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TESTIMONY

Testimony on S. 937 The American Alternative Fuels Act of 2011

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Before the Committee on Energy and Natural Resources
United States Senate

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Chairman and distinguished Members: Thank you for inviting me to testify on S. 937, the American Alternative Fuels Act of 2011. I am a Senior Policy Researcher at the RAND Corporation with over 30 years of experience in analyzing and assessing energy technology and policy issues. At RAND, I have been actively involved in research directed at understanding the costs and benefits associated with the use of domestically abundant resources, such as coal, oil shale and biomass, to lessen our nation's dependence on imported petroleum. The findings that I will discuss today are drawn from studies sponsored and funded by the National Energy Technology Laboratory (NETL) of the U.S. Department of Energy, the United States Air Force, the Federal Aviation Administration, the National Commission on Energy Policy, the U.S. Chamber of Commerce, and the Defense Logistics Agency.

Today, I will discuss the strategic importance of alternative fuels and our assessment of the most promising candidates for near-term production. I will also specifically address Sections 3 and 5 through 7 of S. 937. These are the sections of the proposed legislation where I hope to provide useful insights to the committee based on our recent research on alternative fuels and energy security.

The Importance and Value of Alternative Fuels

The United States' consumption of liquid fuels is about 19 million barrels per day (bpd). Meeting this demand requires importing about 10 million bpd of petroleum, mostly in the form of crude oil. In a world that consumes about 85 million bpd of petroleum products, the United States holds first place in total consumption and in the magnitude of its imports.

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Currently the average price of crude oil imports is over $105 per barrel. At these prices, oil imports will cost U.S. oil consumers nearly $400 billion per year. Considering both direct and indirect expenditures for energy, each $10 per barrel increase in the price of world oil costs the average U.S. household over $550 per year.

The national security consequences of the dependence of the United States, and its allies and trading partners, on imported oil are well-documented.[3] All oil consumers are vulnerable to increased prices for oil when oil exporters are able to reduce supplies on the world oil market. Most serious would be the economic impact of a large and extended disruption in global oil supplies as a result of conflict or natural disaster. There is also the problem of wealth transfers to the governing regimes of some oil exporting nations, such as Libya, Venezuela and Iran, that pursue policies that run counter to the national security interests of the United States and its allies. When oil prices are high, these nations have more funds to invest in purchasing armaments and building their own industrial bases for manufacturing munitions. High oil prices also provide more funds that may eventually find their way to large terrorist organizations such as Hamas and Hizballah.

Alternative fuels are already being produced in many countries. Examples include corn-derived ethanol in the United States and sugar-derived ethanol in Brazil, synthetic crude from oil sands in Canada, coal-to-liquids production in South Africa, natural gas-to-liquids production in Qatar and Malaysia, and small amounts of biodiesel production in the United States and Europe. Expanding alternative fuels production beyond these initial efforts would offer economic and national security benefits to the United States. Because it provides a substitute for products refined from crude oil, increased production of alternative fuels will reduce demand for crude oil, resulting in lower world oil prices to the direct benefit of all oil consumers. Lower world oil prices and greater supply diversity also mitigate the adverse national security impacts of imported oil.

About 45 percent of the operating refinery capacity of the United States is located in the hurricane-prone states of Texas, Louisiana, and Mississippi. Because alternative fuels production would likely occur in diverse locations throughout the United States, a domestic alternative fuels industry would improve the resiliency of the petroleum supply chain, especially against natural disasters. Increasing the geographical diversity of fuels production implies that a smaller fraction of supplies would be affected by any natural disaster. As such, we anticipate less economic disruption as the remaining supplies are allocated to users.

[3] *Imported Oil and U.S. National Security*, Crane et al., Santa Monica, Calif.: RAND Corporation, MG-838-USCC, 2009.

For certain alternative fuels, another important benefit could be a reduction in lifecycle greenhouse gas emissions, as compared to their counterparts produced from conventional petroleum. Alternative fuels that offer significant reductions include some, but not all, types of renewable fuels and fuels manufactured from a blend of coal and biomass.

