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Introduction

Chairman Ortiz, Ranking Member Forbes, members of the Committee, thank you for the opportunity to discuss the progress the Department of Defense has made in energy security for our Soldiers, Sailors, Airmen, Marines, and civilians, as well as the nation. It is important at the outset to frame energy security in a broad context. To be sure, the cost of energy affects the overall budget of the Department; in FY 2007, the Department spent about $13 billion on energy related programs, which is up from $10.9 billion in FY 2005. But energy security entails more than just the cost of fuel. Despite the seemingly low current oil prices, energy remains important to our warfighters because of a number of other dimensions. Energy affects program costs of weapons systems we buy and maintain; the logistics of energy resupply affects force security. Energy use affects our ability to maneuver. Lowered energy use lets us contribute positively to protection of the climate. And finally, lowered energy use contributes to security of supply and reduced reliance on potentially unreliable suppliers. All totaled, energy affects most aspects of the Department of Defense.

Warfighters recognize that the availability of energy impacts their ability to operate and are considering ways to operate more efficiently and plan for supply disruptions, highlighted by a urgent operational requirement. In the summer of 2006, then Major General Rick Zilmer, commander of the deployed Marine forces in Al-Anbar Province Iraq, issued a Joint Urgent Operational Need (JUON) statement that said

“reducing the military's dependence on fuel for power generation could reduce the number of road-bound convoys.…Without this solution [renewable energy systems], personnel loss rates are likely to continue at their current rate. Continued casualty accumulation exhibits potential to jeopardize mission success…”. In response to that JUONs, the Army Rapid Equipping Force (REF) established the Power Security Task Force to determine what could be done to address this need. One thing the Power Surety Task Force found was that there were few “turn key” ready capabilities applicable to the harsh operating conditions at a forward operating base. This realization led to nearly tripling the DoD investment in new and emergent technologies and systems that could address the need in the future. However, the Department has maintained the overriding principal of not subjecting forces to greater risk by prematurely deploying technologies that have not been proven in field testing.

U.S. deployed forces are at risk from attacks on supply lines carrying fuel. A longer supply chain requires more fuel and increases contested lines of communications, resulting in greater risk. The force structure needed to move and protect fuel imposes different important burdens on the Department: operational, cost and force structure.

A recent GAO study entitled “DoD needs to increase attention on fuel demand management at forward deployed locations” recommended the DoD establish an effective approach to managing fuel demand at forward deployed locations by developing fuel demand management requirements, designating the new Director of Operational Energy as the lead proponent of fuel demand management at forward locations, and addressing demand management shortcomings in the DoD energy strategy. These are reasonable recommendations, and in fact, are recommendations the Department was already working

on implementing before the report was published. Through the activities of the Department's Energy Security Task Force, the Department of Defense is addressing both fuel and energy demand at forward deployed locations.

This testimony today focuses on steps the Department has made over the past several years to find effective solutions to energy issues. In the past two years, the Department has established and operated a Defense Energy Security Task Force, of which I have had the honor to serve as Executive Director. The Task Force has coordinated the growing energy programs and raised awareness of energy issues across the DoD. Additionally, each Military Department has established an Energy Security focal office. In total, the Department's investment in Energy Security and energy related projects has grown from requests of $440 million in FY 2006 to $1.3 billion in FY 2009, not including funding in the recently passed American Recovery and Reinvestment Act which provided $300 million to the Department for energy-related research and development. Embedded in this investment are a number of projects specifically focused on either reducing energy demands or increasing energy supply to operational forces, as well as in garrison.

We have developed an Energy Security Strategic Plan, with four overarching goals approved by the Deputy Secretary of Defense. Finally, we have embarked on a number of projects to improve our forward deployed energy posture. Energy security will not be attained by a "silver bullet", but rather, by a long, focused campaign. Before going into specifics of our recent projects, we should examine energy security from an operational perspective.

Energy From an Operational Perspective

Over 70 percent of the convoys in Iraq and Afghanistan are for transporting fuel and water[1]. The DoD operational burden eases when fewer fuel convoys, oilers and other fuel delivery assets are needed to support operations or are put in harm's way. Convoys are favored targets of insurgent forces, and attacks have the potential to produce significant casualties and materiel losses – as well as disrupt future operations. Our approach for supplying energy to our combat forces has been to commit significant combat power to protect the assets and personnel to move fuel and water. The result is increased fuel consumption and increased presence on potentially hostile roads. In Afghanistan, the long distances and challenging terrain makes resupply operations even more complex, especially in the winter months where resupply can take up to 45 days from source of supply to the end user[2].

