

Fiscal Year 2019

Operational Energy Annual Report



Office of the Under Secretary of Defense for Acquisition and Sustainment

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Introduction

The Department of Defense (DoD) Operational Energy Annual Report satisfies the requirements in section 2925(b) of title 10, United States Code, for fiscal year (FY) 2019. The report includes information on operational energy demands, progress in implementing the Operational Energy Strategy, investments in alternative fuels, and support to contingency operations.¹ By statute, operational energy is defined as “energy required for training, moving, and sustaining military forces and weapons platforms for military operations,” and includes energy used by ships, aircraft, combat vehicles, and tactical power generators.²

In FY 2019, the Department consumed nearly 84 million barrels of fuel to power ships, aircraft, combat vehicles, and contingency bases (see Appendix A). This level of energy use has been relatively steady since FY 2013, and reflects stable operations tempo. To best support our forces and reduce the risks of moving fuel, the Department continues to purchase fuel close to point of use. As such, the Department purchased 48 percent of its fuel outside the U.S. in FY 2019.

As part of the establishment of the Under Secretary of Defense for Acquisition and Sustainment (USD(A&S)) and the supporting Assistant Secretary of Defense for Sustainment (ASD(S)), the Deputy Assistant Secretary of Defense for Energy (DASD(Energy)) is now responsible for the Department’s entire energy portfolio and oversaw operational energy activities throughout FY 2019. In support of the *National Defense Strategy*, operational energy initiatives assure the delivery of energy where and when needed and increase the ability to sustain mission effectiveness in contested operating environments. In addition, the Department reviewed the status of the *Operational Energy Strategy* and confirmed that the Department is considering energy as a fundamental enabler of military capability and is aligned with leadership priorities.

Given the *National Defense Strategy*’s focus on lethality, partnerships and reform, operational energy challenges in contested environments will continue to drive the Department’s investments. As described in this report, the Department’s initiatives and programs will increase the resilience and support enhanced range, reach, time-on-station, and performance of the Joint force.

“The Department of Defense must adapt current and future operations to address a variety of threats and increase the resilience of our installations... Energy is an essential enabler of military capability and the Department depends on energy resilient forces and facilities to achieve its mission.”

– ASD(S) Robert H. McMahon before the Senate Committee on Appropriations, April 9, 2019

¹ See the *Operational Energy Strategy* at http://www.acq.osd.mil/eie/Downloads/OE/2016%20OE%20Strategy_WEBd.pdf.

² 10 U.S. Code § 2925.

Implementing the Operational Energy Strategy

Supporting the Secretary of Defense’s focus on readiness and lethality, the *Operational Energy Strategy*’s purpose is to ensure the consistent delivery of energy to the Warfighter. The strategy contributes to that purpose with defined and measurable targets for completion across the Department. Depicted in **Table 1**, the Department completed 14 of the 15 targets identified in the strategy, and partially completed the remaining target on measuring operational energy consumption by type of equipment.

Table 1: Operational Energy Strategy Targets

Objectives	Targets	Status
Increase Future Capability	<ul style="list-style-type: none"> By end of FY 2016, ensure all acquisition programs that use operational energy and are designated as Joint Requirements Oversight Council (JROC) Interest Items by the Joint Staff have an energy supportability analysis (ESA)-informed energy Key Performance Parameter (eKPP). 	Complete
	<ul style="list-style-type: none"> By the end of FY 2018, ensure ESAs are used in all acquisition programs that use operational energy and were established in FY 2016 and later. 	Complete
	<ul style="list-style-type: none"> By end of FY 2018, increase energy supportability, as measured against current capabilities, in 100 percent of all new acquisition programs. 	Complete
Identify and Reduce Risks	<ul style="list-style-type: none"> By end of FY 2017, review operational energy (OE) risks in campaign and contingency plans as part of established DoD review cycles. 	Complete
	<ul style="list-style-type: none"> By the end of FY 2018, mitigate or accept 100 percent of identified OE risks. 	Complete
	<ul style="list-style-type: none"> By end of FY 2016, identify concept of operations (CONOPS) with OE implications. 	Complete
	<ul style="list-style-type: none"> By end of FY 2017, assess energy supportability and OE vulnerabilities of all identified CONOPS. 	Complete
	<ul style="list-style-type: none"> By end of FY 2017, include OE constraints and limitations analyses in all Title 10 wargames. 	Complete
	<ul style="list-style-type: none"> By end of FY 2016, review Department’s capability to test and certify drop-in alternative fuels in pace with emerging technologies. 	Complete
	<ul style="list-style-type: none"> By end of FY 2016, assess opportunities and risks related to expanded use of commercial petroleum products and infrastructure. 	Complete
	<ul style="list-style-type: none"> By end of FY 2017, identify opportunities for harvesting energy from the surrounding environment in Combatant Command (CCMD) operations. 	Complete
Enhance Current Mission Effectiveness	<ul style="list-style-type: none"> By end of FY 2016, establish a recurring assessment of opportunities to increase the energy supportability of current equipment with extensive remaining service lives. 	Complete
	<ul style="list-style-type: none"> By end of FY 2016, assess improvements needed in energy information systems to increase supply chain visibility. 	Complete
	<ul style="list-style-type: none"> By end of FY 2018, measure OE consumption by type of equipment. 	In progress
	<ul style="list-style-type: none"> By end of FY 2018, include OE principles in required Professional Military Education (PME) courses on strategy, logistics, and campaigning, as well as in general military training within the DoD. 	Complete

Regarding the single incomplete target, the Department identified a need for measuring operational energy use by Joint forces to support adaptations and innovations to overcome challenges associated with operating in contested environments, the supportability of emerging concepts, and mitigating the consequences of disruptions in the delivery of fuel. The Department made progress in collecting fuel consumption data, but significant gaps remain in the ability to track ground component equipment in the Army and Marine Corps. To close some of these gaps, the *Capabilities Requirement Document for the Army Fuel Automated Management System* (AFAMS) was completed and signed by the Quartermaster General in FY 2019 and is undergoing review and validation within the Army. The Department will continue to address the measurement of operational energy in FY 2020.

Building on these accomplishments, the Department will integrate operational energy and installation energy activities into a single Department energy strategy that incorporates performance targets similar to the milestones in **Table 1**. This DoD-wide strategy will meet all statutory requirements for a Department-wide transformational strategy for operational energy, as outlined in 10 U.S. Code § 2926(d), and is expected to be complete in FY 2020.

