U.S. Army Energy Security and Sustainability: Vital to National Defense
Sometimes, simple maxims transcend generations of warfare with timeless relevance; in this case: energy is security. Energy, the ability to fuel and drive the world’s preeminent land power, is a requirement that would be familiar to U.S. cavalry units on the plains of the West, armored columns in the Ardennes and today’s helicopter brigades in Afghanistan. The modern force requires a massive amount of power and resources to accomplish its difficult yet vital mission. Against this requirement are increasing strains—manmade and otherwise—on the availability, cost and quality of these resources. Securing, transporting and supplying the Soldier with the energy, water and supplies needed to vigorously train at home and fight and win on complicated battlefields abroad will be a serious future challenge with global implications.

To meet that challenge, the Army is implementing an energy strategy that revolves around the concept of Net Zero—the idea that Army posts and units in both the generating and operating forces will become effectively self-sufficient. This decreased reliance on volatile resources and long supply lines will give the Army much-needed strategic and operational flexibility. In turn, the Army can focus more effort on the warfight while simultaneously reducing the risk to Soldiers.

In this latest installment of AUSA’s signature Torchbearer series, we discuss how the Army envisions its evolutionary pathway to greater resource sustainability and efficiency. A treatment of the underlying principles, cultural changes, mechanisms and levels of scope provide a snapshot into the future of the Army while laying the groundwork for a discussion about the Army as a more “green” and flexible force. We hope this report is a useful and informative resource and that you will continue to look to AUSA for insightful and credible analysis of contemporary national security issues.
Executive Summary

Along with advances in equipment, the Army is seeking new methods to use and secure our scarce energy resources. Clearly, future operations will depend on our ability to reduce dependency, increase efficiency, and use more renewable or alternative sources of energy. We’ve made great strides in this area, and we intend to do more.

The Honorable John McHugh
Secretary of the Army

Historically, the Army has operated under the assumption that low-cost energy and other resources would be readily available when and where they were needed at all levels of operation. Today, however, the Army faces growing challenges to its energy supply at home and abroad. It is essential that the Army take significant steps today to protect reliable access to energy, water and other natural resources to preserve strategic choice and operational flexibility into the future.

The Army is addressing the ideas of sustainability and energy security through the development of a force-wide energy doctrine and operating principles. In particular, the sustainability principle seeks to instill Army-wide change in both culture and practice with regard to energy consumption and generation. Technological investments and developments, operational training, education and facilities management are all critical aspects of instilling a mindset of conservation, efficiency and sustainability. Making all Soldiers power managers will ingrain power and resource planning into all operations while reducing operational risks associated with unnecessary consumption; driving efficiency across the Army enterprise will ensure that sustainability efforts are present everywhere and cannot be discarded when inconvenient. Contributing to an overall strategic improvement in resource management and building resilience through renewable and adaptable power sources will shield the Army from specific disruptions in resources that might otherwise have a significant impact on operations at home or abroad. This total institutional change is driving the Army’s movement toward the concept of Net Zero.

Net Zero is a strategy that seeks to bring the overall consumption of resources on installations down to an effective rate of zero. To become effectively self-sufficient and insulate the Army from potential disruptions in energy supply, installations must be able to generate, repurpose or recycle power, water and waste. Net Zero comprises four main building blocks:

- **Net Zero Energy.** Net Zero Energy installations produce as much energy as they consume over the course of a year. The energy is generated from a variety of means such as overall reduction in total consumption, renewable energy projects on posts and recapture of existing waste energy (such as boiler stack exhaust).

- **Net Zero Water.** A Net Zero Water installation limits the consumption of freshwater resources and returns water to the originating aquifer. Conservation and reduction strategies such as harvesting rainwater, recycling gray water and desalination/purification will reduce the drawdown of major ground water sources.

- **Net Zero Waste.** Net Zero Waste centers on reducing a post’s yearly landfill to zero through a combination of recycling, repurposing and reducing solid waste streams. Additionally, life-cycle waste management strategies are taking the endstate of procurement into account to ensure that new products contribute minimal solid waste throughout the life cycle.

- **Net Zero Hierarchy.** The Net Zero Hierarchy is a simple model that comprises five interrelated steps: reduction, repurposing, recycling and composting, energy recovery and disposal. The hierarchy applies to all levels of sustainability and encourages simple steps to be taken immediately and expanded over time.

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1 “2012 Budget Request for the Army,” testimony before the House Armed Services Committee, 2 March 2011.
The Army is addressing energy sustainability not only at home stations but also at the operational and tactical levels. Power and water logistical requirements in combat theaters represent significant risks, from convoy supply operations to Soldier equipment weight. The Army is committed to easing the aggregate burden of powering the forward edge while still providing the amount of power and resources needed by warfighters to prevail. New technologies are being tested in combat theaters that will increase mission agility through better power management and flexible power sourcing. Further, forward operating base improvements are under development to make them more efficient and less energy intensive. Smart micro-power grids, advanced insulations and onsite water generation are just some of the concepts being explored to reduce the logistical footprint of operations. Immediate and similar future challenges are driving the development of an operational energy doctrine to institutionalize the practices and thought processes of sustainability.

To enable these transformational changes, the Army has paired its energy strategies with an investment strategy that leverages the private sector to advance the technology levels and facilitate the more challenging aspects of resource consumption and repurposing. To support the private-sector partnership initiative, the Army is using a number of special contracting mechanisms to bring in outside investments geared toward long-term installation energy planning that benefits both industry and the Army.

