Powering America:
On the Road to Real Energy Solutions

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U.S. Senator Craig Thomas

Let's Use America's Energy…and Ingenuity

Each and every day, Americans and people across the globe rely on enormous volumes of energy from a vast amount of resources. The development and extraction of energy from the world around us now permeates nearly every conceivable human activity, and as our population continues to grow and evolve, the need for more and better sources of energy will continue to challenge us. Thanks to the many resources in our nation and the ingenuity of the American people, these challenges also create a great opportunity.

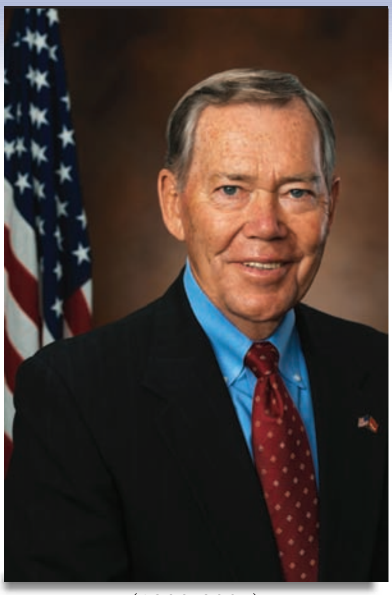
In August of 2005, the United States Congress passed its first major Energy Bill into law in years to address many developing energy issues we are now faced with. I played a key role in negotiating the details of the Energy Policy Act of 2005, which is now helping us take huge steps toward conserving energy, producing energy, and diversifying our nation's portfolio. This bill is a roadmap for the future – promoting greater conservation, efficiency, and new technologies that allow us to use traditional resources more effectively and transition into alternative forms of energy over the long term.

Despite a vast amount of energy resources available in the United States, we as a nation have become increasingly dependent on foreign energy sources, especially for our transportation needs. In April 2007, we imported over 60% of our oil - 13.3 million barrels of oil each day. America also hasn't built a new gas refinery since 1976, and due to this fact, we now must import over one million barrels of gasoline every day – meaning about one of every ten gallons of gas Americans get at the pump is refined in a foreign country. If you visit the gas pump on a regular basis, you see firsthand how getting our energy from foreign sources is increasingly costly to our nation.

In the long term, I have great confidence that we will be able to harness energy en masse from our environment without reliance on fossil fuels and biofuels. Certainly wind and solar technologies have great potential in utilizing natural energy, and there is a promising future in nuclear and hydrogen fuel technologies. Through the Energy Bill and additional legislation, we have created tax policy incentives for a wide variety of alternative energy sources. I strongly support such incentives as a way to assist fledgling technologies until those technologies are economically viable enough to sustain themselves in a free market, but on the other hand, I also firmly believe that we should not create entire industries that can survive only with perpetual support of the federal government.

In the nearer future, there are great opportunities for the United States to use some of the abundant resources we already have. Our natural gas and oil reserves are certainly two potential sources, but as a citizen and Senator of the State of Wyoming, I'd like to focus some attention on one of our nation's most traditional energy sources: coal. The United States has more coal than any other nation in the world, and Wyoming has the most of any state (well over 1/3 of all coal produced yearly in the US). Yes, we all know coal as an important energy source for electricity – it still accounts for more than half of our electric power supply – but the abundance of this resource has given me great responsibility to learn more about coal's many other potential uses.

Biofuels such as ethanol have received much attention and deservedly so, but I believe coal serves as an even more promising source of fuel energy. Through a line of research and development that dates back to WWII when the Germans converted coal into liquid fuel, we are now able to develop coal into a much cleaner and more efficient clean diesel fuel. Unlike biofuels that take a great deal of energy to be created – diesel to run the tractors, natural gas to produce the fertilizer, more diesel to run the trucks and trains that deliver it – coal is already available for conversion into fuel energy. Coal also already has a developed pipeline infrastructure, but biofuels will create a demand to increase our country's strained truck and rail capacities. In addition, biofuels like ethanol made from corn create competition for important resources within our country and around the world, and driving the price of food crops like corn up in this way puts new strain on other industries and on mouths to feed. The use of coal helps to eliminate such competition.



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Of course, there are other new potentials for coal as well. For one, the Department of Energy's FutureGen project is working to convert coal into hydrogen and electricity without producing any emissions. The carbon dioxide produced would be injected thousands of feet underground while the hydrogen not used for electricity could be converted to hydrogen fuel for vehicles. There are also entrepreneurs who are working to convert coal into a clean natural gas. One company is working on a way to produce natural gas from coal at lower temperatures than other processes, and the overall effect is that natural gas is produced in a much cleaner fashion and with far less carbon dioxide than all other gasification processes. What's more, the carbon dioxide could be sold and injected into oil or gas wells to speed production. Developing technologies like these and more continue to make coal a vital source of energy that has an important future in our nation's energy infrastructure.

