Potential for the Use of Energy Savings Performance Contracts to Reduce Energy Consumption and Provide Energy and Cost Savings in Non-Building Applications

A Joint Study by the United States Secretaries of Energy and Defense
Authorized in the Energy Independence and Security Act 2007 by Congress

Prepared by

US Department of Energy Office of Energy Efficiency and Renewable Energy,
Federal Energy Management Program

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MESSAGE FROM ASSISTANT SECRETARY DAVID DANIELSON AND ASSISTANT SECRETARY SHARON E. BURKE

Section 518 of the Energy Independence and Security Act (EISA) of 2007 requires the Secretaries of the Department of Energy (DOE) and the Department of Defense (DOD) to conduct and submit to Congress and the President a study of and a report on the potential for the use of energy savings performance contracts (ESPC) to reduce energy consumption and provide energy and cost savings in non-building applications. The report, undertaken jointly by the Secretaries of Energy and Defense, is now complete.

The report concludes that ESPCs may be a compatible and effective performance-based contracting tool in certain circumstances for non-building applications. It also cautions there are significant differences in terms of scale of projects and level of risk between investing in fixed facilities and operational combat platforms. Any calculation used to determine contractually guaranteed future savings for non-building defense equipment faces far greater variation and risk than the similar calculations for buildings. On balance, a general legislative extension for operational weapons systems is not recommended at this time.

There are opportunities for cost-effective energy efficiency investments in Federal facilities and areas other than buildings. More often than not, the most cost-effective way for the Federal Government to capture these efficiencies is through the use of appropriated funds utilizing competitive selection among qualified bidders. In cases where appropriated funds are not readily available, Federal agencies using performance contracting for any purpose should have established management systems that allow for rapid but competitive selection among firms and a quality assurance mechanism throughout the entire contract period to assess, monitor and validate savings. Additionally, all involved need to make concerted efforts to reduce the financing costs associated with these projects, through competition and transparency of financing offers.

The scoring of ESPCs for facilities is at variance with generally accepted scoring guidelines utilized by OMB, CBO, and the Budget Committees to assess the implications of actions on discretionary spending, direct spending and receipts. The same could be required for non-building applications. Budget scoring typically attributes all the government's expenditures over the life of the project in the first year, even though the actual outlays by the government occur over many years. From a budgetary perspective, this can make ESPC look no better, or worse, than a project where the government makes all the investment itself up front. The scoring guidelines could need to be amended to recognize obligations and budget authority on an annual basis. In addition, a legislative change proposal could be submitted to extend ESPC authority to projects, programs, and accounts not currently covered under 42 USC 8287. Again, on balance, a general legislative extension for operational weapons systems is not recommended at this time.

Pursuant to statutory requirements, this report is being provided to President Barack H. Obama and to President of the Senate Joseph R. Biden, Jr., and Speaker of the House of Representatives John Boehner. In addition, a copy of the report is being provided to the following Members of Congress.

- **The Honorable Harry Reid**
  Senate Majority Leader

- **The Honorable Mitch McConnell**
  Senate Minority Leader

- **The Honorable Barbara A. Mikulski**
  Chairwoman, Committee on Appropriations

- **The Honorable Richard C. Shelby**
  Ranking Member, Committee on Appropriations

- **The Honorable Dianne Feinstein**
  Chairman, Subcommittee on Energy and Water Development, Committee on Appropriations

- **The Honorable Lamar Alexander**
  Ranking Member, Subcommittee on Energy and Water Development, Committee on Appropriations

- **The Honorable Richard J. Durbin**
  Chairman, Subcommittee on Defense, Committee on Appropriations

- **The Honorable Thad Cochran**
  Ranking Member, Subcommittee on Defense, Committee on Appropriations

- **The Honorable Mary L. Landrieu**
  Chairwoman, Committee on Energy and Natural Resources

- **The Honorable Lisa Murkowski**
  Ranking Member, Committee on Energy and Natural Resources

- **The Honorable Carl Levin**
  Chairman, Committee on Armed Services

- **The Honorable James M. Inhofe**
  Ranking Member, Committee on Armed Services

- **The Honorable Nancy Pelosi**
  Minority Leader of the House Representatives

- **The Honorable Harold Rogers**
  Chairman, Committee on Appropriations

- **The Honorable Nita M. Lowey**
  Ranking Member, Committee on Appropriations

- **The Honorable Rodney P. Frelinghuysen**
  Chairman, Subcommittee on Defense, Committee on Appropriations

- **The Honorable Peter J. Visclosky**
  Ranking Member, Subcommittee on Defense, Committee on Appropriations

- **The Honorable Mike Simpson**
  Chairman, Subcommittee on Energy and Water Development, and Related Agencies, Committee on Appropriations

- **The Honorable Marcy Kaptur**
  Ranking Member, Subcommittee on Energy and Water Development, and Related Agencies, Committee on Appropriations

- **The Honorable Howard P. "Buck" McKeon**
  Chairman, Committee on Armed Services

- **The Honorable Adam Smith**
  Ranking Member, Committee on Armed Services

- **The Honorable Lamar Smith**
  Chairman, Committee on Science, Space, and Technology

- **The Honorable Eddie Bernice Johnson**
  Ranking Member, Committee on Science, Space, and Technology

- **The Honorable Cynthia M. Lummis**
  Chairman, Subcommittee on Energy, Committee on Science, Space and Technology

- **The Honorable Eric Swalwell**
  Ranking Member, Subcommittee on Energy, Committee on Science, Space and Technology

- **The Honorable Darrell Issa**
  Chairman, Committee on Oversight and Government Reform

- **The Honorable Elijah E. Cummings**
  Ranking Member, Committee on Oversight and Government Reform

If you need additional information, please contact Ms. Kathleen B. Hogan, Deputy Assistant Secretary for Energy Efficiency and Renewable Energy, at (202) 586-9816.

Sincerely,

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David Danielson
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Enclosure

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I. Executive Summary

A. Findings

The findings of this study indicate that potential exists in non-building applications to save energy and costs. This potential could save federal dollars, reduce reliance on fossil fuels, increase energy independence and security, and reduce greenhouse gas emissions. The Federal Government has more than 17 years of experience achieving energy savings by applying energy savings performance contracts (ESPC) in Federal buildings. Currently, the application of ESPCs is limited by statute to federal buildings. This study indicates that ESPCs could be a compatible and effective contracting tool for achieving savings in non-building applications. However, there are some important differences between investing private capital in operational assets compared to fixed facilities:

- Individual buildings can be upgraded as individual projects. Operational systems are generally part of a fleet, and upgrades need to be accomplished on a fleet-wide basis.
- Since 1997, Federal Agencies have invested over $8B for facility energy upgrades through the ESPC program. A single project to upgrade an operational system can exceed the Federal Government's total 17-year program value in ESPCs for buildings. Re-engining a single airframe such as the B-52, for example, could cost nearly $10B.
- Investments in operational systems are also at different risk than investments in fixed facilities. Fixed installations are stationary in the US while operational systems move into harm's way. After 10 years at war many vehicles and aircraft have been lost to combat; and many others prematurely reached the end of their useful life due to continuous operation in extremely harsh environments.
- To determine the payments to be made under the program the amount of energy saved must be calculated. We have years of experience measuring and verifying energy savings for buildings but need to develop methodologies and gain experience doing it for mobile systems. Further, such payment schemes must be able to account for premature loss of the platform from combat action, accident or prematurely finishing its economic life due to harsh use. Any calculation used to determine contractually guaranteed future savings for non-building defense equipment faces far greater variation and risk than the similar calculations for buildings.
- A process for assessing and accounting for complete cost of capital must be built into the program evaluation decision metrics. GAO has found that "a number of factors may cause third-party financing to be more expensive than timely, full, and up-front appropriations." In specific study cases, GAO found the

government's costs of acquiring assets increased 8 to 56 percent by using ESPC rather than timely, full, and up-front appropriations.[1]

- The scoring of ESPCs for facilities is at variance with generally accepted scoring guidelines utilized by OMB, CBO, and the Budget Committees to assess the implications of actions on discretionary spending, direct spending and receipts. The same could be required for non-building applications. Budget scoring typically attributes all the government's expenditures over the life of the project in the first year, even though the actual outlays by the government occur over many years. From a budgetary perspective, this can make ESPC look no better, or worse, than a project where the government makes all the investment itself up front. The scoring guidelines could be amended to recognize obligations and budget authority on an annual basis.
- Since operational systems are more highly integrated, proprietary, and require a higher degree of design work, the work must generally be done by the original equipment manufacturer (OEM). This essential "monopoly" by OEMs creates a different competitive environment compared to facility upgrades. There are exceptions for work done in military industrial depots.

Therefore, on balance, a general legislative extension for operational weapons systems is not recommended at this time.

B. Background

The National Energy Conservation Policy Act authorizes federal agencies to enter into ESPCs solely for the purpose of achieving energy and water savings, in which a contractor is to be paid based on the realized savings. (42 U.S.C. 8287 *et seq.*) "Energy savings" is defined so as to limit the applicability of ESPCs to federally owned buildings. (42 U.S.C. 8287c(2)). Historically ESPCs have allowed federal agencies to install and maintain energy efficiency improvements in federal buildings in the absence of capital appropriations. Section 518 of the Energy Independence and Security Act of 2007 (EISA 2007, Pub. L. No. 110-140) directed the Secretaries of Energy and Defense to conduct a joint study to examine the potential use of ESPCs to provide energy and cost savings in *non-building applications* including vehicle or other mobile assets. This study was prepared in coordination with the Department of Defense by the Department of Energy's Federal Energy Management Program, the lead agency that has designed and implemented Federal Government facility (building) ESPCs for the past 17 years, implementing over $8 billion in energy savings investments.

C. Study Objectives

This study explores potential energy and costs savings in non-building applications which could include military fleets and weapons platforms, other federal agency fleets and non-

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[1] GAO Report (GAO 05-55), "Capital Financing: Partnerships and Energy Savings Performance Contracts Raise Budgeting and Monitoring Concerns," (December 2004).

building assets such as electric generation and water transport facilities. It determines the potential dollar value of possible energy saving investments by reviewing recent studies on improving energy efficiency in non-building applications. The study also assesses the feasibility of extending the use of ESPCs to energy savings investments in non-building applications.

D. Potential Savings in Non-building Applications

The military has the largest potential for savings in non-building applications because of its fuel intensive activities in air, sea and land supply, support and combat missions. The DOD determined that it represents about 1.3 percent of total U.S. fuel use and that fuels for aircraft, ships, and vehicles account for 74 percent of total DOD use. Recent studies, papers and reports over the past decade, including by the Defense Science Board (DSB), have investigated ways to modernize and reduce energy use for a variety of weapons systems. This reflects a growing awareness within the DOD of the impact of accelerating energy costs on the Armed Services' warfighting capabilities. In many instances these studies concluded that increased energy efficiency in weapons platforms also increases mission capability.

