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**By**

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## Energy Security Means Energy Interdependence

By

Robert Bryce

The phrases “energy security” and “energy independence” have become so hackneyed as to be almost useless.

Of course, the overuse of those two phrases has not prevented any number of energy analysts from stepping forward to offer their ideas about what constitutes the ideal level of “security” and how the US can best achieve the lofty goal of “independence.” And therein lies the attraction of vague concepts like “security” and “independence”: the possibility of affecting significant change over a short period of time is almost nil while the potential for outrage is essentially infinite.

The never-ending quest for “energy security” and “energy independence” reminds me of the quip about the engineer who’s looking for a solution to a sticky problem. And that problem can only be resolved with a big dose of “unobtainium.” Of course, the Periodic Table doesn’t include such an element. Nevertheless, the US defense establishment continues to believe that America’s security – and of course, energy security fits under that category – can only be achieved by maintaining an ever-expanding military footprint. And in the wake of the September 11 attacks, America’s military footprint has grown to a truly colossal size. But has that military expansion resulted in an increase in security for the US?

Some observers will claim that the US must continue to militarize the Persian Gulf in order to maintain “energy security.” But given the vast scale of the \$5 trillion-per-year global energy sector and the interconnectedness of the global energy market, it’s increasingly apparent that markets are trumping militarism. This paper will offer a few points designed to underscore that point.

## **1. Oil is here to stay. Get used to it.**

Regardless of whether the talking point is energy security or energy independence, the focal point, inevitably, is oil. That's understandable. Oil is the most important global energy commodity, accounting for about 35% of total primary energy consumption.<sup>i</sup> Furthermore, the oil price shocks that occurred in the wake of the 1973 Arab Oil Embargo and the Iranian Revolution shook the US and global economies. But much of the blame for the problems that accompanied the oil shocks – and in particular, the gasoline shortages – were not caused by foreign suppliers. Instead, the gasoline shortages in the US were largely the result of misguided political decisions. In 2001, Donald Losman, an economics professor at the Industrial College of the Armed Forces, wrote that “Most of the damage from the 1973 oil embargo emanated from our own policy blunders. Pre-embargo, poor U.S. policies made us vulnerable, and post-embargo, continued price controls and misguided regulation magnified the damage.”<sup>ii</sup>

Despite that fact, politicians and pundits continually use the price shocks of the 1970s to justify their claims that the US could suddenly be cut off from global oil supplies. And that fear has been used to justify a myriad of wasteful government programs, among them, the corn ethanol scam, one of the most misguided and costly subsidies in modern American history. And in the wake of the September 11 attacks, the calls for more alternative fuels and increased efforts to reduce the use of oil, have surged. Those calls are coming from the both the Left and the Right, with both claiming that using less oil will mean less terrorism.

The claimed rationale for using less oil is simple: if the US consumes less, then the price of oil will fall, petrostates who have ties to terrorism will have less money and therefore terrorism will decline. This thesis has already been tested. And it has been proven false. Between about 1986 and 2000, oil prices generally stayed below \$20 per barrel. By the end of 1998, prices had fallen as low as \$11 per barrel. On September 11, 2001, the day of the al-Qaeda attacks on the U.S., the price of oil was \$27.65.<sup>iii</sup> Where is the link between high oil prices and terrorism?

We had terrorism when oil was selling for less than \$30 per barrel. And we will have it if oil ever sells for more than \$300. The conflation of oil prices

and terrorism makes no sense for one simple reason: terrorism is a cheap endeavor. The 9-11 attacks cost about \$500,000. Terrorist organizations don't need the backing of the petrostates in order to launch their attacks. Furthermore, even if the US quits buying oil, it won't mean an end to the flow of money to the petrostates. According to the Energy Information Administration, out of the 204 countries and territories that they track, 173 are net oil importers. If the U.S. quits buying oil, there are 172 other countries on the planet who will enjoy cheaper oil. And they will buy it from the lowest cost oil producer.