Achieving American energy independence and meeting the world's growing energy needs in a sustainable fashion is an arduous task, and the 2005 Energy Bill pointed America forward into the 21st century by promoting and facilitating emerging energy technologies that utilize new and traditional energy sources in cleaner and more efficient ways. There is still much work to do following passage of this landmark bill, but America now understands that dependence on foreign energy is very problematic and costly. We must work hard to facilitate the development of long term technologies that will power our future, but if we are to achieve greater levels of energy independence in the foreseeable future, we must also utilize resources America already has. The entrepreneurial spirit that will harness our future forms of energy is already at work in improving traditional sources of energy like coal, and we must take advantage of the current opportunities we have within reach.

— The Ripon Society was deeply saddened to learn of the passing of U.S. Senator Craig Thomas on June 4, 2007. We decided to print the article he had submitted last month in tribute to his great leadership on this issue and his tireless representation of the people of Wyoming. Senator Thomas was in his 3rd term representing Wyoming. He served on the Senate Finance Committee and was the Ranking Member of the Senate Committee on Indian Affairs.

Alternative Energy in the Dock

Jerry Taylor

With gasoline and electricity prices skyrocketing, politicos on both the Left and Right agree that the government must do something to promote alternative energy sources. The debate is not whether to intervene, but how. Which fuels should we promote? How aggressively should we subsidize those fuels? And to what extent should we mandate production?

This is unfortunate because the underlying premise of energy policy – that the federal government must act to promote alternative energy – is dubious. If investing in alternative energy makes economic sense, investors will make those investments of their own free will because that's how profits are secured in a free market economy. If investing in alternative energy does not make economic sense, investors will rightly eschew those investments. If the government encourages or compels investments in things that don't make economic sense, nobody wins save for the particular parties gaining the subsidy.

Prices are reflections of relative scarcity. If the cost of alternative energy x is 50 percent greater than the cost of fossil fuel x, then we can confidently state that it takes 50 percent more resources to produce alternative energy x than it does to produce fossil fuel x. Subsidizing or mandating alternative energy in this scenario would waste – not save – resources.

Almost all economists agree with the above. Fears that fossil fuels are about to run out, even if true, are irrelevant. After all, if fossil fuels become scarce, fossil fuel prices will go up, which will in turn make investments in alternative energy more attractive. Alternatively, if consumers for whatever reason demand alternatives to fossil fuels, market actors will provide those alternatives because, again, that's how profits are made.

The reason that we don't find more exotic energy sources in the market is because they are simply too costly to produce relative to the costs of more conventional energy sources and consumers do not manifest any interest in paying a premium for alternative energy.

Let's look first at the electricity sector. According to a recent analysis by Tufts economist Gilbert Metcalf[1], the "levelized cost" of building a new conventional coal-fired power plant (that is, the cost associated with building the plant and buying coal over the lifetime of the plant divided by the energy output that one might expect from the facility over its lifetime) works out to 3.53 cents per kilowatt hour (kWh). By means of comparison:

- a new "clean coal" plant costs 3.55 cents per kWh,
- a nuclear power plant costs 4.31 cents per kWh,
- a biomass-fired power plant costs 5.34 cents per kWh,
- a natural gas power plant costs 5.47 cents per kWh,
- a wind power plant costs 5.70 cents per kWh,
- a solar thermal power plant costs 12.25 cents per kWh, and
- a solar photovoltaic power plant costs 22.99 cents per kWh.

But that doesn't tell the whole story. First of all, those cost estimates represent costs under current law, which distort prices via a panoply of subsidies and regulatory interventions. Second, those calculations disregard the costs associated with providing back-up

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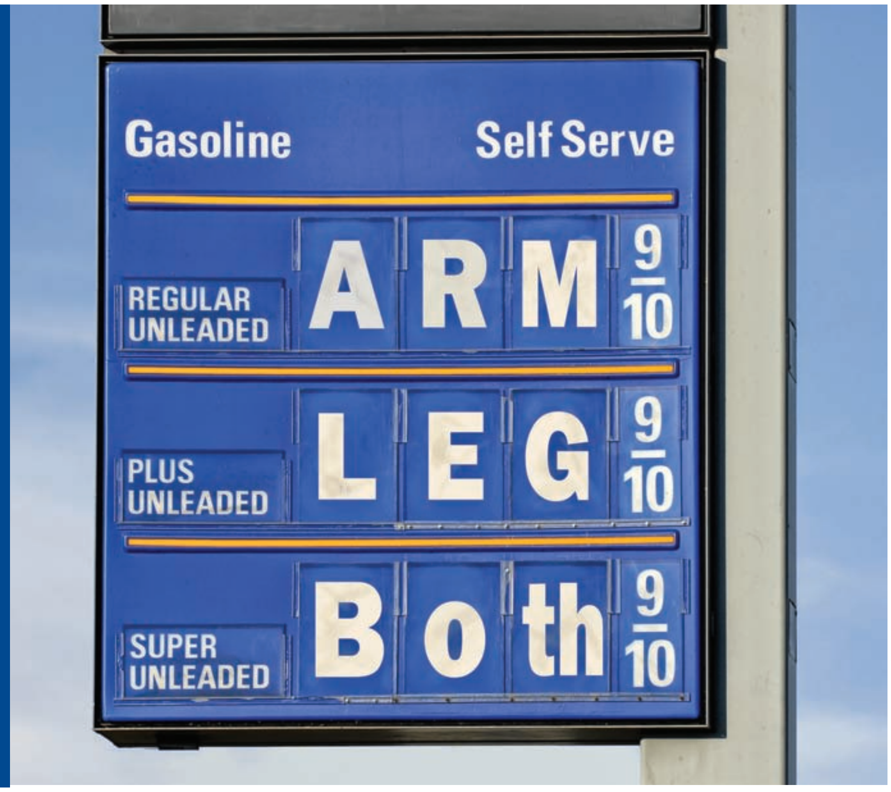

