The United States Air Force Energy Strategy for the 21st Century

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1. Introduction

The United States Air Force (USAF) is the largest single consumer of energy in the U.S. Department of Defense, using over 2.6 B US Gallons (288,117,000 MMBTU) of aviation fuel in Fiscal Year 2005 (FY05), and 73, 240,000 MMBTU of energy to electrify, heat and cool 163 installations, worldwide. In terms of cost, this rate of energy consumption cost the USAF over US$4.7B in FY05.

While the USAF has had a significant facility energy program, investing in $500M over the past 10 years in energy savings and performance opportunities, and achieving in FY05 the Presidential Executive Order mandate to save 30% in facility energy per square foot compared to an 1985 baseline, the USAF has not addressed energy savings opportunities in its significantly larger energy use sector—aviation.

This paper addresses the new USAF Energy Strategy for the 21st Century, which is focused on a balance of demand side conservation initiatives across installations, fleet (vehicle) and aviation operations, combined with achieving supply side assurance of domestic sources of supply of aviation fuels for military operations.

2. Key Features

As a result of the significant destruction of the U.S. domestic oil and natural gas production and refining capacity in the Gulf of Mexico from Hurricanes Katrina and Rita last August (2005), the USAF has aggressively invigorated its energy conservation program.

First, on December 9, 2005 the Secretary of the Air Force appointed his Deputy as the Senior Air Force Energy Official. This is the first time the USAF had named an energy official, and by announcing the #2 civilian leader of the Department, the Secretary of the Air Force made the point that energy would be a significant element of his new administration.

Second, the Headquarters Air Force organized a Senior Focus Group (SFG) comprised of key members of the staff including the Director of Air & Space Operations, and the Assistant Secretaries of the Air Force for Installations, Environment & Logistics, and Acquisition. Also included on the SFG is the Air Force Chief Scientist. The SFG created six working groups, and tasked the working groups to set goals and metrics and report back to the SFG on its funding requirements. The working groups include: 1) infrastructure, 2) acquisition & technology, 3) aviation operations, 4) critical infrastructure program, 5) innovative finance and 6) strategic communications. The SFG has met six times since its creation, and has successfully developed goals and metrics stretching out to 2020.

The Air Force Energy Strategy for the 21st Century has been established to support our vision where Airmen make energy a consideration in all Air Force actions. To underpin this vision, our strategy is two-fold: (1) accelerate development and use of alternative fuels, including synthetic fuels for aviation, and renewable energy for installations, and (2) promote a culture where Airmen conserve energy.

The remainder of this paper will describe some of the key elements of our strategy, focused first in our aviation operations, installations and fleet (vehicle) management.

Aviation Operations

The mission of the USAF is to deliver sovereign options for the defense of the United States of America and its global interests – to fly and fight in Air, Space and Cyberspace. To accomplish this, the USAF operates a fleet of over 6,000 aircraft; over 630,000 military and civilian members of the USAF support this mission.

Approximately 80% of all energy used by the USAF is used in support of aviation operations. Of this the majority is used to support strategic airlift and air fueling tanker aircraft. These strategic airlift aircraft are generally commercially derived – thus energy efficiency, in the form of optimum range and aircraft cargo carrying capability, is generally maximized by the manufacturer.

There are exceptions. For example the USAF is upgrading the cockpits of several of its legacy aircraft such as the C-130 and C-5. These upgrades allow the crews to fly in the national airspace system at optimum (fuel efficient) flight levels. Additionally, the C-5 aircraft is undergoing a major re-engineering. Justified mostly on engine reliability and maintainability, the engine upgrade will also achieve 10% efficiency in fuel use.

The USAF is also investigating the potential of retrofit winglets on some legacy aircraft, projected to save up to 1% in fuel consumption. Also, the USAF is considering increasing the use of "on-wing engine washes" – a maintenance action that increases engine efficiency by 1%.