Table 1 is an overview of findings in previous reports which include only applications that have defined quantifiable savings and capital costs. Limited implementation of these identified technologies has been undertaken. Applications listed are modernizations and retrofits that may have the potential to produce substantial savings; and represent possible ESPC candidates for use of savings to finance capital investment. They represent only a sample of what is possible. Overall, estimated savings generated from projects identified by these studies amount to approximately $1 billion per year from a total project investment of $9.9 billion.

Table 1: Overview of Potential for Non-Building Applications

Application	Agency / Dept.	Paid-by-Savings Investment Potential
Fuel Efficient Coatings for Ground Vehicles: Engines, transmissions and differentials.	Most DOD and civilian agencies	$9-10M
Fuel Efficient Propeller Coatings, Bulbous Bow hydrodynamics, Ship Hotel Load Efficiency, Ship High Efficiency Gas Turbines	Navy / Coast Guard	$595 – 895M
Re-engining TF33 Aircraft engines found on KC-135E, E3 AWACS, E-8 JSTARS, and B52H airframes; Aircraft Wingtip Modifications on KC-10 & KC-135 airframes	Air Force / NASA	$6.4 - 8.7B
Abrams M1A1 / M1A2 Auxiliary Power Unit.	Army	$300M
		$7.3 – 9.9B

Potential applications of ESPCs for non-building assets among civilian federal agencies are less common and substantial than among military weapon systems and mobility assets. This may be attributable to the use characteristics of weapon systems – unlike civilian vehicles, they are intended for readiness for potential conflict rather than routine and steady use, and therefore have extended useful lives during which major advances in efficiency and propulsion may occur. Also, the number of studies on energy efficiency in weapons system indicates awareness within DOD of the impact that accelerating energy costs has on warfighting capabilities. There are notable exceptions on the civilian side. Though no other studies have been found in the development of this report that estimated potential energy cost savings from civilian fleets, energy cost savings may be realized for civilian agencies with significant aircraft, ship and heavy vehicle fleets by implementing retrofits and technology applications similar to those identified for military fleets (see Table 1).

U.S Coast Guard (USCG) operates the largest U.S. military ship fleet outside the DOD. Larger Coast Guard Cutter ship classes would likely benefit from "hotel" load, propulsion system and hull retrofits that are applicable to U.S. Navy ships. Propeller/shaft coatings and hull modifications such as bulbous bows reduce fuel use and increase range. These retrofits have short payback periods and could be good ESPC candidates. "Hotel" loads (e.g.; HVAC, kitchens and electronics) alone on Coast Guard cutters can be substantial – so much so that the "cold iron" load when a vessel is docked, using power from shore rather than its on-board generators, it can be the largest single electrical load at a Coast Guard base. ESCOs implementing ESPCs at USCG facilities have proposed such retrofits, but it has not been legally possible to proceed because of the statutory limitation to buildings.

USCG and the National Aeronautics and Space Administration (NASA) operate the largest aircraft fleets outside the DOD. The fleets comprise over 20 classes of fixed wing aircraft ranging from small 4 seat prop aircraft to large airframes such as the DC-8, 727, C-17, and 747s. Further investigation is required to determine the number of planes to remain in service over the next 20 years for opportunities for potential retrofits such as engine replacement or wingtip modifications. Ships and aircraft operated by the National Oceanic and Atmospheric Administration may also benefit from authorization of application of ESPC to mobile assets.

Significant secondary savings may be associated with non-building energy efficiency applications from impacts on indirect energy use, personnel, materiel, and operations. Indirect energy use may arise from logistical support associated with the primary users particularly in the military context. For example, according to a 2001 DSB report, when the Army deploys into a theatre of operations, over 70 percent of the gross tonnage moved is fuel. Fifty-five percent of the fuel the Army takes to the battlefield does not go to front-line combat units: it is consumed by the logistics tail and its protection. The Army spent $2.8 billion in FY2012 to purchase 16.1 million barrels of fuel, but it also pays significant costs to store, maintain, and transport fuel. Similar examples may be found throughout the military services, including for refueling of ships underway, or in-flight refueling of aircraft.[2]

In addition to savings from reduced indirect energy use, there may also be cost savings from reduced personnel requirements, which can lower the total number of required personnel (e.g. from the estimated 60,000 total active duty and reserve Army personnel cited above) or permit shorter or less frequent personnel deployments. Materiel costs may also be reduced by measures that decrease maintenance requirements and increase materiel lifetime, delaying costly replacements. A prominent example is the frequently-studied potential replacement of TF33 jet engines on B-52s, JSTARS and other large aircraft. These engines must be removed from the aircraft and completely overhauled four to six times more often than equivalent modern commercial jet aircraft engines.

Finally, there may be operational implications that directly affect the ability to perform certain military or non-military missions. For example, increased range for any form of mobility can permit missions that are longer in duration or further in distance; not only may associated logistics support costs be reduced, but freedom to perform completely new missions may result.

The more efficient use of fuel should translate into emissions reductions, including those that contribute to pollution of the local environment, and those that contribute to global climate change. Environmental savings are more difficult to estimate. However, as more certainty is developed in assigning economic values to emissions, such savings could be considered as a component of energy savings.

E. Feasibility of ESPCs

The key element of ESPCs that differs from conventional government contracting is that ESPCs are paid for from future savings guaranteed by a contractor, and therefore incorporate a debt instrument that capitalizes the future savings stream. It is necessary to establish a baseline of current and projected future energy and operating costs from which future savings will be calculated, to establish the terms of the guarantee of those savings (i.e., who is responsible for foreseen and unforeseen variables which may affect those future savings), and to establish methods through which savings will be measured and verified (M&V plans) to confirm that the terms of the guarantee are being met.

These contract elements and the procedures through which they are implemented are well established and continually improving in the ESPC industry for buildings. Federal

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[2] 2001 Defense Science Board Report "*More Capable Warfighting Through Reduced Fuel Burden,*" Chapters III and IV. *FY12 Operational Energy Annual Report*, pp. 10-11, energy.defense.gov. According to the DSB report, in 2000, the Army spent $3.2 billion a year to maintain 20,000 active and 40,000 reserve personnel to move fuel.

practices for the buildings ESPC authority – embodied most extensively in the DOE program – are developed and "routinized," with guidelines based on federal procurement law and more than a decade of experience. ESPC for non-buildings opportunities would share the vast bulk of these practices, but there are salient areas of potential differences in non-building applications – some which could make ESPC potentially easier to implement, and others which might present challenges – that would need to be addressed.

Baseline and operational energy costs of combat systems (e.g., weapons and mobility platforms), which constrain where, when, and how ESPCs can be applied, may be difficult to establish. Besides the unpredictable effect of combat conditions that cause equipment and system failure or loss, many combat systems are used at highly variable rates, ranging from storage mode to full-time deployment. Programs to use private funds to upgrade these systems must accommodate the likelihood that systems may either be lost to combat or become unusable prematurely, sometimes significantly so, due to high tempo operations in harsh environments. Under these conditions the ESPC contract will create "must pay" bills that will not be matched by savings. Moreover, a major driver of energy costs lies not in the direct point of fuel consumption, but in the indirect costs of delivering the fuel to where it is needed, the logistics attendant to that supply chain, and the mission tactics associated with a given vehicle's range.[3] These factors all make it challenging to characterize "average" energy use profiles and to develop a realistic contracting strategy for quantifying and capitalizing energy savings – particular in the ESPC context of guaranteed savings.

As each individual building ESPC task order must result from careful negotiation of terms and responsibilities for the unique circumstances of each project, the exact details of each potential application of non-buildings ESPC would have to be worked out on the basis of the specific facts of that application. The review of potential challenges within this report suggests that, while the same care must be exercised as in every prudent government acquisition, there appear to be no insurmountable challenges to using ESPCs to capture the savings potential of non-buildings applications.

II. Introduction

A. Statement of Task

Section 518 of the Energy Independence and Security Act of 2007 (EISA 2007; Pub. L. No. 110-140), directed the Secretaries of Energy and Defense to "jointly conduct, and submit to Congress and the President, a report of, a study of the potential for the use of [ESPCs] to reduce energy consumption and provide energy and cost savings in non-building applications."[4] This study is in response to that direction.
As directed by section 518 of EISA, this study:

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[3] Paul Dimotakis, Nathan Lewis, Robert Grober, et al., "*Reducing DoD Fossil-Fuel Dependence,*" JASON for the Director of Defense, Research &Engineering, September 2006.

[4] Section 518(b) of EISA 2007.

1. estimates the potential energy and cost savings to the Federal Government, including secondary savings and benefits, from increased efficiency in non-building applications; and
2. assesses the feasibility of extending the use of ESPCs to non-building applications.

For the purposes of this study, "non-building application" is defined as:

1. any class of vehicles, devices, or equipment that is transportable under the power of the applicable vehicle, device, or equipment by land, sea, or air and that consumes energy from any fuel source for the purposes of
   a. that transportation; or
   b. maintaining a controlled environment within the vehicle, device, or equipment; and
   c. any federally owned equipment to generate electricity or transport water.

Also for the purpose of this study, "secondary savings" is defined as:

1. energy and cost savings that result from a reduction in the need for fuel delivery and logistical support;
2. personnel cost savings and environmental benefits; and
3. in the case of electric generation equipment, the benefit of increased efficiency in the production of electricity, including revenues received by the Federal Government from the sale of electricity so produced.

B. Background and Context

1. Overview of Non-Building Federal Energy Use

Although the federal government has had success in meeting past energy-use reduction goals, it is estimated that the federal government still has the potential to save over $1 billion each year on its buildings' energy use.[5] But there is an even greater opportunity to both reduce energy consumption and to replace obsolete equipment that remains entirely left on the table – and that is the energy savings opportunities in non-building applications: in "mobility" assets like transportation fleets and DOD weapons platforms, in aging hydro-electric power plants and water pumping stations, and other non-building assets. Federal energy use by transportation and fleets is far greater than the use in buildings, and in many cases, the savings opportunities are larger. Numerous recent studies summarized in this report have documented savings opportunities running into billions of dollars annually. The Department of Defense, the individual Armed Services and related institutions like the Defense Science Board have in recent years acknowledged and acted upon the importance of fuel costs and fuel efficiency to war-

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[5] Alliance to Save Energy; Fact Sheet; May 2005.

fighting capabilities, and analyses of fuel and cost-savings opportunities have been numerous for mobile weapons platforms. While a modest amount of non-buildings energy savings opportunities have been implemented through investments of appropriated funds it is, like in the buildings sector, only a fraction of what is attainable.

ESPCs in the federal building sector have been operational for more than a decade. Scores of contracts have provided more than $8 billion in efficiency investments, with over $1.3 billion more now in development, and they are the primary vehicle that has allowed progress in reducing federal energy use in buildings (see History of ESPC, Appendix A). With guarantees of energy savings, federal agencies use these contracts to pay for infrastructure upgrades without utilizing capital appropriations. Application of ESPCs to non-buildings could provide opportunities to reduce operational costs in that sector to be converted to capital investments – at no additional upfront capital cost to the taxpayer. The energy savings opportunities for non-building applications of ESPCs include upgrading aircraft, naval vessels, land-based weapons platforms (e.g., tanks), and other opportunities to modernize capital infrastructure that could be achieved simply by generating energy and cost savings, and without competing for appropriated dollars.