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power for wind and solar powered energy plants, which are necessary to ensure that those plants are producing kilowatts even when the wind isn't blowing or the sun isn't shining. A recent study by the Royal Academy of Engineering estimated that including the costs of back-up power raised the price of onshore wind energy production by nearly 50 percent.[2] Third, those calculations ignore the costs associated with building sufficient transmission capacity to ensure that the power harnessed by wind and solar power producing facilities can get to load centers. Given that both of those energy sources are most abundant primarily where people aren't, those costs are not insubstantial.

Given that adding back-up power generation and transmission costs to renewable energy facilities can be difficult, let's simply adjust the above estimates by stripping out the subsidies and regulatory distortions and leaving taxes aside. If we do that, Prof. Metcalf informs us that conventional coal-fired power plants cost 3.10 cents per kWh to build. By means of comparison:

- a new clean coal plant costs 3.53 cents per kWh,
- a nuclear power plant costs 4.57 cents per kWh,
- a wind power plant costs 4.95 cents per kWh,
- a biomass-fired power plant costs 4.96 cents per kWh,
- a natural gas power plant costs 5.29 cents per kWh,
- a solar thermal power plant costs 13.84 cents per kWh, and
- a solar photovoltaic power plant costs 26.64 cents per kWh.

These numbers are not sacrosanct. After all, what one thinks about the future interest rates, fuel prices, and other matters that are difficult to forecast will significantly affect these calculations. But since Prof. Metcalf's estimates on these matters are not particularly controversial within the field, they represent reasonable "best estimates" for analytical purposes.

Now let's look at alternative fuels in the transportation sector. Here, the picture is even worse. The only real alternative to gasoline is ethanol and, for diesel engines, biofuels made from various natural fats and oils. Neither of these fuels is remotely economic absent massive government intervention.

The best numbers we have on ethanol come from a 2002 producer survey conducted by the U.S. Department of Agriculture. That survey reported that it cost an average of $2.53 to produce a gallon of ethanol in 2002; $1.57 per gallon for the cost of building ethanol processing facilities; and 96 cents per gallon to run those facilities and pay for the corn.[3] The USDA recently reported, however, that the sharp increase in corn prices since then has raised operating costs to $1.45 per gallon, which suggests that ethanol costs somewhere around $3.00 per gallon to produce at the moment.[4]

One might reasonably be skeptical about such estimates given that ethanol is increasing market share. If the USDA is correct, after all, ethanol should be priced out of the market. Few realize, however, that the federal government – along with many state governments – mandates ethanol consumption regardless of price. Hence, ethanol producers do not have to find willing buyers – only willing politicians. Second, those costs are disguised by a plethora of federal, state, and local subsidies, which reduce ethanol prices by $1.05-1.38 cents per gallon according to a recent survey by the International Institute for Sustainable Development.[5] Some of those subsidies are built into wholesale ethanol prices and some aren't.

Even if we put those subsidies aside, the fact that a gallon of ethanol has only three-quarters of the energy content of gasoline suggests that, on a gasoline-energy equivalent basis, ethanol costs about $3.99 per gallon of gasoline equivalent before we even get to retail markup.[6]

Biodiesel costs are even higher. Variable operating costs are around $2.50 per gallon (versus $1.45 per gallon for ethanol)[7] while the costs of building the plant itself are about $1.18 per gallon of annual production capacity.[8] Hence, biodiesel costs about $3.68 per gallon before we account for the fact that it takes 1.1 gallons of biodiesel to provide the same energy content provided by conventional diesel fuel.[9] Adjusting for biodiesel's lower energy content means that it costs $4.05 to buy enough biodiesel to replace a gallon of conventional diesel fuel.[10]

Cellulosic ethanol, from an economic standpoint, is the worst transportation fuel of all. Guy Caruso, the head of the Energy Information Administration (EIA) at the U.S. Department of Energy, estimates that the capital costs associated with cellulosic ethanol production would be five times greater than those associated with conventional corn ethanol production.[11] If so, then cellulosic ethanol would cost about $7.50 per gallon today before we even consider the price of the feedstock. We can only speculate about production costs, however, because there is no cellulosic ethanol industry on planet Earth. That alone speaks volumes about the economic competitiveness of cellulosic ethanol.