Decreasing fuel demand reduces the size and frequency of convoys, reduces vulnerability and enables combat forces to perform other duties. Moreover, when operational systems require less fuel, their endurance improves. Systems that can produce their needed effects using less fuel, increases their range, reach and persistence, a vital capability when operating against non-state or other asymmetrical actors.

Reducing energy consumption at forward locations should reduce vulnerable supply lines, thereby putting fewer Soldiers, Sailors, Airmen and Marines in harm's way. We have several efforts to reduce forward deployed energy demands or increase the ability to generate power locally. In addition, we have begun significant research

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[1] Source: Defense Science Board report on DoD Energy Strategy - "More Fight, Less Fuel" February 2008.
[2] Source: LTC Kurt Weinand, former Army Petroleum, Oil and Lubricants (POL) Officer for CENTCOM.

programs to increase fuel efficiency of ground, air and sea platforms. Of interest, not all energy solutions are "high technology". One of our more effective actions to date has been to insulate deployed facilities using spray foam, which yields energy use reductions of 40 to 75 percent compared to non-insulated tents.

Reducing Demand

The DoD has initiated a broad range of demonstrations and other projects to increase energy efficiency and develop assured alternatives. Among these are a number of projects to reduce energy demand—or manage energy demand, at forward locations.

Technology Demonstrations At Forward Locations

One of the greatest consumers of fuel in Iraq and Afghanistan is generators, used to power critical equipment and cool tents. The Army's Rapid Equipping Force (REF) demonstrated a technique for insulating temporary structures in Iraq, Afghanistan, Djibouti and at the National Training Center in California. The insulation resulted in fewer generators required, and the reduced temperature and noise enabled better sleeping conditions. Energy savings of 40 to 75 percent led Multi-National Force Iraq to award a $95 million contract to insulate nine million square feet of temporary structures. The additional insulation was estimated to save between 77, 000 to 180,000 gallons of fuel per day, equivalent to roughly 13 to 26 truckloads of fuel, with associated cost savings (including the military logistics and force protection saved from the demand reduction). The Army has subsequently awarded a similar contract in Afghanistan.

In an effort to demonstrate the operational efficacy of demand reduction coupled with alternative and renewable power, the Army's Rapid Equipping Force (REF), the

Power Surety Task Force and the National Training Center, at Fort Irwin, California, installed energy efficient structures (domes, foam insulation, renewable power generator, efficient heating, ventilating, and air conditioning systems) in the training area. These structures allow us to experiment with various energy-related projects and can demonstrate to ground commanders how a holistic approach can provide an estimated energy savings of about 60 percent over current systems. This proof of concept effort was completed in just over 90 days and was the forerunner of the Net-Zero Plus Joint Concept Technology Demonstration (JCTD) sponsored by the U.S. Central Command to make forward operating bases as energy independent as possible from power generation.

The Net-Zero JCTD will prototype, measure and assess a variety of technologies that could, collectively, use less energy than they create (using both demand reduction and renewable technologies) and determine which, if any, should be recommended for inclusion in sustainable design efforts in DoD installations and tactical bases. By reducing demand, providing efficient distribution, and using alternative energy sources, the FOB should be able to minimize fuel consumption, and ultimately save lives through the reduction in the number of fuel convoys required. The emphasis is on replacing temporary living, office, and operational facilities with enduring energy efficient structures and integrating renewable energy technologies with improved energy generation to power those structures. This Net-Zero JCTD has a 3-year plan, but promising technologies could be spun out as early as this year.

Other Technology Demonstrations

The Army's Tank and Automotive Research and Development Center (TARDEC) in Warren, Michigan is leading a ground vehicle Fuel Efficient Demonstrator (FED).

The FED is testing the feasibility and affordability of achieving significant decreases in fuel consumption (30 to 40 percent) in a tactical vehicle, without sacrificing the performance or capability. This program is integrating potentially high-payoff fuel efficient technologies, like efficient propulsion and drivelines, and advanced lightweight materials in new and innovative designs. Successful technologies may be incorporated in future procurements for the Joint Light Tactical Vehicle (JLTV), the next generation HMMVW. The FED program is employing a concurrent parallel strategy combining a traditional systems integration approach with a "monster garage" approach. The monster garage includes engineers from industry, academia and government, examining over 100 technologies for inclusion on six concept vehicles. Modeling and simulation is ongoing for both approaches. This program is also benefiting the science and engineering workforce by providing hands-on experience across a broad range of technical areas. Government engineers from across DoD are working side-by-side with the contractors in one year developmental assignments, building skills in vehicle design, systems engineering, vehicle integration, modeling and simulation, testing, and project management. Of note today, we have asked the program manager of the FED to determine if there are other viable designs that could be evaluated using some of the research and development recovery funding.