Office of the Secretary of Defense

Within the Office of the Secretary of Defense, the OASD(S), Office of the Under Secretary for Research & Engineering (OUSD(R&E)), and Defense Logistics Agency (DLA) Energy led operational energy activities in FY 2019.

Assistant Secretary of Defense for Sustainment (ASD(S))

In accordance with title 10 U.S.C. 2926(e), ASD(S) reviewed the adequacy of the President's Budget for carrying out the *Operational Energy Strategy*. The Department certified the FY 2020 President's Budget as adequate for implementing the strategy, and initiated the FY 2021 President's Budget review by issuing Program Objective Memorandum (POM) guidance to the Military Departments, reviewing briefings at the Assistant Secretary and Deputy Assistant Secretary level on Department investments in operational energy specific briefings, and developing the draft FY 2021 President's Budget certification report. The Department will use these POM evaluations as well as the final budget materials to evaluate the final President's Budget in the spring of 2020.

The Department continued to review existing policy and doctrine to ensure alignment with emerging lines of effort. This included administrative updates to Department of Defense Directive (DoDD) 4180.01, *Department Energy Policy*, and Department of Defense Instruction (DoDI) 4140.25, *DoD Management Policy for Energy Commodities and Related Services*. OASD(S) also initiated substantive updates to both of these issuances, and will update them with a focus on energy resilience and cybersecurity.

OASD(S) completed two significant analytical efforts to inform program decisions regarding fuel storage and distribution capabilities. First, the Sea-based Petroleum Distribution System (SPDS) study was launched in 2018 after Joint Staff J-4 and Office of the Assistant

Deputy Secretary of Defense for Energy (ODASD(Energy)) staffs determined there was a shortfall in their capability. With ODASD(Energy) providing the analytic underpinnings, the study employed robust quantitative analysis of petroleum requirements and over the shore distribution alternatives to determine that a system-of-systems approach is the optimal approach. In 2019, ODASD(Energy) and Joint Staff J4 staff briefed the results of this study to the Joint Logistics Board, co-chaired by the Joint Staff J-4 Director and the ASD for Sustainment. The Navy was tasked to continue its Research and Development (R&D) efforts, Joint Staff J-4 and ODASD(Energy) were tasked to consider the broader challenges of fuel distribution across operational plans.

Wargaming continues to play a key role in identifying potential energy shortfalls and testing solutions. For example, following the completion of the Global Engagement 2018 Capstone Event, Air Force Operational Energy turned its attention to incorporating the energy needed to run installations and contingency locations into wargaming and developing capabilities to integrate logistics-related modeling and simulation tools into gameplay. In addition, vulnerabilities identified will prove valuable in making informed capability development and procurement decisions. Most importantly, the Air Force continues to build and leverage partnerships throughout the defense logistics community. The Army multi-domain wargame also indicated the need for more sophisticated modeling tools to depict the effects of energy on operations in real-time over longer distances, at a faster pace, and in more domains.

Sponsored by OASD(S) and executed by the United States Indo-Pacific Command (USINDOPACOM), the first Joint Force Energy Wargame (JFEW) took place in August 2019 and brought together the Navy, Air Force, USINDOPACOM and its Components, and OSD to examine energy at the “seams” between Services, Combatant Commands, and Agencies. Several shortfalls were identified for further examination. Using the JFEW as the driving function, the Navy and Air Force teamed with the OSD Office of Cost Assessment and Program Evaluation (CAPE) and USINDOPACOM to create a joint Synthetic Theater Operations Research Model (STORM) database that was then exported for JFEW use in the automated SWIFT (Standard Wargame Integration and Facilitation Tool) and exported back to STORM for post-game quantitative analyses.

The Department also initiated the development of a Department energy strategy that incorporates installation energy and operational energy challenges and solutions pathways into a single strategy to meet long-term Department goals. The Department energy strategy will set the overall direction for the Office of the Secretary of Defense (OSD), Combatant Commands (CCMDs), Defense Agencies, and Military Departments and Services and include cascading objectives, targets, and offices of primary responsibility accountable for implementing the strategy.

In FY 2020, ODASD(Energy) will continue to integrate the installation energy and operational energy programs into a single program. This effort will include a focus on energy resilience, the completion of a Department energy strategy that meets the requirements of an operational energy strategy found in 10 U.S. Code § 2926(d), and updating policy to adapt planning and decision-making for fuel storage and distribution.

Office of the Under Secretary of Defense for Research and Engineering

Overseen by the OUSD(R&E), the Operational Energy Capability Improvement Fund (OECIF) supports operational energy advanced technology and demonstration projects that increase Joint Warfighter capability, reduce risk to coalition warfare, and reform business processes. In FY 2019, OECIF invested \$41.5 million in projects that address these challenges, including \$10.7 million on twelve energy storage, safety, and standardization projects that support OUSD(R&E)'s autonomy modernization priority. Ongoing initiatives for FY 2019 include power and energy enhancements in unmanned systems, power and thermal management for high pulse power weapons, wirelessly transmitting power and analytical studies across the power and energy domain. Studies completed in FY 2019 also provided insight on operational energy gaps and are used as the analytical underpinning for energy strategies across the DoD. Additional details on the OECIF program can be found in Appendix C.

Defense Logistics Agency-Energy

The Defense Logistics Agency (DLA) is the Nation's combat logistics support agency. DLA's mission is to provide the best-value integrated logistics solutions to America's Armed Forces and interagency customers in peace, during national disasters and emergencies and in war, around the clock and around the world. As the Executive Agent for Bulk Petroleum, DLA Energy has the responsibility to perform end-to-end analysis of risk and performance and engages in planning to focus DoD resources on mitigating risks, enhancing mission effectiveness, and avoiding unnecessary redundancies in managing the DoD bulk petroleum supply chain. DLA's contributions to the Department's operational energy objectives focus on reducing operational risks and enhancing the mission effectiveness of commercial-grade petroleum fuels and alternative non-petroleum fuels, as well as the DoD battery supply chain.

The following initiatives highlight DLA Energy's operational energy accomplishments during FY 2019:

- In January 2019, DLA Energy hosted the annual Joint Petroleum Seminar (JPS), which was attended by over 100 participants from across the DoD petroleum community. The JPS provides overviews of important policies, addresses strategic and operational issues, explains and demonstrates supporting systems and applications and details Military Service petroleum and energy programs. Mid- and senior-level DoD petroleum community members received several days of high-level briefings and discussions with the intent of expanding their professional petroleum knowledge.
- DLA began the implementation of a comprehensive additive injection policy to establish expeditionary additization capability and provide a resilient supply chain. DLA Energy collaborated with USINDOPACOM, Pacific Air Forces, and Air Force Petroleum Office (AFPET) to build 40 palletized additization kits. Prepositioned at three DLA Distribution Centers in the Pacific theater, each kit contains the required military additives to convert 280,000 gallons of commercial jet fuel to military specification jet fuel. Additionally,

DLA is pursuing medium and small fuel additive kits to support smaller requirements in remote locations, providing the Services greater agility and flexibility.

