STATEMENT OF

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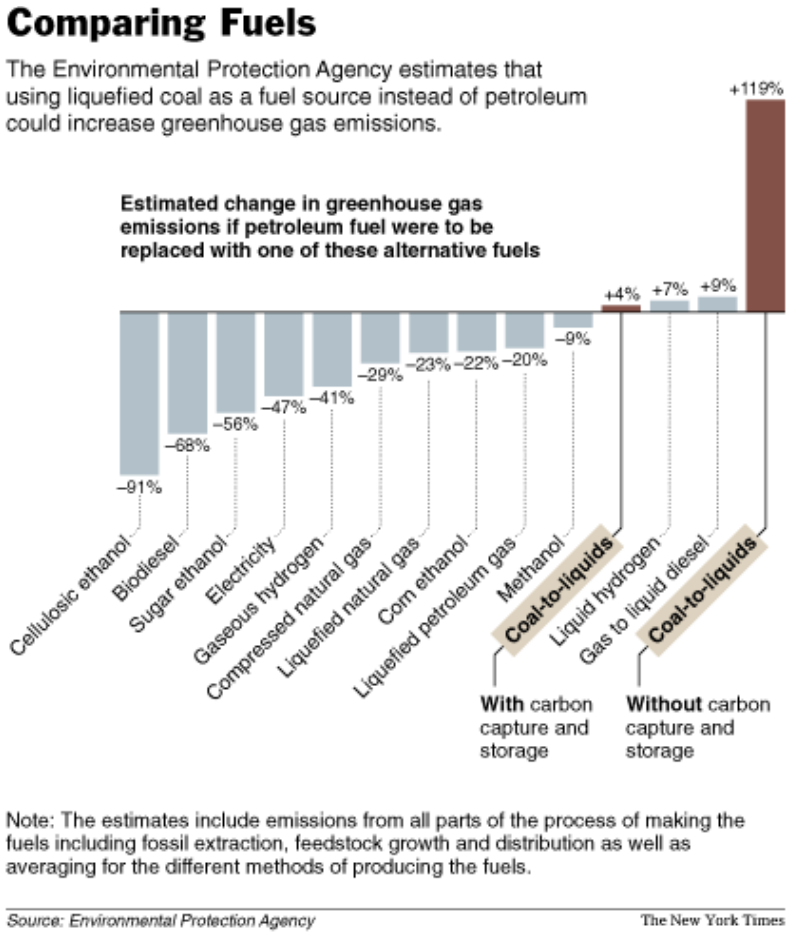
Mr. Chairman, members of the Committee, I am delighted to appear before you today to discuss the subject of liquid fuel from coal. I am a Senior Fellow at the Center for American Progress here in Washington, DC where I run the blog *ClimateProgress.org*. I am author of the recent book *Hell and High Water: Global Warming—the Solution and the Politics* (Morrow, 2007) and have published and lectured widely on energy and climate issues.

I served as Acting Assistant Secretary at the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy during 1997 and Principal Deputy Assistant Secretary from 1995 though 1998. In that capacity, I helped manage the largest program in the world for working with businesses to develop and use clean energy technologies. I hold a Ph.D. in physics from M.I.T.

We are all grappling with how best to avoid catastrophic global warming. I will argue coal to liquids is not part of the solution—and would in fact make the problem worse. The following figure, based on EPA data, shows the estimated change in greenhouse gas emissions from various alternative fuels:



I appreciate the opportunity to share my views on coal to liquids, which are based on numerous discussions with leading energy experts; research and analysis for my book and for the National Commission on Energy Policy; and participation in the Defense Science Board Task Force on Department of Defense Energy Strategy, which heard a number of briefings on liquid coal, including from the Jason's defense advisory group. All references in this testimony can be found in my book or on my blog.

