Producing and Using Biodiesel in Afghanistan

Executive Summary

How the U.S. can save lives, money, and challenge the opium trade

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President Obama's announcement on December 1, 2009 that 30,000 more troops will be sent to Afghanistan was the catalyst for developing the ideas expressed in this paper. The foundation of the strategy proposed rests on three insights.

Insights and Benefits

The first insight is that it is very expensive for the military to import fuel into Afghanistan. In October 2009 DOD officials reported to Congress that the average cost of importing fuel into Afghanistan, or the Fully Burdened Cost of Fuel (FBCF), approaches $400 per gallon when all direct and indirect costs are accounted for, and even sometimes exceeds $400. A 2008 Defense Science Board study, "More Fight Less Fuel," described the FBCF as "several hundred dollars per gallon." By contrast, a November 2009 Deloitte study, "Energy Security- America's Best Defense," calculated the FBCF in a war zone at $45 per gallon. More recently, in an April 2010 paper, "DOD's Energy Challenge as Strategic Opportunity," Amory Lovins, Chairman and Chief Scientist of the Rocky Mountain Institute, described the FBCF as one to two orders of magnitude higher than standard market prices. Regardless, whether the actual FBCF figure is $40 per gallon or $400, the military's cost of fuel in Afghanistan is many times higher than a typical civilian or domestic military market price.

The second insight is that modern biodiesel production technology is both proven technology and relatively inexpensive. The cost of building a medium-sized plant, even in Afghanistan, is on the order of tens of millions of dollars, not hundreds of millions or more.

The third insight is that a high percentage of U.S. casualties in Afghanistan stem from protecting convoys of fuel, water, and other military supplies. The Army calculated in a 2009 study that one casualty occurs for every 24 fuel resupply convoys in Afghanistan.

Our central proposal is to reduce the need for fuel convoys by producing biodiesel fuel in Afghanistan for use by the U.S. military. Because the military would, at least initially, be the sole customer of the biodiesel plant, avoiding the expensive process of importing fuel, the military could afford to pay a higher price for locally produced biodiesel than the petroleum diesel price assessed Army and Marine units by the DOD's Defense Energy Support Center (DESC). The plant, in turn, could pay Afghan farmers a crop rate competitive with that of poppy. (In 2009 Afghan farmers earned three times more growing poppy than growing a food crop such as wheat). Producing and using biodiesel in Afghanistan can therefore reduce U.S. fuel convoys and thereby casualties, achieve dramatic fuel cost savings for the U.S. military, and significantly reduce opium production, hence limiting its trade. Two other important benefits can also be realized: freeing-up troops currently protecting convoys for new missions, and, over time, the creation of a new agriculture-based industry for Afghanistan.

Biodiesel and Military Equipment

Biodiesel has several advantages and disadvantages versus petroleum diesel. Biodiesel has a higher ignition temperature and thus is safer in a war zone than petroleum diesel. Biodiesel is also a better lubricant, prolonging engine life. The two most significant disadvantages for the military are (1) that biodiesel's cold weather properties are in general not as favorable as petroleum diesel, and (2) that above a biodiesel fuel percentage of 5%, most diesel engines designed to meet recent emission standards must also specifically be designed to support the use of biodiesel. Both of these problems can, however, be accommodated.

Safflower is best suited as Afghanistan's first biodiesel crop. It is native to the region and although not a major crop, safflower is already cultivated in Afghanistan. Safflower has a long tap root and is highly drought-resistant. If more safflower is planted than is needed to supply the first biodiesel plant, the oil could be sold to consumers - safflower oil is one of the healthiest vegetable oils for human consumption. (Afghanistan currently imports most of its vegetable oil.) Safflower oil's cold weather properties approach those of petroleum diesel. For subsequent biodiesel plants, crops such as camelina and pennycress should be considered; these crops are not, however, currently grown in Afghanistan.

Addressing the second point above, the biodiesel plant would be generating fuel for the Army or the Marines for use in either generators or vehicles. We recommend that the output of the first biodiesel plant be used exclusively by generators, and that the generators be capable of combusting any percentage of biodiesel from 0% (100% petroleum diesel) to 100% (B100 or 100% biodiesel). About 40% of the oil imported by the military in Afghanistan is used to generate electricity. Although many generator suppliers (and manufacturers of diesel engines for generators) support B100, including John Deere, JS Power, MAN Diesel, Mahindra, Scania, and Wärtsilä, two key U.S. military suppliers of generators, Caterpillar and Cummins, do not warrant their generators for B100. Caterpillar warrants B30 (30% biodiesel) and Cummins B20 (20% biodiesel). Thus, a recommended prerequisite for the military's use of biodiesel in Afghanistan is that Caterpillar and Cummins support B100. In 2010, Cummins begins production of the next generation of medium-sized generator (Advanced Mobile Medium Power Sources or AMMPS), replacing an older generation (Tactical Quiet Generators or TQG). If generators in Afghanistan were only able to support B20 or B30, fuel logistics would be more complex, fewer convoys would be eliminated, and thus fewer lives would be saved. DOD policy should require that all military generators support B100.

