title for this essay states that we can live with a fossil fuel future. *Warmers* and environmentalists will see this as insane. Indeed, our energy secretary, Steven Chu, has stated that "Coal is my worst nightmare." Yes, while coal has the highest level of greenhouse gas (GHG) emissions of all energy sources, I would argue we don't have the luxury to ignore coal. The key pathway to price stability is to reduce our call on global oil. What is necessary is an aggressive move to reduce this call.

Now, oil speculators are broadly accused of manipulating the market. Possibly, but all they do is simply buy and sell crude oil contracts. In order to perform this task, perhaps many times a day, they strive to read the market. Here I argue that the USA's call on global oil is an indicator to such risk takers. If the speculators can't see any progress in our ability to cut demand, or in our ability to increase supplies, they will soon start to bet again that our call on oil will go up. And, in the absence of any other inputs, they will, once again, place their bets that future prices will be a bit higher and not lower. And their next bids will also be a bit higher.

I will argue that, of the three non-perfect initiatives, the fossil fuel focus has the best odds for reducing our oil call, and the best chance at providing large amounts of additional energy.

Supply Security. This interest in supply security is in no way a pitch for energy independence. Indeed, energy independence is seen as an impossibility and an erroneous objective. Supply security can be achieved by building on a strong and reliable mix of all supply options. This includes coal, offshore oil, Alaskan oil, specifically the Arctic National Wildlife Refuge (ANWR). Now the environmentalists insist we can't touch ANWR oil. I would argue we don't have the luxury to "turn up our noses" on this resource. Many papers describe it as a pristine refuge and a cathedral of nature They inevitably show a picture with magnificent mountains in the background - the Brooks Range. But these mountains are about 50 miles from the featureless coastal plain.

George Will raises the idea that "some people use environmental causes and rhetoric not to change the political climate for the purpose of environmental improvement. Rather, for them, changing society is the end, and environmental policies are mere means to that end. The unending argument in political philosophy concerns adjusting the balance between freedom and equality." The overall good "is to enlarge government supervision of individual's lives."

Supply security also includes oil from the Mid East and syn-crude from Canada. One might ask why does it make sense for multi billion dollar investments in Canada for tar sands mining, processing and upgrading, but not an analogous effort in the U.S. on coal mining, processing and upgrading? How much difference can there be, when crude prices exceed $100?

Coal and Climate Change. It would seem that coal has become the pariah of

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any energy plan. Even without the so-called global warming crisis, coal has been viewed by many activists as unacceptable, due to the criteria pollutants (sulfur oxides, nitrogen oxides, and particulate matter) and mercury emissions that. Many activists have tended to ignore that the criteria pollutants have been effectively controlled at an affordable cost, and efforts are underway on mercury emissions.

Perhaps the activists have recognized for a long time that they needed something more—to shackle coal the same way they have shackled nuclear energy—and that is where the global warming issue comes in. Hence we have had a tidal wave of publications against coal. And the conventional wisdom is that this threat of anthropogenic global warming (AGW) is worse than high level radiation from fuel rod disposal.

Many critics of coal insist we must move into a carbon constrained world, even though we are facing the most serious energy situation ever. Of course, our politicians have jumped in, many with well meaning, but terribly misguided ideas, plans and bills. For example, the Democrats have come up with such winners as suing OPEC. And these critics have come up with the phrase: *clean coal*. Any coal that doesn't meet their definition of clean coal—which is coal used in a carbon constrained plant—is dirty or ugly or filthy coal.

The climate change situation facing this country has been described as the most awesome threat our country has ever faced. Barack Obama, as a senator, has stated "The future of our planet is at stake." Harry Reid called "climate change the most important issue facing the world today." Well, not hardly, as the senate shelved this issue after only 3½ days of debate. And Nancy Pelosi has also commented that we must start cutting global warming pollution immediately, "to avoid catastrophic climate impacts."

These, and other politicians, seem to have two naive convictions and/or political positions, namely all climate alarmism is true and all alternative energy hype is true.