**BACKGROUND**

The question of the role of coal to liquids can play in the national energy mix can be understood only with a full appreciation of the scale of climate mitigation the nation and the world must pursue. Global concentrations of carbon dioxide, the primary greenhouse gas, are rising at an accelerating rate in recent years—and they are already higher than at any time in the past 3 million years. The scientific consensus, as reflected in the work of the Intergovernmental Panel on Climate Change (IPCC), appears to be seriously *underestimating* the rate of climate change:

- "The recent [Arctic] sea-ice retreat is larger than in any of the (19) IPCC [climate] models" — and that was a Norwegian expert in 2005. The retreat has accelerated in the past two years.
- The ice sheets appear to be shrinking "100 years ahead of schedule." That was Penn State climatologist Richard Alley in March 2006. In 2001, the IPCC thought that neither Greenland nor Antarctica would lose significant mass by 2100. They both already have.
- The temperature rise from 1990 to 2005 — 0.33°C — was "near the top end of the range" of IPCC climate model predictions.
- Sea-level rise from 1993 and 2006 — 3.3 millimetres per year as measured by satellites — was higher than the IPCC climate models predicted.
- Atlantic hurricane intensity appears to be increasing faster than the models projected.
- The tropics are expanding faster than the models project.
- Since 2000, carbon dioxide emissions have grown faster than any IPCC model had projected.

Worse, the ocean's heat content will keep reradiating heat into the earth's atmosphere even after we eliminate the heat imbalance, meaning the planet will keep warming and the glaciers keep melting for decades after we cut greenhouse gas emissions. Therefore, we *must* act in an "anticipatory" fashion and reduce emissions long before climate change is painfully obvious to everyone.

The planet has warmed about 0.8°C since the mid-19th century, primarily because of human-generated greenhouse gas emissions. If we don't sharply reverse the increase in global greenhouse gas emissions within the next decade, we will be committing the world to an additional 2° to 3°C warming by century's end, temperatures not seen for millions of years, when Greenland and much of Antarctica were ice free, and *sea levels were 80 feet higher*.

How fast can the sea level rise? Following the last ice age, the world saw sustained melting that *raised sea levels more than a foot a decade*. NASA's Dr. James Hansen—the country's leading climate scientist—believes we could see such a catastrophic melting rate within the century, as do many others I interviewed for my book. Other potential devastating threats from unrestricted greenhouse gas emissions include widespread drought and desertification, including in the American southwest, and an increase in extreme weather of all kinds, including heat waves, hurricanes, and severe rainstorms.

To avoid this fate, we must sharply reduce global carbon dioxide emissions from fossil fuel combustion. As an example of the kind of reductions required by climate change, both Florida Governor Charlie Crist and California Governor Arnold Schwarzenegger have committed their states to reduce greenhouse gas emissions to *80% below 1990 levels by 2050*. The United States Climate Action Partnership—a group of Fortune 500 companies and leading environmental organizations—has embraced 60% to 80% cuts by 2050. Former Prime Minister Tony Blair committed the United Kingdom to a 60% reduction by 2050. The IPCC says all industrialized nations, including the United States, need to achieve reductions of 50% to 80% to avoid the worst of global warming—and that requires emissions to peak in the next decade. Many bills have been introduced to Congress to achieve such cuts. The question is where does liquid coal fit in U.S. efforts to achieve such cuts?

**NO ROLE FOR LIQUID COAL**

Coal and natural gas can be converted to diesel fuel using the Fischer-Tropsch process. During World War II, coal gasification and liquefaction produced more than half of the liquid fuel used by the German military. South Africa has employed this process for decades.

The process is not more widely used today in large part because it is incredibly expensive. It costs $5 billion or more just to build a plant capable of producing 80,000 barrels of oil a day (the U.S. currently consumes more than 21 million barrels a day).

*Five to seven gallons of water are necessary for every gallon of diesel fuel that's produced* (and double that if you coproduce diesel fuel and electricity from coal), according to the June 2006 report, "Emerging Issues for Fossil Energy and Water: Investigation of Water Issues Related to Coal Mining, Coal to Liquids, Oil Shale, and Carbon Capture and Sequestration" by DOE's National Energy Technology Laboratory. Here is the key figure from the report:

**Table 2-1. Water Requirements for Coal Liquefaction Plants.**

| Technology | Coal | Size | Water Requirement |
|---|---|---|---|
| Indirect Liquefaction | Eastern | 50,000 BPSD | 10,500 GPM (4.966 Bgal/yr) |
| Indirect Liquefaction | Western | 50,000 BPSD | 7,300 GPM (3.453 Bgal/yr) |
| Direct Liquefaction | Midwestern | 50,000 BPSD | 7,900 GPM (3.737 Bgal/yr) |
| Coproduction (F-T Liquids Plus Electric Power) | Eastern | 25,000 BPSD plus 1,250 MW | 20,800 GPM (9.839 Bgal/yr) |

**Source: Parsons 2005.**

This is not a particularly good long-term strategy in a nation and a world facing mega-droughts and chronic water shortages from human-caused climate change. The heavy water demand is one reason chronically water-short China has raised the capital threshold for liquid coal projects in an effort to scale back growth.