The U.S. federal government is the world's single largest consumer of energy, and has the largest potential to save energy and costs. In 2012, Federal agencies accounted for roughly 1.5 percent of the country's total energy use, at a cost to U.S. taxpayers of $25.3 billion. Of this total, 26.3 percent went to heat, cool, and power the approximately 500,000 federal buildings around the country. 73.7% of federal energy use was for non-building purposes. This includes fleet vehicles, military aircraft and ships, and a variety of mobile systems that must be deployed and fueled wherever they are needed, for defense, disaster relief and recovery, scientific research, and a host of other federal responsibilities.[6]

Nearly two-thirds of the federal potential to convert potential energy savings into capital for improvements, therefore, is thus untouched by present statutory authority. A January 2001 Defense Science Board Task Force Report[7] underscored the opportunities in mobile weapons platforms, and encouraged expansion of ESPC to capture these opportunities. Notable observations included:

- More than 70 percent of the tonnage required to position today's U.S. Army into battle is fuel.
- The Air Force spends approximately 85 percent of its fuel delivery budget to deliver, by airborne tankers, just 6 percent of its annual jet fuel usage.

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[6] Tables for Annual Report to Congress on Federal Government Energy Management and Conservation Programs Fiscal Year 2012; U. S. Department of Energy, Federal Energy Management Program; http://www1.eere.energy.gov/femp/docs/FY12AnnualRpt.xlsx (Table 3).

[7] "More Capable Warfighting Through Reduced Fuel Burden," The Defense Science Board Task Force on Improving Fuel Efficiency of Weapons Platforms, January 2001, Office of the Undersecretary of Defense for Acquisitions, Technology and Logistics; Washington DC 20301-3140.

- The Task Force further found that high pay-off, fuel efficient technologies are available now, and recommended that DOD specifically target fuel efficiency improvements.

III. Estimate of Potential Savings in Non-Building Applications

Studies completed since the 2001 DSB report, and summaries compiled by the Office of the Secretary of Defense, document opportunities in DOD alone to convert potential energy cost savings into productive improvements. Table 2 summarizes the findings. Metrics differ, and limited applications of selected technologies have been undertaken. However, the potential dollar volume identified in existing studies alone exceeds the $8 billion of the past seventeen years of buildings ESPCs.

Table 2: Summary of Known Potential for Non-Building ESPC Applications

Application	Agency / Dept.	Capital Costs	Benefits/Savings	Report Referenced	Estimated Aggregate Investment Potential
Fuel Efficient Coatings for Ground Vehicles: Engines, Transmissions and Differentials.	DOD, truck fleets in civilian agencies	$400/vehicle	▪ 3% improved performance ▪ 10% decrease in fuel use ▪ Reduced maintenance ▪ Saves 22M gal & $46M/yr ▪ ROI is 37%	Presentation, *"Energy Options"* Department of Defense, 2008	$9-10 M
Fuel Efficient Propeller Coatings	Navy / USCG	$200k/ship	▪ 5-6% fuel savings or $140M/yr less fuel costs. ▪ Reduced wear & tear ▪ Lower Maintenance ▪ < 1yr payback	Presentation, *"Energy Options"* Department of Defense, 2008	$15 M
Bulbous Bows on ships for improved hydrodynamics	Navy / USCG	$380k/ship. 79 ships fitted for $30 million in 2000	▪ Arleigh Burke Class Destroyer saves 3.9% in fuel or 2,400 bbl/yr. Partially implemented in Navy Fleet.	CRS Report for Congress, *"Navy Ship Propulsion Technologies"* 2006	$30 M
Navy Ship Hotel Load Efficiency	Navy / USCG	$3M - $7M/ship	▪ $1million/Ship-yr (Aegis Cruiser Class) ▪ 10 to 25% fuel savings ▪ Increased range	DSB Task Force, Rocky Mountain Institute.	$400 M
Ship Hotel Loads – Higher Efficiency Gas Turbines	Navy / USCG	- Variable -	▪ 25%-30% less fuel use ▪ $1.5 Million/Ship-yr ▪ Greater range ▪ 2-6 year payback on premium over original	CRS Report for Congress, *"Navy ship Propulsion Technologies"* 2006	$150 – 450M

Application	Agency / Dept.	Capital Costs	Benefits/Savings	Report Referenced	Estimated Aggregate Investment Potential
Re-engining TF33 Aircraft Engines on KC-135E, E3 AWACS, E-8 JSTARS, and B52H airframes	Air Force / NASA	B52 Fleet: $3.2B	▪ NPV: $264M Based on DESC fuel costs ▪ 46% increase in range ▪ Reduction in Tanker Aircraft needed. ▪ Increased loiter time.	NPS-FM-06-034, *"Using Public-Private Partnerships and Energy Savings Contracts to Fund DoD Mobile Assets"*, 2006	$6-8B
Aircraft Wingtip Modifications on KC-10 & KC-135 airframes	Air Force / NASA	Per Plane KC-135's: $500k - $1m KC-10's: $1.5 – 3.0M	Fuel costs savings per plane KC-135's: $80k-$130k KC-10's: $250k – $410k	"Assessment of Wingtip Modifications to Increase Fuel Efficiency of Air Force Aircraft" NAS, 2007	$350 – 700M
Abrams M1A1 / M1A2 Auxiliary Power Unit.	Army	$300M	▪ $78M per year, fully burden fuel savings, year 2000. ▪ 50% increase in battlefield range	DSB, "More Capable War-fighting Through Reduced Fuel Burden", 2001	$300M
		Totals	**Savings: $1.0 billion/year**		**$7.3 – 9.9B**

A. Military Applications – Summary of Recent Studies on Weapons Platforms

The military has the largest potential for savings in non-building applications due to its fuel intensive activities in aircraft, ships and land-based supply, support and combat missions. DOD energy use represents about 1.3% of total U.S. energy use. Of total DOD energy use, mobility fuels for aircrafts, ships and vehicles account for about 74%. Jet fuel (JP8), also used for tanks, other ground vehicles and electrical generators accounts for 45% of DOD's consumption. Marine diesel fuel (JP5) accounts for 11.8%.[8]

The rapid rise in fuel costs has helped to focus the Defense Department's efforts on fuel and energy efficiency to lower fuel demand and use in its operations. Every $10 increase in the price of a barrel of oil costs the military $1.2 billion a year.[9]

Over the years, numerous reports, papers, studies and research have examined the potential to retrofit and modernize mobile weapons platforms (air, sea and land-based) to

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[8] Ronald O'Rourke, Foreign Affairs, Defense, and Trade Division, Congressional Research Service, CRS Report for Congress, "*Navy Ship Propulsion Technologies: Options for Reducing Oil Use – Background for Congress,*" December 11, 2006. "Purchases by Category," *Defense Logistics Agency Energy, Fact Book Fiscal Year 2012*, p. 33, www.energy.dla.mil

[9] "Net Sales by Category," *Defense Logistics Agency EnergyFact Book Fiscal Year 2012*, p. 31. Available at www.energy.dla.mil.

increase fuel efficiency using known and available technology. Retrofits and modernization that produce substantial savings appear to be good potential candidates for using ESPCs to achieve energy efficient capital investments.

1. Aircraft

Some of the most substantial and best documented fuel cost savings opportunities in military applications are in aircraft: both weapons platforms and transport planes. The Air Force represents more than 50 percent of the federal government's total use of fuels, more than 60 percent of which is devoted to transport planes and bombers. A 2007 study commissioned by the Air Force from the National Academy of Sciences' National Research Council (NRC) analyzed potential engine replacements or retrofits for a variety of large non-fighter aircraft, and found numerous opportunities that would save more than a hundred million gallons a year, improve range and reliability, and reduce environmental impacts and maintenance costs.[10] When the total costs of acquiring and delivering fuel are accounted for, the study found that every major non-fighter aircraft operated by DOD could replace or significantly modify its engines with a payback of less than 20 years.

NRC presents an explanation of why efficiency advances in commercial jet engines present an opportunity for transference to military aircraft. Commercial aircraft are flown as much as practically possible, in order to repay and earn profit on their investment cost. Fuel is the greatest operating cost for commercial aircraft, and improvements in fuel efficiency are adopted when cost-effective. These aircraft experience more than eight times as many flight hours annually than a typical military aircraft, which needs to be flown enough to maintain training, but otherwise kept in readiness. Military airframes therefore have much longer useful lives. More fuel-efficient engines have been developed in, for example, the several decades since the TF33 engines on B-52s (and several other large aircraft) were first put in service.

The NRC study presents a "constrained cost-benefit analysis" of replacing or modifying engines for "each viable engine/airframe modification or re-engining candidate." Costs of the new engines themselves and testing, design and modifications for airframe, controls, weapons systems or other changes that might be required are included; benefits assessed were fuel cost and maintenance savings. The NRC acknowledged that additional benefits would accrue: faster arrival to and longer "loiter time" in the battle space, shorter runway requirements due to improved thrust, reductions in use of imported oil and air and noise pollution, but did not attempt to monetize them.[11]

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[10] "Improving the Efficiency of Engines for Large Non fighter Aircraft," Committee on Analysis of Air Force Engine Efficiency Improvement Options for Large Non-fighter Aircraft, National Research Council; 2007.

[11] "Improving the Efficiency of Engines for Large Non-fighter Aircraft," op. cit. The analysis was "constrained" because the committee decided to use Cost Estimating Relationships (CERs) rather than market cost data, when it was available. The committee also did not take into account the residual value of the engines.