Despite the progress made in sustainability and energy efficiency, more is needed. A steady flow of research and development funds, proper support for long-term projects through the programming cycle and flexible funding tools are required to attract the long-term private-sector partnerships needed to fully develop sustainable technologies. At the operational level, lighter batteries, universal charging devices and contingency base improvements—all in a rapid fielding initiative that reduces traditional procurement delays—are needed to improve Soldier capability. Finally, continued support from Congress and the Department of Defense is needed to develop productive interagency energy-related relationships, reduce the statutory and regulatory barriers to sustainability efforts and properly resource Army sustainability efforts in all operational areas through appropriate budgetary procedures and financial modeling.

The Army is embarking on a long-term program to change the way it uses and understands energy. It is committed to organizational and cultural changes that will ensure the future security of its energy needs through system-wide programs. Involvement of all echelons and the immediate implementation of simple mechanisms are laying the groundwork for sustained Army, and indeed national, energy security. However, for this to work, timely and predictable funding is a must.

**Net Zero Hierarchy**

- **ENERGY**
  - Reduction
  - Re-purpose
- **WASTE**
  - Recycling & Composting
  - Energy Recovery
  - Disposal
- **WATER**

Net Zero is a force multiplier
U.S. Army Energy Security and Sustainability: Vital to National Defense

The Army will continue aggressive support for research, development and acquisition of advanced technologies to increase energy security and sustainability for weapon systems and contingency base camps. Senior leaders will continue to communicate the Army’s energy security and sustainability program initiatives to increase visibility and foster development of awareness and accountability to change the culture within the ranks.

Introduction

Army operations span a diverse range of environments and tasks, from base infrastructure under lesser threat, to expeditionary operations and sustained campaigns in hostile zones. Supplying energy to these diverse missions is increasingly challenging; constraints and threats to the supply of energy, water and other resources are growing in scope and complexity both abroad and at home. Going forward, the full-spectrum operations of the future—conducted across wide areas and austere environments—will require more energy and resources but with greater efficiency and portability at lower overall costs.

Energy security and sustainability are operationally necessary and financially prudent and are key considerations for U.S. Army installations, weapon systems and contingency operations. “Energy security” means that the Army retains access to energy and can continue to operate when catastrophe strikes and energy supplies are disrupted, cut off or difficult to secure. To remain operationally relevant and viable, it must reduce its dependency on energy, increase energy efficiency and implement renewable and alternate sources of energy force-wide. It must also have leaders who are cognizant of, and sensitive to, the complexities of enduring energy and resource requirements. To balance these requirements against the growing constraints on energy worldwide, the Army is applying a key principle to the breadth of operational and organizational settings: sustainability. This sustainability principle is designed to ensure that the Army of tomorrow has the same access to energy, water, land and other natural resources as that of today through the reduction of demand/consumption, the diversification of the energy supply and increased self-sufficiency. The Army is taking steps to reduce its reliance on fragile energy infrastructure and logistical mechanisms that add risk to all missions.

To put the Army’s goal into context, the daily fuel consumption for the Allied Army in Europe during World War II was about one gallon per Soldier; today the figure varies between 15 and 22 gallons per Soldier. Granted, combat operations are always energy intensive, but even during peacetime the military is a significant consumer of resources. For instance, the Department of Defense (DoD) is the largest consumer of power in the United States, although overall power usage levels have been declining since 1985. However, the pace of global operations has halted the downward trend over the past several years. Even though significant challenges exist to reducing energy consumption, especially during times of conflict, the Army is focused on executing change with achievable, risk-managed goals that address different parts of the enterprise at appropriate times.

To accomplish this, the Army has adopted a comprehensive energy security strategy. This strategy will not only lead to energy cost savings but help create a more sustainable force with increased endurance, resilience and force protection. The Army senior leadership is leveraging technology, especially within its logistical tail of the operational energy pipeline, to improve agility and flexibility against all threats, including irregular and decentralized enemies. The Army’s energy strategy will only succeed, however, within an enduring partnership among DoD, Congress and industry that fosters innovation and discipline while providing timely and predictable funding.

**Background**

Since 2000 the Army has made a directed effort to integrate sustainability concepts into its core activities. In 2000–2001 the Army implemented Sustainable Design and Development (SDD) guidelines for new projects; SDD provided a life-cycle model for projects from design, through construction and operation, to reuse/removal—all in an energy-efficient and environmentally informed manner.

In 2004 the Army replaced its two-decades-old environmental strategy with a new one: The Army Strategy for the Environment: Sustain the Mission, Secure the Future. This strategy shifted the Army from a compliance-based approach to sustainability to a mission-based approach that began to incorporate sustainability into the force’s daily operational mindset. Building on that baseline, the Army released its first Annual Sustainability Report in 2007 to document its progress toward sustainability and conservation goals; the goal-oriented implementation was given further expansion and refinement through the 2008 Army Energy Security Implementation Strategy, which provided more specific guidance on how the Army would achieve its energy goals and by what metrics achievement would be measured.

A decade of sustainability and energy-related thinking led to the 2010 Army Sustainability Campaign Plan. The plan synchronized sustainability efforts across the force—from installations to tactical energy—and reinforced the operational, day-to-day nature of sustainability. The implementation of the service-wide plan is overseen by the Army Senior Energy and Sustainability Council, co-chaired by the Under Secretary of the Army and the Army’s Vice Chief of Staff. This provides top-level leadership and buy-in to the goals and outcomes of the Army’s sustainability priorities.