- The Energy Readiness R&D program funded a project to establish a microbial monitoring program to reduce operational costs associated with bio-deterioration and bio-corrosion of fuels in bulk storage tanks. The outcome of the one-year project validated new field test methods that will provide a broad-spectrum field test for microbial populations and type within fuel supplies. Combining proper sampling and test results with a physical evaluation of fuel system conditions will provide a basis for advance warning of microbial growth as well as evaluating tank cleaning effectiveness through test results.
- The Battery Network manufacturing technology R&D program initiated and conducted multiple efforts for improving the supply and reducing the costs of batteries used in fielded weapons or soldier systems. Low cost, high quality, domestically produced, lithium-ion replacement cells with higher energy density were prototyped for the Army's conformal wearable battery; light-weight, extended performance, bi-polar lead-acid batteries were prototyped to replace flooded lead-acid configurations still used in DoD ground systems; a new, lower cost, high-quality producer of carbon monofluoride was established to significantly reduce the materials cost of superior non-rechargeable batteries (BA-5790); a new award was made to research ultra-violet curing technology for lower cost, rapid electrode manufacturing at a major DoD battery supplier; and projects were identified to scale-up and transition solid-state electrolyte advantages for soldier system batteries (FY 2019 Congressional Add).

Air Force

The Air Force remains the DoD's largest consumer of operational energy. In FY 2019, the Air Force spent \$5 billion on approximately 2 billion gallons of aviation fuel to support 800,000 sorties worldwide. Although the Air Force did not identify a dedicated operational energy budget for FY19, exploiting technology and expanding the art of the possible enables the Air Force to optimize operational energy usage to enhance combat capability and readiness. The Air Force is working to collect and analyze data from across the enterprise to make informed decisions for technology and process improvements.

As our national defense posture evolves, the Air Force operational energy program provides senior leadership and Warfighters with greater capability to execute the *National Defense Strategy*. With the shift to the near-peer competition, as well as our on-going efforts to counter non-state actors, the tyranny of distance and the need for persistent surveillance can significantly affect the requirements for operational energy.

Through FY 2019 and prior-year congressional add funding, the Air Force is pursuing multiple operational energy lines of effort to increase capability and reduce risks. With a focus on increased lethality, Air Force Operational Energy is supporting initiatives to develop unmanned aerial systems (UAS) capable of greater range and reduced logistical requirements,

advance hybrid-propulsion systems, and explore liquid natural gas propulsion. Deputy Assistant Secretary of the Air Force Operational Energy (SAF/IEN) has funded operational planning tools that optimize resource alignment further reduce operating footprint, increase agility, and provide resilience. The Air Force support for energy optimization efforts to reform cost, supportability, and efficiency—both materiel and process-oriented—result in increased aircraft lifespan, lower aircraft maintenance costs, and more training opportunities. Lastly, in building partnerships and strengthening alliances, the Air Force is working with multinational partners to improve the aerodynamics of mobility aircraft.

The following initiatives highlight the Air Force’s operational energy accomplishments during FY 2019:

- Air Force Operational Energy continues to advance and expand technologies to support automated planning tools for the Combined Air Operations Center (CAOC) tanker planners such as the “Jigsaw” tool. By increasing the effectiveness of each sortie using Jigsaw, the Air Force can meet mission requirements with 180,000 fewer gallons per week and nine fewer aircrews. The next iteration of the system Pythagoras interfaces with existing air operation center systems to optimize the matching of tankers to users in an automated fashion. These improvements will reduce scheduling time from hours to minutes, and reduce the number of tanker aircraft aircrew, maintenance crews, and support infrastructure required in a theater.
- Investments in planning software are proving valuable at Air Mobility Command where Magellan, a tool developed by Air Force coders in collaboration with Kessel Run Enterprise Labs, now supports global mobility allocation decisions. The tool fulfills a previously unmet need for modern applications that help planners allocate mobility and aerial refueling assets for missions, and was deployed in just three months. Magellan is providing the immediate capability to the Warfighter while still being refined to expand its capabilities.
- The Air Force continued advancements on adaptive jet engines that could provide a significantly greater range or loiter time for 5th generation fighter aircraft and beyond. The Air Force also continued the development of ultra-long endurance unmanned aerial systems. These would provide unprecedented over-watch in semi-permissive environments. Further, their small logistics footprint and great range enable very flexible basing options, a key to operating in areas such as the Pacific and sub-Saharan Africa.
- As a means to expand their message and build coalitions, senior leaders from Air Force Operational Energy participated as keynote, featured, or panel speakers at 16 conferences, seminars, and meetings throughout the year, including Operational Energy Summit, Aerotech Americas, Defense Logistics Agency Worldwide, and the American Institute of Aeronautics and Astronautics (AIAA) Propulsion & Energy Forum.
- The Air Force also continued to integrate operational energy into Service and Joint wargames like the Joint Forces Energy Wargame. These efforts inform scenarios

operational planning as well as prioritization of Military Construction and platform investments by portraying a detailed energy framework for wargames to highlight critical areas of risk and opportunity. Ultimately, these efforts help to shape and influence future theater infrastructure and Concepts of Operation.

Looking to the year ahead, Air Force Operational Energy will continue to push the envelope in technology and process improvements. Energy innovation is key to global airpower dominance and a more lethal force.

Army

During Fiscal Year 2019, the Army continued to revise strategies, mature organizational changes, and prioritize resources in support of the *National Defense Strategy*. Published in FY 2019, the *Army Strategy* describes how the Army will build a more lethal force to retain overmatch to deter, and defeat if necessary, all potential adversaries. The Army Strategy establishes four lines of effort – Readiness, Modernization, Reform, and Alliances and Partnerships – to chart a path toward achieving the objectives of the Army Vision: build readiness for a high-intensity conflict; modernize doctrine, equipment, and formations; and reform the Army to maximize time, money, and manpower.