The Navy is leading an effort to evaluate material coatings on maritime propellers which have the potential to maintain clean blade surfaces for sustainable powering and cavitation performance. Current propellers are susceptible to fouling that increases blade drag, resulting in higher power requirements and earlier onset of cavitation. Improved coatings not only offer reduced cleaning requirements and greater resistance to cavitation

erosion damage, but also the potential to increase energy efficiency by three to five percent. Initial testing is scheduled to be completed by August 2009.

Because of the preliminary success of this project, we have also funded a project to apply these same coatings to the internal combustion engine and drive train of ground vehicles. The preliminary laboratory tests were positive, resulting in a 25 percent decrease in fuel use and 25 percent increase in torque and horsepower of a vehicle tested on a dynamometer. We have initiated steps to extend these tests to extended range field trials. This again highlights the need to test technology solutions to ensure there are no unintended consequences.

The Air Force is developing technologies to increase jet engine efficiency. The Highly Efficient Embedded Turbine Engine (HEETE) initiative, part of the Versatile Affordable Advanced Turbine Engine (VAATE) program, is developing high-pressure ratio, high temperature core turbine technology, with the potential to reduce specific fuel consumption up to 25 percent over today's turbine engines. Such a reduction, if it works, could reduce energy demands for forward locations. HEETE is addressing the highest technical risk element in new engine development – the high pressure compressor component development. The current schedule includes a rig test in FY 2010, demonstrating a technology readiness level of four or five in a laboratory or relevant environment. These technologies are applicable to all turbine engines and could be used in commercial aircraft.

Not all promising savings come from platforms. Sometimes, energy demand for forward locations could be reduced by the type of lighting used. The Pentagon Renovations office is testing light emitting diode (LED) light fixtures in the final wedge

of the renovation, in place of the fluorescent and other lights used in the previous renovated wedges. The effort involves 4,200 light fixtures, each of which uses approximately 20 watts less energy, yielding a total potential energy savings of 376,000 kilowatt hours per year for all of the lights – one-fifth of the Pentagon. The fixtures are expected to last about 11.5 years and have a four year payback, resulting in a net savings of about $6 million over the life of the fixtures. If these systems work as expected, these LED fixtures could become a staple of FOBs of the future.

Assuring Sources

In addition to reducing energy demand, the DoD also needs assured supplies of energy, to include having fuel and other energy sources available and able to get to where they are needed, with reduced energy requirements, to ensure mission sustainability. We are shifting reliance toward alternative and renewable sources of energy, thereby reducing our dependence on non-assured sources of oil. For example, in December 2007, the Air Force commissioned the largest photovoltaic solar array in the Americas – and second largest worldwide (14.2 megawatts) at Nellis Air Force Base. This supports about one fourth of the base's energy usage per day and has an estimated annual cost savings of $1 million. As solar cells become more affordable and reliable, they could be used in a forward deployed package to reduce forward deployed demand.

Renewable and other assured energy sources are important to our ability to sustain missions from our bases, since we are almost entirely dependent on the commercial grid for power. Military installations have appropriate diesel standby power generation for mission critical loads to sustain operations for the short term. However, the Defense

Science Board's (DSB) energy report identified the potential for extended outages that would tax our ability to meet mission needs and are beyond the capability of the standby generators. Renewables can be part of the solution to distributed power generation. As noted by the DSB, the commercial grid is becoming increasingly fragile and susceptible to physical attack by saboteurs or outages from natural events like the 2003 incident in Ohio where a tree branch disrupted power to 9,300 square miles in the Northeast US and Canada.

To mitigate the power reliability problem, we are reducing our electrical demand and improving the security of energy supplied. We have established an internal working group to assess the vulnerability of the distribution system and prioritize solutions.

We are also co-chairing, along with the Department of Homeland Security and the Department of Energy, a Task Force on Electric Grid Vulnerability. The Task Force is chartered by the Office of Science and Technology Policy to examine "gaps and seams" in federal efforts to mitigate grid vulnerability issues. Additionally, the Task Force is examining both physical and cyber security shortfalls. The Task Force, whose membership includes the Federal Energy Regulatory Commission, has received briefings from universities, Edison Electric Institute, Department of Energy National Laboratories, and Homeland Security. Beginning in March, the Task Force will focus on bulk power operators and local distribution companies and expects to have a draft report in July.