Nevertheless, the calls for the end of oil continue. In early 2007, Barack Obama, who was then just beginning his campaign for the White House, declared that America must break free of the "tyranny of oil."<sup>iv</sup> Meanwhile leading neoconservatives are claiming that the US could quit using oil if only it used more electric cars and ethanol. Among the most prominent of these neoconservatives is former CIA director James Woolsey, who was one of the founding members of Set America Free, a Washington-based group that continually touts the idea of "energy independence." Woolsey and his allies at Set America Free have written several articles, and have even published a book claiming that the US should take the lead by, as they put it, "turning oil into salt." Their claim: oil's importance as a strategic commodity will end if the US gets more aggressive in its use of plug-in hybrid-electric vehicles, as well as the consumption of more "methanol, butanol, and other alternative fuels produced from grasses and even waste."<sup>v</sup>

While Woolsey and his allies are focusing on turning petroleum into various condiments, a look back at the federal efforts to create alternatives to petroleum shows an unbroken record of failure. In 1980, the Synthetic Fuels Corporation began providing money and loan guarantees for companies who wanted to produce motor fuel from coal and oil shale. In his 2001 book, *A Policy of Discontent*, energy analyst Vito Stagliano writes that Congress supported the program, "even as one uneconomic project followed another, justified by the ever-elusive standard of energy security."<sup>vi</sup> By 1992, the new federal agency was supposed to be producing 1.5 million barrels of synthetic fuel per day.<sup>vii</sup> It didn't happen. Instead, writes Stagliano, it never produced "a single cost-effective barrel of fuel but managed to rack up federal debt obligations of over \$2 billion."<sup>viii</sup> (The agency was abolished in 1985.)

Wind power and solar power are being pushed by environmental groups and the "green" lobby as essential elements of US energy security. For instance,

a 2007 report by the American Council on Renewable Energy contained a lovely picture of several wind turbines in front of verdant hills. Beneath that photo was a shot of sparkling solar panels set against an azure sky. The text immediately adjacent declared that a “reduction of imported energy provides a more secure future....If we can tap the potential of our domestic renewable energy resources, we can make real progress towards achieving true energy independence.”<sup>ix</sup>

While wind and solar power have enjoyed rapid growth in recent years, by 2008, those two sources were providing just 0.2% of total US primary energy demand.<sup>x</sup> More important, neither solar nor wind have displaced any need for oil, which is the biggest single element of US energy imports. Nor will wind and solar power be able to make a significant dent in global oil demand any time in the foreseeable future. About 1 billion motor vehicles are now traveling the world’s roads.<sup>xi</sup> And those numbers will continue climbing in the decades ahead as citizens in the developing world become more mobile. Add in the tens of thousands of heavy trucks, airplanes, and ships which rely exclusively on diesel fuel and jet fuel, and the scale of the global transportation sector – and its need for oil – becomes even more apparent.

Some 94% of the goods shipped in the US travel on diesel-powered vehicles.<sup>xii</sup> Meanwhile, jet fuel is the cornerstone of the global aviation industry – a business that has seen phenomenal growth over the last half-century. In 1950, the total number of air travelers – which is measured in passenger-kilometers – was 28 billion. By 2005, that quantity of air travel had increased to some 3.7 trillion – a 130-fold increase.<sup>xiii</sup> And many consumers in the developing world have only begun to experience jet travel. In 2006, the US had about 8,800 commercial aircraft in service. By comparison, India had just 130, and China had less than 600.<sup>xiv</sup> As consumers in India, China, and other developing countries grow more affluent, their appetite for air travel will increase. And that will mean increases in jet fuel demand.

The diesel engine and the jet turbine – along with the gasoline-fueled internal combustion engine – are the prime movers of the modern era. And given their high spatial power density, and the continual improvements being made to them, those prime movers are going to retain their dominance for decades to come.