To further guide the development of the future force, the Army updated the Multi-Domain Operations concept – the Army’s Operating Concept. “The U.S. Army in Multi-Domain Operations 2028” concept describes how, as part of the joint force, the Army will deter the enemy and prevail during competition short of armed conflict and, if necessary, penetrate, disintegrate enemy anti-access and area denial systems, and exploit freedom of maneuver to defeat the enemy and achieve strategic objectives until there is a return to competition.³

In support of readiness, the Army is upgrading or replacing combat vehicle fleets. These upgrades are restoring mobility and provide enough electrical power for all current and future systems while providing a means to export power to other systems or individual Soldier equipment. Examples of investments in readiness:

- The M1A2C Abrams tank entered production in 2018 to rectify many space, weight, and power issues. In addition to improved survivability, improvements to increase the electrical power margin allows the integration of current mature and emerging capabilities, while improving the Auxiliary Power Unit, embedded training, and an ammunition data link. It is the most reliable Abrams tank ever produced, will decrease the Army’s logistic burden, and leads the Army in enterprise-level connectivity to maintenance and supply systems.
- The Army continues to field Stryker Combat Vehicles with upgraded powertrain systems and improved electrical systems. These improvements restore the vehicle’s original

³ TRADOC Pamphlet 525-3-1, https://www.tradoc.army.mil/Portals/14/Documents/MDO/TP525-3-1_30Nov2018.pdf

mobility while providing sufficient electrical power for all current and planned capabilities and enabling 4 kilowatts (kW) of exportable electrical power.

- The Army approved the Joint Light Tactical Vehicle (JLTV) for full-rate production in FY 2019. The JLTV replaces the aging High Mobility Multipurpose Wheeled Vehicle (HMMWV), providing modern levels of protection in a highly mobile platform. The JLTV has better ton-miles per gallon performance and reduced fuel consumption at idle compared to the HMMWV. The JLTV can also be equipped with expansion kits for increased configurable on-board power, extended silent watch, and 10kW of exportable power.

Initially established in July 2018 to provide unity of command and unity of effort for the Army modernization enterprise, Army Futures Command reached full operational capability in July 2019. Focused on the Army's six modernization priorities – Long Range Precision Fires, Next Generation Combat Vehicles, Future Vertical Lift, Network, Air and Missile Defense, and Soldier Lethality – Army Futures Command brings together the major modernization stakeholders (requirements, acquisition, science and technology, testing, and logistics) through cross-functional teams to rapidly develop technologies. As part of this unity of effort, Army Futures Command has begun analyzing the power and energy technology needs for each of the modernization priorities to better synchronize and standardize the development of power generation, power distribution, and energy storage needs of future systems.

To advance modernization in FY 2019, the Army is developing new systems that extend range and endurance, power new capabilities (e.g., Active Protection Systems, “smart” ammunition and Directed Energy weapons/Electronic Warfare devices), and reduce consumption while improving reliability. Examples of modernization efforts include:

- The completion of the downselect for the Improved Turbine Engine Program (ITEP) and authorized entrance into Engineering and Manufacturing Development. The ITEP will replace the engines in the Blackhawk and Apache helicopters, providing better performance at full payload, increased range, reduced fuel consumption, and increased reliability. The Army also identified the ITEP program for use in Future Vertical Lift aircraft.
- The release of a Request for Proposal for prototypes of the Optionally Manned Fighting Vehicle (OMFV) to replace the Bradley family of fighting vehicles. One of the requirements for the OMFV is that the vehicle has sufficient power for automotive and electrical purposes, as well as the ability to generate more onboard power to support new capabilities in the future.

To support the Army's modernization priorities, the Army conducted a comprehensive review of all its programs as part of Army Reform initiative. Through this process, the Army canceled 93 acquisition programs and curtailed 93 others, transferring the funding to support modernization. These were primarily low-priority programs that would not significantly enhance the lethality of the future force.

The Army continues to aggressively rebuild readiness and develop technologies that will lead to a Multi-Domain Capable force by 2028, and a Multi-Domain Dominant force by 2035. Energy will remain a critical enabler of the capabilities required by future Soldiers and formations.

Department of the Navy

In FY 2019, the Department of the Navy's operational energy program focused on power and fuel in support of platforms, advanced sensors, and directed energy weapons systems, fuel distribution in contested environments, and developing systems that provide commanders information about their energy use to achieve a more lethal force with increased operational reach and time-on-station. In January 2019, the Secretary of the Navy moved operational energy oversight activities to the Assistant Secretary of the Navy for Research, Development, and Acquisition to resource and guide operational energy capability development with the appropriate policy and resources.

Operational energy investments in the research and development necessary to address capability gaps are coordinated within the Navy and Marine Corps, as well as with other Services, and are greatly aided by the direct involvement of OSD through programs such as the Operational Energy Capability Improvement Fund (OECIF). Solutions necessary to address future weapons systems' high pulse power demands, alternative means of energy conversion, improved energy storage and management, and energy modeling capabilities have all benefitted from OSD's investments in Navy and Marine Corps efforts.

In FY 2019, the Secretary of the Navy signed new operational energy goals for the Navy and Marine Corps continuing the progression of operational energy development.⁴ The Navy and Marine Corps must enhance the lethality and effectiveness of forces through energy resilience, operational reach, and time on station of forward presence naval forces by:

- Extending operational reach of current and future weapons systems through more effective use of energy;
- Reducing energy consumption and external energy logistics requirements to forward deployed strike groups and expeditionary units;
- Increasing energy resilience of forward bases, supply depots, and cooperative security locations to get more energy to the warfighter;
- Increasing the effective use, conversion, storage, distribution, and control of energy to enable the integration of future weapons and sensors onto platforms; and

⁴ Department of the Navy Operational Energy Goals, June 27, 2019, <https://sims3.sscno.nmci.navy.mil/energy/docs/2019%20DEPARTMENT%20OF%20THE%20NAVY%20OPERATIONAL%20ENERGY%20GOALS.pdf>

- Fostering and guiding an energy culture in our Marines and Sailors through policy, training and education.

Navy

In FY 2019, the Chief of Naval Operations updated the Navy’s Design for Maintaining Maritime Superiority to align Navy warfighting strategy to the January 2018 *National Defense Strategy*. The update, referred to as “Design 2.0,” further describes distributed operating concepts, and highlights three central themes -- agility, sustainability, and control of maritime conflict -- and specifically calls for the development of improved refuel options, unmanned vehicles, a Large Surface Combatant, and laser weapons. Navy energy investment prioritized key enablers and technologies to optimize lethality through sustained control of maritime conflict as described in Design 2.0.