The NRC study in 2007 used a base fuel price of $2.14 per gallon. Payback periods within which savings will recoup costs were calculated based on 3 percent, 6 percent and 9 percent fuel cost inflation. Those costs and escalation rates, and therefore the savings estimates, were completely eclipsed just one year later. In September, 2008, the airline industry association IATA reported that their average jet fuel cost was $3.08/gallon, and the rate of inflation as 33.5 percent from one year prior. Half a year later, the price was $4.09/gallon, nearly double what it was when the NRC completed its analysis. As of October 2011, the price moderated to $2.91/gallon.[12]

Figure 1: Sensitivity of Years to Recoup Investment to Total Burdened Fuel Cost[13]

Candidate Aircraft/ Engine Configuration	Years to Recoup Investment with Total Burdened Fuel Cost of $2.50/Gal[b]	$5/Gal[b]	$10/Gal[b]	$20/Gal[b]	$40/Gal[b]
Re-engining					
C-130H/AE 2100[c]	17.7	10.9	7.3	4.2	2.5
C-130H/PW150[c]	19.5	11.7	7.9	4.8	3.1
B-1/F119/5.0	>60	55.7	24.4	12.9	7.8
E-3/CFM56-2B-1	22.2	15.7	10.5	7.2	5.2
E-3/JT8D-219	36.3	26.2	17.5	11.3	7.5
E-3/CFM56-7B22	16.5	11.6	8.0	5.7	4.0
E-8/CFM56-2B-1[d]	–	–	–	–	–
E-8/JT8D-219[d]	–	–	–	–	–
E-8/CFM56-7B22[d]	–	–	–	–	–
KC-135D/E/CFM56-2B-1	45.1	28.6	17.6	11.0	7.4
KC-135D/E/JT8D-219	>60	48.9	27.8	16.3	10.0
KC-135D/E/CFM56-7B22	31.6	20.9	13.5	8.8	6.2
B-52/F117-PW-100 [4]	20.6	13.2	8.7	6.1	3.9
B-52/CF34-10A [8]	28.4	20.0	13.3	8.9	6.3
B-52/CFM56-5C2 [4]	16.1	11.2	7.8	5.6	3.6
C-5/CF6-80C2 (F103-GE-102)[e]	–	–	–	–	–
Engine modification					
KC-135 R/T/CFM56-2B-1 Mod	>60	>60	30.0	15.9	9.5
C-130H/T56-A427 Mod[c]	17.8	11.1	7.6	4.6	3.1
C-130H/T56-S3.5 Mod[c]	26.1	15.3	9.9	6.6	4.1
B-1/F101 Mod	8.0	6.9	5.4	4.3	4.1
KC-10/CF6-50 Mod	3.8	3.6	3.3	3.0	3.0

NOTE: The engine cost estimates presented are derived from correlations developed for historical military engines and may not reflect the current fair market prices of commercial engines considered in this study. Engine cost estimates vary widely, and the estimates presented may vary by as much as 100 percent from estimates developed by other independent sources such as the Avitas *BlueBook of Jet Engine Values 2007* or the *IBA Engine Value Book 2005*.

[a] Values corrected after release of the January 31, 2007, prepublication version of the report.

[b] Shading indicates a recouping of investment costs in less than 20 years and thus a positive cash flow at the 20-year point.

[c] The fuel savings noted for the C-130 with new or modified engines are based on the aircraft being flown at the optimal altitude and airspeed for the selected engines and propellers. The flexibility exists in most C-130 missions for the aircraft to be operated at the best range or fuel consumption conditions. The other aircraft and engines considered in the study are operated at their prescribed mission conditions.

[d] E-8 re-engining already in progress.

[e] C-5 re-engining already in progress

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market cost data, when it was available. The committee also did not take into account the residual value of the engines.

12. International Air Transport Association Jet fuel Price Monitor, October 6, 2008 and October 6, 2011 <http://www.iata.org/whatwedo/economics/fuel_monitor/index.htm>

13. "Improving the Efficiency of Engines for Large Nonfighter Aircraft", op. cit.

The NRC study also tabulates the payback periods that would be required to recoup investment if the burdened cost of fuel is accounted for: i.e., the actual delivered costs of fuel to the battle space where it is used, taking into account delivery logistics, aerial refueling, and security (see Figure 1). At a price of $2.50/gallon – lower than the present commercial cost of jet fuel alone – 7 of the 17 replacement/retrofit options analyzed pay for themselves in 20 years. At a burdened cost of fuel of $20/gallon, every single one of the re-engining and modification options analyzed has a payback within 20 years.[14]

In 2004, the DSB estimated the fully burdened cost of fuel at $17.50/gallon in 1999 dollars.[15] A 2006 Air Force analysis (before the fuel cost inflation of 2007-2008) stated that the cost of fuel for in-flight refueling was $24.23 per gallon, for a fully burdened cost of $26.37 per gallon.[16] The 2008 DSB report "More Fight – Less Fuel" cited delivered fuel costs in the range from a low of $4 per gallon for ships on the open ocean to $42 per gallon for in-flight refueling to several hundred dollars per gallon for combat forces and forward operating bases (FOBs).[17] The implication is that if all the costs of delivering fuel to Air Force aircraft are accounted for, replacement or retrofit of virtually every engine system used in the non-fighter fleet could be cost-justified. The savings implied by these estimates generally assume a significant change to the infrastructure or to other elements of the burdened cost, which may be difficult. For example, fewer in-flight refuelings and less frequent maintenance needs will reduce variable costs such as fuel use by tanker aircraft and parts and consumables used in maintenance, but the full costs savings would not be realized unless there were reductions in refueling aircraft fleets, maintenance facilities and/or personnel and related infrastructure. However, even if not all potential cost savings can be easily realized, the NRC study makes clear that there are a significant number of cost effective retrofits available, even if only the direct cost of fuel and maintenance are accounted for.

TF33 Engines and B-52s as an instructive example

One engine system alone, the TF33 aircraft engine, found on KC-135E, E3 AWACS, E-8 JSTARS, and B-52H airframes, has been proposed by several sources in numerous studies as a candidate for replacement to yield fuel savings and improve range. In a 2002 DSB study, re-engining B-52s was estimated to yield as much as $1 billion in savings, even when figuring the price of fuel at the then-current direct cost of $1.20 per gallon.[18] The cost in 2008 was higher and as noted above, the total potential savings is the actual delivered costs of fuel to the battle space where it is used – taking into account delivery logistics, aerial refueling, and security. Thus, that total is ten to fifteen times the purchase price of the fuel.

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14. Ibid.

15. "Acquiring Combat Capability through Innovative Uses of Public Private Partnerships;" Buchanan, Cabell & McCrary, Naval Post graduate School, 30 June 2006., citing Defense Science Board Task Force, B-52H Re-engining (Washington, DC, 2004)

16. "Improving the Efficiency of Engines for Large Non-fighter Aircraft," op. cit., p. 15

17. "More Fight – Less Fuel" Defense Science Board Task Force on DoD Energy Strategy (Washington, DC, February 2008)

18. "Final Report of the Defense Science Board (DSB) Task Force on B-52 Re-Engining," December 2002.

The B-52 is an instructive example of possibly using an ESPC as opposed to direct use of appropriated funds: the fundamental engine technology is several decades old, and there are over a decade of authoritative studies that document the savings available, yet business-as-usual continues despite the potential. One characteristic, noted in the 2002 DSB report and updated by NRC, serves to illustrate: the TF33 engine requires a complete removal from the aircraft and overhaul four to six times more often than do modern equivalent commercial aircraft engines, and re-engining would effectively eliminate this cost during the remaining life of the airframe. The cost of these overhauls, estimated at $257,000 in FY96, had escalated to $1.25 million per engine in FY06.[19] This constitutes yet another stream of costs that could be saved with re-engining. The NRC study, reviewing the evidence on all aircraft powered by the TF33, concludes that all applications of the engine should be removed from the inventory, noting this would allow an $800 million maintenance inventory to be disposed of and more than 188 personnel and 82,000 square feet of support real estate to be redeployed for other Air Force needs.[20]

Financing and Implementation

Despite several analyses of the potential benefits over the past two decades, non-fighter aircraft have not been re-engined for solely fuel savings.[21] NRC attributes this principally to the challenges of justifying large initial investments in an era of constrained budgets and competition from other funding priorities and to difficulties in exploiting long-payback savings opportunities within federal expenditure and procurement guidelines.[22] NRC concludes their analysis with ten policy options, four to be implemented "right away," four others to be "aggressively evaluated," and two sale-leaseback options they acknowledge are outside federal procurement and financing practices.

NRC recommended the implementation of a Fuel Savings Performance Contract Strategy." They recommend this strategy as a viable response to the two challenges noted above to funding through capital appropriations (which also is also noted as a possible option), and note that "for specific capital investments programs, such as energy and utilities investment projects, Congress has managed to provide specific authorities that overcome the challenges and allow for alternative approaches to financing capital investments."[23]

The NRC report acknowledges and describes the existing building ESPC authority in 42 USC 8287, and notes that equipment replacements/retrofits which are life-cycle cost effective are the very sort of capital investment for which ESPC has been so successfully

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19. "Improving the Efficiency of Engines for Large Nonfighter Aircraft," op. cit., p. 40
20. Ibid., p. 41.
21. Ibid., p. 106
22. Ibid.
23. Ibid, p. 111

applied in federal buildings. The NRC also states that the committee finds no restriction to applying the use of an ESPC to aircraft propulsion systems.[24]

Aircraft Wingtip Modifications

The Air Force's National Research Center commissioned an assessment by the National Academy of Sciences (NAS) to study the potential for wingtip modification to increase fuel efficiency on cargo, tanker and common airframes within the fleet. Based on fuel consumption the aircraft examined were the C-5, C-17, KC-10, KC-135, and C-130, all non-fighter aircraft with long mission time requirements. (Since the report was written, winglets have been installed on the C-17).

A winglet, a common wingtip modification, is a retrofit that up sweeps the wing to near vertical at the tip, and is a common sight on commercial aircraft. The winglet reduces aerodynamic drag and improves lift without significantly increasing overall wingspan. This results in a net aerodynamic performance improvement with benefits including reduced fuel burn, increased payload capability and improved take-off performance.[25]

Based on recent studies, commercial experience with winglet retrofits on Boeing 737s indicate a 2.4 percent total fuel savings for trips of 500 nautical miles (nmi) and 4 percent for trips of 2,000 nmi. Winglets were projected to save on an annual basis, 130,000 gallons of fuel per aircraft for 737s and up to 300,000 gallons of fuel per aircraft on the 757.[26] Net fuel savings is affected by length of trip since savings occur during flight and not on the tarmac. The ratio of tarmac to flight time is greater for shorter trips.

Greater fuel efficiency results in multiple benefits. The aircraft can carry the same payload a greater distance providing more operating range. The aircraft can also carry a larger payload for the same distance and fuel. For commercial aircraft these range and payload benefits become meaningful for ranges beyond 2000 nmi.[27] Increasing payload range capability is valued in military missions. Carrying more payload the same distance could reduce number of sorties to meet objectives.

Costs for a wingtip modification retrofit include non-recurring engineering for the specific airframe model, wingtip design, manufacturing and installation. As an example of the variance, in 2007 for commercial narrow-body aircrafts such as Boeing 737s, wingtip modifications cost from $500,000 to $1 million per aircraft. For wide-body airframes such as a Boeing 767, costs were between $1 million and $1.5 million.[28]

Based on net present value analysis, the 2007 NAS assessment prioritized five military aircraft on cumulative fleet benefit from wingtip modifications and determined that the

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24. "Improving the Efficiency of Engines for Large Nonfighter Aircraft," op. cit., p. 112
25. "Assessment of Wingtip Modifications to Increase Fuel Efficiency of Air Force Aircraft," National Academy of Sciences, 2007.
26. Ibid., p. 25, p. 43.
27. Ibid., p. 26.
28. Ibid., p. 27-28.

