The Oil Drum
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

Advice to Pres. Obama (#5): One Engineer's Advice for Energy Policy

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This article is one of a series of articles, offering energy advice to President Obama and his administration.

The incoming Obama administration has promised a much-needed change in the direction of US energy policy (or non-policy, as some see the current situation). However, some of those changes appear to be campaign gimmicks or aimed at satisfying special interests rather than solving our various problems. (The heavy-for-light crude swap in the Strategic Petroleum Reserve proposed in the Obama-Biden energy proposal appears to be one such gimmick.)

For much too long, US energy legislation (I hesitate to call it policy, because it lacks the coherence to justify the label) has been aimed at short-term patches on problems which have only gotten worse. CAFE regulations have barely held fuel economy steady, while low fuel prices caused consumption to skyrocket. "Free trade" allowed cheap oil imports to kill movement toward efficiency and substitutes. The auto industry lobbied against fuel taxes to promote its short-term interest in selling profitable trucks, with the long-term result that all 3 US automakers will go bankrupt in the next year if nothing is done.

We've had change before, but the results put us where we are now. It's time for the *right* change.

And it has to be right this time, because after 30 years of screwing around we are out of second chances. And one thing we must be very careful to avoid is...

Cargo-cultism, Ghost Dances and Stone Heads

This is not a Field of Dreams; you can build it, but it will not make them come. Building airplanes and control towers of bamboo will not bring prosperity from the sky. Mysticism and cargo-cultism are not things of other places and other times; we are human and can make the same mistakes, only New, Improved, and much, much bigger.

We can laugh and marvel at the ancient inhabitants of Easter Island, whose stone-carving came at the expense of the last trees they had. Once the island was denuded, they had no boats, no building materials, nothing; with no boats there was neither fishing nor escape. The people starved and the population crashed. We can make mistakes as much bigger as Madoff's pyramid scheme is compared to Ponzi's, and so much more disastrous.

Cargo-cultism and ghost dances are alive and well in America today. You can "drill here" all you want, but dry holes benefit no one. You can start the "shovel-ready" road projects, but people who drive less and less every year will get no use out of them. You can make ethanol out of corn, and watch the nation's best topsoil wash down the Mississippi to expand the dead zone in the Gulf of Mexico. All of these cults have their constituencies. All of them will want more mandates, more money, more power. If you're going to be the one to fix this mess you've inherited, all of them must be told "No."

Whatever we undertake to do must aim for three very important things:

1. It must reduce the use of what is scarce, imported, or gives money to people hostile to us.
2. It must only increase the use of what we have in abundance (which isn't everything touted

as such).
3. It must reduce the burden of emissions on land, water and air.

If we don't keep all of these things in mind, we will make bad problems worse. (How much worse? Think "TVA coal-ash lagoon burst", but flooding the entire Ninth Ward of New Orleans. *That* much worse.)

Employment and Economic Stimulus

The massive financial meltdown has put many Americans out of work and idled a great deal of our industry.

Paradoxically, the economic slump has created opportunities. Demand for both industrial and consumer goods is down, and the idle production capacity can be used to improve our economic and energy situation. Vast amounts of materials such as scrap metal, once headed to China, now languish in ports; recent news reports state that the price of scrap aluminum has fallen from 80¢/lb to 40. These materials are a boon. We can use metal which would have gone to make appliances to upgrade our infrastructure. This nation needs a great deal of repairs, upgrades and additions, starting with light and heavy rail and support towers for high-tension electric lines. We don't need plans to start building, either. Materials like rails, cables and material for pylon towers can be fabricated starting immediately and stockpiled for later use. All of this can put people back to work as soon as the first orders are placed.

The stimulus should emphasize manufacturing, not the "consumer economy". The US economic crisis is as much about our inability to finance our trade imbalance in general as it is about any particular import, such as oil. Pumping money into the economy to send it to China for plastic toys and big-screen TVs is just going to drive us further into debt. We are now at the end of our ability to print dollars to buy things; we used to be a country that made things, and we must return to our heritage. This is the only way to create the jobs that will pay, and the improvements that will last.