The following specific initiatives highlight the Navy’s operational energy accomplishments during FY 2019:

- MQ-25A Unmanned Aerial Tanker – The Navy continued the development of the MQ-25A in FY 2019 with the intention to deploy initial operational capability in FY 2024. The unmanned aerial tanker will increase the range and lethality of the carrier strike group (CSG) air wing and will return F/A-18E/F aircraft to the strike fighter role by assuming tanker duties.
- Shipboard Power and Energy – The next generation of shipboard weapons and sensor systems will require significantly increased amounts of power in unconventional forms not achievable with our current shipboard electrical architectures. In FY 2019 the Navy continued to seamless energy storage and distribution technologies to support pulse power systems when fielded. The 2019 Naval Power and Energy Systems Technology Development Roadmap lays out the Navy’s approach and identifies necessary development activities. FY 2019 investments continued in the Next Generation Integrated Power and Energy System (NGIPES), High Density Shipboard Energy Storage (multiple projects, including Energy Magazine), Control of Power Science, Heat Transfer and Thermal Management Science, Global Energy Information System (GENISYS), and the Electric Ship Research and Development Consortium.
- Power Conversion – The Navy continues investment in Silicon Carbide-based (SiC) power electric modules, as well as in other wide bandgap semiconductor materials, based power electronic modules. SiC-based materials afford more compact, thermally tolerant power conversion equipment making them highly desirable for naval applications. Specific areas of investment are: SiC Power Converter Simulation, Medium Voltage (MV) SiC Semiconductor Module Refinement and Validation, and MV SiC Semiconductor Module Endurance Test and Prototype Power Converter Development.

- Energy Command and Control – The Navy recognizes the importance of situational awareness at every operating level and highlights the need for data-driven decision making in Design 2.0. The Navy continued investment in Energy command and control technologies like GENISYS for the Navy’s combatant and expeditionary forces and Replenishment at Sea Planner (RASP) for logistics and fuel distribution planning. Additionally, the Navy’s Maritime Tactical Command and Control (MTC2) program began integration research for an energy application to provide operators additional battle management and awareness.
- Autonomous Systems Power – The Navy continued Science and Technology (S&T) in advanced power generation and energy storage alternatives for unmanned systems, along with the infrastructure necessary to keep those systems fielded.
- Battery Development and Safety – The demand for higher energy density batteries has increased significantly over the past few years, and lithium chemistries dominate the industry. However, safety concerns restrict employment. In FY 2019, the Department of the Navy (DON) established coordinated Battery Development and Safety Office to support the development and sustainment of advanced battery technologies to expedite safe integration to warfighting capabilities. The Navy invested a small amount in FY 2019 to seed the BDSE.
- Hybrid Electric Drive – Installation of the Hybrid Electric Drive onboard the USS TRUXTUN has demonstrated the feasibility and provided initial results. The Navy continues to address various technical challenges and risks before future installation.
- Energy in Aviation – In FY 2019, the Aircraft Energy program continued development of a high-fidelity F/A-18 fuel consumption dashboard and analysis tool based on aircraft-generated data. The Navy also continued investments in multiple programs to increase operational capability through the development of more efficient platforms. Those include the trim-optimizing flight control algorithm for the F/A-18, recuperator technology on unmanned systems, and performance improvements to the F414 engine of the F/A-18E/F Super Hornet.
- Training and Education – The Navy seeks to ensure current and future commanders and operators understand operational energy requirements and incorporate the requisite actions to balance demand and supply in the operating environment. To provide that knowledge to the warfighter, the Navy’s Operational Energy Training and Education Plan integrates operational energy concepts into tasks, doctrine, policy, and throughout the Navy’s Training and Education continuum.
- Fuel Testing and Certification – The Navy’s Mobility Fuel program continued the necessary testing to assure naval tactical platforms (air, sea, and ground) remain compatible with the continually evolving changes in fuel, refining processes, and commercial specifications.

In FY 2020, the Navy anticipates continuing research and development to support afloat fuel distribution, enabling directed energy weapons on ships and aircraft, energy storage, microgrid resiliency, energy command and control, and energy optimization. The Navy energy analytic agenda will focus on Indo-Pacific theater operations.

Marine Corps

As the Marine Corps optimizes the force to better meet the challenges of its peer competitor, operational energy remains one of the most important and most complex challenges. The Marine Corps operational energy focus in FY 2019 was on supporting the challenges associated with distributed operations. Designing a risk-worthy inside force capable of providing sea control and denial, while becoming a Joint Force enabler is one of the Marine Corps primary missions. The six goals in the 2018 S&T Strategic Plan are still valid and will ensure a sustainable future force:

- Expeditionary energy harvesting from environmental resources;
- Austere environment capable electronics free from heating and cooling requirements ;
- Innovative technologies that enhance the maneuverability, self-sustainability, and performance of dismounted forces;
- Lightweight high energy density (watts/kilogram) and high energy volume (watts/liter) approaches to store harvested energy;
- Integrated technologies that evolve current and future vehicles into multi-capable platforms, that perform designated combat mobility functions while enabling an efficient and flexible Marine Air Ground-Task Force (MAGTF) energy network; and
- Timely and cyber-secure energy command and control systems to track how energy is being produced, consumed, stored, and transported.

In FY 2019, the Marine Corps continued to evaluate operational energy risk using modeling and simulation and began direct coordination with the Navy to identify requirements for energy to meet the needs of the concepts defined in the *National Defense Strategy*. This coordination is critical to defining the capabilities needed to meet emerging demands.

In the area of capability development, the Marine Corps is moving forward with efforts that span from science and technology through the fielding of acquisition programs. These efforts are coordinated with the other Services, as well as the Office of the Secretary of Defense.