Although most people think of renewable energy when they think of alternative fuels, there are also examples of energy exotica to be found in the fossil fuels market. Liquefying coal to produce oil (so-call "coal-to-liquids" technology) is a primary example, as is the process of extracting oil from shale rock. It is unclear, however, whether the economics of fossil fuel exotica are any better than they are for renewable energy exotica.

While there's no trick to transforming coal to oil (and then, to gasoline),the problem has long been cost. Headwaters Inc., a major player in this field, thinks that a standard plant that produced 40,000 barrels of oil-based fuel per day could turn a 15 percent profit if oil prices were around $48 per barrel.[12] While that sounds pretty good given today's prices, oil prices would have to average $48 or more per barrel in today's dollars over the entire lifetime of the facility in order for those profits to be realized. Thus far, private investors have been unwilling to make that bet. Whether that's because investors don't think today's high oil prices are long for this world or because they fear that the industry is low-balling its cost estimates is unclear.

Extracting oil from shale rock is even more problematic. Although the amount of oil embedded in shale rock in the Rocky Mountain West is three times greater than the total proved reserves of crude oil in Saudi Arabia, analysts at the Rand Corporation estimate that world crude oil prices would have to average between $70-90 a barrel over the lifetime of an investment before extracting oil from shale would be economically viable.[13]

Is there a promising tomorrow for these fuels? The honest answer is "we don't know." While the world is full of analysts who confidently predict this and that about future fuel costs and the technologies of tomorrow, the fact is that energy forecasting has proven no more reliable than the end-of-year predictions made famous by Jean Dixon in the *National Enquirer*. A thorough survey of past predictions from government, academia, consultants, industry, and financiers by Prof. Vaclav Smil of the University of Manitoba finds that drunk monkeys might well have been better than energy experts at forecasting future technologies and prices.[14]

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Although most armchair energy gurus believe that government subsidy can hasten the day in which alternative energy sources can compete in the market without government help, this represents the proverbial triumph of hope over experience. Five decades of lavish nuclear energy subsidies have yet to produce a technology that could compete in the electricity market absent subsidy. Ethanol has been on the federal dole since the late 1970s. Renewable energy has been subsidized to varying degrees over the last three decades yet wind and solar energy still constitute less than 1 percent of the electricity market and likewise wouldn't exist at all absent government intervention. Herculean efforts to promote "Synfuels" in the 1970s (what we once called "coal-to-liquid" technology) produced nothing but epic economic loss. If the objective of government subsidy is to produce industries that ultimately won't need government assistance, then we have yet to find a consequential example of energy subsidies that have produced the intended result.

Regardless, there is one main reason why the above arguments don't quite extinguish the case for government promotion of alternative energy. Relying on market prices to guide economic behavior only yields positive results if market prices are accurate. If energy prices are "wrong" – that is, if the total costs associated with energy consumption are not reflected in energy prices – then energy production and consumption patterns will prove suboptimal. Government could improve the economy by either intervening to get energy prices right or by shaping the energy markets so that they look like what they would otherwise look like if energy prices were correct.

While there are dozens of claims commonly made about why energy prices are "wrong," only three are taken very seriously by economists.

The first claim is that federal and state subsidies are so omnipresent in energy markets that fuel prices are hopelessly distorted. While the ideal remedy would be to remove the offending subsidies, that's often thought to be politically difficult if not impossible. Many thus hold that a second-best remedy is to offer countervailing subsidies to "level the playing field."

Metcalf's data, however, suggests that fossil fuel prices in the electricity sector are not artificially reduced by federal tax preferences. In fact, the opposite is the case: Federal intervention on balance *increases* the price of electricity produced by fossil fuels. While Metcalf's analysis ignores direct federal expenditures (such as government funded R&D), those expenditures are relatively small given the size of the industry and have no impact on marginal production costs and, hence, on consumer prices.

Subsidies in the transportation sector are likewise small. When the EIA examined federal oil subsidies in 1999 (the last year in which a comprehensive analysis was performed), they found that they totaled $567 million per year.[15] That total did not change significantly until passage of the 2005 Energy Policy Act, which added an estimated $1.4 billion of subsidies to the oil industry over ten years.[16] Although no comprehensive, up-to-date assessment of federal oil subsidies is currently available, the 2006 total is certainly less than $1 billion a year, which translates to 0.3 cents per gallon of gasoline.[17] Even that small figure overstates the impact of subsidies because those subsidies do not reduce marginal production costs and, hence, do not reduce consumer prices.