DoD also is exploring the use of renewable energy at forward locations through testing of generators that can be powered by solar or wind energy. The Hybrid Intelligent Power generator (HI-Power) is demonstrating intelligent power management and the integration of renewable energy technologies to reduce fuel and energy consumption in

tactical and operational environments. The HI-Power architecture is a paradigm shift from stove-piped power generation to integrated power management. The architecture could provide a modular power grid and intelligent control capability, seamlessly integrating current and future renewable energy sources. Modeling showed a potential 25 to 40 percent reduction in fuel consumption and lower operations and support costs. The HI-Power is a six-year development program, and is linked in with the Net-Zero Plus JCTD.

The Army, along with the other Services, is actively pursuing waste-to-energy and fuel for FOBs, as well as installations. The military has been working with the Defense Advanced Research Projects Agency (DARPA) as well as private industry to identify several promising technologies and methods to achieving waste-to-energy. While battlefield waste (e.g. food, packaging, and wood) may be a viable source of energy and may offset some fuel consumption, it may not provide dramatic reductions of fuel consumption. However, it does provide some improvement with other benefits from waste reduction, like reducing military security escorts for trash removal, keeping our Soldiers out of harm's way, and improved environmental conditions. Several concepts have been tested. For example, the Tactical Garbage to Energy Refinery (TGER) deployed two early prototype systems to Iraq from May to Aug 2008, using a dual bio-reactor and gasifier. These prototype systems validated the concept, but there are a number of challenges for use in non-installation applications, such as unpredictable waste streams (in amount and composition); system efficiency, reliability, ease of operation; and size, weight, and transportability.

In February 2009, the Army conducted a two-day workshop to evaluate the readiness of various waste-to-energy technologies for operational applications. The general consensus was that while these technologies offer potential for both providing power and reducing base camp waste management problems, they are too immature for near-term operational/field applications, and the requirements must be better defined. A significant additional investment will be required to make mobile systems practical. However, commercially proven stationary facilities have great potential to produce continuous megawatts of energy on our installations, using both the installation's own waste stream as well as waste streams from the surrounding communities.

In the past few months, DARPA has also initiated a major project to develop and test various feed stocks for synthetic jet fuel that would have the same energy density as current petroleum-based fuels. DARPA initiated $100 million program to further development of affordable algae-based synthetic fuels (synfuels), with the goal of driving the cost to $2 per gallon in 18 months. In December 2008, DARPA awarded two contracts – $19.9M to General Atomics and $14.9M to SAIC. DARPA also recently issued a broad area announcement for coal-to-liquid fuels that are environmentally friendly and cost competitive with petroleum-based fuels. This project could provide strategic resilience through reduction in the need for local oil.

In addition, several efforts are underway by the Services to test and certify synthetic fuels on aircraft, ground vehicles, and support equipment. The Air Force is certifying its aircraft, applicable vehicles and support equipment, and associated storage and distribution infrastructure for unrestricted operational use of a 50/50 synthetic fuel blend by early 2011. To date, the B-52, C-17 and B-1B have been certified for

unrestricted operations using the synthetic fuel blend. The certification effort is on track to meet the 2011 goal. In addition to the synthetic fuel blend certification, in January, the Air Force initiated a biomass-derived aviation fuel certification program.

The Army and Navy are developing and demonstrating compact and mobile 10 kilowatt high temperature fuel cells to power critical equipment, including GPS, radio and communications equipment, computers, intelligence, surveillance and reconnaissance gear, and laser designators. These systems provide silent, portable power and eliminate dependence on large generator or grid power for battery charging. These fuel cells are demonstrating a high efficiency (about 55 percent) and are being designed to use jet fuel. They provide low weight for the available energy content to the warfighter carrying them. Additionally, they could provide auxiliary power for applications on vehicles for missions over 24 hours.

Improving Processes

DoD has made progress in integrating energy considerations into business processes – requirements development, acquisition, and budgeting – and we are focused on describing energy options by their return on investment, both financially and in terms of operational capability. For instance, in November 2008, the DoD acquisition directive (5000.2) directed energy costs be included in calculations for total ownership costs, to include the fully burdened cost of fuel – the cost to deliver fuel the last "tactical mile". The Office of the Under Secretary for Acquisition, Technology and Logistics (OUSD(AT&L)) also is finalizing guidance on the methodology and requirements new acquisition programs should follow to calculate, report and glean insights from the fully

burdened cost of fuel. In some cases, fuel delivery adds a large dollar and operational cost that has not been considered in the past when making program design and acquisition decisions.