Today, the Army has four tenets of sustainability:

- Developing, producing, fielding and sustaining materiel that is more energy efficient, is capable of using renewable energy resources, minimizes the use of hazardous materials and generates less waste.
- Ensuring the Army has sufficient access to training and testing resources and incorporating sustainability into operational planning and execution, so the Army can continue to effectively train today and in perpetuity.
- Expanding the Army’s commitment to sustainability by instilling sustainable practices into all levels of Soldier and civilian equipping and education programs.
- Providing services and operating facilities in a manner that reduces consumption of energy, water and other resources, promotes the use of renewable energy sources, enhances quality of life and continues to protect the environment.

Guided by these tenets, the Army is continually working to broaden understanding and institutionalize a commitment to sustainable practices in every aspect of the Army’s activities: planning, training, equipping and conducting operations. At the same time, the Army is serving as a steward of the environment and improving its ability to provide the energy required to meet its operational, industrial and installation needs, now and in the future.
Changing the Organizational Culture

The Army has already made significant progress in a variety of energy and resource conservation efforts, reducing overall energy consumption by more than 30 percent since 1985 and initiating a number of innovative and successful projects. Still, part of the process toward full-scale integration and adoption of sustainability principles is a change to the organizational culture of the Army. The challenge going forward is to take an enterprise-level approach, incorporating sustainability into every aspect of Army operations and making projects heretofore considered “exceptional” the norm. The past decade of war and a fundamentally different resource environment have generated certain operational tendencies (with regard to sustainability and energy) and mindsets, some of which need to be sustained, some of which need to be modified. To fully embrace the transformational change envisioned in the campaign plan, the Army is addressing three key organizational challenges:

Change the Culture: Every Soldier a Power Manager. Energy and sustainability must be considerations in all Army activities, from major operations planning to combat patrols. To achieve this, individuals and units must be given the means to manage, measure, monitor and control energy status, usage and system performance while prioritizing and redistributing resources. This change means not just building sustainability awareness and power management into training and planning but also providing technological solutions that enable energy to be quickly and easily transferred among a variety of systems dependent on mission.

Drive Efficiency Across the Enterprise. The Army is working to significantly reduce requirements for natural resources, to include energy and water, both on installations at home and in combat environments. Reducing resource demand through efficiency improvements is often the cheapest and fastest way to save funds and reduce dependency and corresponding operational risks. The need to reduce energy vulnerabilities and associated costs is clear given experiences in Iraq and Afghanistan with the cost in lives paid to secure the long logistical formations. Moreover, the enterprise approach brings forward-edge and home-station sustainability together in the same scheme; the Army cannot discard sustainability and efficiency just because it goes overseas. Although the specific mechanisms and levels of efficiency will vary across operational theaters, the principles must remain unchanged and uncompromised. This approach will require a concerted effort involving a combination of new technologies, changes to user behavior and conversion of waste in resource streams to usable energy, along with mechanisms that convert waste heat or garbage into electricity.

Build Resilience through Renewable/Alternative Energy. Army forces must prevail even in the face of disruptions from enemy action, weather, shifting strategic priorities or energy availability. Therefore, it is prudent that the Army take steps to diversify its sources of energy to include renewable and alternative sources available both here and abroad. By doing so, the Army is building resilience and flexibility into the force that will allow it to continue operating in the face of energy disruption. Potential disruptions can occur at the national, regional or local level and can affect bases, platforms and Soldiers; mitigating the effects of specific or clustered disruptions will preserve overall force readiness and availability.
Army Energy Security and Sustainability Challenges

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<td>• Enhance Military Construction compliance with energy mandates; focus modernization efforts; institutionalize energy and water savings and conservation procedures</td>
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<td>• Leverage private-sector investment</td>
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<td>Net Zero</td>
<td>• Identify renewable/alternative sources to develop Net Zero Energy installations</td>
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<td>Energy Managers</td>
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<td></td>
<td>• Meet requirement for significant reduction in energy usage</td>
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<tr>
<td>Non-Tactical Vehicles</td>
<td>• Implement use of alternative/renewable fueled vehicles; decrease petroleum usage 20%; and upgrade non-tactical vehicle fleet using advanced technologies</td>
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Source: Headquarters, Department of the Army

**Net Zero as a Force Multiplier**

To meet these challenges, the Army has launched a “Net Zero” initiative on its home-station installations as well as a complementary policy regarding contingency base camps. It is working to leverage private investment and accelerate technologies from home-station installations into the operational theater.

Net Zero is best described as an integrated process of design, decisionmaking and operations that takes a “systems of systems” approach to reducing requirements, eliminating waste, saving money and increasing capability. It is the means to achieve the Army’s sustainability vision of preserving strategic, operational and tactical choice for the future. The Army’s vision of Net Zero is a holistic approach to addressing the installation and operational issues surrounding energy, water and waste to the benefit of current and future missions. Given an unpredictable future threat environment and diverse mission portfolio, appropriate resource and energy management can be a true force multiplier through decreased logistical footprints, wider unit dispersion, increased mobility in theater and more fiscal resources available for training and operational support at home station.

The Net Zero vision seeks sustainable practices that will be instilled and managed throughout the appropriate levels of the Army, while also maximizing operational capability, resource availability and well-being. It is composed of three core components coupled to an enabling hierarchy:

**Net Zero Energy.** A Net Zero Energy installation produces as much energy on site as it uses over the course of a year. To achieve this goal, installations must first implement aggressive conservation and efficiency
The Oregon National Guard (ORNG) has embraced the sustainability concept and has seized the initiative to apply Net Zero models to its statewide facilities with significant new military construction and expansion of existing sustainability projects. The ORNG has been intimately tied into state-level energy initiatives since 1999, with the Deputy Director of the ORNG sitting on the State of Oregon Energy Council.