The second claim is that the environmental costs associated with fuel consumption are not fully reflected in energy prices. Energy consumers do not have to compensate third parties for human health or environmental damages caused by their energy consumption. If they did, the energy market would look a lot different than it does today. Selectively applied subsidies and consumption orders can thus remedy this structural inefficiency.

Few understand, however, how difficult it is to quantify and monetarize the aggregated external health and environmental costs associated with energy consumption. Economist Ian Parry and his colleagues at Resources for the Future, for instance, report that the plausible estimates for the external environmental costs associated with conventional pollutants generated by gasoline consumption range from $0.36 to $4.20 per gallon.[18] A review of the literature by economists Thomas Sundqvist and Patrik Soderholm finds estimates for the environmental costs of coal-fired electricity range from 0.004 cents per kilowatt hour (kWh) to 67.7 cents per kWh; gas-fired electricity from 0.003 cents per kWh to 13.2 cents per kWh; nuclear power from 0.0003 cents per kWh to 64.5 cents per kWh; hydropower from 0 to 26.3 cents per kWh; wind energy from 0 to 0.88 cents per kWh; solar power from 0 to 2.2 cents per kWh; and biomass energy from 0 to 22.1 cents per kWh.[19] Estimates regarding the climate-related costs associated with consuming a ton of carbon likewise vary greatly; according to one survey of the literature, from $9 – $200 in 2000.[20]

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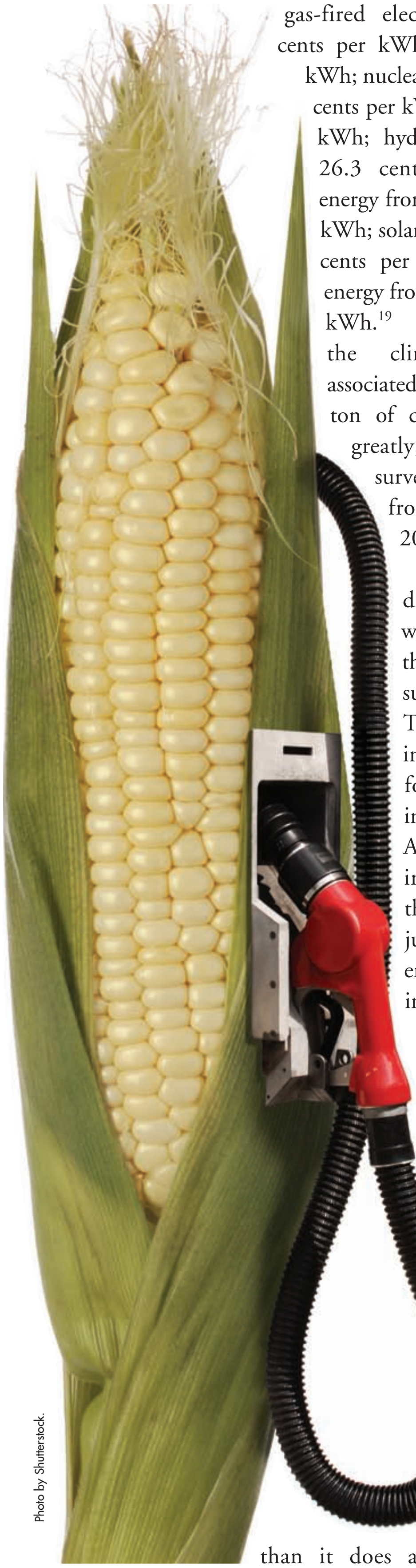

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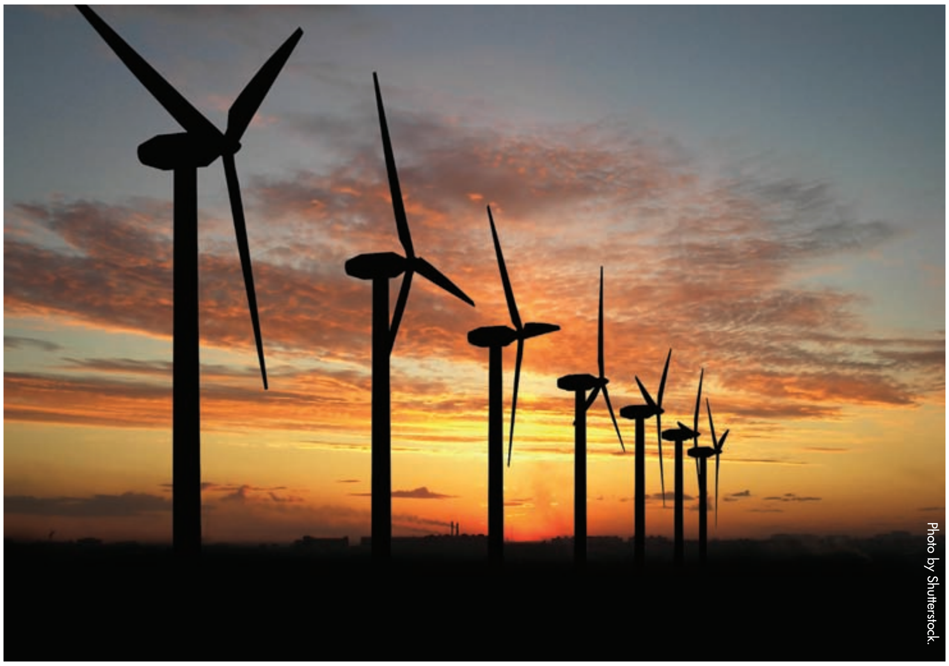
Thus, it's very difficult to know to what extent – if any – that energy prices are substantially "wrong." There is too little information available for government to intervene intelligently. Aggressive intervention under these circumstances is just as likely to make energy markets more inefficient – not less.