“There is one thing all energy transitions have in common: they are prolonged affairs that take decades to accomplish,” wrote Vaclav Smil in November 2008. “And the greater the scale of prevailing uses and conversions the longer the substitutions will take.”<sup>xv</sup> Smil, the polymath, prolific author on energy issues, and distinguished professor at the University of Manitoba, wrote that while a “world without fossil fuel combustion is highly desirable...getting there will demand not only high cost but also considerable patience: coming energy transitions will unfold across decades, not years.”<sup>xvi</sup>

Smil’s point can be proven by looking at US history. From 1776 to 1885, wood was the dominant fuel in the US energy market. It wasn’t until 1885 – the year that Grover Cleveland was first sworn in as president – that coal finally surpassed wood as the largest source of primary energy in the US. For the next 75 years, coal was king.<sup>xvii</sup> During the first two decades of the 20<sup>th</sup> century, coal was supplying as much as 90 percent of all the primary energy in the US. Thanks in large part to the booming demand for kerosene for lighting and more particularly, for gasoline to fuel automobiles, oil began whittling away at coal’s market share. World War II was a turning point. The massive production of airplanes, ships, and motor vehicles during the war years accelerated the demand for oil.

In 1949, coal accounted for about 37.4% of the US energy market, with oil trailing close on its heels with a 37.1% share. In 1950, oil hit the tipping point. That year, oil surpassed coal in US primary energy use, taking 38.4% of the total market.<sup>xviii</sup> And since 1950, oil’s reign as the most important energy source in the US has not been challenged. By 2008, oil’s share of the US energy market was at the exact same level as it was in 1950: 38.4%.<sup>xix</sup>

Nor has oil lost much ground in global primary use. In 1965, oil provided about 40% of the world’s total primary energy. By 2008, oil’s share of the global primary energy market had fallen to 35%.<sup>xx</sup> The reduction in oil’s share of the global market has many factors, the most important of which: a reduction in the amount of oil used for electric power generation. That last point can be proved by looking at France – a country that has led the world in the transition to nuclear power. In 1973, the French were getting about 68% of their electricity from oil-fired generators.<sup>xxi</sup> Today, France gets about 80% of its electricity from nuclear reactors. And while that move has provided significant benefits to France, including a reduction in oil

consumption, it must be noted that when it comes to reliance on oil, the French are still nearly as reliant as the US.

In 2008, France got 36% of its primary energy from oil – just slightly less than the 38% level in the US.<sup>xxii</sup> Why does oil retain such a significant portion of France’s primary energy mix, even though they have an abundance of relatively cheap, no-carbon electricity?

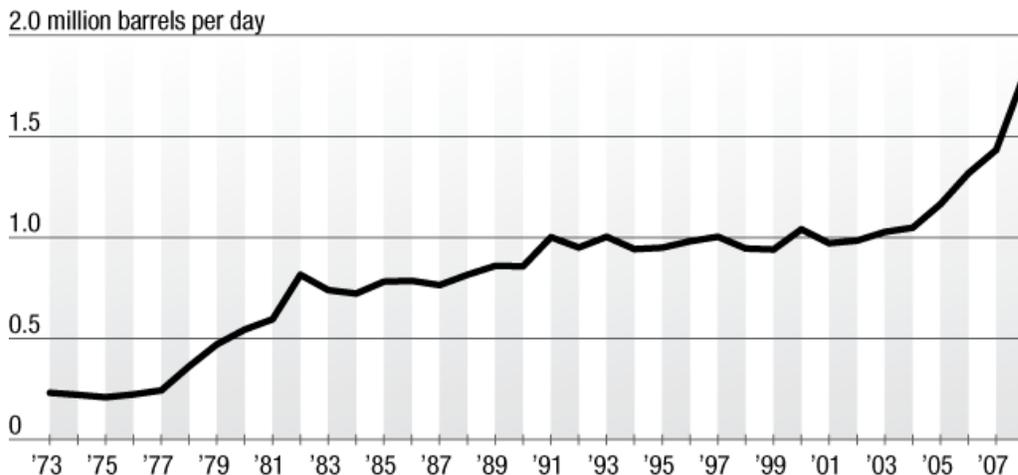
The answer is simple: when it comes to transportation fuels, oil has no peer. Yes, all-electric cars, hybrid-electric vehicles, and alternative fueled vehicles are proliferating. And over the next few decades, they will help reduce the rate of growth in oil consumption in the terrestrial transportation market. That said, no other fuel can match oil when it comes to gravimetric and volumetric energy density.<sup>xxiii</sup> And that means oil is here to stay.