The following initiatives highlight Marine Corps operational energy accomplishments in FY 2019:

- The Marine Corps is continuing the development of concepts of operations and defining the Joint requirements for Joint Operational Energy Command and Control (JOEC2). JOEC2 will increase the operational reach of the MAGTF by empowering commanders to understand their influence on unit energy performance. JOEC2 has transitioned from a technology demonstration to a program of record in FY 2019 with the drafting of a Capabilities Development Document for insertion into the Joint Capabilities Integration and Development System (JCIDS).
- In FY 2019, the Marine Corps conducted multiple technology demonstration efforts in support of the Mobile Amphibious Assault Fuel Distribution (MAAFD) experimentation program. These demonstrations assess mitigation options for the ship-to-shore bulk fuel distribution and expeditionary fuel capability gaps identified in previous warfighting analyses. MAAFD experimentation demonstrates capabilities to increase the MAGTF's operational reach and enable naval support to naval concepts like the littoral operations in a contested environment (LOCE), expeditionary advanced basing operations (EABO) and Operational Logistics in a Contested Maritime Environment. These MAAFD capabilities will reduce energy-induced risks by enabling the force to establish and sustain distributed operations despite persistent threats in the littorals. Demonstration efforts included novel bulk fuel storage and delivery methods utilizing the Navy Improved Naval Lighterage System and Supervisor of Salvage Dracones as representative fuel barges to assess at-sea storage and movement of fuel from ship-to-shore.
- MAAFD also successfully demonstrated expeditionary systems that can quickly set up and take down Forward Arming and Refueling Points in austere locations. The capabilities are designed to be aviation insertable via MV-22 and able to operate without significant support. The Expeditionary Mobile Fuel Additization Capability (EMFAC) provides the capability to additize commercial fuel to meet DoD specifications and is being deployed to meet the requirements of an Urgent Universal Needs Statement submitted by the operating forces. In addition, MAAFD demonstrated the Tactical Aviation Ground Refueling System (TAGRS) that provides the equipment to tap into a fuel source and create a two-spot fueling point for aircraft. The Marine Corps successfully demonstrated the capabilities and identified funding to transition the efforts to programs of record.

Finally, the Marine Corps adapted the training and education of Marines. The first goal is to integrate operational energy considerations into the Motor Transportation (MOTOR-T) Formal Learning Centers. MOTOR-T is the first Military Occupational Specialty (MOS) to be targeted as they are the largest user of fuel on the ground and the second-largest MOS in the Marine Corps. In addition to this tactical level training effort, the Marine Corps has partnered with the Office of Naval Research and Massachusetts Institute of Technology (MIT) Lincoln Laboratory to create an interactive gaming based tool to demonstrate to Marines the impact of poor energy planning on operational tempo and mission success. The United States Marine Corps Training and Education Command is closely linked and is working to transition the effort as it becomes technologically viable.

Navy and Marine Corps investments in operational energy enable a more lethal and resilient force with enhanced mission effectiveness that supports increases in warfighting capability while reducing logistics risk. As new technologies like directed energy weapons continue to be developed, the operational energy program ensures support to advanced weapons and capabilities. The incorporation of technological advancements, cultural and behavioral changes to energy usage, and greater analysis-based decisions into the DON's energy program will enable a more lethal force.

Combatant Commands

The Combatant Commands continued to enable improvements in the use of energy in current operations around the globe. Highlights include:

- U.S. Indo-Pacific Command. To meet emerging strategic challenges, the Department must rethink the deployment and sustainment of forces across an area that contains over half of the world's population, the world's three largest economies, half the world's declared nuclear powers, 24 of the world's 36 megacities, and key lines of communication through which over half the world's liquid fuel travels daily. In collaboration with the Joint Staff and OASD(S), USINDOPACOM is evaluating the petroleum requirements process, the role of commercial storage and distribution capabilities, and options for intra-theater fuel distribution. To support this evaluation, USINDOPACOM hosted the Joint Force Energy Wargame to evaluate Joint seams in the fuels supportability of operation plans and concepts. Sponsored by OASD(S), the wargame also provided a comprehensive Joint data set to support follow-on quantitative analyses of risk and mitigations.
- U.S. Central Command (USCENTCOM). Facing multiple *National Defense Strategy* (NDS) challenges, USCENTCOM operates the largest fuel operation in the DoD. In February and March 2019, USCENTCOM hosted the Joint Strategic Support Board (JSSB) wargame at MacDill Air Force Base, Florida, to address the challenges of supporting deployed forces efficiently while operating in austere conditions across USCENTCOM's area of responsibility. The exercise focused on strategic support issues like fuel logistics and emphasized the importance of synchronizing efforts across all of the command's service components and combat support agencies like the Defense Logistics Agency and U.S. Transportation Command.
- U.S. Africa Command (AFRICOM). AFRICOM is adapting operations to the austere conditions and long distances that characterize the operational environment. In particular, AFRICOM is collaborating with other U.S. agencies to field innovative technologies that reduce demand for fuel, including an evaluation of the use of micro-grids and hybrid battery storage systems at deployed locations. AFRICOM partnered with the Niger Armed Forces ground fuels facility to develop standardized procedures for fuel operations through an exchange of tactics, procedures, and techniques. AFRICOM also supported the refurbishment of a former Soviet air base in Somalia to

handle changing missions. Extensive runway repairs included upgrades like LED elevated runway lights and the addition of 20W solar panels to each light that eliminated the need for generators and reduced the resupply burden for the base.

- European Command (EUCOM). In FY 2019, USEUCOM continued to enhance and strengthen partnerships, improve mission readiness, and counter global threats alongside allies and partners. EUCOM is evaluating the operational energy requirements for U.S. Forces, allies, and partners across the deliberate planning process. In collaboration with OASD(S), EUCOM, Components, and Federally-funded research and development centers are assessing the operational energy requirements to support the planned scheme of maneuver. U.S. Army Europe also conducted a wargame assessing the ability to deploy Army units to a European conflict. USEUCOM requested the wargame team expand that wargame to include all U.S. units deploying to Europe. The planning has progressed through 2019 with the wargame execution planned for March 2020.

