

**Working Paper:**

## ***Parsing Energy Plans: Count to 28***

**Supplement To:**

***The NEI Plan: Ending All America's Oil Imports in Twelve Years and Building a 21<sup>st</sup> Century Energy System***  
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## **Parsing Energy Plans: Count to 28**

Energy systems cost trillions of dollars and take decades to build. America's security, energy security, and future viability depend on choosing the right plan and executing it successfully.

This brief paper provides a summary of plans (on the final page) plus discussions of the following:

- Several tests to aid in evaluating any plan.
- Numeric benchmarks that can help define "How much is enough?"
- It also briefly addresses some of the plans before the public, including the Pickens Plan, Repower America, the American Energy Security (AES) plan, the National Commission on Energy Policy (NCEP) plan, and the National Energy Independence Plan (with which the author and contributors of this paper are associated).

### **Energy Threats: Two Forms**

America's energy problem comes in two forms: foreign oil dependency and climate change.

#### ***Foreign Oil Dependency***

The first critical problem—as a potential threat to national security—is foreign oil dependency. It affects the nation in three forms. First, according to Oak Ridge National Laboratories, it is a "sea anchor" for the economy, a \$0.7 Trillion drag every year (based on \$100 per barrel oil). Second, the potential for an oil shock is ever-present. According to testimony before Sen. Richard Lugar's committee in 2006, an oil shock could take place at any moment, bringing commerce to a halt at a cost of \$5-8 Trillion. Third, only the uninformed believe that oil can't regain its prices of mid-summer, or much higher. T. Boone Pickens, on Meet the Press (Nov 16, 2008), predicted that oil would be "\$200 to \$300 a barrel in ten years." Allowing such vulnerabilities—with a combined probability far above Mr. Cheney's 1%—to such colossal risks is national security malpractice.

Mr. Pickens has done the nation a service by stating the obvious. America has 3% of the world's oil reserves, 4% of the population, uses 25% of the world's oil, and its habit—at \$0.7 Trillion per year—will cost \$7 Trillion over ten years. "Things can't go on like this," he says. Put it this way: America is paying \$0.7 Trillion each year for the right to be highly vulnerable. America can buy a lot of energy infrastructure for the \$7 Trillion that would otherwise be squandered.

A million barrels of oil per day for a year is roughly equal to 2.11 Q-Btu. One Q-Btu, or "Quad," is one quadrillion British thermal units. This unit is a tidy way to think about energy. America consumes about 100 Q-Btu of energy per year, 25% of the world's consumption. Thus, the world consumes about 400 Q-Btu per year. In oil form, America uses 40 Q-Btu of oil per year and imports 28 Q-Btu, i.e. 70%. It is the 28 Q-Btu of oil imports to which the title of this note refers.



## Climate Change

Only a 21st Century Energy System—supply (for which electricity is the medium), distribution (infrastructure), and demand (how the energy is used by vehicles, dwellings, and industry)—can provide energy that is cheap, clean, domestically sourced—and limitless.

## Parsing Plans

Energy plans abound. How to identify those offering a real solution? The answers are surprisingly easy. First, energy security: America must deal with the foreign oil imports first, on an emergency basis. Second, control greenhouse gas emissions. These imply two tests:

- (a) The 28 Q-Btu per year test: Energy security cannot be achieved by a plan that does not total 28 Q-Btu replacement of foreign oil per year (or close to it) in about a decade.
- (b) The *replace, not mitigate* test: Any purported plan to “stop America’s contribution to global warming” by 2050 is suspect if it offers the word “mitigate.” Look for a plan that replaces—not mitigates—dirty energy sources (internal combustion engines, coal-fired electrical generation) between now and 2050 and offers limitless clean expansion. “Mitigates emissions” in a plan means temporarily. What counts is permanent change.

## Fossil Fuels

Fossil fuels in a plan should not be feared; rather, how they are employed is key to evaluating any plan. Look for an end date within a maximum of 20 years. It is not a given that fossil fuels will remain affordable. Fossil fuels are unavoidable in the short run and should be used to facilitate rapid change while their costs permit. If all 28 Q-Btu of imported oil replacement came from “dirty” domestic fossil sources, this outcome would still be a major—though temporary—victory:

- The nation would achieve energy (but not climate) security.
- America would save the \$0.7 Trillion foreign oil dependency drag on the economy.

Converting to domestically-sourced fossil fuels buys time with energy security. Since carbon emissions would remain the same as now, such a plan would have to be paired with a plan to provide and use domestically-sourced, clean, cheap energy—a “green” energy track which leads to a permanent change—to non-emitting, non-fossil, domestic energy sources.