One must be careful comparing too closely commercial and military aviation operations. For example, where commercial aviation generally flies scheduled routes on a daily/hourly basis, thus having up-to-date meteorological reports to add to their flight scheduling considerations, as well as well defined knowledge of the air transportation system routing, loading and associated potential bottlenecks, USAF strategic airlift generally flies "non-scheduled" and unique routes without the aid generally of daily/hourly ground weather inputs. To compensate for this lack of knowledge, Air Mobility Command's Tactical Airlift Control Center has recently upgraded its weather forecasting and flight scheduling models to better predict flight plans. Fuel conservation (energy) is a major consideration in flight planning.

Acquisition and Technology

As part of its Energy Strategy for the 21st Century, the USAF has invigorated it's aircraft energy conservation research & development focused on three thrust areas: (1) lightweight composite structures, (2) aerodynamic configurations, (3) turbine engine technology, (4) lightweight and high temperature materials, and (5) alternative (synthetic) fuels. The USAF plans to double its investment in aircraft energy efficiency initiatives over the next five years.

Our vision with lightweight composite structures is to achieve a new generation of aircraft structures that are stronger and contribute to lower costs through fewer pieces and aircraft parts.

Radically new aircraft wing and body configurations are possible with the advent of new materials. Key to our vision is a blended wing configuration.

New jet turbine designs – through adaptive versatile engine configurations that allow the engine to operate at most efficient pressure ratios at various flight levels – are critical to achieving up to 25% decrease in fuel use.

Future fuels – synthetic and bio-fuels that maximize thermodynamic effectiveness of revolutionary new propulsion systems – are possible. The USAF is developing new modeling and simulation tools for combustion technology to assess the effects of fuel properties (chemistry and transport) on propulsion system performance.

Earlier this year the Secretary of the Air Force directed Air Force Materiel Command to take on a project to procure synthetic fuel, conduct static ground tests on the fuel on engine test stands at the Oklahoma City Air Logistics Center at Tinker AFB, Oklahoma City, Oklahoma, and, if ground tests were successful, accomplish an aviation flight demonstration at the Air Force Flight Test Center, Edwards Air Force Base, California.

To ensure maximum crew safety in the first US military jet aircraft powered by synthetically manufactured liquid hydrocarbons, the test was conducted using a 50/50 blend of crude-oil refined jet fuel and synthetically manufactured product. Also, the first flight was arranged so that only a single pod of 2 engines were powered by the blend. The remaining 6 engines of the aircraft used crude-oil refined jet fuel. The first flight occurred on the morning of Tuesday, September 19, 2006, and while there was an unrelated mechanical issue with the aircraft, 2 hours of flight time occurred demonstrating the applicability of synthetic fuel for military aviation use. Two additional flights occurred on September 27 and 29, 2006. To date, the aircraft has flown over 10 hours, and combined with over 50 hours of engine tests on the ground, the USAF has not seen any deleterious effects on the engine, fuel system or in the ground support equipment.

At the writing of this statement, additional flights are planned, including flying the aircraft on all 8 engines powered by a 50/50 blend of synthetic and crude-based fuel.

On a technical note the synthetic fuel manufactured by the Fisher-Tropsch process has no sulfur and aromatic content, thus, in its "neat" form, it does not create smog producing sulfur dioxide or particulate matter.

In April of this year, the USAF requested the Defense Logistics Agency's Defense Energy Support Center (DESC) to poll industry regarding its ability to provide DOD with 100 million gallons of synthetic jet fuel (JP-8) beginning in January 2009, along with capacity estimates for future years. The Navy subsequently asked that DESC include 100 million gallons of synthetic JP-5 in the request. The Request for Information, or RFI, was released May 30, 2006 and responses were due by August 10, 2006.

The RFI asked the respondents a number of questions including what their proposed feedstock would be, where their plant would be located, when their planned streams of synfuels would become available, and what risk mitigation strategies they would be seeking to make such a product economic.

There was significant interest with 28 firms responding, 22 of which intended to manufacture synthetic fuel. Twenty of the 22 proposed using the Fisher-Tropsch Coal-to-Liquid manufacturing process, and 18 said they would use domestic coal. If such endeavors could acquire appropriate financing, the aggregate stream of synjet by 2016 would far exceed the amount necessary to supplant 50 percent of domestic DOD crude oil-derived jet consumption, about 38 million barrels per year.