It is important, however, to follow one principle: all investment must reduce costs and pollution. The world is running out of oil, and the atmosphere's capacity to absorb more CO_2 without damage is already exhausted; our new investments should be aimed to solve both problems and exacerbate neither. This means that we cannot and should not "invest" in new steel mills or vehicles which do not slash petroleum use. Repairing roads is probably a good idea, but adding roads is a bad one. Last, anything that reduces our need for fossil fuels in general and oil in particular is going to be a very good idea for the years ahead.

And since this gets us around to the topic of energy, it's time to talk about

Electricity

No modern society can run without electricity, but the US electric grid is both somewhat run-down and supplied by some of our biggest sources of pollution. These have cost us in many ways both immediate and deferred, from the costs of blackouts, to acid rain and mercury emissions killing forests and making fish dangerous to eat, to each added ton of CO_2 acidifying the world's oceans and increasing the threat of climate change. Finally, we are not getting the most benefit out of the investment we've already made. We need to both make the grid better, and use the grid better.

The US electric grid represents perhaps a trillion dollars of investment, and carries on the order of $400 billion in power per year. However, this investment was originally made for providing power from local plants to local consumers, with relatively little transfer of power over long distances; most of the long-distance connections were planned to provide reserve capacity only. Recent changes in law have forced utilities to buy power from distant generators, but did not provide investment to increase the capacity of the transmission lines to carry it. Carrying power from ever-more distant supplies to population centers, such as wind farms in the Midwest to the Great Lakes and the coasts, will require many times the long-haul transmission capacity now installed.

The consumption end needs work too. Electric consumption in most parts of the USA peaks in summer afternoons, and in other places on winter nights. The grid is designed to handle these peaks and is under-utilized the rest of the time. The law must encourage the shift of power consumption to times when the grid has surplus capacity. Ice-storage air conditioners and electric vehicles are two ways to help improve the utilization of the electric grid, getting more out of the investment already made.

Of course, none of this would be possible without generators. Whether we increase overall consumption or decrease generation from certain fuels, we will need new generation to make up the difference. I'll touch on that below.

Transportation

The world oil shortage (which precipitated the credit crunch and economic contraction) mostly affects air and road transport. Trains use relatively little oil, and pipelines use even less. Both pipelines and trains can be electrified and use no energy from oil at all.

The bulk of the USA's diesel fuel goes to run medium and heavy trucks, carrying freight on freeways. Not long ago, most of this freight would have gone by rail instead; we can make it so again. Just a couple of decades ago, rail rights-of-way were stripped of track to reduce the property values and the taxes they had to pay. Railroads are already replacing some of that track, but government assistance can get it done much faster. Exempting the added value from property taxes (the same as Interstates enjoy) would make certain that the same thing does not happen again.

Instead of building new freeways, a sensible program would be to develop new rail lines or redevelop abandoned ones. These new rail lines would help get freight traffic off the highways, both saving fuel and reducing road congestion and damage. This will not only save huge amounts of diesel fuel, it will save lives. These rail lines should be electrified to eliminate diesel noise and pollution. You can call this the Interstate Rail Transport Network.

Light rail for passenger transport is a good alternative to automobiles for many trips. There is a backlog of streetcar and other projects requested by cities; these should be put on the fast track (no pun intended).

The personal vehicle is not going to go away, and both the pollution and fuel consumption of this class must be addressed. The plug-in hybrid has had your support for some time, but further initiatives are needed to get the charging infrastructure into the field and promote interoperation with the electrical grid. This can simultaneously cut fuel demand, cut air pollution and make the grid more reliable—a three-fer.

One last detail is intermodal transport. Containerized cargo has long gone from container ship to rail flatcar to semi-truck, but vehicles themselves can be made intermodal. The Blade runner dual-mode truck could put semi rigs directly on rails; those trucks could then draw electric power from overhead wires, eliminating the fuel consumption and pollution. Dual-mode electric delivery trucks could use streetcar tracks and overhead power lines to run most of their mileage and recharge batteries between stops. This would make it far easier to convert truck fleets to electric and save critical diesel fuel for off-road and emergency uses.

One detail of intermodal transport is worth dwelling on: vehicles capable of jumping between roads and rails would allow the conversion of expressway medians to rail lines. If maintenance of a lane of roadway is too expensive, it could be rebuilt as rail instead. Rather than having to rebuild the road surface every ten years or so, the rails would be good for 50 and the concrete sleepers and roadbed for a century. This would truly be a lasting legacy.