If additional biodiesel plants are built, then the military should use biodiesel in vehicles in addition to generators. There are three types of military vehicles deployed in Afghanistan: combat vehicles, tactical combat vehicles, and tactical supply vehicles (trucks). Caterpillar and Cummins and supply most of the diesel engines used in tactical combat vehicles, and Caterpillar supplies virtually all of the engines in the families of tactical supply vehicles currently being produced for the Army and Marines. Combat-related vehicles should be capable of supporting B30, Caterpillar's current standard. Tactical supply vehicles should be capable of supporting

B100. A number of leading truck manufacturers, including MAN Nutzfahrzeuge, PACCAR's European subsidiary DAF, and Scania support B100. The military should have the same flexibility to use biodiesel that exists in the commercial marketplace.

The Biodiesel Plant in Kandahar

We recommend that the military initially contract for a single medium-sized biodiesel plant capable of producing 12 million gallons per year (56.8 million liters), using private industry for both construction and on-going operations. This capacity allows the generation of electricity for a range of 4,800 – 5,600 soldiers. The plant should be located near a large U.S. or International Security Assistance Force (ISAF) base in Kandahar Province, since the southern provinces of Kandahar and Helmand account for 73% of Afghanistan's poppy cultivation. The climate in Kandahar is also very warm; the average low temperature reaches freezing levels only in December and January (-1 °C), so biodiesel would rarely be combusted under cold weather conditions. Afghan farmers would need to plant about 61,500 hectares of safflower in order to generate enough safflower oil to produce 12M gallons of biodiesel. 61,500 hectares is equivalent to about 50% of the 2009 Afghanistan poppy crop. For every 100 gallons of biodiesel produced in Afghanistan, 13.75 gallons of chemical inputs must be imported by the military: 11 gallons of methanol, 2.25 gallons of a catalyst (sodium methylate), and 0.5 gallons of acid (typically sulfuric or phosphoric).

Biodiesel production technology platforms can be modular. Roughly 75% of the biodiesel plant can be manufactured in the U.S. before shipment to Afghanistan, minimizing local construction time. Elapsed time, from start of the project to production in Afghanistan, is expected to be thirteen months.

Financial Analysis

The one-time cost of building the plant is $90M, a relatively small cost compared to other military expenditures in Afghanistan. This figure includes $31.7M in plant capital costs, $30M for the purchase of new generators capable of supporting B100, $5M for transportation of equipment from the U.S. to Afghanistan, another $5M for a U.S. program to buy safflower-based biodiesel for testing by generator suppliers, and $18.3M for working capital and miscellaneous expenditures.

Annual operating costs cover importing the chemical inputs, safflower payments to farmers, labor costs for a plant staff of twenty people, a contract for a private security team of eighteen security personnel, and electricity to run the plant. Initially nearly all of the staff and security personnel would be experienced American or ISAF professionals.

Now let's look at two scenarios, one using a FBCF of $400 per gallon, and one using a FBCF of $41 per gallon. Both scenarios assume biodiesel production of 12M gallons per year, and that the cost per gallon of chemical inputs is the same as the FBCF. Afghan farmers would be paid $5,000 per hectare of safflower, which is 40% higher than the price they were paid for poppy in

2009. When the FBCF is $400 per gallon, the military saves $3.7B the first year of operation and $3.8M per year in subsequent years. Savings are higher in subsequent years because the $90M one-time cost has already been recovered. Payback of the $90M occurs in much less than a month. When the FBCF is $41 per gallon, payback is about one year. The military saves $90M per year starting in the second year. Since the plant is fully paid for after one year, the production cost per gallon drops from $41 per gallon to $33.50 per gallon. The average farm size in Helmand Province is 6.92 hectares. Thus to realize the savings above projected for the $400 per gallon case or the $41 per gallon case about 8,900 farmers must be persuaded to switch from poppy to safflower. This objective appears to be achievable, since USAID trained more than 160,000 farmers across Afghanistan in 2009.