Worse than the water issue, the total carbon dioxide emissions from coal-to-diesel are about double that of conventional diesel, as the earlier figure shows. It is possible to capture the carbon dioxide from the process and store it underground permanently. But that will make an expensive process even more expensive, so it seems unlikely for the foreseeable future, certainly not until carbon dioxide is regulated and has a high price and we have a number of certified underground geologic repositories.

More importantly, even with the capture and storage of $CO_2$ from the Fischer-Tropsch process, the final product is diesel fuel, a carbon-intensive liquid that will release $CO_2$ into the atmosphere once it is burned in an internal combustion engine. A great many people I have spoken to are confused about this point: They think that capturing and storing the $CO_2$ while turning coal to diesel is as good an idea as capturing the $CO_2$ from the integrated gasification combined cycle (IGCC) process for turning coal into electricity. No. The former process still leaves a carbon-intensive fuel, whereas the latter process yields near zero-carbon electricity.

***The future of coal in a carbon-constrained world is electricity generation with carbon capture and storage, not CTL plus carbon capture and storage.*** Capturing and storing even one gigaton of carbon a year requires a flow of carbon dioxide *into* the ground equal to the current flow of oil *out* of the ground. That by itself represents an enormous engineering challenge. We need to devote the vast majority of this level of sequestration effort to power production, to generation of zero-carbon electricity from coal, not to generation of an endless stream of carbon-intensive liquid fuel like Fischer-Tropsch diesel. Worse, some people propose taking the captured $CO_2$ and using it for enhanced oil recovery, which, as discussed below, is the equivalent of not capturing the carbon dioxide at all.

Coal to diesel is a bad idea for the nation and the planet. If the United States pursues it aggressively, catastrophic climate change will be all but unavoidable. Turning natural gas into diesel is not as bad an idea, at least from the perspective of direct emissions, because natural gas is a low-carbon fuel. But it represents a tremendous misuse of natural gas, which could otherwise be used to reduce future greenhouse gas emissions.

A 2006 study by the University of California at Berkeley found that meeting the future demand shortfall from conventional oil with unconventional oil, especially coal-to-diesel, could increase annual emissions by 2.0 billion metric tons of carbon (7.3 gigatons of carbon dioxide) for several decades. That is more than current total U.S. carbon emissions and would certainly be fatal to any effort to avoid 3°C increase in average worldwide temperature. Indeed, in a liquid coal scenario, a tripling of carbon dioxide emissions by century's end seems likely, which would likely leave the planet 5°C warmer than preindustrial levels by 2100—a temperature not seen since before Antarctica had ice, when sea levels were 280 feet higher than current levels. Again, avoiding 3°C requires a substantial *decrease* in total upstream and downstream carbon emissions from oil by mid-century.

**EIA PREDICTS CARBON PRICE FATAL TO LIQUID COAL**

Instead of promoting of liquid coal, Congress must address the climate problem by establishing a cap on emissions that creates a price for carbon dioxide. What will be the impact on liquid coal of a carbon cap? Two recent reports by the U.S. Energy Information Administration (EIA) provide the answer.

In its January 2007 report, "Energy Market and Economic Impacts of a Proposal to Reduce Greenhouse Gas Intensity with a Cap and Trade System," EIA examined the impact of a draft version of Sen. Jeff Bingaman's global warming bill. That bill has a safety valve, which limits the price of carbon dioxide permits. In the EIA analysis, the permit price starts around $4 a ton of carbon dioxide in 2012, rises to $7.15 in 2020 and reaches only $14.18 in 2030. *This is a relatively low price for carbon dioxide*. Indeed, this 2030 price is considerably lower than the current price for carbon dioxide in the European Union – and the first budget year for Kyoto isn't even until next year. In this scenario, EIA finds:

> in 2020, CTL production is 0.2 million barrels per day (*74 percent*) lower than in the reference case. By 2030, the change is 0.6 million barrels per day (*85 percent*) lower than in the reference case.

In short, a relatively low price for carbon dioxide wipes out the vast majority of projected CTL.