## **2. The US is a major oil exporter.**

Most energy analysts focus on the level of US oil imports. Few bother to look at the amount of oil leaving US ports. Over the past few years the US has become one of the world’s biggest exporters of refined products. In 1998, the US was exporting about 945,000 barrels of oil and refined oil products per day. By 2008, the US was exporting nearly twice that amount, some 1.8 million barrels per day.<sup>xxiv</sup> And through the first six months of 2009, those exports have continued, with daily exports averaging 1.9 million barrels per day.<sup>xxv</sup> At that level, US oil exports are on par with countries like Angola and Venezuela.<sup>xxvi</sup>

Of course, the vast majority of those exports are refined products, not crude. But why has the US become a major player in the international oil market for refined products? The answer: US refineries are among the best in the world. And those refineries can produce the types of fuels the global market demands. One of the largest elements of US oil exports involves distillate fuel oil, much of which is going to customers in Europe and South America.<sup>xxvii</sup> Buyers in those regions are eager to purchase low-sulfur diesel fuel. Europe has a shortage of diesel refining capacity and given that US refiners can supply the needed product, European buyers are relying on the US to make up for their shortfall.

## Annual US Crude Oil and Refined Products Exports, 1973 to 2008



Source: E.I.A.

While America's role as an oil exporter is partly a function of its position as the world's biggest oil importer, it's also true that the US refining sector is bolstering its role as a global player in manufactured goods. That can be seen by looking at crude oil import levels. In 1998, US crude oil and petroleum product imports averaged 10.7 million barrels per day. By 2008, that number had increased to 12.9 million barrels per day.<sup>xxviii</sup> Thus, while total US imports increased by 2.2 million barrels per day over that time period, the amount of US exports of refined products doubled to 1.8 million barrels per day.

The fundamental point here is obvious: the US cannot secede from the global oil market. It has always been a major player in global oil trade and it will continue being a major player for decades to come.

### 3. US oil imports are nothing new. And they are not a security threat.

In recent years, T. Boone Pickens, Thomas Friedman of the *New York Times*, and various other high-profile individuals have sounded the alarm about America's oil imports. Alas, they are a little late to the game. The US has been a net crude oil importer since 1913. In fact, between 1913 and

2008, the U.S. was a net crude exporter in just nine of those years.<sup>xxxix</sup> In 1913 – just five years after Henry Ford began selling his Model T – America was importing 36,000 barrels of crude oil per day.<sup>xxx</sup> Nine decades later, in 2005, with George W. Bush in the White House, the U.S. was importing almost 300 times as much oil as it did when Woodrow Wilson was living at 1600 Pennsylvania Avenue.<sup>xxxi</sup>

But those numbers must be put in perspective. Over the past century or so, America's energy consumption has grown in direct relation to its economic growth: In 1913, America's gross domestic product was about \$39 billion. By 2005, U.S. GDP was more than \$12.4 trillion, or about 300 times as much as the 1913 figure.<sup>xxxii</sup> Thus, in a remarkable parallel, that 300-fold increase in oil imports has been accompanied by a 300-fold increase in America's economic output.

Despite the long history of US imports, US politicians continue to stoke fears about oil imports and the possibility of another oil embargo. For instance, in 2006, Bill Clinton gave a speech in California during which he said "Think of the instability and the impotence you feel knowing that every day we have to have a lifeline from places half a world away that could cut us off in a minute."<sup>xxxiii</sup>

Of course, any time Bill Clinton uses the word "impotence" is worth noting. But a May 2009 report by the Rand Corporation thoroughly debunks this type of rhetoric. "The fact that the United States imports nearly three-fifths of its oil does not pose a national security threat," said Keith Crane, the study's lead author and senior economist at Rand. "There is an integrated world oil market, and embargoes do not work."<sup>xxxiv</sup>

