

DARPA BIOFUELS PROGRAM INFORMATION PAPER

DARPA's BioFuels program is exploring energy alternatives and fuel efficiency efforts in a bid to reduce the military's reliance on traditional fuel for DoD.

As Dr. Doug Kirkpatrick explained in a speech given at DARPA's 25th Systems and Technology Symposium, August 9, 2007, in Anaheim, Calif.: "Throughout history, energy has been the limiting factor in all military operations, whether it was Roman armies foraging for supplies, or General George S. Patton running out of fuel as he dashed across France, or the long military buildup in Desert Storm. The situation today is little different. Most of the convoys on the road in Iraq are delivering fuel and batteries. These are arguably our most exposed targets, and the toll in lives and material is huge. We're tied down in an endless web of logistics. Seventy percent of our strategic logistics lift requirement is in bulk fluids, primarily fuel." Kirkpatrick is DARPA's program manager for BioFuels. The full text of his speech is available at http://www.darpa.mil/DARPA_Tech2007/proceedings/dt07-sto-w-kirkpatrick-energy.pdf.

Current commercial processes do not produce alternative fuels that meet the higher energy density and wide operating temperature range necessary for military aviation uses. Current biodiesel fuels are 25 percent lower in energy density than JP-8 and exhibit unacceptable cold-flow features at the lower extreme of the required JP-8 operating temperature range.

JP-8 constitutes more than 90% of the fuel used by DoD. It is similar to Jet-A commercial aviation fuel and the Navy's JP-5 fuel used in Naval aircraft.

Mobility is a strategic advantage for the military, and fuel is required for mobility. Fuel is DoD's primary logistics burden – more than 70% of the trucks in convoys carry fuel. This logistics burden drives the number of support personnel and other materiel needed on the battlefield.

DARPA is sponsoring two programs looking at affordable alternative sources for military aviation fuel. The cost goal for this surrogate aviation fuel is \$3 per gallon.

The first program, the BioFuels program, began in 2007. Contractors in this program are developing affordable alternative production processes to achieve a 60 percent or greater conversion efficiency, by energy content, of crop oil to military aviation fuel (JP-8) and elucidating a path to 90 percent conversion. Contractors are delivering 100 liters of JP-8 biofuel to DARPA for testing in a DoD test facility. The results of the Government testing will be used by DoD to make decisions regarding future use of the surrogate biofuel. The 100 liter samples are expected in fall 2008.

The BioFuels program is supporting three contractors that are looking at processes to convert crop oils into surrogate JP-8. The program is focused on developing JP-8 that is indistinguishable from petroleum-based JP-8, but that is 100% biofuel and not a blend with a petroleum-based fuel. The program is particularly focused on crop oils from diverse crops,

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especially those that do not compete with food crops, and is interested in processes that are feedstock-flexible.

The three contractors, contract amounts, and feedstocks are:

- General Electric Global Research - \$3.1M - soy, camelina and canola oil
- UOP LLC - \$6.2M – soy and coconut oils and algae
- The University of North Dakota Energy and the Environment Research Center - \$4.7M – cuphea, coconut and soy

In addition to the three BioFuels contractors who will deliver 100 liters of surrogate biofuel in 2008, DARPA is also supporting a longer-term effort. Swedish Biofuels AB is investigating the use of waste products such as seed hulls. A study looking at other feedstock possibilities such as cellulosic materials (switchgrass, poplar, eucalyptus, etc.) and algae was conducted in 2007 by Logos Technologies.

In November 2007, DARPA issued a solicitation calling for proposals for technologies to enable the affordable production of a bio-derived military aviation fuel from agricultural or aquacultural crops that do not compete with food materials. This program is known as BioFuels-Cellulosic and Algal Feedstocks, and aims to dramatically broaden the portfolio of feedstock materials suitable for the affordable and efficient production of alternatives to petroleum-derived JP-8.

Cellulosic feedstock materials, comprised of cellulose, hemi-cellulose, and lignin components, offer the potential of a widely available low-cost feedstock material. DARPA's initial goal is the demonstration of 30% conversion efficiency, by energy content, of the feedstock material into the target JP-8. By the end of the cellulosic feedstock effort, DARPA hopes to demonstrate 50% conversion efficiency by energy content.

Algae offer the potential of a feedstock with extremely large yields per acre and do not compete with the production of food crops. The affordable production of a JP-8 from algae crop stocks requires reducing the cost of algae triglyceride oil to the level of \$1 to \$2 per gallon of oil. This cost goal has not been attempted previously.

Proposals for the BioFuels-Cellulosic and Algal Feedstocks program are due in February 2008; DARPA intends to award contracts later that year.

DoD Fuel Facts

- Secretary of Defense Robert M. Gates at the Asia Security Summit in Singapore, June 2008: DoD is “probably the largest single user of petroleum products in the world....Every time the price of oil goes up by \$1 per barrel, it costs us about \$130 million....”
- DoD spent \$12.6 billion on jet fuel, diesel and other fuels in 2007, with operations in Iraq and Afghanistan consuming \$1.7 billion of that total.

(Source: American Forces Press Service article, “Military Looks to Synthetics, Conservation to Cut Fuel Bills,” by Donna Miles, 6/6/08. Full article:

<http://www.defenselink.mil/news/newsarticle.aspx?id=50131>)

PETROLEUM PURCHASES (FY06)

TYPE	THOUSANDS OF BARRELS*	PRODUCT COST (\$M)
AVGAS	16	2.6
DISTALLATES & DIESEL	22,079	1,821.9
GASOHOL	45	4.4
JP-4	15,598	1,122.5
JP-5	14,424	1,240.1
JP-8	71,318	6,162.3
LUBE OILS	28	5.0
MOGAS (LEADED AND UNLEADED)	1,971	176.1
RESIDUALS	733	40.8
TOTALS	126,212	10,575.7

*One U.S. petroleum barrel equals 42 U.S. gallons
(Source: Defense Energy Supply Center FY 06 Fact Book)

Additional Resources

- Media point of contact: Jan Walker, DARPA, (703) 696-2404, jan.walker@darpa.mil .
- BioFuels – Cellulosic and Algal Feedstocks program solicitation (November 2007): <http://www.fbo.gov/spg/ODA/DARPA/CMO/BAA08-07/Attachments.html>
- “Energy as a Tactical Asset,” speech delivered by Dr. Doug Kirkpatrick at DARPA’s 25th Systems and Technology Symposium (August 2007): <http://www.darpa.mil/DARPATech2007/proceedings/dt07-sto-w-kirkpatrick-energy.pdf> .
- U.S. Embassy Stockholm press release announcing Swedish Biofuels project (May 2007): <http://stockholm.usembassy.gov/newsflash/pressrelease051107.html>
- BioFuels solicitation (July 2006): <http://www.darpa.mil/sto/solicitations/BioFuels/>
- DARPA BioFuels program website : <http://www.darpa.mil/sto/chembio/biofuels.html>
- Defense Energy Supply Center FY 06 Fact Book: http://www.desc.dla.mil/DCM/Files/FactBook_FY06.pdf

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