The third and final claim is that energy consumption imposes significant national security costs that are unreflected in market prices. If those prices were reflected in energy costs, the market would look a lot different than it does at present. Again, selectively applied subsidies and consumption orders can remedy this structural inefficiency.

It's important to note, however, that these alleged "national security externalities" are exclusively related to oil – not to coal, natural gas, or any other sort of fossil fuel because we don't import those energy sources by any appreciable amount. Accordingly, subsidizing wind, solar, and nuclear power will do little to improve national security because those energy sources do not compete with crude oil and would not displace crude oil. Until plug-in cars are both available and economically attractive to consumers, building 100 new wind, solar, and nuclear power plants won't reduce oil consumption by very much at all.



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So how much do we spend to protect foreign oil and to secure the transit lanes associated with oil imports? The Congressional Research Service estimated in 1997 that those costs may be anywhere between $0.5 and 65 billion, or 1.5 cents to 30 cents per gallon for motor fuel from the Persian Gulf.[21] Agreement about the extent of the military's "oil mission" is difficult to achieve because military and foreign policy expenditures are generally tasked with multiple missions and objectives and oil security is simply one mission of many. Analysts disagree about how to divide those missions into budgetary terms.

Do those expenditures subsidize oil consumption in the sense that they reduce oil prices below what they would otherwise be in a world without the U.S. oil mission? The answer is probably not. The cessation of U.S. security assistance would almost certainly be replaced by security expenditures from other parties. First, oil producers will provide for their own security needs as long as the cost of doing so results in greater profits than equivalent investments might yield. Because Middle-Eastern governments typically have nothing of value to trade except oil, they must secure and sell oil to remain viable. Second, given that their economies are so heavily dependent upon oil revenues, Middle-Eastern governments have even more incentive than we do to worry about the security of production facilities, ports, and sea lanes – and the fiscal means to address those worries.[22]

Many foreign policy elites think that U.S. oil imports are dependent upon friendly relationships with oil producing states. The fear is that unfriendly regimes might not sell us oil. Maintaining good relations with oil producers, however, interferes with other foreign policy objectives and increases anti-American sentiment in producer states with unpopular regimes. While the costs associated with this distortion of foreign policy are difficult if not impossible to quantify, that doesn't make them any less real. And motorists are getting a free ride by not paying those costs and hence consuming oil inefficiently.

The problem with this argument, however, is that its fundamental premise is incorrect. Friendly relations with producer states neither enhance access to imported oil nor lower its price. Selective embargoes by producer nations are unenforceable unless (i) all other nations on Earth refuse to ship oil to the embargoed state, or (ii) a naval blockade were to prevent oil shipments into the ports of the embargoed state. That's because once oil leaves the territory of a producer, market agents dictate where the oil goes, not agents of the producer, and anyone willing to pay the prevailing world crude oil price can have all he wants.[23]

The 1973 Arab oil embargo is a perfect case in point. U.S. crude oil inventories actually increased from 1.7 million barrels per day (mbd) in 1971 to 2.2 mbd in 1972, 3.2 mbd in 1973, and 3.5 mbd in 1974.[24] As MIT's Thomas Lee, Ben Ball Jr., and Richard Tabors observe: "It was no more possible for OPEC to keep its oil out of U.S. supply lines than it was for the United States to keep its embargoed grain out of Soviet silos several years later. Simple rerouting through the international system circumvented the embargo. The significance of the embargo lay in its symbolism."[25] Granted, "there were short term supply disruptions," but "the only tangible effect of the embargo was to increase some transportation costs slightly, because of the diversions, reroutings, and transshipments necessitated."[26]

Do oil producing nations allow their feelings towards oil consuming nations to affect their production decisions? Historically, the answer has been "no." The record strongly indicates that oil producing states, regardless of their feelings toward the industrialized West, are rational economic actors. MIT oil economist M.A. Adelman concluded after a detailed survey of the world oil market since the rise of OPEC, "We look in vain for an example of a government that deliberately avoids a higher income. The self-serving declaration of an interested party is not evidence."[27]

If a radical new actor were to emerge on the global stage, conditions may change. For example, if the House of Saud was to fall and the new government consisted of Islamic extremists friendly to Osama bin Laden, the new regime might reduce production and increase prices.[28] But even Iran, despite all its anti-western rhetoric, has not reduced oil output because the Iranian economy and regime are dependent on oil revenue and the Saudis are even more dependent.[29] Regardless, higher prices would set in motion market supply and demand responses that would encourage alternative energy investments without any need of governmental policy to lighten the way.