Alternative Energy

As supplies of fossil fuels become smaller and more difficult to extract, what replaces them will be "alternatives" almost by definition. However, "alternatives" vary widely in their usefulness. The real alternatives can displace large amounts of other energy supplies while using little or no fossil energy themselves, and are viable without subsidies. Some of today's "alternatives" cannot meet either standard, and should be de-emphasized or dropped.

Wind

Wind is the alternative-energy elephant. It is mostly useful for electricity, but its share of US generation is roughly 1% and rising rapidly. The estimated energy available from wind power in the USA's land and continental shelves exceeds the nation's total energy consumption from all sources. This is clearly a place for the Engineer's corollary to Sutton's Law[1]: Go where the energy is.

There are two problems with wind, one legislative and one logistical. The legislative problem is the structure of the Production Tax Credit, which is only available to indirect investors. This should be replaced with a straight feed-in tariff, simplifying the system and cutting out third parties. The logistical problem is more difficult. The windiest parts of the country are also the least-populated and have little grid capacity to export their power to the rest. A new network of high-voltage DC (HVDC) power lines is needed to help get power from the major areas of supply from the Dakotas down to Texas out to buyers across the country.

Solar

Solar energy has even greater potential than wind, but it is far more expensive and only accounts for perhaps 1/100 of 1% of US electric generation. This makes it difficult to scale up in time to make a big difference in the short term.

Regardless of this, solar needs attention - R&D and targets for installation are good, but more important is legal protection. Residential solar electric, solar heat and solar hot water can make big contributions over time, but building codes and residential associations often throw up roadblocks. Just as some states have prohibitions against SLAPP lawsuits, it is time we took action against SLURS: Strategic Lawsuits Undermining Residential Solar. It is time to define classes of solar installations which must be allowed, and levy triple damages against persons, associations or governments which attempt to restrict or prohibit them.

Tidal, Wave and Micro-hydro

These are even smaller than solar. They have less potential than wind, but may be suitable for niche applications. No big bets are warranted.

Biofuels

Biofuels are a problem. Yes, you read that right: a problem. They have been promoted heavily as the solution to all our petroleum woes ("Live Green, Go Yellow"), but they cannot deliver. Ethanol from corn is a particularly large problem. It has an enormous political constituency from farmers and distillers, all built on subsidy money from US taxpayers and creditors. Corn ethanol is essentially "laundered" fossil fuels: diesel for cultivation, natural gas for fertilizer and distillation, oil for petrochemical pesticides. US natural gas drilling costs are skyrocketing; it is only a matter of time before the bill for this comes due.

Most of the claims made for ethanol are pure marketing hype. If the entire US corn crop were turned into ethanol, it would only replace about 1/5 of the recent US consumption of gasoline by volume (and a substantially smaller fraction by energy). This is not a solution[2].

I believe this was always the point: it isn't a solution and was never really intended to be one. Ethanol as it currently exists is a farm subsidy program marketed as an energy program, and it can soak up as much corn as we can grow. Its purpose was not to get the US off imported oil, but to guarantee that surpluses could not drive the market down again. It works, but we cannot afford such luxuries any more; if we cut off the subsidies, the entire industry would dry up and blow away. As a senator from a farm state, you should know this as well as anyone. We can no longer use borrowed money to hide from politically difficult facts; it's time to fix the real problem.

Biomass does have a future. It is the only way that we can take carbon out of the air and control what happens to it. It is the only source of carbon that will not become more and more scarce over time. We are going to need it to make chemicals, plastics, and just to reduce the CO2 level in the atmosphere. Dow Chemical has already started working with a Brazilian company to convert ethanol from sugar cane into ethylene, which is the raw material for polyethylene and so much else. Stone-age methods are sufficient to turn inedible crop byproducts into charcoal; stirred into soil this creates "terra preta", which increases the fertility of soils and stores carbon for thousands of years. As a senator from a farm state, you should know how important soil fertility is. It is one of the USA's little-recognized natural assets, and it behooves us to improve it. We'll need it more

than you know.

If we need to pay farmers to do something more than grow food, we should pay them to make energy and take carbon out of the air. If we are going to charge carbon taxes, we can pay farmers for every ton of carbon they remove from the air and plow into the soil. When farmers turn the charcoal's byproduct gas into electricity, or digest the manure from livestock to make biogas, we can guarantee them a market for their power. The law can help the farmers help us, by paying them to do the right thing. For decades, the farm bill paid them to do the wrong thing; that's one change that is long overdue.