## CCS, Carbon Capture and Sequestration

In any plan, the words “clean coal” mean “watch out.” The idea behind CCS, carbon capture and sequestration, is to capture the CO<sub>2</sub> from a coal-fired generator (the best theoretical capture rate is 90% and costly), compress it into slurry, pipe it several miles to an underground cavity (if one



exists near the plant), where it will remain permanently. Since “permanent” must be tested for at least 20 years, and since not all geologic formations are the same, this is a technology that is not yet proven and cannot be relied upon until a 20 year test in many areas has established that the “sequestered” CO<sub>2</sub> remains in the earth. Consider three items:

- A test of CCS near Houston, TX, which used an abandoned oil well, was stopped because of interaction between the limestone in the cavity and the CO<sub>2</sub>. The toxic materials in the oil well were percolating toward a water supply. A report stated,  
*“...the injected CO<sub>2</sub> could also mobilize toxic organic compounds. Environmental impacts could be major if large brine volumes with mobilized toxic metals and organics migrated into potable groundwater.”*<sup>1</sup>
- A test of CCS in Georgia was halted because the local municipality demanded proof that the CO<sub>2</sub> was not a residential hazard. CO<sub>2</sub>, like radon, is colorless and odorless and displaces oxygen. The fear was that it would flow up into residences and become a hazard, the same effect as a disaster in Cameroon involving residents around a lake. The lake inverted, releasing trapped CO<sub>2</sub>, and killed over 1,000 persons.<sup>2</sup>
- One writer summarized “clean coal” CCS as follows:

*Then there are the safety questions. One large, coal-fired plant generates the equivalent of 3 billion barrels of CO<sub>2</sub> over a 60-year lifetime. That would require a space the size of a major oil field to contain. The pressure could cause leaks or earthquakes, says Curt M. White, who ran the U.S. Energy Dept.'s carbon sequestration group until 2005 and served as an adviser until earlier this year. “Red flags should be going up everywhere when you talk about this amount of liquid being put underground.”*<sup>3</sup>

### The 28 Q-Btu Test

28 Q-Btu per year of foreign oil reduction stops imports. Charting a path to reach it requires knowing a few numbers about sources and uses of energy. Here are some ways to replace imported oil. One fossil source is needed for transition. The figures are annual.

- Biofuels grown in the U.S.A. are limited to about 7 Q-Btu; heavy trucks use 5 Q-Btu and make a good fit between source and use.
- Wind energy delivered to the plug or car charger is limited to 10-15 Q-Btu.
- Solar energy, though, is simply unlimited. A 95x95 mile square of Arizona desert can produce 6.6 Q-Btu of energy per annum at the field, equal to the electricity from a billion

<sup>1</sup> Kharaka, Y.K., Cole, D.R., Hovorka, S.D., Gunter, W.D., Knauss, K.G., and Freifeld, B.M., 2006, Gas-water-rock interactions in Frio Formation following CO<sub>2</sub> injection: Implications for the storage of greenhouse gases in sedimentary basins: *Geology*, v. 34, p. 577-580.

<sup>2</sup> <http://www.gsjournals.org/perlserv/?request=get-abstract&doi=10.1130%2FG22357.1&ct=1>

<sup>3</sup> [http://en.wikipedia.org/wiki/Lake\\_Nyos](http://en.wikipedia.org/wiki/Lake_Nyos)

<sup>3</sup> Ben Elgin, “The Dirty Truth About Clean Coal,” *Business Week*, Energy Section, June 19, 2008. [http://www.businessweek.com/magazine/content/08\\_26/b4090055452749.htm](http://www.businessweek.com/magazine/content/08_26/b4090055452749.htm)



tons of coal per year, or half all U.S. electricity generated per year. There are two types of solar, concentrated solar power (CSP) and photovoltaic (PV). Any plan proposed that today eliminates one or the other, CSP or PV, is acting too soon. Both work. Time is needed to determine the lowest cost at scale.

- Special Case for Transition: Coal to liquids (diesel or gasoline) is normally considered much dirtier than using crude oil, but a process called “synergistic coal to liquids and then to biofuels” (SCTL-B, in the NEI Plan), using known technology, can actually produce usable energy—including 5 Q-Btu of diesel at \$2.00 per gallon, \$2.50 with taxes—at a net reduction of CO<sub>2</sub> from current practices. It is still similar to current practices, but when biomass is ready can be converted to “green” biofuels using the same physical infrastructure.
- Light Trucks and Cars: no plan can reduce 28 Q-Btu of oil without eliminating the 13.4 Q-Btu used by light vehicles. Currently there are two approaches to converting light vehicles: plug-in hybrid-electric vehicles (PHEV) like the Chevy Volt and hydrogen fuel cell cars like the Honda FCX Clarity. Both are considered advanced electric vehicles.