As long as the plant achieves 12M gallons of biodiesel production in the first year, our assumptions are very conservative. Although part of the project plan, the effect of methanol recycling technology has not been included in the financial analysis. This recycling technology could reduce costs by 25%. Also, if methanol (or ethanol which can substitute for methanol) can be procured locally then costs would decline dramatically. Two byproducts of the production process, glycerin and safflower meal, have not been valued. Glycerin can be used as a deicing agent for aircraft, a fuel, or, depending on its purity, as a food additive for humans or animals. Safflower meal is valuable as an animal feed. Over time, labor costs could decline if Afghan labor is substituted for American labor. Lastly, carbon credits could become an additional source of revenue.

Other DOD Projects to Reduce Petroleum Dependence

The DOD has made significant progress in reducing its dependence on petroleum in the U.S. but only limited progress in non-domestic military theaters. To our knowledge, the DOD is not investigating the use of biodiesel in either generators or tactical vehicles. However, producing and using biodiesel in Afghanistan would be consistent with several other projects described in the chapter “Current Efforts by the Army and Marines to Reduce Petroleum Dependence.” Our research has highlighted two cases where the DOD’s approach is suboptimal. First, given the critical importance of generators and generator efficiency, the military should be running projects to modernize small, medium, and large generators in parallel, not sequentially. Second, since 1998, New York City has been using hybrid diesel-electric buses, similar in weight to military supply trucks; 38% of New York City buses are now hybrids. U.S. truck manufacturers Freightliner, Navistar, and PACCAR all sell hybrid trucks in the heaviest weight classes (Class 6, Class 7, and Class 8). By contrast, the Army has been unsuccessful in deploying hybrid technology, even on a trial basis. Moreover the Army is focusing on tactical combat vehicles, rather than supply trucks. Supply trucks consume the greatest amount of fuel during wartime and are the tactical vehicles most similar to commercial vehicles. When used together, hybrid technology and biodiesel are symbiotic. Both reduce diesel fuel consumption via strategies of improved fuel efficiency and substitution of a renewable fuel for petroleum.

Two Complementary Recommendations

If the Pakistan railroad network were extended 115 km (71 miles) from Chaman, Pakistan to Kandahar the military may be able to further reduce the cost of importing fuel, lower casualties, and at the same time improve Afghanistan's infrastructure. This extension has long been desired by Pakistan, and is worthy of further analysis.

USAID should fund a study to investigate the creation of a commodities exchange in Afghanistan. A commodities exchange could both support Afghanistan's critical agricultural sector, including biodiesel crops, and create a new financial industry for Afghanistan. Two commodities exchanges in the region have recently been launched: Pakistan's National Commodities Exchange Limited (2007) and Mercantile Exchange Nepal Limited (2009).

Additional Benefits

The capacity of the initial biodiesel plant matches the fuel needs of utilities' diesel generators that supply electricity in Kandahar and Helmand Provinces. In Kabul, the 100 MW Tarakhil power plant (which uses Caterpillar equipment) could use the output of one Kandahar-sized biodiesel plant, assuming the generators combust B20, or five plants, assuming combustion of B100. The Kabul vehicle market is four times larger than the capacity of the Kandahar biodiesel plant, assuming the use of B20. In addition, an export market may be possible since neighboring countries also import large quantities of oil. However, U.S. and ISAF countries may need to offer assistance to local biodiesel producers for several years as the Afghan biodiesel market evolves from a military to a commercial market.

Russia should be very interested in biodiesel's potential to challenge the opium trade. Russia suffers from a high incidence of heroin addiction and AIDS, and 90% of the world's opium, the source of heroin, originates in Afghanistan.

Conclusion

A single medium-sized biodiesel plant in Afghanistan can achieve five benefits: casualties can be reduced by four to five soldiers a year, about 120 soldiers can be reassigned from fuel convoys to new missions, millions or billions of dollars can be saved each year, up to 50% of the poppy crop can be replaced by a biodiesel crop, and a new industry may be created that, over time, can greatly benefit the Afghan people.

Producing and using biodiesel in Afghanistan is consistent with the three pillars of American strategy in Afghanistan: improving security, improving Afghan governance, and accelerating economic development.

The Afghanistan biodiesel project spans the interest of multiple government agencies: the Department of Agriculture, Department of Defense, Department of Energy, State Department and USAID. Since many agencies are involved, we believe the project will require a champion with the support of the Administration who can motivate these disparate agencies to work together with a sense of urgency.