Nuclear

Nuclear is the other problem facing the USA, but for the opposite reason. It has long been the bogeyman of "progressives" and self-styled environmentalists, to the point that they have attempted to eliminate it world-wide and have actually succeeded in some countries. In the USA, their efforts have managed to make nuclear power more expensive and frustrated efforts to dispose of spent fuel, causing the US government to default on its obligation to take control of it and forcing it to be stored at plant sites even after the plants have closed.

The driving force behind this is mostly a mistaken impression that nuclear reactors equal nuclear weapons, which has been repeated by many ideologues. This propaganda and the consequent nuclear paranoia have been felt throughout society, even forcing nuclear magnetic resonance scanners—which have nothing to do with nuclear fission or radiation—to be renamed "magnetic resonance imaging" (MRI) to avoid frightening the public!

We can't afford such misconceptions any longer. Fortunately, they seem to be falling to the pressure of reality. No less a luminary than James Lovelock has recognized that climate change is a far greater threat than nuclear energy, and it's time to switch away from fossil fuels ASAP. The recent natural-gas spat between Russia and Ukraine has re-awakened interest in nuclear energy across Europe as an energy source with fewer sources of insecurity.

Nuclear energy is certainly worthwhile. It is one of the safest sources of electricity in the USA, with an enviable record of accidents. Unlike most renewables, it can be located where the users are and is available whenever desired. Despite the concerns about nuclear waste, the volume of spent fuel is so small that a plant's lifetime production can be stored in concrete casks on the grounds; the recent flood of a billion gallons of toxic coal ash from a TVA dump makes a very sharp contrast to the minuscule output of a reactor.

This isn't good enough. Our nuclear technology still has faults:

- it uses only a fraction of the energy in the uranium we mine,
- it leaves much more waste than is necessary, and
- it presents proliferation hazards that could be avoided.

We should do better, and we can.

The USA has developed technologies to address all of these problems, and then mothballed them. The failure to develop our capabilities was not technical, but political, and came mostly from within your own party. This is another luxury we can no longer afford. These should go back on the front burner as soon as humanly possible.

The neglected technologies are:

- The molten-salt reactor (MSR)
- The Integral Fast Reactor (IFR)

These two technologies have several very valuable properties in common:

1. They reprocess their fuel at the reactor site.
2. Because of the on-site reprocessing, there is no storage of spent fuel.
3. Also because of this, the volume of waste is minuscule; the waste from a reactor's entire lifetime can be stored on-site and not removed until decommissioning.
4. They can use roughly 100 times as much of the raw fuel material as today's reactors.

A ton of raw nuclear fuel (uranium or thorium) can make approximately one gigawatt-year of electric power in an MSR or IFR. The total electric power needs of the USA could be satisfied by less than 500 tons per year of either, and a great deal of this could come from material already mined or even designated as "waste". Because of these properties, the MSR and IFR are potential solutions to both the USA's energy difficulties and the nuclear waste problem.

The Molten-Salt Reactor (MSR)

The Molten-Salt Reactor was originally developed for nuclear aircraft, but it was later tested as an alternative to water-cooled reactors. An experimental reactor at Oak Ridge National Laboratory was tested using three different fuels: enriched uranium-235, plutonium and uranium-233 (bred from thorium). It ran well on all of them. The final run was intended to gather data to evaluate the feasibility of a thorium-uranium fuel cycle, and was apparently successful.

Molten-salt reactors have a number of advantages over today's water-cooled technology:

1. They cannot suffer a meltdown, because the fuel is already molten. If the cooling systems are shut off, the reactors shut down through their essential physics; they are inherently safe.
2. They cannot explode, because they run well below the boiling point of the salts and require no pressure vessels. This also makes their components relatively lightweight and easy to manufacture.
3. They can run at relatively high temperatures, which increases their efficiency and makes the heat usable for many industrial purposes.
4. They can remove fission wastes continuously, so there is never a danger from "afterheat" when a reactor is shut down.
5. The extracted wastes are relatively pure rather than containing large amounts of unused fuel, so their bulk is comparatively tiny. The wastes can be made ready for permanent disposal right at the reactor site. Fuel cannot be diverted for weapons because it never leaves the reactor building.
6. They can be started up with plutonium from spent nuclear fuel or reclaimed weapons material, and can destroy this fuel while breeding new fuel from thorium.
7. The physics of breeding thorium to uranium creates uranium-232 as well as uranium-233, which is not a difficulty for power production but makes the material unsuitable for use in weapons. Even more so than light-water reactors, molten-salt thorium breeders do not pose a risk of nuclear weapons proliferation.