Emerging Strategies I: Focus on Alternative Energies

Wind Energy

• **Recent growth**. In previous writings I noted that California had over 15,000 windmills by 2000, but these produced power only 18% of the time and contributed only 1¼% of total state generation. Since then growth of this energy source in Texas has been notable, and exceeded California in 2006. By 2007, TX had 4,296 mws, CA 2,459 and the U.S. 16,596.

• **Key problems with wind energy**. Surely much of the above growth in Texas is due to government support at all levels. However, in spite of this support there are many problems.

(i) High equipment and installation costs, even with many subsidies.
(ii) Limited availability of the installed capacity and hence limited generated power.
(iii) Very remote locations frequently requiring new and long transmission lines.
(iv) Working with governments. This comes at a price. A recent commentary noted what government involvement can lead to, when it gets into market creation such as wind energy. The writer reported on a meeting on wind energy, attended by 10,000 and commented that the more the hype blows the more Robert Bradley, a former director of public policy analysis for Enron, "hears the voice of his old boss, Ken Lay." Bradley spent 16 years at Enron. He noted Enron "was a major backer of the state's 1999 mandate calling for the development of renewable energy sources, including wind generation."
Bradley further notes that "Enron lived, thrived, and perished in and through the mixed economy. Enron's artificial boom and decisive bust had more to do with government regulation than free markets. Ken Lays meteoric rise and stunning fall were not the saga of a capitalist wildcatter, they were the tragedy of a political rent-seeker in action, prominently including government intervention sought in the pretext of addressing climate change and promoting 'green' energy."
(v) System penetration. This attribute was reported on in a summary of the hype used by politicians. This case study is from the Canadian province of New Brunswick (NB). The energy minister for NB started with a claim they would add 4,500 mws of wind energy to an existing system of 4,000 mw. The neighboring state of Maine, with twice the population, had all of 42 mws. He back tracked to 1,250 to 2,000 mws. However, there is the question of system design. Even adding as little as 15 percent wind generation to an existing system requires constant monitoring and adjustment to prevent power fluctuations and grid instability.

• **Conclusions on wind energy**. With this panorama of problems it is hard to believe that this source of energy, in spite of major government support, will be the solution to our crisis.

Biofuels

There is little question that biofuels will play a role in our energy system. However, projections range from unbelievably bullish to one beset by many problems. One input comes from a key environmentalist. This scientist asked the question on the amount of electrical generation that could be achieved from wood grown on the net forest area of commercial timberland, namely 483 million acres. The answer was 17.5 percent. He concluded that the idea "that biofuels are going to end U.S. dependence on foreign energy supplies, is an illusion." Another reference reported world consumption of 10 billion gallons of biofuels in 2006, including ethanol and biodiesel. "This is 650,000 barrels/day, less than 0.8% of world oil consumption." A summary on biofuels follows.

Basic Ethanol Production

Ethanol from corn. While modestly boosting the supply of liquid fuels, this fuel may actually be increasing our overall energy demand. Many references report that this fuel requires more energy to produce than it delivers. Bloomberg reports that David Pimentel, of Cornell University of Ecology and Agriculture, argues it uses 29 percent more energy than it delivers.

Ethanol enthusiasts seem to prefer talking about the oil imports displaced. For example, one reference cited 170 to 500 million barrels of import reductions in 2006. These comments were by the Renewable Fuels Association (RFA) or its friends. However, the RFA also noted that ethanol production amounted to 4.86 billion gallons for 2006 or 116 million barrels. However, since ethanol has about two-thirds the energy content of gasoline, the116 million barrels drops to 77 million barrels or only 2¼ percent of U. S. gasoline consumption. Today, this incredibly subsidized field—corn subsidies and ethanol subsidies—has 20 separate federal laws to boost ethanol use, and 49 states offer additional support.

There are problems with this option such as impact on many food markets such as beef, cheese and milk, and related businesses. Also the energy secretary has been a staunch opponent.

Ethanol from sugar cane. Supporters conveniently ignore that Brazilian ethanol comes from a far superior feedstock - sugar cane, not corn. They also forget to mention that Brazil, in parallel with their ethanol efforts, has also become one of the giants in offshore drilling and production. The prospects for this fuel in the U.S. have been dismal, with U.S. sugar cane production less than one percent of Brazil's. And U. S. production is located only in Florida and Louisiana.