But if alternative fuels are to achieve these economic, security, and environmental benefits, combined global and domestic production of alternative fuels must be an appreciable fraction of global and domestic demand for liquid fuels. Specifically, the need is for an alternative fuel portfolio that can competitively produce millions of barrels per day in the United States. Alternative fuel advocates often use gallons per year when describing production potential. For perspective, one million barrels per day is 15.3 billion gallons per year.

An important finding from our research in alternative fuels is that the United States has resources that could be used to produce alternative fuels at a rate of millions of barrels per day. The largest deposits of oil shale resources in the world are located primarily in western Colorado and eastern Utah. The potential yield is about triple the oil reserves of Saudi Arabia. Our coal resource base is also the world's largest. Dedicating only 15 percent of recoverable coal reserves to coal-to-liquid production would yield roughly 100 billion barrels of liquid transportation fuels, enough to sustain production of three million barrels per day for more than 90 years. Our biomass resource base is also appreciable, offering to yield over two million barrels per day of liquid fuels. And over the longer term, advanced research in photosynthetic approaches for alternative fuels production offers the prospect of even greater levels of sustainable production.

Presently, mining in the United States produces about 1.1 billion tons of coal per year. Nearly all of this production is directed at the generation of electric power. Coal's future in power generation will depend on whether the United States adopts measures to control greenhouse gas emissions. If such measures are implemented, it is very likely that the level of coal mining will decrease, with potential adverse economic impacts in traditional coal mining areas. Using coal to make liquid fuels, especially when combined with biomass so that greenhouse gas emissions are favorable, provides not only the economic and national security benefits associated with reducing dependence on imported oil, but also a new market for coal that could counter the adverse local and regional economic impacts of reduced demand for coal in power generation.

Assessment of Alternative Fuels

The Duncan Hunter National Defense Authorization Act for Fiscal Year 2009 contained a provision calling for the Secretary of Defense to select a federally funded research and development center (FFRDC) to conduct a study of the use of alternative fuels in military vehicles and aircraft. Responding to Congress, the Department of Defense asked the RAND National Defense Research Institute, an FFRDC, to conduct an examination of alternative fuels for military applications. Our report on this study was published and delivered to the Secretary of Defense and Congress in January 2011.[4] As part of that study, RAND researchers examined the opportunities to produce alternative fuels in a way that reduces lifecycle greenhouse gas emissions relative to emissions from the production and use of the petroleum products that they would replace.

Because this Congressionally-mandated study was directed at military applications, we focused our attention on alternative fuels that could substitute for jet fuel, diesel fuel, and marine distillate fuel, since these are the major liquid fuels consumed by military aircraft, ships, ground vehicles, and associated combat support systems. These fuels are often referred to as distillate fuels to distinguish them from the more volatile and more easily ignited gasoline used in spark-ignition automobiles.

As a group, distillate fuels account for over 95 percent of military fuel purchases, which are currently averaging about 340,000 barrels per day. Distillate fuels are also important in the civilian sector, fueling the trucking industry and commercial aviation and serving as an important home heating fuel in some parts of the United States. Current consumption of distillate fuels in the United States is about 5 million bpd. For comparison, recent gasoline demand is running at slightly below 9 million bpd.

While the emphasis of our assessment of alternative fuels was on military applications, our results also apply to alternative fuels that could displace petroleum-derived distillate fuels that are used in civilian application. Note, however, that as part of this Congressionally-mandated study, we did not examine options for producing alternative fuels that can substitute for gasoline, such as alcohol fuels. For safety and operational reasons, these more volatile fuels are not appropriate for military applications. Since RAND has not conducted an in-depth examination of alcohol fuels, my remarks today will not cover this family of fuels.

Also included here is a brief statement regarding the oil shale resources located in the Green River Formation of Colorado, Utah, and Wyoming. Here our findings derive from the RAND 2005 examination of oil shale and our continuing monitoring of progress in this area.[5]

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[4] *Alternative Fuels for Military Applications*, Bartis and Van Bibber, Santa Monica, Calif.: RAND Corporation, MG969-OSD, 2011.
[5] *Oil Shale Development in the United States: Prospects and Policy Issues*, Bartis et al., Santa Monica, Calif.: RAND Corporation, MG 414-NETL, 2005.