Few people would consider the Rand Corporation as soft on defense. The think tank has been a powerful player in the US defense establishment for more than six decades. (Daniel Ellsberg, the author of the *Pentagon Papers*, worked at Rand.) And yet Rand concludes that "reliance on imported oil is not by itself a major national security threat."<sup>xxxv</sup> Just as important, the Rand study also debunks the conflation of oil prices and terrorism. Crane and his co-authors conclude that "Terrorist attacks cost so little to perpetrate that attempting to curtail terrorist financing through measures affecting the oil market will not be effective."<sup>xxxvi</sup>

Furthermore, the Rand analysts determined that Congressionally mandated

programs like corn ethanol are actually harming America's security. "Using corn for ethanol is economically inefficient and has harmed U.S. national security," they write. "Diverting corn from food to ethanol production has pushed up world market prices for grains and other foods, which, in 2008, resulted in riots in a number of developing countries. In addition, the net energy benefit of corn-based ethanol is low because so much energy is used to fertilize, harvest, and transport corn."

#### **4. Energy security means interdependence in oil, natural gas, and the "green elements."**

There has never been a more global, more integrated, more transparent market than the modern crude oil and oil products market. The numbers to back up that statement are easily had. In 2007, when you count crude oil and all other oil products, the US imported oil from 90 different countries.<sup>xxxvii</sup> That same year, the US exported oil and oil products to customers in 73 countries.<sup>xxxviii</sup>

That interdependence in the oil market is being extended to the natural gas sector. In June 2009, the International Energy Agency released its Natural Gas Market Review. The agency's conclusion: "Gas markets are increasingly interdependent."<sup>xxxix</sup> Evidence of that can be seen by looking at the rapid growth in the global demand for natural gas.

Between 1973 and 2008, worldwide consumption of natural gas jumped by 156% – faster than any other primary energy source with the exception of nuclear.<sup>xl</sup> Demand for gas is accelerating because consumers want fuels that emit less carbon dioxide and fewer air pollutants. And that growing demand can be seen by looking at the global market for liquefied natural gas. In 2008, global gas liquefaction capacity was 280 billion cubic meters. By 2013, total capacity is expected to grow by nearly 50% to some 410 billion cubic meters.<sup>xli</sup> In 2009 alone, four major LNG liquefaction projects – Sakhalin II, Yemen LNG, Tangguh, and Qatar Mega Trains – are expected to come online.<sup>xlii</sup>

Furthermore, there is evidence that global LNG producers are shipping their cargoes longer distances. In 2000, the average shipping distance for LNG was 5,700 kilometers. By 2008, that distance had risen to more than 7,100 kilometers. In addition, several countries are adding LNG regasification

facilities. In 2008, Argentina became the first country in South America to import LNG. In early 2009, Brazil unloaded its first LNG cargo and Chile is expected to finish its regasification facility soon.<sup>xliii</sup> The boom in LNG has spawned an increase in the number of new LNG carriers. In 2008, a record-breaking 53 new-build LNG carriers were added to the global fleet, representing a 25% increase in LNG cargo capacity.<sup>xliv</sup>

While the interdependence in oil and natural gas is apparent, one of the less-discussed aspects of the increasingly global marketplace is the importance of the “green elements.” Indeed, at the same time that many of the neoconservatives and environmentalists in the US are advocating policies aimed at reducing the use of hydrocarbons, few people are focusing on the rare earth commodities that are needed to manufacture hybrid-electric cars, batteries, wind turbines, and solar panels.

Those products depend on the availability of a group of elements known as the lanthanides.<sup>xlv</sup> Between 90% and 100% of the global trade in lanthanides is controlled by China.<sup>xlvi</sup> The lanthanides include neodymium and dysprosium, both of which are used in high-strength magnets that are essential components in hybrid-electric cars. Another lanthanide, lanthanum, is used in batteries for cars like the Toyota Prius.