Second generation biofuels. Dr. Chu's key work at the Lawrence Berkeley National Laboatory (LBNL) was the so-called Helios Project. This included the Energy Sciences Institute, a joint effort by BP, Cal-Berkeley, Dupont, the University of Illinois and LBNL. Unlike his position on corn ethanol, Dr. Chu has been reported to be a big proponent of cellulosic ethanol. Hence one can expect an acceleration of effort in this area. Three areas show promise:

(i) Ethanol from cellulosic feedstocks.
(ii) Biodiesel.
(iii) BioButanol

An expanded version of this essay provides details on these options.

Hydrogen

Promoters of H_2 frequently claim its only emission is water vapor, from the fuel cells. This is highly duplicitous. For example, in a 2004 paper, a professor emeritus of environmental studies, noted that "given current technology switching from gasoline to H_2 powered fuel cells would greatly increase energy consumption and nearly double GHG output.

One might cite several routes to get H_2.

Direct Electrolysis. H_2 could be extracted from water via electrolysis, a 200 year old process, but it is expensive, would take a major amount of electricity and any emissions caused by this new demand for power would need to be allocated to hydrogen. About 4% of global hydrogen production is by this process.

Indirect Electrolysis by thermo-chemical cycles. In theory H_2 could be extracted from water via electrolysis by thermo-chemical cycles. For example the Hybrid Sulfur Process, derived from a Westinghouse process, uses two reactions.

A low temperature production reaction: $2H_2O + SO_2 = H_2SO_4 + H_2$.

A high temperature regeneration reaction: $H_2SO_4 = H_2O + SO_2 + ½O_2$. This high temperature reaction ~950 ºC, would use energy obtained from advanced nuclear reactors.

Steam Reforming. Almost all H_2 produced in the world today is via this process. The raw material for

this process is inevitably natural gas. It has been estimated that ~15 trillion cubic feet of gas would be needed, annually, to produce H_2 for the U.S. to power the vehicle fleet. This would boost the consumption of natural gas in the U.S. by about 66 percent. Even today gas supply requires imports from Canada, and even from the world, via specialty tankers. And any emissions caused by this new demand for gas would need to be allocated to H_2.

Solar-themal processes. A new process, but essentially unproven, could emerge. A recent reference supported "solar-thermal biomass gasification to syngas using 'rapid aerosol reactors' in a 'power tower configuration'." Sounds like a huge amount of new technology.

Summary. As noted above there are rather huge problems with hydrogen production. There are also major problems with H_2 distribution, storage and use. The current fuel cells were developed for the space program and may not be optimized for autos. There is also the issue of cost. So hydrogen is an extreme long shot as a replacement for gasoline.

Conclusion on Alternative Energy

The above is a sampling of key areas of alternative energy. In spite of its costs (and the need for subsidies); its embryonic status (and the need for major research breakthroughs); its low availability (and the need for backup generation); the remote locations (and the need for transmission capacity); and in some cases the low liquid fuel contribution; the various forms of AE can make a contribution. Can they be the solution? The above analysis would suggest not.

Emerging Strategies II: Focus on Electrified Transportation

High Energy Density Battery R & D.

Sodium Sulfur battery (NaS). One area that looks very promising is the emergence of the Sodium Sulfur battery (NaS, where Na is the chemical symbol for Sodium and S for Sulfur). Note that this approach was pioneered by Ford Motor Company for the auto application, and by the Dow Chemical Company, over 40 years ago. One key problem for this battery in autos is a very high operating temperature of 350 ºC, hence a key safety problem.

However, the NaS unit was brought to the demonstration stage for electric utility power storage, by a Japanese company and American Electric Power (AEP). Many NaS batteries are in use in Japan, and AEP has tested a 1,200 kw unit, with plans to add a unit twice that size. Another utility is planning on a 5,000 kw unit.

A slightly different application involved an installation at a major bus company. This is the first installation on the *customer side* of the power meter in the United States. This installation used electric motors to drive three compressors, used to refuel natural gas busses. This battery is capable of providing one megawatt for up to seven hours a day. It permits buying power at off peak times, plus cutting back a shift in operations.

Lithium ion battery (Li-ion). Recent developments—where the initial work is 100 years old—are encouraging. There are many major organizations active in this field, and many technical developments emerging. Two are noted here.