Fischer-Tropsch fuels are the most promising near-term options for producing middle distillate fuels cleanly and affordably. The Fischer-Tropsch (FT) method was invented in Germany in the 1920s. It can produce alternative liquid fuels that can substitute for petroleum derived civilian and military fuels, including civilian and military jet fuels, marine fuels, and automotive diesel fuel, and home heating oil. Generally, gasoline is produced as a co-product in FT facilities, and one commercially proven variant can be configured to produce only gasoline. The method accepts a variety of feedstocks. For example, a commercial facility operating in South Africa uses coal, one operating in Qatar uses natural gas, and forest product firms in the United States are examining the viability of small facilities that would use biomass. Blends of up to 50 percent FT-derived jet fuel and petroleum-derived jet fuel have been certified for use in commercial aircraft. Ongoing work by the services strongly suggests that appropriately formulated FT fuel blends can be safely used in tactical military systems as well.

Both coal and biomass are abundant in the United States. Together, they are sufficient to support a multimillion-barrel-per-day alternative fuel industry based on FT fuels. But if FT fuel production is to occur without compromising future national goals to control greenhouse gas emissions, the following must hold:

- For biomass-derived FT fuels, the biomass feedstock must be produced in a sustainable manner; specifically, its production should not be based on practices that lead to sizable emissions due to direct or indirect changes in land use. If this is achieved, lifecycle greenhouse gas emissions can be near zero.
- For coal-derived FT fuels, carbon dioxide emissions at the FT fuel production facility must be captured and sequestered. If this is achieved, lifecycle emissions can be in line with those of petroleum-derived fuels.
- For FT fuels derived from a mixture of coal and biomass, carbon dioxide capture and sequestration must be implemented. The biomass must also be produced in a sustainable manner. If this is achieved, lifecycle emissions can be less than half those of petroleum-derived fuels. For example, a feedstock consisting of a 60/40 coal/biomass blend (by energy) should yield alternative fuels with lifecycle greenhouse gas emissions that are close to zero.

The preceding approaches can result in FT fuels with lifecycle greenhouse gas emissions that are less than or equal to those of their petroleum-derived counterparts and thereby fuels that are eligible for government purchase per the provisions of Section 526 of the Energy Independence and Security Act of 2007.

Considering economics, technical readiness, greenhouse gas emissions, and general environmental concerns, FT fuels derived from a mixture of coal and biomass represent the most promising approach to producing amounts of alternative fuels that can meet military, as well as appreciable levels of civilian, needs by 2030. But whether this technology will reach its potential depends crucially on gaining early production experience—including production with carbon capture and sequestration—in the United States. To our knowledge, no agency of the U.S. government has announced plans to promote early commercial use of FT fuels derived from a mixture of coal and biomass.

It is highly uncertain whether appreciable amounts of hydrotreated renewable oils can be affordably and cleanly produced within the United States or abroad. Hydrotreated renewable oils are produced by processing animal fats or vegetable oils (from seed-bearing plants such as soybeans, jatropha, or camelina) with hydrogen. Various types of algae have high oil content and are another possible source of oil for hydrotreatment. Fifty-fifty blends of hydrotreated oils have already been successfully demonstrated in flight tests sponsored by the commercial aviation industry. Laboratory analyses and testing strongly suggest that hydrotreated renewable oils can also be formulated for use in the Department of Defense's tactical weapon systems. Technical viability is not an issue.

The problem lies in uncertainties regarding production potential and commercial viability, especially affordability and lifecycle greenhouse gas emissions. Animal fats and other waste oils may offer an affordable low-greenhouse-gas route to hydrotreated renewable oils. But these fats and waste oils are also traditionally used in other nonfuel applications, including animal feed additives and the manufacture of soaps, household cleaners, resins, and plastics. Because the supply of these feedstocks is limited, substitutes would need to be found for use in these other applications. These substitutes may cause additional greenhouse gas emissions. Production potential is also a significant issue with animal fats and waste oils: The available supply of these feedstocks will likely limit production to no more than 30,000 barrels per day.