KC-10 and KC-135(R/T) based on the DC-10 and Boeing 707 airframes respectively have the highest overall benefit. The assessment was based on multiple factors, including the expectation that "Some of these aircraft are expected to be in service until approximately 2040."[29]

The results shown in Tables 3 and 4 suggest that modifying the KC-135R/T and KC-10 fleets could financially benefit the Air Force, assuming the fleet is not retired from the inventory. These tables delineate results based on the parameters of fuel price and cost of modification. With jet fuel prices hovering around $4.00/gal (July, 2008), payback from a wingtip modification for a KC-135 was estimated to range from 3.9 to 12.9 years and for a KC-10, from 3.6 to 12.1 years. In October 2011, jet fuel prices have moderated to slightly under $3.00/gal. This would stretch paybacks to a range from five to seventeen years – still well within the anticipated useful life of the aircraft.

Table 3: Payback Period for a KC-135R/T Using 649,000 gal/yr[30]

Estimated Cost of Modification (FY07 $M)	Fuel Usage Reduction from Modification (%)	Fuel Saved (K gal/yr)	Fuel Cost Saved (FY07 $K)	Payback Period (years)
Fuel at $4.00/gal				
0.5	5	32	130	3.9
0.5	3	19	78	6.4
1.0	5	32	130	7.7
1.0	3	19	78	12.9

Table 4: Payback Period for a KC-10 Using 2.057 million gal/yr[31]

Estimated Cost of Modification (FY07 $M)	Fuel Usage Reduction from Modification (%)	Fuel Saved (K gal/yr)	Fuel Cost Saved (FY07 $K)	Payback Period (years)
Fuel at $4.00/gal				

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[29] Ibid., p. 88

[30] Ibid., p. 65

[31] Ibid., p. 66

1.5	5	103	412	3.6
1.5	3	62	248	6.0
3.0	5	103	412	7.3
3.0	3	62	248	12.1

As with re-engining non-fighter aircraft, the National Academies/National Research Council recommends innovative financing strategies to specifically include creating a line item in the defense budget, implementing an *energy saving performance contract* strategy, and competing airframe maintenance contracts could be used to implement wingtip modifications.[32]

2. Ships

According to the Naval Research Advisory Committee (NRAC) in October 2005, Navy ships accounted for eight percent of DOD total fuel consumption, or about 24,000 barrels of oil per day (BPD).

Reducing energy use in fossil fueled ships can reduce fuel costs and increase range, thereby improving fleet stationing capability by decreasing refueling frequency and increasing a ship's range away from refueling points. If efficiency measures are applied to enough ships, the resulting fleet range may allow for a reduction in the fuel-related force structures, such as oilers and storage facilities, and their associated attendant costs.

Bulbous Bows

The bulbous bow is widely used on large commercial ships, where it can reduce fuel consumption by five percent at cruising speeds. The essential result of a bow bulb is the change in the shape and location of the ship's bow wave to reduce hydrodynamic drag. The Navy now features bulbous bows on aircraft carriers and on amphibious, auxiliary, and support ships. The Navy also has examined incorporating them into surface combatant ships (destroyers, cruisers and frigates). A Navy study by the David Taylor Model Basin (DTMB) estimated that the addition of a bulbous bow on an Arleigh Burke (DDG-51) class destroyer could reduce annual fuel use by 3.9 percent, or 2,400 barrels.[33] An earlier (1994) DTMB study estimated that 79 Navy cruisers and destroyers could be fitted with bow bulbs for less than $30 million and yield a life cycle fuel savings of $250 million. Similarly, DOD stated in 2000 that fitting bow bulbs onto 50 Arleigh Burke class destroyers could save $200 million in life cycle fuel costs.[34]

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32. Ibid., p. 10-11

33. Dominic S. Cusanelli, "Stern Flaps and Bow Bulbs for Existing Vessels, Reducing Shipboard Fuel Consumption and Emissions," December 2000.

34. Ronald O'Rourke, Foreign Affairs, Defense, and Trade Division, Congressional Research Service, CRS Report for Congress, *"Navy Ship Propulsion Technologies: Options for Reducing Oil Use – Background for Congress,"* December 11, 2006.

Hull and Propeller Coatings

The latest commercial marine hull coatings are based on silicone elastomer or fluoropolymer technologies that provide a smooth, low energy surface to which marine organisms cannot attach or adhere strongly. Propeller coating materials under consideration include metal borides and nanomaterial-based metal oxide. Benefits range from reduced cavitation and erosion to anti-fouling and fuel efficiency. According to DOD testimony in September 2006, applying special coatings to Navy ship propellers may reduce ship fuel use by four to five percent with possible maintenance savings resulting in a one year payback. Coatings can reduce a propeller's friction and reduce corrosion aiding in maintaining higher efficiency and reduced maintenance.[35] If applied to 200 ships, savings are estimated to be approximately $142 million per year with total implementation costs expected to be approximately $200,000 per ship or $40 million in total.[36]

Ship Hotel Loads

The DSB estimates that nearly one-third of the Navy's non-aviation fuel goes to "hotel loads," facilities such as pumps, fans, chillers, and lighting that make the ship habitable for its occupants. Hotel loads do not include shipboard operations such as propulsion, radars, weapons systems, and aircraft-launching catapults.

A study conducted for the Navy in 2001 by the Rocky Mountain Institute found that hotel energy loads could be substantially reduced on the Aegis cruiser *Princeton* (CG-59). The Navy has 27 ships in this class. Key findings of the study:

- The *Princeton* uses approximately $6 million worth of diesel fuel per year for gas turbines that are very similar to older commercial jet engines.
- $2-3 million of fuel is used to produce 2.5 megawatts required for shipboard electrical loads. The remainder is used for 80,000 horsepower of propulsion.
- Retrofitting electric motors, pumps, fans, chillers, lights, and potable water systems could save 20 – 50 percent of the ship's electricity, cutting its fuel use by 10 – 25 percent.
- Since electricity is made from fuel mainly delivered by ship (oilers), it costs over $0.27/kwh, which is more than six times the typical industrial tariff.
- Each ship board chiller could be improved to save its own capital cost ($120,000) every eight months.
- Re-configuring the fire pumps to operate automatically when needed instead of constantly circulating pressurized seawater with two 125 hp pumps can save over $200,000/year.

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[35] Joint Statement of Honorable John J. Young, Jr., Director, Defense Research and Engineering, and Mr. Philip W. Grone, Deputy Under Secretary of Defense (Installations and Environment), Op. cit.

[36] Al Shaffer, Director, Plans and Programs, Op. cit.

- The *Princeton*'s total electricity savings potential could reduce energy costs (in the form of fuel) by nearly $1 million a year. Reducing fuel use for power needs increases overall operating range without refueling.[37]

With over 300 ships, the Navy's potential to reduce hotel loads is significant. Increasing the efficiency of the ship's electricity use also directly benefits warfighting capability by being able to go farther without refueling. Since current DESC cost of fuel has increased by over three-fold since the time of this DSB study, savings and overall return-on-investment has increased dramatically for the Navy. Many of the improvements to shipboard hotel loads are similar to those made in buildings via traditional ESPCs.

Higher Efficiency Gas Turbines

Gas turbines with greater efficiencies than simple cycle gas turbines currently used in Navy surface ships could significantly reduce Navy ship fuel use. An example is the WR-21, an inter-cooled recuperated (ICR) gas turbine engine which was a joint development effort between the US, UK and French governments. This 25 MW engine offers a 27 percent fuel savings over currently used simple cycle gas turbine marine engines. Other benefits include lower manpower demands, increased mission capability, enhanced reliability, a reduced signature, decreased maintenance, and reduced life-cycle costs. It is projected that this engine in a new destroyer would save about $1.5 million per year in fuel and operating costs, which could pay back the premium on the original purchase (difference in price over the conventional engine) in two to six years.

Diesel Engine/Generator Improvements

The Navy's Development, Test and Evaluation program has within it goals to improve fuel efficiency primarily in legacy ships. Funding for efficiency improvements decreased by over 75% during the 1990s as the cost of fuel decreased. Ship based power plants consume over 37 million gallons per year or 18% of total fleet fuel use. The Navy fleet has 2428 diesel power plants of which 14% are medium speed engines and 86% are high speed engines. The following efficiency measures have been identified:

- Retrofit electronic fuel injection – fuel reduction up to 5% saving 71,000 gal/yr/ship and $250,000/yr/ship maintenance.
- Low load operations management – Fuel reduction up to 14% saving 125,000 gal/yr/ship and $305,000/year/ship maintenance.[38]

Navy Secretary Mabus's plans for a "Great Green Fleet," part of a sweeping energy efficiency and alternative energy utilization throughout the Navy, include many of these vessel efficiency improvements:

> At least 220 of today's Navy's 286 ships will still be in service in 2020 as part of the "Great Green Fleet." In order to meet alternative-energy standards, they will have to be

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[37] Amory B. Lovins, "All Energy Experts on Deck!" available online at https://old.rmi.org/sitepages/pid955.php

[38] "More Capable Warfighting Through Reduced Fuel Burden," Op. cit.

retrofitted with new power-generating equipment and hull alterations. Upgrades to hull design—reducing wave resistance, altering water flow, and cutting drag—can be costly, but they can increase fuel efficiency tremendously, saving millions of dollars. Three of these technologies have been retrofitted to various surface ships during dry-dock availabilities: bulbous bows, stern flaps, and propeller and hull coatings.[39]

3. Land Platforms/Vehicles

Retrofits for Legacy Systems in the Abrams M1 Tank

The Rand Corporation "Fuel Efficient Army After Next" studies (1998) identified achievable fuel efficiency improvements of 35 percent achievable by modifying vehicle subsystems for the Abrams M1A2/A1 tank. It also estimated that retrofitting completely new subsystems improve fuel efficiency by 60 to 80 percent.

Re-engining the 1960s vintage AGT 1500 turbine engine in the Abrams tank yields a host of benefits. A number of manufacturers produce engines that could replace the existing engines; these commercially available units produce:

- Four to five times improvement in mean time between failures (MTBF)
- 15 to 20% improvement in mobility
- 35% reduction in fuel consumption
- 42% fewer parts
- 40% reduction in cost of ownership over 30 years.[40]

The Army embarked on the LV100 engine development program for the Abrams and awarded the contract to GE and Honeywell. The final iteration LV100-5 was going to be the common engine with the Crusader self-propelled howitzer, but the program was shelved with the cancellation of the Crusader program.

APU for Abrams M1A2 Tank

The Under Armor Auxiliary Power Unit (UAAPU) is a small auxiliary turbine engine that is built into the M1A2 tank as a modification. It may be used to power the tank electrical, climate, and hydraulic systems without operating the main engine. Since many hours of tank operations are stationary including combat "silent watch" mode, operation and support savings accrue from the reduced main engine operating hours. Using the UAAPU in "silent watch" mode also increases survivability by reducing audible and heat signals.

The UAAPU uses fuel at four gallons per hour versus the main engine at 12 gallons per hour. Refitting 996 M1A2 tanks is projected to cost $322 million. The fleet consumes an average of 13.7 million gallons of fuel without APUs, and 4.6 million with the APUs.