Plastic film separator. Exxon-Mobil, in conjunction with it's affiliate, Tonen Chemical has developed and is now producing an advanced performance film for the Li-ion battery. These separators offer enhanced permeability, higher meltdown temperature and melt integrity. This film offers major increases in the film's thermal safety and overall quality control.

Silicon nano wires. The key development is to replace the existing carbon anode. This revised battery "produces 10 times the amount of electricity of existing lithium-ion" units.

The market for Lithium-ion batteries is anticipated to grow ten fold, from 2008 to 2015, reaching $9 billion. Applications in laptops, power tools, military and space are proving the technology for the large emerging units for hybrid vehicles and full electric automobiles.

While there has been a tidal wave of news items on the Li-ion battery, there has been very little hard data on Li-ion battery costs, performance and lifetime. Until such data emerges this battery must be filed under a work in progress. Still, in spite of the lack of such information, there has almost been as many news items on new demo or prototype vehicles.

Conclusions on new batteries. These two areas surely look promising:

NaS Unit. This unit looks like a fit for standby power. It is rugged and reliable looking. It would seem that it could be built just about as large as desired. However, it does not appear to be a fit for the vehicle market, primarily due to its high operating temperature.

Li-ion Unit. This looks good for vehicles and clearly is getting all of the attention today. With the

new technologies reported above, the previous problems with fires and explosions should be a thing of the past. Indeed, optimism for this unit is now very high. At least five manufacturing plants are planned: four in Michigan and one in Kentucky. One forecast has suggested a growth from $700M in 2008 to $3.2B by 2012

Surely more hard data is needed on both of these units, particularly on cost, performance and lifetime. Also it is useful to remember historical development times for batteries in general.

Power Support

Nuclear. An acceptable battery just might see the rebirth of nuclear power. Senator McCain recently called for 45 new nuclear plants. However, as one who spent part of his career trying to get a nuclear project rolling—a half a dozen tiny assignments, plus dozens of letters, only to see it converted to a natural gas plant—a program to build 45 nuclear plants will be extremely difficult to get underway, and even more difficult, if not impossible, to implement.

Fossil Fuel based. Acceptable batteries just might have to be supported by other types of power plants than nuclear. Clearly we would need the fuels to fire such plants.

Emerging Strategies III: Focus on Fossil Fuels

Oil and Natural Gas. We can do much more to improve domestic oil and natural gas supply. *No way, the enviros/warmers scream*. Whether it is outer continental shelf (OCS) oil or the ANWR, this crowd inevitably bad-mouth such initiatives as providing only a tiny amount of energy that will never help our situation. Naturally they never see that such a problem may exist with AE. Their bad mouthing on ANWR and the OCS includes their claim that such oil development would only cut three cents off the price for a gallon at the pump. However, if one assumed an ANWR yield of 10 B barrels of oil, over 25 years, this is about 1 MBPD. There would be a cut of the same size off of our global oil call. And only three cents? Please!

While U.S. oil production peaked over thirty years ago natural gas is enjoying a bit of a boom. In 2009, gas production surged due largely to unconventional gas (UCG) resources such as the Barnett Shale, that had not been tapped in the past. This UCG resource—shale gas, tight sands gas and coal bed methane—has shown a rather surprising increase. Note that the EIA projects unconventional gas will represent about half of total U.S. production by 2012.

While this increase in UCG speaks volumes about drilling technology and geological savvy in managing these resources, it does not speak well of the state of conventional gas resources. This includes the fact that decline rates for gas wells have almost doubled over the past ten years. Perhaps more ominous is the well known dramatic decline rates for shale gas. All of these inputs suggest we will soon be looking strongly again at gas imports.

Coal. This fuel is undergoing massive expansion in China, India and elsewhere. We can do much more with coal, not only for power, but for gaseous and liquid fuels too. For coal, the resource base is almost unlimited. The U.S. has been called the "Saudi Arabia of coal." We need a program here on coal, analogous to the Canadian effort on the Athabasca Tar Sands.