Money spent on gasoline flows to oil producers, and many of those producer states use those revenues to directly or indirectly fund Islamic extremists. Private individuals who profit from the oil trade likewise contribute to Islamic extremists. Those extremists pose foreign policy and national security problems. This suggests that the cost of terrorism should be built into oil prices, and if it were, we'd see a lot more investment in alternative energy.

What is the relationship between oil consumption and Islamic terrorist incidents? My colleague, Peter Van Doren, and I estimated two regressions using annual data from 1983 to 2005: the first between fatalities resulting from Islamic terrorist attacks and Saudi oil prices and the second between the number of Islamic terrorist incidents and Saudi oil prices. In neither regression was the estimated coefficient on oil prices at all close to being significantly different from zero.[30]

That finding shouldn't be too surprising. Inflation-adjusted oil prices and profits during the 1990s were low. But the 1990s also witnessed the worldwide spread of Wahabbi fundamentalism, the build-up of Hezbollah, and the coming of age of al Qaeda. Note too that al Qaeda terrorists in the 1990s relied upon help from state sponsors such as Sudan, Afghanistan, and Pakistan – nations that aren't exactly known for their oil wealth or robust economies.

Alternative energy is not economically competitive in America today absent large-scale government intervention. But the intellectual case for such intervention is threadbare. Market actors will produce alternative energy when it makes economic sense for them do to so. Government's ability to hasten the day in which those energies become economically competitive is likely to be zero.

— Jerry Taylor is a Senior Fellow at the Cato Institute.

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[1] Gilbert Metcalf, "Federal Tax Policy Towards Energy," Working Paper 12568, National Bureau of Economic Research, October 2006; http://www.nber.org/papers/w12568.

[2] Royal Academy of Engineering, "The Costs of Generating Electricity," 2004.

[3] Husein Shapouri and Paul Gallagher, "USDA's 2002 Ethanol Cost-of-Production Survey," Agricultural Economic Report no. 841, Office of the Chief Economist, July 2005, Table 1, p. 4, and p. 8; http://www.usda.gov/oce/reports/energy/USDA_2002_ETHANOL.pdf.

[4] Keith Collins, Chief Economist for the U.S. Department of Agriculture, Statement before the U.S. Senate Committee on Agriculture, Nutrition, and Forestry, January 10, 2007.

[5] Douglas Koplow, "Biofuels – At What Cost?" Global Studies Initiative of the International Institute for Sustainable Development, Geneva, Switzerland, October 2006, Table 5.1, p. 51; http://www.globalsubsidies.org/IMG/pdf/biofuels_subsidies_us.pdf.

[6] $3.00 x 1.33 = $3.99.

[7] Ibid.

[8] EIA reports that biodiesel plants cost $1.04 per annual gallon of capacity. If we assume that the plant is financed by equity with an annualized return of 10 percent over 15 years. And treat the hypothetical income stream as an annuity over the 15 years, the estimated capital cost of that capital is 13.6 cents per gallon (2002 cents) at full output. $1.04 + 0.136 = $1.18 rounded up. Anthony Radich, "Biodiesel Performance, Costs, and Use," Energy Information Administration, June 8, 2004; http://www.eia.doe.gov/oiaf/analysispaper/biodiesel/index.html.

[9] Vern Hoffman, Dennis Wiesenborn, Michael Rosendahl, and Jason Webster, "Biodiesel Use in Engines," AE-1305, North Dakota State University, January 2006, p. 6; http://www.ag.ndsu.edu/pubs/ageng/machine/ae1305.pdf.

[10] $3.68 x 1.1 = $4.05.

[11] Michael Burnham, "EIA Chief Offers Preview of 2007 Long-Term Outlook," Greenwire, November 29, 2006.

[12] John Ward, Vice President, Marketing & Government Affairs, Headwaters Inc., presentation before the House Western Caucus, September 25, 2006.

[13] James Bartis, Tom LaTourrette, Lloyd Dixon, D. J. Peterson, and Gary Cecchine, *Oil Shale Development in the United States: Prospects and Policy Issues* (Rand Corporation, 2005).

[14] Vaclav Smil, *Energy at the Crossroads* (MIT Press, 2003), Chapter 3.