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39. "The Great Green Fleet," Lieutenant Alaina M. Chambers, U.S. Navy, and Steve A. Yetiv, U. S. Naval War College Summer Review, 2011.

40. "More Capable Warfighting Through Reduced Fuel Burden," Op. cit.

Using an estimate of fully burdened peacetime fuel cost of \$13/gallon[41] (for M1A2s, at a DESC JP8 fuel price of \$3.04/gallon), the payback period would be about four years; using the Army's estimated delivered cost of \$40 to \$400 per gallon in long-distance deployments, the payback period would be measured in months.

Engine, Transmission and Differential Coatings

The Army operates and maintains the largest trucking fleets in the U.S. Specialized coatings on engine and transmissions and drive trains of the Army's truck fleet potentially can save significant costs from increased overall performance and reduced fuel consumption and maintenance.

It is anticipated that applying top candidate coatings such as metal borides or nano-materials based metal oxide to a truck's drive-train would cost approximately \$400 per vehicle. Estimates of fuel savings are as high as 10% with 3% better engine performance and 10% better transmission and differential performance. Assuming 37% of the light tactical vehicles (LTVs) and medium tactical vehicles (MTVs) received coatings, and JP8 fully burdened cost of fuel is \$5.62/gallon (for these vehicles), total savings would be \$500/vehicle, resulting in payback period of less than one year.[42]

4. Tactical / Mobile Power Generation

Mobile Power Generation is critical to battlefield operations. Costs to supply power to a war zone include the cost of fuel, maintenance, transportation, and support personnel. These costs are also incurred at remote and relatively insecure locations, which make battlefield power cost several times the \$0.40/kWh of diesel generator power produced in the US. The highest potential for savings is in energy efficiency and maintenance reduction. Increases in energy efficiency could save fuel and decrease transportation costs throughout the logistics chain. Reducing maintenance requirements could make more Soldiers available to perform other mission tasks.

Opportunities to improve efficiency to generate savings come from improved diesel engine technology, and alternative generation technologies including renewable technologies and high density energy storage.

Though no direct savings numbers have been estimated in previous studies, the need for quiet, highly efficient, and highly mobile power systems will most likely increase. Future "digital" soldiers will be using three to 10 times more power than today's soldiers. In some field operations, there may also be end-use efficiency measures that add to these savings potentials. An example may be initiatives to insulate tents used in field

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41. Ibid.

42. Al Shaffer, Director, Plans and Programs – Office of Director, Defense Research and Engineering and Joe Illar, Office of Program Analysis and Evaluation, "*DoD Cost of Energy and Options for the Future,*" presentation, October 9, 2007.

operations in Iraq and Afghanistan, which not only reduced power demands for air conditioning, but also improved occupant comfort and productivity.

B. Federal Civilian Agency Applications

Potential applications of ESPC for non-buildings uses among civilian federal agencies are less common and substantial than among the mobile weapons platforms. In part, this is attributable to use-cycle characteristics of weapons platforms. Unlike civilian vehicles, these platforms are intended for readiness in time of conflict rather than routine and steady use, and therefore may have extended useful lives within which considerable advances in the fuel efficiency of propulsion technologies may occur. In addition, the number of available studies of weapons systems efficiency potential reflects the growing awareness within DOD and the DSB of the impact of accelerating energy costs on the Armed Services' warfighting capabilities. There are notable exceptions within civilian agencies.

1. Non-Tactical Fleets/Trucks

Government Non-Tactical Fleet applications for fuel conversion and related cost savings from reduced fossil fuel sources do not indicate significant potential for use of ESPCs. The engine, transmission and differential coatings retrofits discussed for military tactical and transport vehicles are not expected to apply to civilian vehicle fleets not exposed to harsh driving environments. The focus of civilian fleet transition to alternative fuels does not necessarily generate enough cost savings to warrant use of an ESPC. It includes the acquisition of alternatively fueled vehicles, cost of alternative fuels (which may become more cost effective in the future if fossil fuel prices climb), and construction of alternative fuel infrastructure. In the future, the environmental benefits of non-tactical fleet transition to alternative fuels may be monetized, through a carbon reduction credit, sales of emission reduction credits or other fungible cash stream. If these policies or regulations occur, then it may be possible to use that cash stream as a source of repayment for ESPC financing of vehicle conversion to alternative fuels.

One non-renewable fuel opportunity for non-tactical fleet conversion with considerable cash savings has emerged just in the past few years. With the development of much cheaper shale gas supplies, reports of conversions of corporate and public-sector fleets have proliferated in the trade press, and New York, Pennsylvania and other states have offered technical assistance and cash subsidy programs. Both fuel cost reductions and maintenance savings from the cleaner-burning fuel, with paybacks less than ten years, are reported. Where state or utility financing is not available, ESPC may be viable for non-tactical fleets.

2. Ships

U.S. Coast Guard (USCG), Department of Homeland Security, has a fleet of ships that could benefit from propulsion system retrofits (e.g. propeller and shaft coatings) as discussed above for naval vessels.

Further investigation of the USCG fleet is required at this time to inventory classes of vessels that have not undergone Fleet Renovation and Modernization Programs, such as the 378 foot High Endurance Cutters, which were commissioned in 1967, and renovated between 1980 and 1992. This also highlights the need to identify vessel classes which lack funding for renovation that are still in high use today. Current USCG fleet comprises 240 Cutters (classified as 65-420 feet) and 1,875 Boats (less than 65 feet).

3. Aircraft

Two other agencies with aircraft are the USCG and NASA. It is assumed USCG and NASA aircraft could benefit from engine replacement and wing tip modifications as discussed above for military aircrafts.

USCG
Similar to exploration of USCG vessel inventory, further investigation is required to identify USCG aircraft needing engine replacement or other efficiency improvements. USCG currently has 211 aircraft serving various missions from Search & Rescue, Law Enforcement, Environmental Response, and Air Interdiction. A large segment of USCG fixed wing inventory is turbo-prop aircraft. Further investigation is necessary to identify older aircraft classes still planned for long term use that could benefit from propulsion system improvements.

NASA
Currently there are over 20 classes of fixed wing aircraft ranging small from four-seat prop aircraft, the workhorse P-3 four-engine turbo-props, T-38 Training aircraft, to the large scale B-377 Guppy and 747 jets.

These classes of aircraft require further investigation to determine the number of planes to remain in service over the next 20 years for opportunities for potential retrofits (e.g., engine replacements).

Prominent civilian applications of mobile power include remote area research such as conducted by the National Science Foundation; remote stations for surveying and other observational work as required, for example, by the Department of the Interior National Park Service; for remote communications stations, as operated by NOAA, FAA and other organizations; and general facility upgrades such as lighting or emergency phones where a simple stand-alone power system may be less expensive than connecting to the grid. No data quantifying the net potential for these applications were identified.

4. Water Transport/Irrigation

The federal government owns a vast array of water resources projects mostly associated with flood control, commercial navigation, aquatic ecosystem restoration, irrigation and associated purposes such as hydropower generation. Responsibility for owning and operating federal water resources projects lies primarily in the Bureau of Reclamation and the Army Corp of Engineers with project beneficiaries such as ratepayers also being key contributors towards the costs associated with developing, owning, and operating them. Federal dams and associated gravity fed systems deliver water to state, regional, or local water agencies are where a significant amount of energy intensive pumping, transport and treatment takes place. It is not clear whether or not federal water resource facilities present opportunities for ESPCs. Repeated contacts with both agencies in the conduct of this study did not yield evidence of specific potential projects, but further examination is warranted to explore potential benefits to use ESPCs for energy savings improvements to these facilities.

C. Secondary and Environmental Savings

1. Secondary Savings Opportunities

Significant secondary cost savings may be associated with the military and civilian mobility applications discussed in the preceding sections. These are due to impacts on indirect energy use, personnel, materiel, and operations.

Indirect energy use may arise from logistical support associated with the primary users addressed in the preceding sections, particularly in the military context. For example, when the Army deploys into a theatre of operations, over 70 percent of the gross tonnage moved is fuel. Of the top ten Army battlefield fuel users, only two, the M1A2 tank and the Apache Helicopter are combat platforms.[43] The rest are supply transport and one mobile kitchen system. Each battle tank is trailed by several large 5,000-gallon tankers. Fifty-five percent of the fuel the Army takes to the battlefield does not go to front-line combat units; it is consumed by the logistics tail and its protection. The Army used 300 million gallons in fuel a year (FY00) and paid $3.2 billion a year to maintain 20,000 active and 40,000 reserve personnel to move that fuel. Similar examples may be found throughout the military services, including for refueling of ships underway, or in-flight refueling of aircraft.

In addition to savings from reduced indirect energy use, there may also be cost savings from reduced personnel requirements, which can lower the total number of required personnel (e.g. from the estimated 60,000 total active duty and reserve Army personnel cited above) or permit shorter or less frequent personnel deployments.

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[43] "More Capable Warfighting Through Reduced Fuel Burden," Op. cit.

Materiel costs may also be reduced by measures that decrease maintenance requirements and increase materiel lifetime, delaying costly replacements. For example, the ship propeller coatings noted above, in addition to decreasing ship fuel use, can reduce propeller friction and reduce corrosion.

Finally, there may be operational implications that directly affect the ability to perform certain military or non-military missions. For example, increased range for any form of mobility can permit missions that are longer in duration or further in distance. This may result in associated logistics support costs being reduced, and freedom to perform completely new missions may result.

2. Environmental Savings Opportunities

In addition to primary and secondary cost savings opportunities, the more efficient use of fuel may translate to significant emissions reductions, including those contributing to pollution of the local environment, and those that contribute to global climate change. Environmental cost savings are more difficult to estimate. However, as more certainty is developed in assigning economic values to emissions, such savings could be considered as a component of energy savings.

There are examples of ESPC building applications that resulted in financial benefits for NOx reductions. Under an ESPC for a VA Hospital in San Diego, a new cogeneration plant was installed replacing an old cogeneration system that significantly reduced NOx emissions. Under a program to reduce NOx, Southern California Air Quality Management District provided nearly $4 million dollars for the NOx emission reduction (nearly 30 percent of the capital cost of the new cogeneration system).

IV. Feasibility of Extending the Use of Energy Savings Performance Contracts to Non-Building Applications

The key element of ESPCs that differs from conventional government contracting is that they are paid from contractually guaranteed future savings, and therefore incorporate a debt instrument that capitalizes the future savings stream. It is necessary to establish a baseline of current and projected future energy and operating costs from which future savings will be calculated, to establish the terms of the guarantee of those savings, and to establish methods through which savings will be measured and verified to confirm that the terms of the guarantee are being met.