Some will think such a pathway is absolutely insane. However, the hope is that, in the future, they will come to the conclusion that it is the only way out of our situation. Here we would boost our conventional supplies of domestic oil and gas, we would increase our use of coal generation and we would start to utilize coal gasification, coal liquefaction and shale oil.

One cannot expect the *warmers* and the environmentalists to salute the fossil fuel focus plan. As with nuclear, opposition will be loud, massive and entrenched. Indeed this could well be the fight of the century. However, we don't have a century, probably less than a decade.

Climate Change

I have followed and written on global warming (GW) for 20 years. My recent inputs have focused on what I call the key witnesses for the defense of the skeptical perspective, including:

- key non scientists, such as Vaclav Klaus, Michael Crichton and George Will.
- *Distinguished Veterans(DVs)*, mostly scientists, mostly retired, with incredible accomplishments (These are veterans from the research community, some with emeritus in their title. I have developed a listing of over 60 such scientists. In a recent paper the views of four DVs on hurricanes, three on physics and four on various aspects of food production were noted. In a more recent paper the views of 17 physicists, all skeptical on GW, are noted.).
- other witnesses, include active scientists, TV weathermen and State Climatologists.

Conclusions on the Climate Change Situation. In a recent paper the views of the above witnesses have been noted. Their lifetime publications and comments give the nature of their views on the GW issue: all skeptical. There are simply too many highly educated, high horsepower individuals—that are concerned that we have not diagnosed the climate scene completely or correctly—to ignore their views.

Today the proponents of this issue are a mixed bag. This includes the behind the scene organizers; those who are intimidated by the fear of job or funding loss; the many fellow travelers who are riding the political winds; and many who have been brainwashed on this issue, or who endorse the global warming issue as it makes their lives easier.

The very best one can say about the GW issue, and the need to move to a carbon constrained world, is that it is premature. The very worst is that it is a fraud.

The Environmental Situation in General

I have followed environmental issues in general for over 40 years, and for the coal area, in particular, for over 30 years. My position in this area is that we can live with this fuel. One might ask what are my credentials to take such a position. This position has been based on inputs from three areas: emissions control improvements; individual exposure to coal, oil and key chemicals; and experience obtained via The National Coal Policy Project from 1977 to 1979.

Emissions Control Improvements. As noted above, the key pollutants from coal fired power plants have been controlled. "On balance we've achieved much 'cleaner' generation of electricity from coal since the Clean Air Act of 1970." With such improvement in the environment in general and coal units in particular, a key question is why then do we hear so much bad news about the environment? Could it be that environmentalists often lie? Indeed, Lomborg has shown the ways in which professional environmentalists play loose with the truth.

Individual Exposure to Coal, Heavy Oil and Critical Chemicals. The public is concerned about such a reliance on coal. As a means to soften such concerns I will offer a view of my trip through life, as it has been involved with coal, heavy oil and other potential environmental problems. Yes, this represents only a sample of one, and yes, this is not proof that these commodities have never had problems in the past. Rather I present this input to raise the possibility that coal just might not be the pariah it has been painted to be.

Saskatchewan. I will start this trip in the city of Saskatoon.

Home heating. I was born into a coal fired home, and spent my first dozen years living with coal. We had a coal bin and had periodic coal deliveries. And there was a certain amount of coal dust. Over this period we converted initially to a coal stoker, then fuel oil and finally gas.

Coal fired trains. For my first six years our home was one block from the Canadian National Railroad tracks heading to the downtown station, and other destinations. The engines, perhaps a dozen or more a day, slowed down as they entered downtown, or speeded up, as they left.

Source of electricity. I was also born into a city with a coal fired electric system and spent my first 22 years living with this system. The local utility had two large coal fired steam-electric stations. One of these was ~ ⅓ of a mile away, the newer unit was about five miles southwest.

Local refinery. This refinery was about as small as a refinery could get, but one knew it was around. We lived about five miles east of it, yet when the west wind blew, which was most of the time, the aromas would be very noticeable. And one could also see the plant flare at work.

What does one do with a used coal bin? When I was 18 I took a summer job in construction. The first task was on a project where a building was being renovated, and a coal bin had to be torn down. This room had plaster walls and ceilings and coal dust was everywhere. It took a week to complete, and each day I came home totally black. I had to strip to my briefs, and be hosed down extensively. I could clean the outside of my body, but doubtful on the inside.