[15] The EIA study is examined in detail in Ronald Sutherland, "Big Oil at the Public Trough?" Policy Analysis 390, Cato Institute, February 1, 2001; http://www.cato.org/pubs/pas/pa390.pdf. An excellent overview of federal tax preferences afforded the oil industry can be found in An inventory of federal tax preferences for the oil sector as of 2006 is provided in Gilbert Metcalf, "Federal Tax Policy Towards Energy," Working Paper 12568, National Bureau of Economic Research, Cambridge, MA, October 2006.

[16] Maya Jackson Randall, "House Energy Chief's Loss Opens Door for Energy Policy Shift," MarketWatch, November 8, 2006; http://www.marketwatch.com/news/story/story.aspx?siteid=mktw&guid=%7BD9CFA89F-6287-43EC-8CE9-62FEBC20360E%7D.

[17] Oil consumption over the first seven months of 2006 averaged 20.4 million barrels per day according to the EIA's International Petroleum Monthly. That translates into 13.4 cents per barrel, or 0.3 cents per gallon.

[18] Ian Parry, Margaret Walls, and Winston Harrington, "Automobile Externalities and Policies," Resources for the Future Discussion *Paper* 06-26 June 2006 p. 4 gives a range for local pollution of 1.6 to 18.6 cents per mile. Assuming 22.6 miles per gallon (Parry and Small 2005 Table 1) gives a range of $.36 to $4.20 per gallon.

[19] Thomas Sundqvist and Patrik Soderholm, "Valuing the Environmental Impacts of Electricity Generation: A Critical Survey," *The Journal of Energy Literature* 8:2, December 2002, Table 3, p. 20.

[20] R. Clarkson and K. Deyes, "Estimating the Social Cost of Carbon Emissions," Environmental Protection Economics Division, Department of Environment, Food and Rural Affairs, London, August 2001, cited in David Newberry, "Why Tax Energy? Towards a More Rationale Policy," *The Energy Journal* 26:3, 2005, p. 21.

[21] Congressional Research Service, "Oil Imports: An Overview and Update of Economic and Security Effects," CRS Report for Congress, 98-1, December 12, 1997, Table A-1.

[22] J. Robinson West, "Saudi Arabia, Iraq, and the Gulf," in *Energy Security*, Jan Kalicki and David Goldwyn, eds. (Washington: Woodrow Wilson Center Press, 2005), pp. 197-218.

[23] This is such an obvious point that energy economists rarely bother to explore the issue in detail. To understand how the world crude oil market works is to understand that embargoes are unenforceable. See Philip Verleger, *Adjusting to Volatile Energy Prices* (Washington: Institute for International Economics, 1993) and M.A. Adelman, *The Genie out of the Bottle: World Oil Since 1970* (Cambridge, MA: MIT Press, 1995).

[24] Energy Information Administration, *Annual Energy Review 2004*, Table 5.3.

[25] Thomas Lee, Ben Ball Jr. and Richard Tabors, *Energy Aftermath* (Boston: Harvard Business School, 1990), p. 17.

[26] Ibid., p. 30. See also Edward Fried, "Oil Security: An Economic Phenomenon," in *Oil and America's Security*, ed. Edward Fried and Nanette Blandin. (Washington: Brookings Institution, 1988), pp. 56–59.

[27] Adelman 1995, p. 31. Former OPEC Secretary-General Francisco Parra makes the same point. Francisco Parra, *Oil Politics: A Modern History of Petroleum* (New York: I.B. Tauris, 2004).

[28] Bin Laden has said on many occasions that he thinks the Saudi monarchy keeps oil prices below true market value in order to maintain friendly relations with the West.

[29] Oil revenues are 40-50 percent of Iranian government revenues and 70-80 percent of Saudi government revenues. See Energy Information Administration, "Country Analysis Briefs," available at http://www.eia.doe.gov/emeu/cabs/contents.html accessed on November 14, 2006. Iran's oil output increased steadily from 3.7 mbd in 2003 to 4.1 mbd in 2005. *Energy Information Administration, International Petroleum Monthly*, Table 4.1a

[30] Data on international Islamic terrorism incidents and fatalities were taken from the MIPT Terrorism Knowledge Base, an interactive website maintained by the Memorial Institute for the Prevention of Terrorism; http://www.tkb.org/. Data on that website comes from the RAND Terrorism Chronology and RAND-MIPT Terrorism Incident databases; the Terrorism Indictment database; and DFI International's research on terrorist organizations. Nominal Saudi oil prices were obtained from Energy Information Administration, *Annual Energy Review 2005* p. 169 Table 5.19 "Landed Costs of Crude Imports From Selected Countries" and deflated with the GDP deflator. Unit root tests suggested that fatalities and Saudi oil prices had unit roots but terrorist incidents did not, so the former were first differenced before the regressions. Even after first differencing, auto correlation existed so autoregressive terms were added to each regression, which further weakened the insignificant relationships.