With regard to feedstock vegetable oils, to keep lifecycle greenhouse gas emissions at levels lower than those of petroleum-derived fuels, these oils must be derived from crops that do not compete with food production and that minimize nonbeneficial direct and indirect changes in land use. Jatropha and camelina are often mentioned as ideal plants to meet these requirements, but there exists little evidence to back these claims. Even if low-greenhouse-gas approaches can be established and verified, total fuel production is likely to be limited. Producing just 200,000 barrels per day (about 1 percent of daily U.S. petroleum consumption) would require an area equal to about 10 percent of the croplands currently under cultivation in the United States.

Advanced approaches, such as photosynthetic approaches using algae or other microbes as a feedstock, may yield renewable oils without the limitations and adverse land-use changes associated with seed oils. But all of these advanced approaches are in the early stages of the research and development (R&D) cycle. Large investments in R&D will be required before confident estimates can be made regarding production costs and environmental impacts. Considering (1) the very limited production potential for fuels derived from animal fats and waste oils, (2) the highly uncertain prospects for affordable, low greenhouse-gas fuels derived from seed crops, and (3) the early development status of algae/microbe-based concepts, renewable oils do not constitute a credible, climate-friendly option for meeting an appreciable fraction of civilian or military fuel needs over the next decade. Because of limited production potential, fuels derived from animal fats, waste oils, and seed oils will never have a significant role in the larger domestic commercial marketplace. Algae/microbe-derived fuels might, but technology development challenges suggest that algae/microbe-derived fuels will not constitute an important fraction of the commercial fuel market until well beyond the next decade. This assessment holds for algae-derived fuels based on photosynthetic energy conversion or based on the conversion of cellulosic biomass. Algae-derived fuels based on the conversion of sugars compete with food production and are not a sustainable source of liquid fuels.

The prospects for oil shale development in the United States remain uncertain. With regard to oil shale, most of the high-grade shale is on federal lands. Six years ago, when we published our examination of oil shale, we concluded that the prospects for development were uncertain. They remain so today. The Bureau of Land Management has made available small amounts of acreage so that private firms can perform research and development and demonstrate technology performance before committing to the construction of full-scale commercial plants. It is our understanding that privately-funded research activities are ongoing but that no private firm is prepared to commit to commercial production. Meanwhile, the Department of the Interior has announced a review of the commercial rules for the development of oil shale resources on public lands. In part, this review will examine approaches for assuring a fair return for providing access to oil shale lands. This part of the review is consistent with recommendations provided by RAND to the Congress in 2007.[6] The key to progress lies in formulating a land access and incentive policy that rewards those private firms willing to take on the substantial risks associated with investing in pioneer production facilities. It would not be advisable to develop detailed regulations that would pertain to full-blown commercial development until more information is available on process performance and impacts.

[6] "Policy Issues for Oil shale Development," Testimony by James T. Bartis presented before the House Natural Resources Committee, Subcommittee on Energy and Mineral Resources, April 17, 2007. Available for download at http://www.rand.org/pubs/testimonies/CT279.

Comments on S. 937

The remainder of my testimony is focused on specific sections of S. 937.

Section 3. Repeal of Unnecessary Barriers to Domestic Fuel Production

Section 3 would repeal Section 526 of the Energy Independence and Security Act of 2007 as well as Section 1112 of the National Aeronautics and Space Administration Authorization Act of 2008.

Section 526 prohibits federal agencies from entering into a contract for procurement of an alternative fuel or a fuel from an unconventional petroleum source unless the contract specifies that the lifecycle greenhouse gas emissions of that fuel are less than the equivalent product produced from conventional petroleum. The only exception would be for alternative fuels purchased for the purposes of research and fuel testing.