In July 2007, EIA released "Energy Market and Economic Impacts of S. 280, the Climate Stewardship and Innovation Act of 2007," an analysis of the global warming bill by Senators John McCain and Joe Lieberman. S. 280 sets considerably more stringent reduction targets than Sen. Bingaman's draft bill—ultimately reaching 60% below 1990 emissions levels by 2050. This bill has no safety valve. As a result, the permit price reaches $22.20 in 2020 and hits $47.90 in 2030. The report finds:

> **None of the 15 coal-to-liquids plants built in the reference case are projected to come on line in the main S. 280 cases**. In the reference case [business as usual], coal consumption at CTL plants reaches 109 million tons in 2030.

A moderate price for carbon dioxide wipes out all projected CTL.

Since it is all but inevitable that we will have a low-to-moderate price of carbon dioxide by 2020, and at least a moderate price by 2030, CTL will not achieve any significant market penetration. No amount of federal research and development investment or tax credits or loan guarantees are likely to change that equation.

**CTL FOR ENHANCED OIL RECOVERY DOES NOT HELP THE CLIMATE**

The carbon dioxide from CTL could be used to squeeze more oil out of the ground by injecting it into a well where it would be sequestered permanently. It might be argued that the carbon dioxide could

have dual value—for enhanced oil recovery (EOR) and as a certified greenhouse gas emission reduction—and that such a dual value would make CTL more economical.

That, however, makes neither environmental nor economic sense. The key ratio is carbon dioxide injected vs. carbon dioxide released from recovered oil. BP and UCLA did such a life-cycle analysis in 2001 and concluded, "the EOR activity is almost carbon-neutral when comparing net storage potential and gasoline emissions from the additional oil extracted." And that may be optimistic. The study notes:

> The results presented reflect only gasoline consumption but do not take into account the additional emissions that would originate from the refining process, nor the emissions arising from the combustion of the other products of crude oil such as diesel, bunker or jet fuels.

In short, the carbon dioxide used to recover the oil is less than the carbon dioxide released from that oil when you include the carbon dioxide released from 1) burning all the refined products and 2) the refining process itself. For that reason, no nation should give carbon credits for carbon dioxide used for EOR**.**

The study, however, has a different conclusion: "utilizing captured and recycled CO2 *instead of using CO2 exclusively from natural reservoirs* reduces greenhouse gas emissions to the atmosphere from EOR" (emphasis added). This is true because most carbon dioxide used for EOR today comes from "natural reservoirs."

But the nation and the world have barely touched the full potential of EOR even though it can potentially double the oil output from a well that has undergone primary and secondary recovery. Why? As a 2005 Department of Energy press release on an EOR-sequestration project noted, "much of the CO2 used in similar U.S. EOR projects has been taken *at considerable expense* from naturally occurring reservoirs" (emphasis added).

Cheap, widely available carbon dioxide would be a game-changer for oil recovery. The DOE carefully studied EOR and came to an amazing conclusion in 2006. In the U.S. alone, "next generation CO2-EOR technology" and "widespread sequestration of industrial carbon dioxide" could add a stunning "160 billion barrels of domestic oil recovery." The combustion of that oil would produce more than 60 billion tonnes of CO2, equivalent to ten times annual U.S. CO2 emissions.

A CTL project where the carbon dioxide is captured and used for new EOR is a doubly bad idea from a climate perspective. Nor does it solve the problem of oil dependency. As President Bush has said, "we are addicted to oil" and "we need to get off oil." Achieving those goals while sharply reducing greenhouse gas emissions can be accomplished only with cars that are significantly more fuel-efficient running on low-carbon alternative fuels, such as cellulosic ethanol or electricity from zero-carbon sources for plug-in hybrid electric vehicles.

**CONCLUSION**

We are simply running out of time to avoid catastrophic warming, and we no longer have the luxury of grossly misallocating capital and fuels to expensive boondoggles like coal to liquid. Because of the urgent need to reduce greenhouse gas emissions—because Congress is finally considering the passage of a cap and trade system to reduce emissions—CTL should have little future in this country.

Congress should certainly not allocate significant funds to CTL R&D, nor should it take other measures to promote CTL. The future of coal in a carbon constrained world is in the form of electricity generation with carbon capture and storage. And if coal has a future as a transportation fuel, it is with plug in hybrids running on such zero-carbon coal electricity. For these reasons, accelerating the transition to such zero-carbon power is where Congress should be focusing its time and resources.