Conclusion

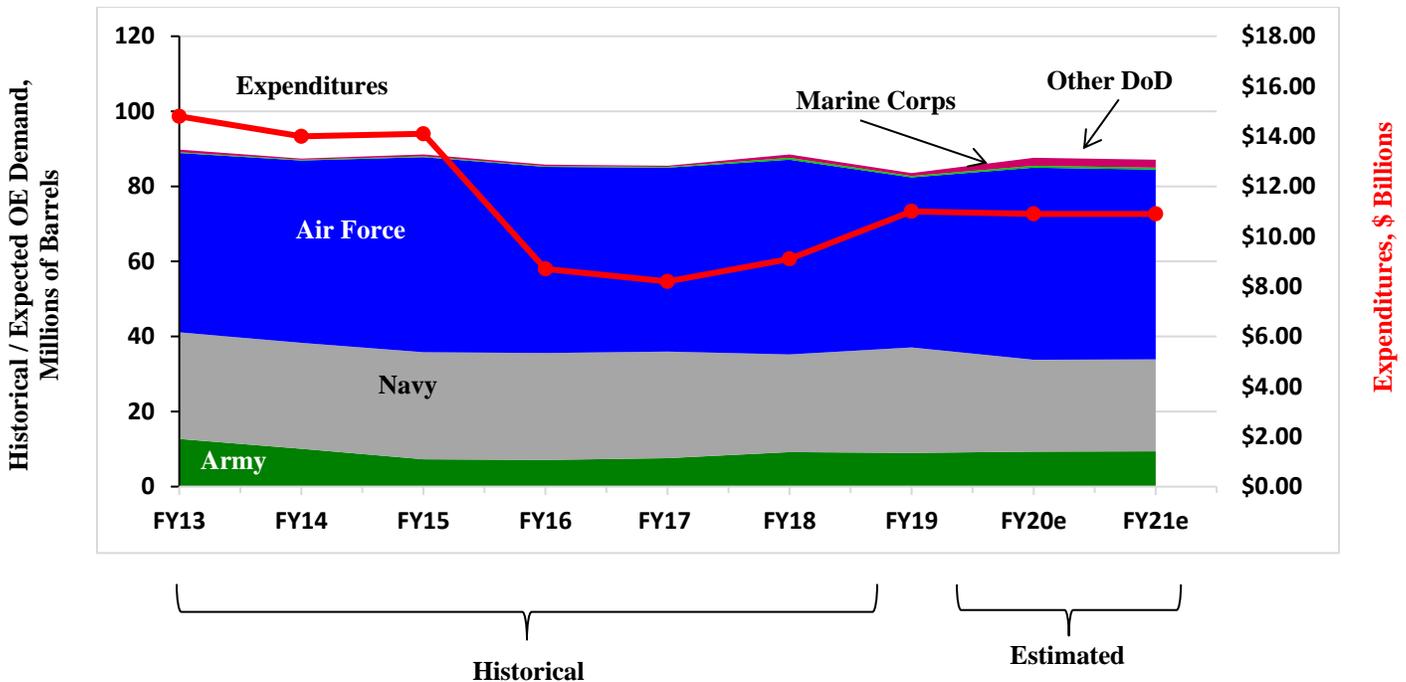
The *National Defense Strategy* outlines a challenging operating environment and specifies the need to enhance “forward force maneuver and posture resilience” and seek “resilient and agile logistics” in contested environments. As a result, the Department needs to think differently about how we deploy, employ, and sustain forces with the energy needed to conduct worldwide missions. The shift toward strategic competition with Russia and China means that the role of energy will only grow, especially as these adversaries develop multi-domain threats to the delivery of energy. The Department investments and initiatives reviewed in this report will increase the resilience of the force against emerging threats and enable the successful implementation of the NDS.

In FY 2020, the Department will focus on the goals of the NDS through resilient fuel infrastructure and agile logistics and sustainment, and develop an integrated Department energy strategy to guide these initiatives. Through wargames, new propulsion technologies, targeted research and development, and platform upgrades, the Department is committed to improving the lethality of our forces in a changing and contested operational environment.

Appendix A: Historical and Estimated Demand for Operational Energy

Figure 1 and **Table 2** describe the historical demand for operational energy in FY 2013–2019, the estimated demand for operational energy in FY 2020–2021, and total expenditures to purchase that fuel. Historical operational energy demand is based on net sales of selected liquid fuels by DLA Energy to the Services, while future operational energy demand estimates are based on the FY 2021 President’s Budget. Expenditures for operational energy are estimated using the average fuel sales price for the specific fuel provided to the customer at the point of sale, and include procurement and overhead costs. This price does not reflect additional costs imposed on the Department for force protection, storage, and transportation beyond the point of sale. As a purchaser of fuel on the open market, the Department is subject to the same price volatility experienced by commercial customers.⁵

Figure 1: DoD Operational Energy Demand, FY 2013 – FY 2021e⁶



⁵ Standard DLA Energy fuel prices can be found at <http://www.dla.mil/Energy/Business/StandardPrices.aspx>

⁶ Updated analysis of expenditures may lead to different results from previous Operational Energy Annual Reports. Expenditures are not adjusted for inflation; data on historical demand may not capture final end use nor account for fuel transfers between the Services; Historical and Estimated Demand include Base and Overseas Contingency Operations (OCO) funding and purchases using Transportation Working Capital Fund (TWCF).

Table 2: DoD Operational Energy Demand by Service

		FY13	FY14	FY15	FY16	FY17	FY18	FY 19	FY20e	FY21e
Operational Energy Demand, Million Barrels	Army	12.7	10.1	7.3	7.1	7.6	9.2	9.0	9.3	9.4
	Navy	28.4	28.2	28.5	28.5	28.4	26.0	28.1	24.5	24.5
	Air Force	47.8	48.6	52.0	49.6	49	51.9	45.3	51.2	50.6
	Marine Corps	0.2	0.2	0.2	0.2	0.2	0.5	.38	.5	.5
	Other DoD	0.7	0.3	0.5	0.4	0.3	0.9	.77	2.1	2.1
	<u>Total Demand</u>	89.8	87.4	88.6	85.7	85.5	88.5	83.6	87.6	87.1
	<u>Expenditures (Billions)</u>	\$14.8	\$14.0	\$14.1	\$8.7	\$8.2	\$9.1	\$11.0	\$10.9	\$10.9

Appendix B: Alternative Fuels Initiatives

In support of alternative fuels, Department conducts activities related to testing and evaluation (T&E), production capacity, and bulk procurement.

Testing and Evaluation.

Testing and evaluation of all fuel, including alternative fuels, remains essential for DoD readiness. In 2019, the Department continued coordinating and supporting the evaluation of alternative fuels through the Tri-Service POL (Petroleum Oils and Lubricants) User's Group (TriPOL). Since the completion of DoD's conversion from a military jet propellant (JP) fuel, JP-8, to commercial jet fuel in 2014, alternative fuels can enter DoD service through the commercial alternative fuel specification by the American Society for Testing and Materials (ASTM) D7566, *Standard Specification for Aviation Turbine Fuel Containing Synthesized Hydrocarbons*. To obtain approval, fuels are evaluated by ASTM D4054 (*Standard Practice for Evaluation of New Aviation Turbine Fuels and Fuel Additives*). This four-tiered evaluation process proceeds through fuel composition and property measurements and culminates in component and engine tests. Industry reviews the results as they are obtained, comparing the results to conventional fuels to determine if the results are “within experience.” Testing can be waived depending upon the results of the evaluation.