The ORNG's plan is to make “Fort Oregon”—the composite facilities around the state—into a Net Zero installation using a variety of renewable-energy means to power its readiness centers and armories. It is studying the potential use of wave power from coastline property, the possible use of wind power at Camp Rilea Maneuver Training Center and over 2,000,000 square feet of rooftop space that can accommodate solar panels. Most ambitious, though, is the potential development of a 20 megawatt (MW) solar array in Christmas Valley, Oregon. The ORNG is also researching a state partnership which would allow eventual expansion of the site to more than 100 megawatts (MW). Renewable-energy projects will be sustained through a hybrid funding scheme of federal, state and private partnerships that will form a model for future nationwide energy-related programs. The renewable energy sources under development will meet or exceed the total energy consumption of the ORNG, providing opportunities for expanded partnerships with utility companies and Oregon communities.

To take advantage of the planned renewable energy sources, new military construction of readiness centers and facilities emphasizes Leadership in Energy and Environmental Design (LEED) certifications that surpass normal building code efficiency requirements. Since 2004 six new facilities built across Oregon have replaced older ones constructed as far back as 1911. The new facilities, on average, exceed building code energy efficiency requirements by 40 percent. Four of the six facilities are, or are pending, LEED Gold; one is LEED Silver and one is LEED Certified.

Finally, the ORNG is turning Camp Rilea into a Net Zero Water installation. Camp Rilea, with an annual Soldier throughput of around 45,000, is on the verge of completing $7 million in water improvement projects—a $3.2 million water supply project and a $3.8 million waste water efficiency project. The water supply project will separate the post from municipal water sources entirely while still providing self sufficiency and aquifer control. The waste water project will reprocess 65 percent of all wastewater for safe use in landscaping or to recharge the ground aquifer supply through a new treatment facility coupled with innovative rapid-infiltration basins that naturally filter and treat wastewater. Along with the physical infrastructure, the ORNG is using a water management and conservation plan to institutionalize water efficiency through education, training, water use audits and leak detection and management tools.

Net Zero Water. A Net Zero Water installation limits the consumption of freshwater resources and returns water to the originating watershed to preserve the ground and surface water resources of a region (in both quantity and quality) for a yearly aggregate use of zero. The Net Zero Water strategy balances water availability and use to ensure a sustainable water supply for years to come. This concept is of increasing importance since the scarcity of clean, potable water is becoming a serious issue around the world due to the rapid drawdown of major aquifers. Strategies such as harvesting rainwater and recycling discharge water for reuse can reduce the need for municipal water. Exported sewage or storm water and desalination can be used to convert briny, brackish or saltwater to freshwater so it is suitable for human consumption or irrigation.

To achieve a Net Zero Water installation, efforts begin with conservation followed by efficiency in the use and improved integrity of distribution systems. Water is repurposed by using gray water generated from sources such as showers, sinks and laundries and by capturing precipitation and storm water runoff for
onsite use. Wastewater can be treated and reclaimed for other uses or recharged into groundwater aquifers. Several Army installations are already on the path to reaching Net Zero Water goals.

**Net Zero Waste.** The approach to creating a Net Zero Waste installation is similar to creating a Net Zero Energy installation. A Net Zero Waste installation reduces, reuses and recovers waste streams and converts them into resources with zero landfill over the course of a year. The components of net zero solid waste start with reducing the amount of waste generated, repurposing waste and maximizing recycling of waste stream to reclaim recyclable and compostable materials. Recycling strategies are being developed that move beyond metals, paper and cardboard to include mattresses, glass, plastics, batteries, computer printers and motor oil.

Evolving purchasing and procurement strategies consider the waste stream when purchasing items, reduce the volume of packaging, reuse and repurpose wastes where possible and recycle the remainder. A true cradle-to-cradle strategy considers the end state at the time a purchase decision is made. A net zero waste strategy eliminates the need for landfills, protects human health, optimizes use of limited resources and safeguards the environment.

The **Army Net Zero hierarchy comprises five interrelated steps: reduction, repurposing, recycling and composting, energy recovery, and disposal.** Each is a link in achieving Net Zero. Reduction includes maximizing energy efficiency in existing facilities, implementing water conservation practices and eliminating generation of unnecessary waste. Repurposing involves diverting energy, water or waste to a secondary purpose with limited processes. Recycling or composting involves management of the solid-waste stream, development of closed-loop systems to reclaim water or co-generation where two forms of energy (heat and electricity) are created from one source. Energy recovery can occur from converting unusable waste to energy, harvesting renewable energy or tapping geothermal sources. Disposal is the final step and last resort after all other waste mitigation strategies have been fully exercised.

An example of immediate action toward Net Zero installations is the baseline use of American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) guideline 189.1, which addresses mutual sustainability principles in building construction. Through strategies such as site selection, cool roofing (roofing techniques that reflect away unwanted solar energy), solar water heating, storm water management and water efficiency, the Army will reduce its impact on the environment. The use of high-efficiency lighting and energy-efficient designs and appliances not only reduces energy use but yields certain tax advantages. Together these actions set the Army building standard for new construction and renovation as the highest in the federal government.