The respondents identified significant risk mitigation requirements before they could engage in the development of a Fisher-Tropsch Coal-to-Liquid capability in the U.S. Most identified a need for long-term contracts (15 to 25 years) with guaranteed minimum annual DOD purchases. In addition, most wanted a guaranteed minimum price for their product during the contract term. In essence, the respondents could not provide their own risk mitigation and have requested that DOD assume the risk.

Both of these requirements are understandable from the manufacturer's perspective, but would expose the Department of Defense (DOD) to a significant risk of paying much more than the market price for fuel. The primary barriers to commercial introduction of the technology have been: the uncertainty of world oil prices; the high cost of production coupled with high initial capital cost (US$70 to US$90 thousand dollars per barrel of daily capacity for the first US plant, for a total cost of US$3 to US$8 billion for a full scale plant); and the long decision-to-production lead times (which could be in the seven year range). However, the respondents proposed to put all the risk mitigation responsibility in the hands of the public sector and none of the responsibility on the private sector. The manufacturers want the length of the contract term to be commensurate with the term of the financing they need to pay back the major capital investment (15 to 25 years). The guaranteed minimum price would be to protect the industry initiative from a dip in the crude oil commodity market below the level of economic viability – precisely the scenario that doomed an attempt in the early 1980s to encourage synthetic fuel production in the U.S. when the futures markets were not yet available for private risk mitigation.

Another developmental challenge noted by the respondents is that of carbon capture. The Fisher-Tropsch Coal-to-Liquid process produces almost twice as much carbon as the crude oil refining process. There is no current requirement for carbon capture in the U.S. in either process but there is concern in the industry that such will be required in the relatively near future and this requirement would raise the price of manufacturing a barrel of SynFuel. Not requiring carbon sequestration would pose additional risk for the potential manufacturer should it be required in the future, and the price estimates cited earlier do not include these costs, which may add $5 to $10 per barrel.

Installations and the Ground Vehicle Fleet

The intent of this paper was to describe what is new about the USAF energy program. The facilities energy management program is very robust, saving 30% (BTU/SF) over the past 20 years. Installation and vehicle energy use is about 20% of the total USAF energy. However, with the stand up of the SFG, the installations and ground transportation sector has accelerated its energy conservation initiatives. On the installations sector, we are investing significantly in improved heating and cooling systems as well as aggressively improving our program to create a culture where Airmen conserve energy. On the vehicle sector, besides increasing the use of Biodiesel and Ethanol use, the USAF has created a new policy where 30% of the on-installation vehicle fleet will be "low speed vehicles". These vehicles have significant fleet wide energy conservation benefits—over 50 mpg in some models.

3. Conclusions

The USAF has developed a vibrant new energy strategy for energy program focused on aviation operations.

Speaker's Biography

Michael A. Aimone, a member of the Senior Executive Service, is the Assistant Deputy Chief of Staff for Logistics, Installations and Mission Support, Headquarters U.S. Air Force, Washington, D.C. Mr. Aimone is responsible to the Chief of Staff for leadership, management and integration of Air Force civil engineering, logistics readiness, supply, transportation, and aircraft and missile maintenance. He is also responsible for setting policy and preparing budget estimates that reflect enhancements to productivity, combat readiness and quality of life for Air Force people.

Mr. Aimone entered the Air Force in 1970 after graduating from Michigan Technological University. While on active duty, he served in numerous field and staff engineering assignments. Mr. Aimone separated from active duty in 1979, and continued his military career in the Air Force Reserve. He was recalled to extended active duty to command the 819th RED HORSE Squadron, Malmstrom AFB, Mont., from July 1997 through December 1998.

Mr. Aimone joined the federal civil service in 1980 as a project Electrical Engineer with Headquarters U.S. Air Force, Washington, and D.C. He served in various supervisory positions within the Department of the Air Force and the Office of the Secretary of Defense until leaving federal service in 1993. From 1993 until his recall to active duty in 1997, Mr. Aimone was Vice President of an electrical engineering software development company. In January 1999, he returned to civil service and was appointed to the Senior Executive Service.

Mr. Aimone is a Professional Engineer and is registered in Virginia, California, Wisconsin and Ohio.