These contract elements and the procedures through which they are implemented are very well established in the ESPC industry for buildings. Federal practices for the buildings ESPC authority of 42 USC 8287 – embodied most extensively in the DOE ESPC IDIQ program – are "routinized," with extensive guidelines based on federal procurement law and more than a decade of experience. ESPC for non-buildings opportunities would share the vast bulk of these practices, but there are salient areas of potential differences in non-building applications – some which could make ESPC actually easier to implement, and others which might present challenges – that should be addressed. Just as each individual building ESPC task order must result from careful negotiation of terms and responsibilities for the unique circumstances of each project, the exact details of each potential application of non-buildings ESPC have to be worked out and tested in advance based on the specific facts of that application. However, the following overview of potential challenges suggests that, while the same care must be exercised as is done with every prudent government acquisition, it appears there may not be insurmountable obstacles to using ESPC to capture the energy and cost savings potential of non-building applications.

A. Measurement & Verification (M&V)

1. Performance M&V

The most crucial element of accurate measurement and verification of savings in a performance contract is acquiring reliable data with which to establish performance baselines, and with which to measure savings after the installation of performance improvement measures. While the full range of potential non-buildings applications obviously represents tremendous variety, for many of the largest known and best studied non-buildings applications – the engine systems in military aircraft, vessels and ground-based weapons platforms, this particular aspect of M&V is quite possibly easier than is the case for the typical building ESPCs.

Ongoing measurement of energy use in buildings is often not highly sophisticated. While some modernized facilities have energy management control systems that manage and monitor energy consumption in important subcomponents of building systems, many do not. Most have one or two utility meters, the consumption data from which may or may not be monitored and retained by the building staff. Many large federal building complexes, such as military bases, have a small handful of meters for scores of buildings. These circumstances are changing in the federal sector due to recent statutory mandates for increased metering, but the fact remains that establishing building energy use baselines for performance contracts is a highly specialized procedure, often involving acquisition of raw data from servicing utilities, spot-metering of building subsystems through the project design phase, and projection of what data is available into a model of building energy use that is then agreed upon by ESCO and client as the baseline for pre-retrofit energy consumption.

By contrast, the energy-using components of weapons platform mobility systems use a great deal more energy, their rate of use and refueling needs are critical components of warfighting readiness, and their reliability is so critical (consequences of aircraft engine failure are more serious than a building's chiller), that the typical military weapons platform engine's performance is monitored, recorded and analyzed to a far greater extent than are building components.

It is beyond the scope of this study to confirm specific on-board engine diagnostics systems on every weapons platform that demonstrates potential for fuel and maintenance savings. However, whether designated platform diagnostics, vehicle management systems, Health and Usage Monitoring Systems (HUMS) or other management systems, modern weapons platforms increasingly have diagnostic and monitoring capabilities that exceeds that of most stationary buildings, and should more readily support M&V of an ESPC. A few examples include:

- The B-52 was selected for an Air Force side-by-side test of Fischer-Tropsch synthetic fuel with JP-8, because of its fuel management system which allowed isolation of fuel tanks and monitoring of consumption.[44]
- The F-22 Raptor engine systems have "advanced diagnostics that can immediately discover operational problems and identify them by part number."[45]
- The Abrams Battle Tank, under the new Total InteGrated Engine Revitalization (TIGER) program, will have on-board monitoring capability for engine performance and fault detection that can be remotely monitored.[46]
- Navy vessels have reported fuel consumption into the Navy Energy Usage Reporting Systems (NEURS) for several years, which is in turn linked to the Navy's Incentivized Energy Conservation (i-ENCON) program: a "best practices" effort.[47]

In every ESPC, a necessary first step to creating a performance baseline and M&V plan is to specifically identify performance data availability and ongoing monitoring capacities. Every indication is that these prerequisites will be comparatively easy to meet for mobile weapons platforms. The DSB, in recommending that DOD investigate ESPCs as a possible mechanism for re-engining, noted that the extensive commercial experience with engine modernization provides another benchmark for M&V. Commercial history of modern high bypass fan engines provides a sound basis for calculating fuel and maintenance costs and for devising an M&V plan.[48]

While instrumentation and recordkeeping may be superior for a typical weapons platform, this may be offset by the challenges presented by operating schedules and characteristics. Agencies and ESCOs will need to develop baselines thoughtfully and carefully for these applications. Baseline and operational energy costs of combat systems (e.g., weapons and mobility platforms), which constrain where, when, and how ESPCs can be applied, may be challenging to establish. Besides the unpredictable effect of combat conditions that cause equipment and system failure or loss, many combat systems are used at highly variable rates, ranging from storage mode to full-time deployment. Moreover, a major driver of energy costs lies not in the direct point of fuel consumption, but in the indirect costs of delivering the fuel to where it is needed, the logistics attendant

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44. AF press release, March 31, 2008
45. Avionics Magazine, F-22 Special Report, p. 4
46. Defense Industry Daily, June 4, 2008
47. Defense Industry Daily, July 15, 2008
48. Defense Science Board, 2002, op. cit., p.39

to that supply chain, and the mission tactics associated with a given vehicle's range.[49] Characterizing "average" energy use profiles for these applications will require careful construction of "most-likely" projections by military agency personnel, and careful negotiation of an agreement between the agency and ESCO. Likewise, the development of realistic contracting strategies for quantifying and capitalizing on energy savings will place a burden on using agencies that is greater than for buildings, where the fully burdened costs of energy used can be simply metered, and do not have to be re-reconstructed through multiple accounts and operational organizations.

2. Maintenance, Labor and Material M&V

Another major element of secondary cost savings are reductions in maintenance labor and material required as a result of energy efficiency retrofits. The agency and ESCO need to establish the current cost of personnel and material required prior to retrofits to establish this element of the secondary savings baseline for personnel, labor requirements (hours) before retrofit along with fully burdened salary information This information can be used to establish the labor savings baseline. Personnel cost savings can be calculated based on difference between before and after labor hours at burdened salary information. [An important caveat here is that it is an established precedent in the federal buildings ESPC practice that labor costs savings must be real – reflecting actual reductions in maintenance personnel or contracts – rather than reassignment of personnel or contractors to other duties.] Material cost savings can be estimated based on lifetime extensions for a particular piece of equipment, and also from reductions in frequency of maintenance operations.

Cost benefits of improvements to operational capabilities may be addressed using the established methods of operational research, which may involve modeling or simulation of example applications or by interviews with established experts. All of these baseline derivation techniques are well established in the buildings ESPC practice, and can be replicated for mobile platforms.

B. Guaranteed Savings

1. Risk/Responsibility

The most common risk taken by the federal government under an ESPC is the utilization rate of an asset.[50] The equivalent in a building ESPC is occupancy. The usage and occupancy hours of a given facility may change due to unforeseen circumstances, the most dramatic of which may be the use/occupancy of military assets with the vicissitudes of war. These routinely are and have been dealt with in building ESPC by establishing an

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49. Paul Dimotakis, Nathan Lewis, Robert Grober, et al.,"*Reducing DoD Fossil-Fuel Dependence,*" JASON for the Director of Defense, Research &Engineering, September 2006

50. Buchanan, op. cit., p.24

occupancy schedule based on historical data, an agency's long term site plans, and the agency's best judgment. Similarly, the usage of non-building assets can be reasonably projected, and provisions be made within the ESPC's Risk/Responsibility Matrix if circumstances change.

The most dramatic such change could result from a salient characteristic of mobile weapons platforms which are intended to be deployed in a battle space, where they may be destroyed by enemy action. The contingency was addressed in two Naval Postgraduate School analyses of using ESPCs for mobile assets.

In the 17-year experience, Federal ESPC contracts have a significantly better record of success than other Federal contracts. There are no "Terminations for Default" on record and the few "Terminations for Convenience" cases have been most frequently precipitated by Federal agencies using end-of-year excess funds to "buying out" well-performing ESPCs.

There have been a handful of "Termination for Convenience" cases where the underlying asset was lost, such as a General Services Administration building located near the World Trade Center that was destroyed on September 11, 2001. This demonstrates an example of how an ESPC may be used for upgrading combat aircraft that could be lost to enemy fire or accident.[51]

In this case the experience of the GSA building in New York's World Trade Center complex (that was upgraded under a traditional ESPC and destroyed on September 11, 2001) is relevant. The government could simply continue to make payments as if the assets were not destroyed, or it could pay a termination liability lump-sum payment to close the contract. In the case of this GSA building, the government continued making payments for about six months and then terminated the contract for convenience, paying a lump-sum amount to the contractor in accordance with a termination liability schedule in the original contract.[52] It is worth noting that this situation was the result of a historically unusual direct attack on the continental United States, whereas operational weapons systems are assumed to go in harm's way and likely run a higher risk of loss.

There have also been cases of termination for convenience where buildings have been closed due to Base Realignment and Closure (BRAC). Again, these are dealt with through the contract clauses that are standard in every ESPC. However, it is possible that the retirement of a fleet of systems that had used ESPCs for upgrades could occur more quickly than BRAC closures, potentially leading to higher financial losses for the government.

Additionally, a risk reduction strategy that is not readily feasible under typical buildings ESPCs could potentially be employed for war-fighting mobile assets. Potentially, an

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51. Ibid., p.27

52. Miguel & Summers, "*Using Public –Private Partnerships and Energy Savings to Fund DoD Mobile Assets,*" September 2006

ESPC for retrofits could be deployed for a portfolio of mobile assets, with an agreed – upon projection for anticipated survival rates built into the projection of guaranteed savings.

C. Applications Not Feasible Under Existing Legislation

All of the non-building applications (military vessels, aircraft, and tactical and civilian vehicle fleets) discussed in the study, cannot utilize the current ESPC statutory authority, as ESPC statute under energy savings at 42 U.S.C. § 8287c(2) is currently applicable only to existing Federal buildings and facilities.

Additionally, at 42 U.S.C. § 8287b, the source of funds to pay for ESPC services provided by an ESCO is limited to appropriations made available for facility utility expenses and energy related O&M expenses. Although the energy related O&M expenses may apply to mobility applications, it would not permit ESPC payments to be made from fuel cost savings for mobile applications.

Implementation Challenges:

Long term payback

Payments to an ESCO for the private capital invested, financing, and services provided during the performance period are predicated on an agency maintaining levels of energy funding that would occur absent the energy efficiency improvements. Therefore, the federal agency using the ESPC needs to maintain the current budgeted levels of funding in future fiscal years.

Funding Transfers

The value of fully burdened fuel cost comprises fuel purchase, delivery to transportation assets (fuel trucks or refueling aircraft), transportation, and delivery to aircraft or ground based equipment. If the burdened cost of fuel is used as the basis of ESPC payment, shorter paybacks can be expected. Whether the fully burdened fuel cost savings will materialize (e.g., will less need for fuel transport result in fewer transport vehicles and personnel) or can be applied to mobile ESPC payments may be an organizational and accounting challenge. It can be assumed that, within a given civilian agency or DOD service there may be multiple organizational units responsible for funding fuel purchase, delivery, transport, security or other elements of fully burdened delivered fuel cost.

To apply these multiple cost streams to ESPC payments, each organizational unit may need to transfer its share of energy or secondary cost savings to the contracting office that performs contract administration and approves ESCO payments, or some higher organizational level may need to assume responsibility for payment. A key action needed early in mobile ESPC project development would be identification of intra-agency stakeholders who fund elements of mobility asset costs and which benefit from resulting energy and secondary cost savings. It is possible that fiscal policy changes may be required to allow transfer of budgeted appropriations from one organizational unit to the unit administering the ESPC contract.