Local asphalt plant. For two summers, I was an inspector at the city's asphalt plant. There were two environmental problems at this plant: fine dust from the hot gravel and tar oil vapors.

Ontario. After graduating I went to work in Ontario, with a major oil company.

Refinery Design. This included work for refineries in Calgary, Vancouver and Norman Wells. Clean work, but our offices were across the street from the largest refinery in Canada.

Petrochemical Plant Startups. The first startup was on a detergent-alkylate plant. Everything that could go wrong with a new plant did and I was involved in this startup, for almost a year. It used benzene as one of its raw materials, a known toxic substance. Several precautions were taken, but there were bound to have been some trace benzene leaks all during this startup. The next startup was a heavy oil

steam cracker for ethylene, propylene and butadiene production.

Michigan. Next, I worked for a huge chemical company in Michigan.

Steam and power system. Coal fueled this plant, and the first environmental problem was coal dust. We had moved into an apartment in 1960, when we discovered our car and our window sills would frequently turn black, ditto for the inside window sill. This plant needed electricity for motors and for chlorine production. However, the power plants were old, with no stack-gas treatment. When I complained, I was told be patient. It took about a year of patience.

Chemical exposure. This included brief times in a glycol ether - brake fluids complex, a polystyrene plastics plant, a styrene butadiene latex system, and a herbicide plant. In 1962 the DOD asked Dow to make Agent Orange, a mixture of two herbicides: 24D and 245T. One of the herbicides, if it was not made properly, could contain an impurity, dioxin, The company scientists developed analytical tools that could measure dioxin in the parts per trillion level. Because of this rather incredible new capability they found that dioxins were all over our society, wherever any burning occurred . They were found in auto mufflers, cigarette smoke, wood soot and many other places, including chemical plants and paper mills.

Summary on personal exposure to coal dust, tar and critical chemicals. I believe one can conclude that I have had more than my share of exposure to coal dust, tar and critical chemicals. I am now 76, and going strong. Again I realize this is only a sample of one, but it is food for thought. Can the hideous problems painted about coal just be a bit over-stated?

The National Coal Policy Project (NCPP) - 1977 to 1979

There were also environmental concerns, back in the 1970s, on the further use of coal. As a result, the NCPP, under the auspices of Georgetown University, was initiated. Here meetings between environmentalists and industrialists were held to try to define a future pathway for coal that would be acceptable to both camps. This was a difficult project to progress. Indeed, it was decided early on "to leave the task of making projections to others." However, some 200 recommendations were made. I will note my impressions of this activity, primarily from the perspective of the coal transportation sub-committee.

My first impression was that the environmentalists were better prepared. In contrast all the members of the industrial side would seem to have very little time to do any homework. My second impression was that we could never get these environmentalists to make a list of the problems and define their priorities. I came to the conclusion they would never do this. My final impression was that the attitude of some members of the environmental movement "scared the devil out of me." They were so intense, so certain of their cause and so socialistically oriented, that they seemed to be saying "get us elected and get out of the way."

Today I hear what all the activists and the politicians have to say about coal and I'd swear they are the same people that I met 30 years ago. They are so intense, so certain and so socialistically oriented, they seem to be saying "get us elected and get out of the way."

Conclusions

Today, our country is in the most serious energy situation it has ever faced. Here, I have argued, directly or indirectly, that:

- while the various forms of AE can make a contribution they will not be the solution to our current crisis - we will be using fossil fuels for decades to come;
- the pathway to price security is to reduce our call on global oil via a substantial boost in our conventional supplies of domestic oil and gas, via an expanded and broader use of coal, via a start on shale oil, via a dramatic improvement in electric vehicles and the power system to support such a move and via a boost in AE and on energy efficiency and conservation;
- the most positive area is the development of high energy density batteries, while the most negative area is the incredible support and subsidies for corn based ethanol;
- the climate change situation, in regards to fossil fuel use, is manageable, and the need to move to a carbon constrained society is premature at best;
- the environmental situation with coal is manageable, a judgment based in part on my lifetime exposure to coal, and in part on the improvements in emissions control over the past 40 years.