Add in the fact that 90% of the world’s lithium, an essential element in high-capacity batteries, comes from just three countries – Argentina, China, and Chile – and it quickly becomes apparent that the potential for a “green revolution” in the US, along with millions of “green collar” jobs may not rely on the inventiveness of battalions of tinkerers in thousands of American garages, but rather on the export practices of a handful of developing countries whose economic, political, and environmental concerns are wholly divorced from those of the US.<sup>xlvii</sup> Indeed, in its headlong rush to go “green” the US may simply be trading its reliance on imported oil for reliance on imported lanthanides and lithium.

Of course, we live in a global economy, particularly when it comes to energy. The petrostates of the Persian Gulf and elsewhere must sell their oil. They can’t drink it or use it to water their geraniums. The same holds true for the countries that produce lithium, neodymium, and rare elements. And given the ongoing globalization of the world economy, it stands to reason that the marketplace will help assure that buyers and sellers will reach an agreed-upon price for whatever goods or services are on offer. That said, the

difference between the hyper-global oil sector and the near-monopoly that China has on the rare earths market business is akin to the difference between aluminum and dysprosium.<sup>xlvi</sup>

In summary, the reality of the energy sector is this: energy security – whatever the favored definition for that term – means interdependence. And that interdependence goes far beyond energy commodities like diesel fuel, gasoline, natural gas, and neodymium. The US is a vital player in the global marketplace for a myriad of commodities, ranging from iPods and tennis rackets to fresh flowers and bottled water. The sooner the US discards the hypertrophied rhetoric about energy security and energy independence and accept the reality of our interdependence, the more secure and prosperous it will be.

END

Robert Bryce's latest book is *Gusher of Lies: The Dangerous Delusions of "Energy Independence."* His website: robertbryce.com.

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<sup>i</sup> BP Statistical Review of World Energy 2009.

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<sup>iii</sup> E.I.A. data. Available: <http://tonto.eia.doe.gov/dnav/pet/hist/rwtcd.htm>

<sup>iv</sup> CBS News, "Transcript of Barack Obama's Speech," February 10, 2007. Available: <http://www.cbsnews.com/stories/2007/02/10/politics/main2458099.shtml>

<sup>v</sup> R. James Woolsey and Anne Korin, "Turning Oil into Salt," *National Review Online*, September 25, 2007. Available: <http://article.nationalreview.com/?q=OTlmMjFjYWRjOWI3ZGI0MzUxZDJjYTBlMmUzOTc2Mzc=>

<sup>vi</sup> Vito Stagliano, *A Policy of Discontent: The Making of a National Energy Strategy*, 42.

<sup>vii</sup> Milton R. Copulos, "Salvaging the Synthetic Fuels Corporation," Heritage Foundation, April 12, 1985. Available: <http://www.heritage.org/Research/EnergyandEnvironment/bg423.cfm>

<sup>viii</sup> Stagliano, 42.

<sup>ix</sup> Robert Bryce, *Gusher of Lies: The Dangerous Delusions of "Energy Independence,"* 229.

<sup>x</sup> Robert Bryce, "Let's Get Real About Renewable Energy," *Wall Street Journal*, March 5, 2009. Available: <http://online.wsj.com/article/SB123621221496034823.html>

<sup>xi</sup> David J.C. MacKay, *Sustainable Energy -- Without the Hot Air*, 132.

<sup>xii</sup> E.I.A. data. "Diesel – A Petroleum Product," undated. Available: <http://www.scribd.com/doc/12860647/Encyclopedia-of-Energy-Basic>