According to recent news, the USA has approximately 900,000 tons of high-grade thorium reserves. This is approximately 2000 years of supplies at current rates of electric consumption,

or hundreds of years if thorium was substituted for all fossil fuel. Lower-grade thorium resources include coal ash.

In addition to reactors using molten fluoride salts, it appears to be possible to make fast-breeder reactors using molten chloride salts. This has not yet been tested, but it probably should be.

The Integral Fast Reactor (IFR)

The IFR is another promising technology nixed by partisan politics. A prototype reactor was killed by a Democratic congress in 1994, despite test results showing great potential. Fifteen years have now passed, fifteen lost years. It's time to go back to it.

The IFR is similar in some ways to the Molten Salt Reactor. It can convert nearly 100% of the raw fuel (uranium in this case) to useful energy; it reprocesses fuel at the reactor; it produces tiny amounts of waste pre-packaged for disposal; the fuel processing does not separate weapons-grade components; and the fuel from the reactor is always too radioactive to be safe to divert.

Unlike Light Water Reactors which use fuel as ceramic (oxide) pellets and the Molten Salt Reactor which uses salt mixtures, the IFR's fuel is metallic. This fuel is cast into rods and cooled by liquid metal. Both liquid sodium and lead-bismuth alloy have been suggested as coolants. Like the MSR, the IFR operates at atmospheric pressure and requires no large metal forgings. The last design tested was also proven to be passively safe.

The IFR may seem redundant if we have MSRs, but it has proven capabilities that MSRs do not, capabilities that we need:

1. It is a fast-neutron reactor, so it can "burn" troublesome isotopes of plutonium and americium rather than leaving them as a disposal problem.
2. It can turn stocks of uranium to fuel, even the uranium in spent PWR fuel.
3. Because of this, it can ultimately eliminate the entire stock of nuclear fuel piled up at present and past nuclear plants.
4. It can also convert our entire stock of Depleted Uranium (DU) to fuel.

It may be possible to make a fast-neutron reactor using molten salts, but the fuel chemistry and other details have not been tested; the IFR has. The IFR needs to be taken to full-scale test ASAP, so that our big nuclear waste problem can be turned into a small, short-lived one.

The Consequences of Breeders

Between the two technologies of the MSR and IFR, the USA's entire inventory of spent nuclear fuel (43,000 tons of uranium as of 2002), depleted uranium (roughly 6 times as much) and thorium (900,000 tons of reserves) become available as domestic fuel reserves. The entire electric demand of the USA could be met with roughly 500 tons per year of this; the entire energy needs of the USA would take perhaps 1500 tons. We could export both clean, no-carbon power generators and the fuel to run them. If we are looking to save the world from climate change, we have to grab these opportunities with both hands.

Conclusion

As you noted in your inauguration speech, we are facing problems created and made worse by our refusal to make tough decisions. Now is not the time to cave on those. If we are going to address

all the problems facing the nation and the world, we have to avoid wasting effort on measures that won't build for the future. The stone heads of Easter Island were shovel-ready, but spelled suicide for the people. Expanding today's pot-holed roads may just leave them empty five years from now, but rails will be usable for 50. No amount of effort will raise US oil production to what we now use, but we can change from petroleum to electricity. For the sake of public health and the planet we must switch our electricity away from coal and gas, and our main near-term options appear to be wind and nuclear. These can supply our needs for decades from our "waste" alone, and hundreds of years after that. They can even help give us the export markets needed to heal the economy again.

We need a future. You have to point the nation where the future is.

Endnotes

1. Sutton's Law: Go where the money is (attributed to bank robber Willie Sutton).
2. Ethanol can be used as an octane-booster in specially-designed engines to allow the same power out of an engine only half the size (link). The smaller engines would save as much as 30% of the fuel. Using a few percent of ethanol as a separate fuel stream (not blended with gasoline) would save far more, and ethanol from corn would save enough other fuel to be worth it.