Going forward, Army installations required to project and support a joint and expeditionary force must operate more efficiently, while enhancing quality of life for servicemembers and families. They must become more sustainable, with buildings, facilities and housing that need significantly less electrical power (ideally coming from renewable energy sources) and with post activities that embrace and reinforce water conservation and better waste management/reclamation.
Operational Energy – Accelerating Technologies from Installations to the Battlefield

Operational and tactical energy management is a significant and enduring challenge within the Army energy initiative. Energy has always been a consideration for the force, but the consumption trend line has been steadily increasing since World War II. Today, it is fair to ask whether the Army will be able to provide the energy required to meet its future mission. Furthermore, energy consumption nearly doubles during wartime, with the possibility of even larger multiples for higher-intensity conflicts. For context, the average fuel demand for the American Soldier has ballooned from one gallon per day in World War II to around 20 gallons per day in current contingencies. Half of this consumption is from modern tactical vehicle requirements; the other half is to generate forward-edge power. This rate of consumption, amplified by distributed operations across multiple theaters, creates a significant logistical effort and sustainability challenge; providing fuel and water to the Soldiers comprises 70–80 percent of the resupply weight for logistical convoys, and at great cost. In Afghanistan, for example, there is, on average, one military casualty per 24 ground resupply convoys. Increased efficiency, demand management and diversification of energy supply will save lives.
To address the specific operational challenge of fuel, the Army developed a planning tool to consider these factors and measure the fully burdened cost of fuel, which accounts for the direct and indirect costs and other impacts of delivering energy to the warfighter. The Army is participating in the Sustain the Mission Project (SMP) to evaluate the costs and benefits of energy and energy-impacting solutions based on operational scenarios. The SMP is a project initiated in 2005 by the Army Environmental Policy Institute that developed both analytic methods to calculate the fully burdened cost of fuel, water and waste in contingency operations and a user-level tool to assist in evaluating sustainability at the operational level. The SMP Tool not only evaluates fully burdened costs of fuel but can also be used to measure other metrics such as fuel consumption, miles driven, casualties avoided and greenhouse gas emissions.

This work is providing the critical data necessary to support initiatives to address the operational energy challenges and maintain an efficient, flexible energy posture that will enable highly effective, widely dispersed and increasingly mobile forces in combat. Providing war-fighters with the correct amount and type of energy at the forward edge will require innovation, investment and flexibility within the broader energy strategy. To support these mechanisms and meet the challenges of changing culture, driving efficiency and building resilience in the operational context, the Training and Doctrine Command (TRADOC) Army Capabilities Integration Center is in the process of developing an operational energy doctrine to guide the force. Developing doctrine is a key component in establishing the institutional knowledge necessary to ensure the long-term strategy. The main concepts of this emerging doctrine are:

**Contingency Base Operation Improvement.** Improving efficiency at base camps represents one of the best opportunities to decrease Army operational energy usage. The Army is looking to significantly reduce base camp energy by as much as 30–60 percent through solutions such as smart microgrids, renewable energy sources, better-insulated shelters, more efficient generators and onsite water production. These methods are currently being tested in operational theaters and will reduce logistical convoys, free up theater combat power or lower the total deployment figure.

**Soldier Power Management.** Currently Soldiers have to carry seven pounds of batteries for each day on mission. This weight can significantly affect a unit’s mobility and endurance. The Army is developing and implementing solutions such as solar-power battery rechargers to lighten the load and increase Soldiers’ agility and stamina.

Soldiers from the 1-16th Infantry Battalion, Fort Riley, Kansas, deployed to Afghanistan in support of Operation Enduring Freedom and are using an advanced portable power network called the Rucksack Enhanced Potable Power System, of which more than 100 systems have been deployed for testing since 2010. The ensemble includes rechargeable batteries, solar and fuel cell chargers and a pocket-sized networking device that allows Soldiers to use nearly any available power source to...
In January 2011, the “Iron Rangers” of the 1-16 Infantry Battalion (1st Heavy Brigade Combat Team, 1st Infantry Division) deployed to support coalition forces in Afghanistan. The battalion is conducting small-unit operations against insurgent enemies in rugged, rural areas, challenging especially their capabilities of mobility, resilience and tactical security. In the months of preparation at home station (Fort Riley, Kansas), the battalion engaged in a “limited user test,” evaluating candidate small-unit command and control capabilities associated with the Nett Warrior program. Underlying the suite of radios, transducers and displays were a number of advanced power and energy capabilities, such as networked power, conformable batteries and portable/silent battery charging at individual and squad levels—including solar, methanol and propane fuel-cell options. Soldiers experimented and conducted side-by-side comparison of modular systems provided by three competing vendors through a series of realistic operational scenarios and battle drills to assess performance and operational utility, balancing weight, volume and complexity with contributions to lethality, mobility, endurance and resilience. The Soldiers picked winning technologies and identified those they judged worth carrying into the rugged mountains of Afghanistan.

The Army’s Project Manager (PM) Soldier Warrior coordinated the testing and facilitated system evaluation, but the process comprised a team effort engaging the unit and its chain of command; Army Materiel Command’s Research, Development and Engineering Command; Army Training and Doctrine Command’s Maneuver Center of Excellence; and other Army elements to ensure realistic operational context and adequate technical evaluation without impacting the unit’s preparation for deployment.

The 1-16 Infantry deployment represents a useful example of streamlining the new-equipment fielding process by engaging the unit early, executing a thorough evaluation under realistic conditions and leveraging direct Soldier feedback to assess operational costs and benefits. This model prevents operational problems due to inadequate procedures, training or logistics support. The 1-16’s tour in Afghanistan is contributing to development of the newest generation of Soldier capabilities and helping the Army streamline its approach to modernization.