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- <sup>xiv</sup> Frost and Sullivan, “North American Commercial and Military Ground-Based Flight Simulation Market,” August 31, 2006, 5-1 to 5-3.
- <sup>xv</sup> Vaclav Smil, “Moore’s Curse and the Great Energy Delusion,” *The American*, November 19, 2008. Available: <http://www.american.com/archive/2008/november-december-magazine/moore2019s-curse-and-the-great-energy-delusion>
- <sup>xvi</sup> Ibid.
- <sup>xvii</sup> E.I.A. data. Annual Energy Review 2008, Figure 5. “Primary Energy Consumption by Source, 1635-2008.” Available: [http://www.eia.doe.gov/emeu/aer/ep/ep\\_frame.html](http://www.eia.doe.gov/emeu/aer/ep/ep_frame.html)
- <sup>xviii</sup> E.I.A. data. Available: <http://www.eia.doe.gov/emeu/aer/txt/ptb0103.html>
- <sup>xix</sup> BP Statistical Review of World Energy 2009.
- <sup>xx</sup> BP Statistical Review of World Energy 2009.
- <sup>xxi</sup> Author interview with Bertrand Barré, Areva headquarters, Paris, May 7, 2009.
- <sup>xxii</sup> BP Statistical Review of World Energy 2009.
- <sup>xxiii</sup> For a comparison of various fuels in volumetric and gravimetric terms, see Wikipedia. Available: [http://en.wikipedia.org/wiki/Energy\\_density](http://en.wikipedia.org/wiki/Energy_density)
- <sup>xxiv</sup> E.I.A. data. Available: <http://tonto.eia.doe.gov/dnav/pet/hist/mttexas2a.htm>
- <sup>xxv</sup> E.I.A. data. Available: <http://tonto.eia.doe.gov/dnav/pet/hist/mttexas2M.htm>
- <sup>xxvi</sup> E.I.A. data. Available: <http://tonto.eia.doe.gov/country/index.cfm>
- <sup>xxvii</sup> E.I.A. data. Available: [http://tonto.eia.doe.gov/dnav/pet/pet\\_move\\_expc\\_a\\_EPDM10\\_EEX\\_mbbldpd\\_a.htm](http://tonto.eia.doe.gov/dnav/pet/pet_move_expc_a_EPDM10_EEX_mbbldpd_a.htm)
- <sup>xxviii</sup> E.I.A. data. Available: <http://tonto.eia.doe.gov/dnav/pet/hist/mttimus2a.htm>
- <sup>xxix</sup> E.I.A. data. Available: <http://tonto.eia.doe.gov/dnav/pet/hist/mcrntus2a.htm>. Note that there is no data available for 1916 through 1919.
- <sup>xxx</sup> It’s worth noting that Ford’s Model T got 25 miles per gallon. That’s better than the current fleet of vehicles and higher than current CAFE standards.
- <sup>xxxi</sup> E.I.A. data. Available: <http://tonto.eia.doe.gov/dnav/pet/hist/mcrntus2a.htm>.
- <sup>xxxii</sup> For 1913 GDP data see: [http://eh.net/hmit/gdp/gdp\\_answer.php?CHKnominalGDP=on&year1=1913&year2=](http://eh.net/hmit/gdp/gdp_answer.php?CHKnominalGDP=on&year1=1913&year2=)
- <sup>xxxiii</sup> California Progress Report, “President Clinton: Why I Support Proposition 87 and Why the Oil Companies are Wrong – The Complete Speech Delivered at UCLA,” October 14, 2006. Available: [http://www.californiaprogressreport.com/2006/10/first--\\_thank\\_y.html](http://www.californiaprogressreport.com/2006/10/first--_thank_y.html)
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<sup>xxxviii</sup> E.I.A. data. Available:

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<sup>xxxix</sup> International Energy Agency, “Natural Gas Market Review,” summary slides, 22.

<sup>xl</sup> BP Statistical Review of World Energy 2009.

<sup>xli</sup> International Energy Agency, “Natural Gas Market Review 2009,” 99.

<sup>xlii</sup> *Ibid*, 96.

<sup>xliii</sup> *Ibid*, 98.

<sup>xliv</sup> *Ibid*, 99.

<sup>xlv</sup> This group is also sometimes referred to as lanthanoids. Among the best interactive periodic table of the elements is available here: <http://www.dayah.com/periodic/>

<sup>xlvi</sup> Keith Bradsher, “China Tightens Grip On Rare Minerals,” *New York Times*, September 1, 2009. Available:

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