OUSD(AT&L) and the Joint Staff will soon embark on developing a methodology for implementing the Energy Efficiency key performance parameter (KPP), established in 2007. The study will help inform us of when to apply this energy-related KPP, and how to determine what the metrics should be for a given platform or system type.

The Joint Staff is leading a study to assess current simulator usage, develop a cost model for the business case supporting greater simulator use, and determine the feasibility of substituting additional simulator time for live training without decreasing operational capability. Preliminary studies have indicated that the increased use of simulators could potentially yield savings of over $1 billion, resulting from reduced fuel costs, maintenance, and platform "wear & tear". A final report is due in June 2009.

The OUSD(AT&L), the Army, and the Marine Corps are in the very early discussions about how best to set energy "productivity" metrics for the Joint Light Tactical Vehicle program. We expect this to be addressed in the program's study plan prior to the next milestone decision, currently scheduled for 2011. For ground systems, miles per gallon may be a misleading metric because, even in combat situations, vehicle duty cycles include significant idling and the running of electronics gear (communications, sensors, etc.) that draws power and hence, burns fuel. Additionally, new systems may include the requirement to export power. So we're looking at metrics like "gallons per day at various electricity output levels". We're also examining how to

move towards a force that needs less fuel logistics support to be combat effective. So including fuel "tail" demand reductions in our metrics is something we're examining. The bottom line is that this line of thinking on energy demand in our combat forces is new, and not simple to implement. Thinking about energy security in this way represents a culture shift, much as the GAO recommended. Hence, we are being careful to pursue changes that will realistically represent energy impacts, but that will not lead us to making decisions that will reduce operational effectiveness just to save a few gallons of fuel. We are pursuing metrics that will help deliver a force that is more capable and that reduces our fuel demand in theater. These can and should be complementary.

DoD Energy Security Progress

In 2006, the Secretary of Defense established the DoD Energy Security Task Force to make recommendations on increasing energy efficiency, reduce dependence on foreign oil, and integrate energy efforts across the Department. The Task Force included senior leaders in the Office of the Secretary of Defense, the Services and the DARPA from all functional areas with a stake in energy – installations and environment, logistics, technology, acquisition, policy, comptroller and the joint staff. Taking a holistic, systems approach, the Task Force explored energy options across the spectrum of supply, demand and assured distribution to ensure the enterprise understands the interdependencies of energy-related decisions.

DoD is making progress in energy security. Since 2006, we have more than doubled our energy investment, and overall energy consumption is down six percent

since FY 2005. Installations energy demand is down 10 percent since FY 2003, and 12 percent of our electricity comes from renewable sources, well above the federal average.

Through the Energy Security Task Force, DoD has developed the DoD Energy Security Strategic Plan, providing a framework for energy management across the enterprise, with four Deputy Secretary-approved strategic outcomes:

1. Maintain or enhance operational effectiveness by reducing total force energy demands ➔ *REDUCE DEMAND*.

2. Increase energy strategic resilience by developing alternative/assured fuels and energy ➔ *ASSURE SOURCES*.

3. Enhance operational and business effectiveness by institutionalizing energy solutions in DoD planning and business processes ➔ *IMPROVE PROCESSES*.

4. Establish and monitor Department-wide energy metrics ➔ *IMPROVE PROCESSES*.

The main objectives of the Energy Security Strategic Plan has been approved by the Deputy Secretary of Defense, and the formal plan is awaiting signature and will be released shortly. The Services also have established strategic plans and organizational structures to coordinate energy efforts.

Summary

DoD has proactively responded to the energy challenge. The Department, under the coordination of the Energy Security Task Force, improved DoD's energy posture through increased collaboration, resulting in an overall decrease in energy consumption DoD-wide. We have initiated numerous demonstrations and other projects to reduce consumption and increase assured alternatives for installations, both fixed and tactical,

and weapons systems, with anticipated savings from five to 25 percent. Technologies that make good business sense, both financially and operationally, are being implemented on a wider scale. These efforts will improve the Department's energy posture by reducing costs and enabling sustained, uninterrupted operations while putting fewer service members in harm's way. As indicated in the recent GAO report, there is much work still to be done, but DoD is on the right path to addressing their recommendations.