V. Findings

The findings of this study indicate that significant potential exists in non-building applications to save energy and costs. The Federal Government has more than 17 years of experience achieving energy savings by applying ESPCs to Federal buildings. Currently, the applications of ESPCs are limited by statute to federal buildings. This study indicates that ESPCs could potentially be a compatible and effective contracting and financing method for non-building applications.

If non-building ESPCs are pursued, amending and revising existing legislation (42 U.S.C. § 8287) to accommodate non-building applications would be required. However, on balance, given the increased complexity, uncertainties and risks associated with extending ESPCs to operational weapons systems, a general legislative extension of the authority to such is not recommended at this time.

To achieve maximum energy cost savings from non-building or mobility applications, Congress and the Administration would need to consider possible changes to fiscal regulations or policies to allow various agency organizational units to contribute savings from reductions in fuel supply, delivery and transport, particularly for military operations. Applying the burdened cost of fuel use in peacetime or wartime theaters could significantly reduce the ESPC payback and shorten contract term. Additionally, where secondary cost savings are achieved from reduced maintenance (labor and material savings), a decision to allow verified cost savings to be applied as payment is also needed.

APPENDIX A

Study Authorization Text

Energy Independence and Security Act of 2007

Section 518. Study of Energy and Cost Savings in Non-building Applications.

(a) Definitions- In this section:

(1) NONBUILDING APPLICATION- The term 'nonbuilding application' means--

(A) any class of vehicles, devices, or equipment that is transportable under the power of the applicable vehicle, device, or equipment by land, sea, or air and that consumes energy from any fuel source for the purpose of--

(i) that transportation; or

(ii) maintaining a controlled environment within the vehicle, device, or equipment; and

(B) any federally-owned equipment used to generate electricity or transport water.

(2) SECONDARY SAVINGS--

(A) IN GENERAL- The term `secondary savings' means additional energy or cost savings that are a direct consequence of the energy savings that result from the energy efficiency improvements that were financed and implemented pursuant to an energy savings performance contract.

(B) INCLUSIONS- The term `secondary savings' includes--

(i) energy and cost savings that result from a reduction in the need for fuel delivery and logistical support;

(ii) personnel cost savings and environmental benefits; and

(iii) in the case of electric generation equipment, the benefits of increased efficiency in the production of electricity, including revenues received by the Federal Government from the sale of electricity so produced.

(b) Study-

(1) IN GENERAL- As soon as practicable after the date of enactment of this Act, the Secretary and the Secretary of Defense shall jointly conduct, and submit to Congress and the President, a report of, a study of the potential for the use of energy savings performance contracts to reduce energy consumption and provide energy and cost savings in nonbuilding applications.

(2) REQUIREMENTS- The study under this subsection shall include--

(A) an estimate of the potential energy and cost savings to the Federal Government, including secondary savings and benefits, from increased efficiency in nonbuilding applications;

(B) an assessment of the feasibility of extending the use of energy savings performance contracts to nonbuilding applications, including an identification of any regulatory or statutory barriers to that use; and

(C) such recommendations as the Secretary and the Secretary of Defense determine to be appropriate.

APPENDIX B

History of ESPC in Federal Buildings

Energy Savings Performance Contracts (ESPCs) were originally authorized in 1986 amendments to the National Energy Conservation Policy Act (NECPA) of 1978 (42 USC8287). Congress created ESPCs as a tool for agencies to use in meeting conservation and efficiency goals for federal buildings. These goals were set forth in detail by various Executive Orders and directives that have cumulatively required federal agencies to reduce energy use by 2010 by as much as a third in comparison to 1985 usage levels, and were more recently enhanced by Congress in the Energy Infrastructure and Security Act of 2007 to require an additional reduction of 3% per year over a baseline of 2003 usage. Use of ESPCs accelerated with the promulgation of program regulations by DOE in 1995, the streamlining in 1998 of ESPC contracting into blanket Indefinite Delivery Indefinite Quantity (IDIQ) contracts, with pre-selected Energy Service Companies (ESCOs) and the issuance of OMB policy to support their use.

ESPCs have been and increasingly will be a vital tool in efforts to reduce federal energy and water use, and its use in buildings is accelerating rapidly. In the first five years after being fully operational (1999-2003), ESPCs accounted for fully half of federal spending to meet federal energy and water use reduction goals. Appropriated funds accounted for only 22% (the remainder is attributable to conservation spending by utilities).[53]

ESPCs are guaranteed performance-based fixed price contracts that allow federal agencies to upgrade obsolete capital assets and install and maintain energy efficiency improvements in federal buildings in the absence of capital appropriations. Private-sector ESCOs provide design services, construction management and financing for these energy conservation measures (ECMs), in return for payments to be made from a portion of the guaranteed future energy and water savings (for a contract term of up to 25 years). (Examples of ECMs include: new energy efficient lighting, building controls, operations and maintenance savings, boilers, chillers and renewable energy measures.) The federal agencies incur costs for procurement and project management that are similar to a conventional bid-to-spec project, but do not incur the capital costs of the ESPC (unless they find it advantageous to leverage appropriated funds they would otherwise have expended on a smaller portion of the scope of work).

By requirement of the authorizing statutes, the government never pays more than it would have paid for utilities if it had not entered into the ESPC for the term of the contract. In addition to generating energy, water, and dollar savings, years of deferred energy related maintenance at federal facilities have been effectively addressed by the ESPC program.

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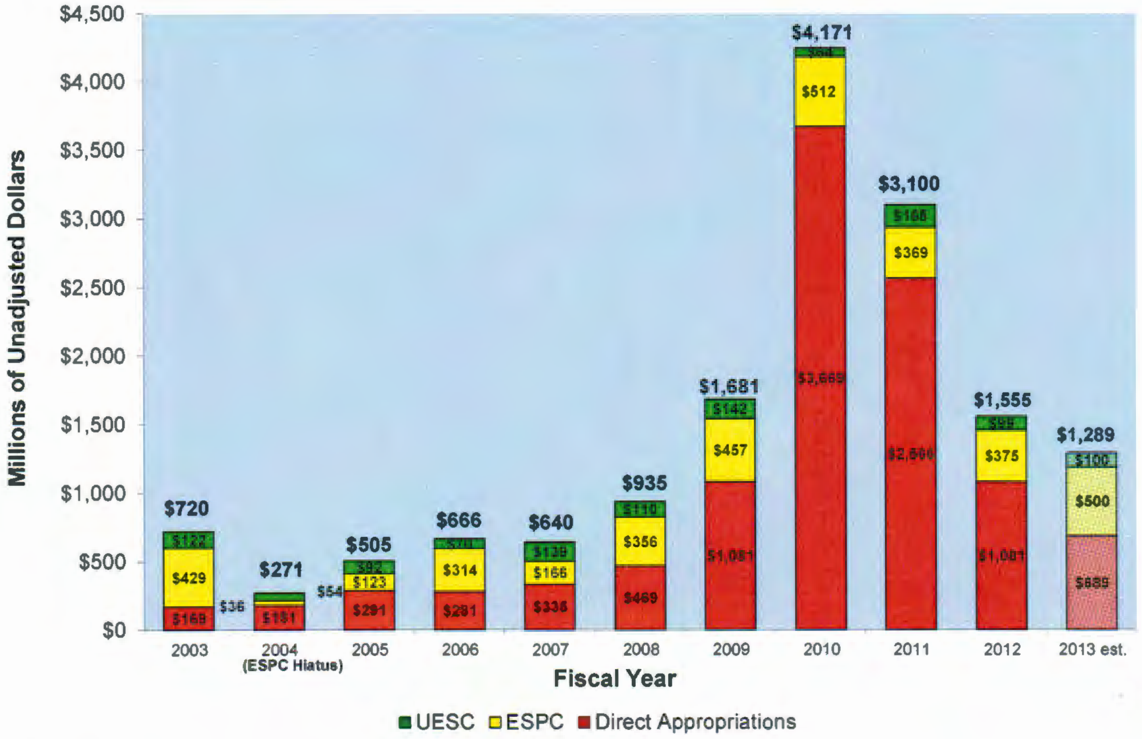
53. Federal Spending by Funding Source to Meet Conservation Goals, 1999-2003
From: Federal Energy Management Advisory Committee (FEMAC); Energy Savings Performance Contracts (ESPC)-Report on ESPC authority; Sep 08, 2004

Despite a slow start, and despite a hiatus when the statutory authority lapsed due to a sunset provision, ESPCs have made an enormous contribution to the federal government's energy-cost reduction goals.

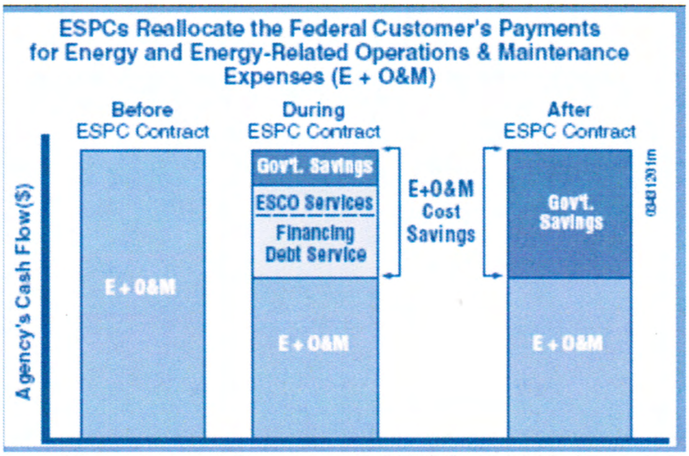
Figure B1: Federal Spending for Conservation Goals 2003-2013



ESPC projects have been implemented by 20 different federal agencies and departments in 47 states, and for U.S. facilities overseas. More than 600 federal ESPC projects, altogether worth $8 billion in private-sector funds, have been awarded through FY 2013, with more than a billion dollars in additional projects now in development. These projects are guaranteed by their ESCOs to pay for themselves, with more than $8 billion in energy and operational cost savings.

But as important as energy efficiency is in this era of global warming, the significance of ESPCs are greater than the reductions in energy use. It truly represents the conversion of otherwise inefficiently spent operating dollars into a revenue stream that would not exist without ESPCs – energy and water costs would simply go on being paid. This revenue stream permits agencies to upgrade obsolete capital assets, reduce their backlog of deferred maintenance, solve occupant comfort problems and improve working conditions and productivity in their facilities – all without spending more than they would spend if they allowed their buildings to remain inefficient and unimproved. After the ESPC payback period, the government continues to reap all of the savings, freeing up even more taxpayer dollars to be used for other priorities. Figure B2 below graphically illustrates the Agency's cash flows before, during, and after ESPCs.

Figure B2: Agency's Cash Flows Before, During and After ESPCs



From Fed Energy Management Program; DOE/GO-102003-1744 July 2003