**Leverage Home-station Testing.** The Army is working on solutions at home stations that will help Soldiers in combat. These include piloting technology on permanent installations that can significantly reduce the use of natural resources in combat operations; developing doctrine that can help Soldiers better manage their resource needs; and developing new efficient vehicles and weapon systems to dramatically reduce the number of fuel convoys needed to support them. Addressing these challenges is operationally necessary, financially prudent and essential to mission accomplishment.

run related equipment. The whole equipment set fits in their rucksacks and meets the energy and battery-charging requirements for squad and platoon operations; the results of this operational test will be compiled and examined for future deployments of the system.

**Ground and Air Vehicle Power and Energy Management.** The Army is exploring more efficient engines, better energy storage, power conditioning devices and even enhanced rotors for helicopters to reduce energy use and increase vehicles’ versatility and sustainability.

The Army is also working to complete development of high-efficiency turboshaft engines to reduce fuel burn rates, reduce weight and increase engine reliability across the current aviation fleet. The Advanced Affordable Turbine Engine (AATE) Science and Technology program has produced developmental engines to replace the baseline T-700 engine, which currently powers all Apache and Black Hawk aircraft. The AATE engines will provide a 30 percent improvement in thermal efficiency for Black Hawk and will become a mainstay of the Army’s Improved Turbine Engine Program production program in 2013.
The U.S. Army Reserve is demonstrating its pursuit of sustainability with new construction around the country. Reserve Centers at Fort Shafter, Hawaii and Gainesville, Florida embraced energy and water efficiency standards and earned LEED Silver ratings. Further, the Army Reserve is addressing the larger issue of energy generation, not just conservation, at its largest installation, Fort Hunter Liggett.

With almost 300 days of sunshine per year, Fort Hunter Liggett (FHL) in southern California is an ideal location to harness solar energy in support of current and future energy requirements. As such, FHL is breaking ground on its first solar microgrid facility. The Renewable Energy Solar Microgrid Carport PV Power System is an Energy Conservation Investment Program Project (ECIP—a Department of Defense program that supports energy efficiency and sustainability projects) that will span an existing parking area to both generate energy and insulate the post from power transmission issues that stem from the sheer length of power lines that run to the base.

The Microgrid project, awarded in Fiscal Year 2010, recently broke ground in early April 2011. The $9.8 million one-megawatt (MW) array is funded by the U.S. Army Energy Conservation Investment Program, which targets renewable energy programs. The solar microgrid will save FHL approximately $1 million per year in energy costs, which will pay off the project (life-cycle) cost within 10 years. Up to 33 percent of FHL’s current 3MW annual energy demand, or 50 percent of its daytime demand, will be provided by the microgrid. This and future FHL microgrids will include “net energy metering” to offset FHL’s costs for electricity by putting excess generated power back into the grid in exchange for billing credits from utility companies.

The project supports preferred environmental practices by using an existing active site and renewable solar energy in a commercial application, addressing LEED requirements for project sites and maximizing reuse of construction material including fence, pavement and land assets. The project is supported by state utility partner Pacific Gas and Electric and qualifies for the several federal and state tax rebates and credits as well as the Environmental Protection Agency’s Energy Star rating.

**Investment Strategy and Mechanisms – Leveraging the Private Sector**

Creating Net Zero installations, more efficient operating bases and less burdened Soldiers is achievable and affordable over the life cycle of the sustaining investments; said investments in sustainability will more than pay for themselves over time. Nonetheless, the Army requires up-front investment if it is to realize this potential efficiency savings. **There is no single “energy” line in the Army’s budget; rather, energy and sustainability are issues that cut across a range of budget efforts.** Maximizing the impact of constrained funds across budget categories will require intense oversight and meticulous planning and programming. The Army must work to maximize the impact of its constrained appropriated funds, whether for installation management, a new series of generators or investments in more efficient data centers.

To meet the challenges of changing the culture, driving efficiency and building resilience, the Army is moving toward higher energy efficiency standards for new military construction, more creative use of Energy Conservation Investment Program funds, procurement of more efficient appliances, better Sustainment, Restoration and Modernization design guides, and data center consolidation. Still, maximizing the current funding streams will not be sufficient to meet the Army’s goals, particularly in the areas of energy efficiency and renewable power generation on its installations; thus, the Army’s need to increase involvement of private-sector capital on installations.

Congress has given the Army a unique set of authorities to work in concert with the private sector that allows nonappropriated investment in Army installations. These investment funds would be paid back over time from energy savings, access to land or new energy generation. During the past decade, the Army has experienced tremendous success with programs such as the Residential Communities Initiative—attracting capital from private investors needed to rapidly improve the quality and availability of housing on installations. Expanding the Army’s use of these authorities and programs offers one of the best means to achieve its energy objectives. Army senior leadership is fully committed to harnessing the power of these alternative financing
authorities and investment/development partnerships to close gaps in funding and attract capital.

Four primary types of alternative financing mechanisms are being considered for energy-efficient and renewable-energy projects on installations:

**Energy Savings Performance Contract (ESPC).** Under an ESPC, an energy services contractor installs, maintains and finances the project and guarantees the resulting savings, which are used to repay the capital expenses over time. Although more often used for energy-efficiency projects, ESPCs can be used effectively to bundle renewable-energy projects, which usually have a long return on investment (ROI), with energy-efficiency projects with relatively shorter ROIs. The installation, which often owns and operates the equipment, can generate savings over and above payments to the contractor. Currently, the Army uses ESPCs at 60 installations with over 10,000 billion BTUs in energy savings per year. ESPCs have brought $865 million of private-sector investment into the Army, with $850 million more currently in development.