### Infrastructure

In any plan, look for infrastructure. If the plan proposes wind and solar without infrastructure, it can't work, except in trivial amounts. America paid \$14 Trillion for its current fossil infrastructure (oil wells, tankers, pipelines, refineries, mines, trains for coal, storage tanks) and, according to the EIA, will have to add \$5.4 Trillion by 2030, a total of about \$20 Trillion, just to have gas at the pump (price not guaranteed).

Infrastructure is needed for wind and solar, which can be delivered to local power grids from Arizona or Nebraska as steady base load power, the same as coal or nuclear.

The infrastructure needed must be two-part—high voltage direct current (HVDC) transmission and compressed air energy storage (CAES) to smooth the current and make it available 24/7. Discussion of renewables without renewable infrastructure or just a grid and no storage is fantasy. Moreover, there is much talk about a “smart grid” but little discussion about which grid, national or local. Energy is generated at the solar field or wind farm, then transmitted by the HVDC connections, then delivered through the local grid. Requiring many thousands of local grids to become “smart” will not provide 24/7 base load power. Only CAES (or solar thermal storage—not yet proven) acting before download from HVDC to the local grid, can provide base load power. Any plan, of course, should give quantities and a schedule.

[Disclosure: the NEI Plan is unique in one respect: it recognizes current science and mandates energy storage (CAES, compressed air energy storage, or TES, thermal energy storage) to condition the renewable power to base load quality before delivery to the local grid. Attempts to use a “smart grid” and car batteries will be insufficient and inappropriate for replacing coal or nuclear base load quality power.]



## Emissions

Man-made energy related CO<sub>2</sub> emissions due to energy are now on the order of 20 metric tons per person per year, 600 billion tons per year total, roughly 50-50 between coal generators and oil and natural gas emissions. If emissions can be brought permanently below 4 tons of CO<sub>2</sub> per person per year by 2050, that's an achievement. U.S. population now is 300 million; the Census Bureau forecasts a U.S. population of 439 million by 2050. It must be noted that in addition to energy-related emissions, one billion metric tonnes per year are produced by non-energy sources, like volcanoes, forest fires, concrete, and flatulent animals. So, caution must be exercised about a plan that is slow to get CO<sub>2</sub> under control – it is “dirtier” than one that does the same thing quickly.

## Realism

Caveat: moving quickly requires realism. Technology ramp-up, the learning curve, must be addressed in any plan. One should require the models that specify transitions and costs. How are goals attained? Coal fired electrical generation is important and four areas should be addressed.

- Coal accounts for half America's electricity. The rest is hydro, nuclear, and a trivial amount from renewables. That's 1 billion tons of coal burned, 20 Q-Btu of energy in the coal, to generate about 1/3 that much electricity, 6.5 Q-Btu.<sup>4</sup>
- 600 coal-fired generating plants in the U.S. can't be just waved away. Each generates about 1 billion watts, and each represents an investment of about \$600 million, or \$360 billion total. During the transition to a new energy system, any plan must recognize coal-fired electrical generation, showing a reasonable retirement schedule or how to deal with the lost capital investment due to accelerated retirement.
- Any viable plan to replace the 600 plants will have to specify a credible energy alternative that can generate about 6.5 Q-Btu of electricity. The source must be non-emitting, it should start to be on line in a decade or less, and it should include lots of room for growth due to electric cars, desalination in mid-century, vast irrigation projects, and other future and massive energy needs.
- Schedules need to be reasonable. For example, 242 one-GW nuclear plants would generate 6.5 Q-Btu, but getting them built in ten years in the needed locations may not be reasonable.

## Funding

In any plan, source of funds should be designated and—since alternatives differ in their lifespans—costs need to be reconciled over time. There are three characteristics to look for.

- If the plan can't explain how it would be paid for, it is not yet a plan. For example, the NEI Plan specifies that it will be paid for from bonds repaid by charges for energy delivered

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<sup>4</sup> Heat engines of any kind, like coal power plants, gasoline car engines, or even nuclear plants, are about 1/3 efficient when converting the thermal energy in the fuel to useful form, like electricity.



- through the Grid (renewable sources plus renewable infrastructure) at 13.5 cents per kilowatt-hour until the Grid is paid for (20-40 years) and then 5 cents per kWh for the rest of the century. This process, except for some seed money, is off the Federal budget.
- Question agendas. If a plan does not account—in its comparisons—for the \$0.7 Trillion of annual foreign oil dependency costs, then it may not reflect a straightforward agenda to minimize costs to America's citizens. If a plan saves \$0.7 Trillion per year, those dollars should not be ignored in comparisons with other plans.
  - Free enterprise to the oil companies can be a tax to the citizen. Who paid for the \$14 Trillion U.S. fossil infrastructure? Not the energy companies: it was the citizens at the pump who paid the bill, and they have had very little to say about the (fossil) future. The additional \$5.4 Trillion to be spent to get to 2030 may be expended by an oil company, but to the citizen it is essentially a tax at the pump, and citizens should have some say about what they get for the money. At the moment the vague promise is availability at some undetermined price. This is not a bargain and there are alternatives.