As enacted, Section 526 places severe restraints on the government's ability to purchase fuels. It would prohibit the government from purchasing any mobility fuel that might be derived in part or whole from coal, oil shale, oil sands, or biofuels without a certification from the fuel supplier regarding lifecycle greenhouse gas emissions. To my knowledge, Section 526 has not been applied to biofuels, even though biofuels can have lifecycle greenhouse gas emissions that are higher than the equivalent product produced from conventional petroleum.

Since passage of Section 526, the main concern has been whether the law prohibits government purchases of fuels that might be derived in part from Canadian oil sands. If this were the case, the government would be unable to purchase fuels from a growing number of commercial fuel vendors. With less competition, it is reasonable to expect that the government would incur increased costs. Additionally, the Defense Department may find it difficult or very costly to purchase aviation fuel in South Africa or Qatar, where alternative fuels from coal and natural gas are likely to be blended with conventional fuels.

To remedy this problem, Congress in 2010 passed legislation (Public Law 111-314, Sec 30210) that provides an exception to the fuel purchase prohibitions of Section 526. That exemption *apparently* allows government purchases of commercially available fuels that might in part be derived from alternative fuels so long as three conditions hold. The language of Section 30210 is unclear, so my interpretation of Public Law 111-314 as providing a remedy to the more onerous provisions of Section 526 may be incorrect.

Repeal of Section 526 would remove any confusion regarding the exemptions to constraints on government purchases of mobility fuels. It would also allow agencies to continue their current practice of purchasing biofuels, such as corn-derived alcohol fuels and biodiesel, without regard to lifecycle greenhouse gas emissions. Finally, it would allow federal procurement of alternative fuels such as coal-derived liquids, natural gas-derived liquids, and fuels produced from oil shale without regard to lifecycle greenhouse gas emissions.

The primary policy issue raised by repeal of Section 526 is whether it is in the national interest to allow government agencies to promote the production of alternative fuels that have lifecycle greenhouse gas emissions that are significantly higher than their petroleum counterparts. For example, repeal of Section 526 would open the door to a government procurement of coal-derived liquids produced without managing greenhouse gas emissions.

If Congress is concerned with the limitations and continued uncertainties associated with the implementation of Section 526, I suggest consideration of legislation that would clarify the meaning of Section 30210 of Public Law 111-314 so that the government is not prohibited from purchasing commercial fuels derived in part from alternative fuels or oil sands. Congress should also clarify whether Section 526 prohibitions apply to biofuels.

If the intent of Congress is to promote the early production of alternative fuels with greenhouse gas emissions that are comparable or better than those of their petroleum counterparts, I suggest consideration of an amendment to Section 526 that would allow the government to target purchases of alternative fuels derived from fossil fuel resources (such as coal, natural gas, or oil shale) if 90 percent of greenhouse gases produced during the alternative fuel production process are captured and sequestered or if lifecycle greenhouse gas emissions are no more than five percent above the lifecycle greenhouse gas emissions of their petroleum counterparts. This suggested amendment would still require management of greenhouse gas emissions, but it would significantly reduce the costs of building and operating pioneer alternative fuels facilities that are based on coal, stranded natural gas resources in Alaska, and possibly oil shale.

Section 5: Algae-Based Fuel Incentives

Section 5 would modify a portion of the Clean Air Act that governs the implementation of the Renewable Fuel Standard program managed by the Environmental Protection Agency (EPA). This program forces the use of government-selected fuels in the transportation sector. It provides unknown, but potentially very high, levels of subsidies to certain renewable fuel producers, but works in a way that the total costs borne by the public are hidden. These hidden costs include not only increased prices at the pump but also at the supermarket. Finally, this program puts government in the position of picking technology winners irrespective of whether these technologies offer environmental or energy security benefits.

Under Section 5, each gallon of algae-based fuel would basically receive a triple subsidy if it were produced using carbon dioxide from an energy production process that would otherwise release that carbon dioxide into the atmosphere. Section 5 does not define an "energy production process." Possible candidates include electric generating plants that use fossil or biofuels, oil refineries, alternative fuel production facilities, and natural gas processing plants.