**Utility Energy Service Contract (UESC).** Under a UESC, a utility company installs, maintains and finances projects and recovers the resulting savings, which are used to repay the capital expenses over time. It is similar to an ESPC but is used exclusively with utility service providers, and a savings guarantee is optional. Not all utilities offer UESCs. Currently, the Army uses UESCs at 30 installations with 750 billion BTUs in energy savings per year. UESCs have brought in $336 million in private-sector investment, with $100 million more in development.

**Enhanced Use Lease (EUL).** Under an EUL, an installation leases available “non-excess” real property (land

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**Energy Program**

<table>
<thead>
<tr>
<th>Financing Vehicle</th>
<th>Asset Owner</th>
<th>Maximum Contract Length</th>
<th>Legal Authority</th>
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</thead>
<tbody>
<tr>
<td><strong>Energy Savings Performance Contract (ESPC)</strong></td>
<td>Installation or contractor owns; contractor usually maintains</td>
<td>25 years</td>
<td>10 USC 2865 42 USC 8287</td>
</tr>
<tr>
<td><strong>Utility Energy Service Contract (UESC)</strong></td>
<td>Installation or utility owns; utility usually operates and maintains</td>
<td>25 years</td>
<td>42 USC 8256 10 USC 2913 EISA Sec 513</td>
</tr>
<tr>
<td><strong>Enhanced Use Lease (EUL)</strong></td>
<td>Privately owned, operated and maintained</td>
<td>5 years, or up to 50 years with approval of the Secretary of the Army</td>
<td>10 USC 2667</td>
</tr>
<tr>
<td><strong>Power Purchase Agreement (PPA)</strong></td>
<td>Renewable energy is privately owned, operated and maintained</td>
<td>10 years (FAR Part 41) or 30 years (2922a, but requires approval of the Secretary of the Army)</td>
<td>FAR Part 41 10 USC 2922(a)</td>
</tr>
</tbody>
</table>

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EISA – Energy Independence and Security Act  
FAR – Federal Acquisition Regulation  
USC – United States Code  

Source: Headquarters, Department of the Army
and facilities) to the private sector in return for cash and/or in-kind consideration including installation of energy-efficient roofs, HVAC (heating, ventilating and air conditioning), building controls, lighting insulation or renewable technologies.

Power Purchase Agreement (PPA). Under a PPA, a private entity finances a renewable-energy power project’s development, equipment, installation, operation and maintenance for the term of the contract. The energy system is privately owned, and the installation purchases the electricity through a long-term agreement. The installation maintains ownership of the land, and most PPA agreements include an option for the installation to purchase the system at a predetermined price at the conclusion of the contract.

What is Needed
The future Army will need enhanced capabilities with a smaller logistical footprint and lower resource consumption rates to sustain a wide range of operations in diverse locations. To do this, it will need to mate innovative and emerging technologies with strong leadership to produce true operational sustainability.

At the installation level, the Army needs to continue to use high-standard efficiency construction baselines and energy-sensitive designs in all its new construction. Further, the Army needs to support long-term energy and sustainability projects through appropriate programming and budgeting activities; some projects are currently generating resistance due to the lag between program execution and return on investment. The Army also needs continued leeway in installation project funding to attract private industry capital and reduce the up-front costs of long-term sustainability projects.
At the operational level, the Army needs a steady flow of research, development, test and evaluation funding to accelerate the design and fielding of tactical sustainability solutions. Lighter batteries, universal charging devices, energy-efficient prefabricated buildings, water purifiers and smart microgrid technologies are all important developing technologies. The Army also needs a flexible method of getting these products to the warfighter for testing and use as soon as possible, without the long delays usually associated with procurement. Rapid evolution of technologies must be met with rapid fielding initiatives to best support Soldiers in combat.

Finally, at the individual level the concepts of sustainability must be instilled at every opportunity. The completion of an energy doctrine to guide operations and the introduction of sustainability principles at every level of training will grow a generation of leaders and Soldiers who are comfortable with operations in resource-constrained environments. An aggressive and fully formed training and education plan is needed to prepare the force before the next conflict.

What Must Be Done

For the Army to succeed, it must continue to support sustainable solutions for operations, installations, systems and communities. Even in a time of fiscal constraint these issues must remain a priority. The administration and Congress must:

- support the Army’s efforts to work in concert with the private sector and use alternative financing authorities to provide business-based opportunities for energy-related investment (AUSA Resolution 11-18);
- reinforce procurement specifications that include contract clauses for industry standards for sustainable goods and services;
- support interagency cooperation, such as the Memorandum of Understanding (MOU) between the Department of the Army and the Department of Energy;
- provide a single statutory definition for renewable energy that is not limited to just “electric energy” and includes ground source and solar thermal energy;
- address inconsistencies in definition and baseline measurements in legislation and mandates, provide fewer but more significant overarching goals (AUSA Resolution 11-18);
- rationalize the budget scoring of investments in energy efficiency and renewable power generation, encouraging long-term and large-scale investment (AUSA Resolution 11-07);
- change budget rules to allow for utility rate projections based on actual costs and not tied to the lower rate of inflation, aligning the federal government’s business case analysis with that of private investors.

Congress must:

- reinforce and provide funding for the Army’s efforts to increase its sustainability and energy security through strategies such as developing the Net Zero installations (AUSA Resolution 11-07);
• support energy efficiency measures, including the Army Sustainable Design and Development standards that incorporate ASHRAE 189.1 and the development of renewable-energy sources for Army installations;

• provide funding for investments in research and development to develop technology and infrastructure (AUSA Resolutions 11-07 and 11-15);

• support the Army in developing sustainability standards for its suppliers and in working with the federal acquisition community to incorporate those standards in government procurement regulations and statements of work; and

• promote sustainability strategies and practices by other federal agencies so the Army can better partner and leverage capabilities.