### Where are the Numbers?

Many plans provide precious few numbers. Here are the activities that consume oil: Transport consumes about 28 Q-Btu, coincidentally the same as oil imports. Trucks use 5; light four wheeled vehicles—239 million of them—use 13.4 Q-Btu; planes, trains, farm, etc. use 9.4 Q-Btu. Space and water heating use 2.1 Q-Btu. Industrial uses total 9.7 Q-Btu. The military uses about 0.75 Q-Btu. Altogether these activities sum to about 40 Q-Btu, America's annual oil use, or about 19 million barrels per day. So, roughly, petroleum is 40, natural gas is 24, coal is 23, renewables are 6 (mostly hydro), and nuclear is 8.

### Five Plans

Following are partial notes on plans offered to the public; oil reductions, funding, and emissions.

- [www.PickensPlan.com](http://www.PickensPlan.com) 5 Q-Btu reduction of oil imports and temporary net reduction of CO2 emissions by using natural gas for truck transport. The idea is to provide a transition from oil for transport. The Pickens Plan uses wind to replace natural gas, currently burned to generate electricity. The plan has problems with replacing gas for electrical generation, since its wind lacks renewable infrastructure. Accordingly it can't get where it is needed (the plants now using natural gas) and the electricity is unconditioned on arrival so therefore not useful to the plant. Neither costs nor funding methods are given. The Pickens Plan is a transitional strategy that does not achieve energy security, its stated purpose.
- <http://www.energycommission.org> The National Commission on Energy Policy (NCEP, perhaps the basis for the Obama plan): saves a total of 6.6 Q-Btu by 2018 via tightening CAFE standards and other measures that continue to use fossil. The CO2 tailpipe emission reduction based on better mileage will not be permanent if the nation continues



- to grow. The plan continues to use fossil via enhanced oil recovery using CO2. The plan talks about CO2 CCS (carbon capture and sequestration). Funding is through the federal budget at \$15 billion per year. The oil import reduction is insufficient to achieve energy security.
- [NEI Plan \(“highlights” previously furnished\)](#). The National Energy Independence (NEI) Plan can save about 29 Q-Btu of imported oil, or 100% of total imports within 12 years, with a minor net reduction of CO2. Since it has a parallel track that replaces gasoline vehicles with electric and trucks to biodiesel over time, its total emissions reduction of CO2 (84% from 2005 to 2050) is permanent. Self-funding through bonds and energy sales. The total cost is almost all off the federal budget. It provides both national energy security within 12 years and a transition to a cheap and domestically sourced energy system by 2050.
  - [www.RepowerAmerica.org](http://www.RepowerAmerica.org) ignores imported oil and focuses on replacing coal for electric generation with wind and solar via a “smart grid.” Storage is supposedly from parked car batteries, but this type of storage is not credible for conditioning power to base load quality. Oil reduction is unknown but is small, perhaps 0%-10% in a decade. It discusses electric vehicles but provides no schedule. Since coal and tailpipe emissions are about the same, this approach will affect CO2 for about 50% of emissions. Funding is not clear, particularly what to do with 600 coal plants. It does not directly address energy security.
  - <http://www.americanenergysecurity.org> Finally, there is the American Energy Security (AES) plan. This is an excellent and well thought out plan but only addresses emissions via the fig leaf of “clean coal,” (discussed on pages 3 and 4). It replaces imported oil with domestic fossil fuels, biomass, and increased vehicle fuel economy. The primary sources of energy are oil shale, coal to liquids (11Q-Btu), enhanced oil recovery (EOR), and biofuels. The plan deals with demand by fuel economy (50% by 2030). This plan reduces imports by 50% by 2020 and 100% by 2030. However, the plan is not sustainable. Coal experts say that such use of coal would provide serious shortages within 50 years, leaving America with no path to an advanced energy system. The plan is very weak on CO2 emissions and it is not a sustainable energy path through 2050.

### Summary of Plan Outcomes

- Energy security from foreign oil dependency within ten years: only AES and NEI.
- Oil dependency costs from years 2030-2039 (assuming \$100 oil): AES and NEI are zero cost starting in 2030; all others are \$7 Trillion for the decade.
- New and clean energy system by 2050: Repower and NEI. Pickens should not be faulted since he states his plan is transitional. Repower cannot work without CAES.
- CO2 Reduction: NEI is 84% by 2050. Plans using CCS (“clean coal”) are rated zero for the periods in question since the process is not proven and still needs 20 years of tests.
- Self-Funding, off the Federal Budget: Only NEI.