Section 5 applies to algae that use sunlight to convert carbon dioxide to oils that are similar to vegetable oils. These oils can be converted to a biodiesel or can be treated with hydrogen so that they are interchangeable with conventional diesel or jet fuel. The technical viability of producing useful fuels from algae has been established for some time. The big unknown is whether these fuels can be produced at costs that are competitive, or even in the ballpark, with conventional fuels. Over the past two years, we have closely examined this issue. Our finding is that photosynthetic approaches to algae appear very promising, but that at this time algae-derived fuel is a research topic, not an emerging fuel option.

EPA has published its renewable fuel standards for 2011. From their Notice of Final Rulemaking, it is clear that the rule requires the use of fuels from small experimental facilities. This could lead to fuel refiners and importers paying very high premiums i.e., over $10 per gallon for certain renewable fuels. These additional costs will likely be passed to consumers. If EPA continues to apply this logic, any small pilot or demonstration plant built for the purpose of understanding scale-up and operational issues would be transformed into a commercial production facility. The same would apply to pre-commercial algae-derived fuel production facilities, including those being built with federal funds.

If this were a direct government expenditure, many would doubt that subsidies in the range of $10 to $30 per gallon are appropriate. Considering that commercially viable photosynthetic algae production is many years in the future, a more productive approach in accelerating this technology is direct investment in research and development.

Overall, the net effect of Section 5 will be a transfer of wealth from fuel consumers to firms trying to develop algae-derived fuel. It is difficult to see how these subsidies and this approach will have any impact over the next decade on the rate of development of a commercially viable industry.

Section 6. Loan Guarantees

This section would amend the Energy Policy Act of 2005 so that eligibility for DOE loan guarantees would include facilities that produce a fuel that can substitute for natural gas using a solid feedstock, provided that at least 90 percent of the carbon produced through the gasification process is captured. Since any renewable energy projects already qualify for loan guarantees, the net effect of this amendment would be to extend the coverage of the loan guarantee program to projects that use coal, or possibly oil shale, to make a substitute natural gas.

Considering the resource estimates and recovery costs for shale gas, it is highly unlikely that any firm will consider using any solid, non-renewable feedstock to produce natural gas as a primary product. Oil shale production facilities might produce natural gas as a by-product, although it is not clear whether such production would cause them to qualify for a loan guarantee. Overall, it is highly unlikely that enactment of this section will have any impact, positive or negative, on energy production in the United States.

Section 7. Multi-year Contract Authority for Department of Defense For Procurement of Alternative Fuels.

The main benefit would be to allow the use of the purchasing power of the Defense Department for the promotion of early commercial experience in the production of alternative fuels. The "Required Provisions" within Section 7 make it fully consistent with the findings of our research on alternative fuels for military applications. Specifically, our analysis suggests that a cost-effective approach, considering both government and industry perspectives, would be one in which:

- the Defense Department would commit to purchase alternative fuels that meet military specifications at a specified floor price;
- the alternative fuels producer would commit to sell alternative fuels that meet military specifications to the Department according to a specified formula that would basically set a ceiling price; and
- the Department's purchase price would be set using a market-based formula when prices for the corresponding petroleum-derived fuels are between the floor and the ceiling.

This arrangement places a collar on the prices of some fraction of the fuels that would be produced by an alternative fuels production facility. In return for guaranteeing a minimum sale price to the benefit of the producer in the event that world oil prices are low, the Department would be guaranteed a maximum purchase price that would be lower than world oil prices in the event that world oil prices pass a specified threshold. Such arrangements appear to be allowed and meet the provisions of Section 7 that call for "pricing mechanisms to minimize risk to the Federal Government from significant changes in market prices for energy."

This arrangement would have the added benefit of promoting the use of coal-derived liquids in applications where they have the greatest value. In particular, most military applications involve the use of high sulfur jet fuel in turbine engines. These applications place no value on the high cetane number and near-zero sulfur levels of hydrotreated renewable fuels and Fischer-Tropsch fuels.

In closing, I thank the Committee for inviting me to testify. I hope the foregoing analysis of policy issues is useful to your deliberations.