The Department of Defense should inculcate the growing use of sustainability and energy security efforts into the department. In particular, **DoD must:**

• reinforce the increasing emphasis on sustainability and energy security in its DoD-wide strategic plans for installations, with special focus on Net Zero installations, high-efficiency buildings, alternative and renewable energy and collaboration;

• further develop and support the Office of the Secretary of Defense Energy Clearing House to provide support and guidance to Army installations working with the private sector (AUSA Resolution 11-18);

• focus on range management and collaboration with surrounding communities whose cooperation is needed to protect training capabilities and support use of environment management systems;

• promote underserviced partnerships and conversation in the areas of sustainability and energy security.

**Industry partners must:**

• accelerate the development of alternative and renewable energy generation, supply, volume and reliability;

• incorporate sustainability and participate in the creation of a level playing field for sustainable products and services through adoption of industry sustainability standards;

• accelerate the development of alternative fuels that meet all combat conditions and all combat needs;

• pursue innovative solutions and technologies to address the Army’s efforts to secure energy sources and create a more sustainable force.

The Army is moving forward to address the challenge of sustainability and energy security to ensure the Army of tomorrow has the same access to energy, water, land and natural resources as the Army of today. Net Zero installations, operational power analysis, industry partnerships and initiatives and alternative funding mechanisms are all part of the sustainability movement shaping the future force. Taken together, these actions represent great steps forward, yet much work remains to be accomplished. Through doctrine, leadership and technology, enhancing sustainability and energy security must become a basic responsibility of every Soldier and every civilian. Technologies that support alternative energy, clean-water generation, energy efficiency and waste reduction—both at the installation level and in theaters of operation—hold great promise for tactical systems, logistical support and base infrastructure needs. The Army needs mission-wide systems that make full use of alternative energy sources and fuel-efficient technologies. Innovative solutions are critical to success, and addressing sustainability challenges is operationally necessary, fiscally prudent and mission essential. To enable innovation and transformational change, the Army must remain a leader in enhancing sustainability technologies to provide the quantities of reliable, secure and uninterrupted resources needed in theaters of operations and at home stations to meet the Army’s current and future mission requirements.
The past decade of conflict has starkly illustrated the resource requirements for dispersed, multitheater, long-term military engagements. The Army recognizes the challenge in powering and supplying its force throughout all areas of operation from home stations to combat zones. Army energy security and sustainability programs are shaping a modern force with resource conservation and security as core values that will provide strategic and operational flexibility for full-spectrum operations in increasingly resource-restrictive environments.

An Army-wide strategy to ingrain and operationalize sustainability principles is under way. A three-pronged effort to establish a permanent doctrine and guiding principles is addressing the culture of the Army and the installation/basing and tactical power aspects of the Army mission. A pairing of short- and long-term goals allows immediate action toward achievable effects that build into far-term success.

At the cultural level, the Army is developing a doctrine that incorporates sustainability planning into all echelons. Making every Soldier a power manager and providing the latest sustainability technologies will enable logistically simpler and more operationally agile future missions. Further, the Army is driving the sustainability effort across the breadth of the enterprise to ensure that sustainability principles are not discarded when inconvenient. For its installations, the Army has implemented a Net Zero approach: a plan to make Army installations effectively self-sufficient in energy, water, solid waste or all three. Onsite renewable energy generation, water repurposing and aggressive solid waste recycling are just some of the mechanisms that are driving the total resource consumption of Army posts down toward zero and will ultimately serve to protect the Army from potential resource and energy disruption.

The Army is also working to address the tactical power and tactical resource consumption challenges of current contingencies. Rising per-Soldier resource requirements strain logistical systems and put Soldiers at increased risk on the battlefield. More efficient forward-based power management, improved Soldier-level power technologies and advanced vehicular designs will lower the overall resource burden for full-spectrum operations across wide areas.

Despite this aggressive adoption of sustainability principles, much work has yet to be done. The energy and sustainability portfolio needs a steady stream of research, development, testing and evaluation funding to enable cutting-edge technologies to reach both the warfighter and supporting installations. Sustainment of alternative funding mechanisms to encourage private-sector investment in installation energy is critical to providing the Army the capital and expertise needed to truly reach Net Zero. The Army will need to properly support and shepherd long-term investments and projects in renewable-energy technologies through the programmatic cycle to completion to realize the full potential of these private-sector partnerships. Moreover, robust interagency cooperation will allow the Army to leverage capabilities found in other government departments, such as the Department of Energy, to lower the collective burden of implementing new concepts. Finally, a responsive partnership with industry and a rapid fielding initiative are needed to get the latest developing tactical and vehicular technologies to the front line with a minimum of lag time and traditional delays.

Future operational relevance and viability will depend on the Army’s ability to protect itself from resource disruption, sustain itself in dispersed mission environments and achieve mission goals with a minimum of logistical support. Energy security and resource sustainability are no longer afterthoughts for the Army worldwide mission—they are core competencies. The Army has taken the lead and is aggressively implementing a force-wide sustainability strategy that is not only fiscally prudent but will ultimately save lives on the battlefield.
Energy security, sustainability and efficiency are national security imperatives.
Katherine Hammack, Assistant Secretary of the Army for Installations, Energy and Environment, at AUSA's Annual Meeting and Exposition, Washington, D.C., 27 October 2010