Through TriPOL, the Air Force, Navy, and Army support the Federal Aviation Administration led alternative fuel evaluation process as needed, using expertise developed during previous DoD alternative fuel programs. Participation in the process enables the TriPOL to help ensure military applications are considered as the evaluation process continues. Several fuels are currently going through the ASTM process, including fuels from hydrocarbon-producing algae and another from waste cellulosic biomass. These fuels, if certified by ASTM, could expand the pool of alternative jet fuel feedstocks, a key driver in reducing fuel cost. TriPOL also supports process improvements through leadership in programs such as the National Jet Fuel Combustion Program, which is striving to streamline the combustion evaluation of alternative fuels. DoD also supported the development of the “Fast Track” process for evaluating low-risk alternative fuels.

Beyond the TriPOL, the components conducted varying levels of activity in support of alternative fuels testing and certification. For ground platforms, the Army ended support for the T&E of alternative jet fuel pathways that have been or are expected to soon be approved by ASTM International after FY 2018. For air platforms, the Army ceased funding T&E of alternative jet fuels after FY 2014. Similarly, the Air Force has not funded alternative jet fuel T&E since FY 2013, and, in FY 2019, did not provide in-kind or work-for-others support to any international or interagency alternative jet fuel T&E initiatives. DLA-Energy also supported no testing and evaluation activities in FY 2019.

For both aviation and ship platforms, the Navy continued to actively participate in commercial specification organizations, such as ASTM, to engage fuel suppliers and review commercial qualification data to assess potential impacts on Naval tactical platforms and

interoperability. To expedite the internal assessment process, the Navy also engaged key aircraft original equipment manufacturers and requested blanket approvals for the unrestricted use of new fuels in Navy and other military systems upon their adoption into commercial specifications.

Production Capacity

In the fall of 2014, three \$70 million Defense Production Act Title III Phase 2 awards were announced for the construction of facilities capable of producing at least 10 million gallons per year of military specifications (MIL-SPEC) neat biofuels for blending with traditional petroleum-based MIL-SPEC fuels. The source of funds for these awards included FY 2012 and FY 2013 funding from OSD and Navy, respectively, and additional funding from the Department of Energy. Fulcrum Sierra Biofuels reached financial close, which is required to commence Phase 2, in October 2017 after already having completed and operated a feedstock (municipal solid waste) processing facility at full capacity in 2017. Red Rock Biofuels reached financial close in December 2017. The third company receiving a Phase 2 award, Emerald Biofuels, did not achieve financial close by the end of 2017, and its Phase 2 award was terminated for default.

Both Fulcrum Sierra and Red Rock Biofuels broke ground for construction of their biorefineries in the spring of 2018. Fulcrum Sierra completed Stage 2 construction of its Feedstock Processing Facility and initiated system commissioning in September 2019. While biorefinery construction progressed in FY 2019, the effort is behind schedule due to delayed fabrication and delivery of equipment. Originally projected for January 2020, the mechanical completion of the biorefinery is expected to slip.

While Red Rock Biofuels continued construction of its biorefinery in FY 2019, construction is months behind schedule due to late delivery of major pieces of equipment. Additional equipment fabrication issues also are likely to delay mechanical completion of the Red Rock facility until April 2020, and possibly further. Both companies are expected to achieve routine fuel production by the end of 2020.

Procurement

Per statute and policy, drop-in alternative fuels can be procured for use in operations when compatible with existing equipment and infrastructure and cost-competitive with traditional fuels. The Department's solicitations for bulk fuels provided in or after FY 2016 have been open to fuels that include blends of alternative fuel pathways consistent with the fuel specifications presented in **Table 5**. Following two fuel contract awards that incorporated blends of drop-in alternative fuels, DLA-Energy made a third such award in July 2018. Awarded to AltAir Paramount (acquired by World Energy in March 2018), the procurement included up to 54 million gallons of F-76 at a price of \$1.912/gallon, for delivery in FY 2019. Under this contract, the F-76 fuel may contain bio-based hydroprocessed esters and fatty acids (HEFA) fuel derived from renewable fats, oils, and greases. Under this contract, AltAir delivered 48 million on gallons of blended F-76 to DLA-Energy FY 2019, bringing the total supply of drop-in compatible alternative fuels purchased by the Department since FY 2016 to 145.5 million gallons.

Table 3. Initiatives to Model and Develop Alternative / Non-Petroleum Fuel Feedstocks and Fuel Production Capabilities
(Dollars in Thousands)

Service	Program Title	Initiative Title	Description	Treasury Code (TC)	Budget Activity (BA)	Budget Line Item	Program Element (PE)	FY2019 Funding
Navy	Defense Research Sciences	Naval Biosciences: Biosynthesis of Liquid Fuels	Develop transformational approaches using living organisms to produce fuel components (e.g., alkanes)	1319	01		0601153N	0
Navy	Bio-Centric Technology (Energy)	Biosynthesis of Liquid Fuels	Develop transformational approaches using living organisms to produce fuel components (e.g., alkanes)	1319	02		0602236N	446
Navy	Synthetic Biology for Sensing and Energy Production	Carbon Capture from Seawater	Finalizing the construction of the scaled-up carbon capture prototype that will produce enough carbon dioxide and hydrogen to make up to 1 gallon of fuel per day.	97X4930	020060658			250
Navy	Synthetic Biology for Sensing and Energy Production	Navy Synthetic Fuel Production from Seawater	Assessment of the effects of reactor and catalyst scale-up on catalyst performance in commercial-scale chemical reactor	97X4930	020060658			250
Subtotal for Investments in Alternative/Non-Petroleum Feedstocks and Production								946

Table 4. Initiatives to Test and Evaluate Alternative / Non-Petroleum Fuels for Use in Military Fuel Systems⁷
(Dollars in Thousands)

Service	Program Title	Initiative Title	Description	Treasury Code (TC)	Budget Activity (BA)	Budget Line Item	Program Element (PE)	FY 2019 Funding
Air Force	Sweden Alcohol-To-Jet Fuel Processing and Performance	Alternative Fuels	Develop the Alcohol-To-Jet (ATJ) aviation fuel process, produce a sufficient quantity of ATJ fuel to satisfy program requirements, and establish ATJ test and analysis requirements to enable a flight demonstration of a Gripen aircraft using a 50/50 blend of ATJ and JP-8.					50 ⁸
Army	Aviation Technology	Fuel Qualification and Certification Efforts	Assess the impact of using emerging alternative fuels in aviation platforms and identify changes in fuel specifications to implement alternative fuels into Army aviation systems.	2040	02	EM8	0602211A	0
Army	Combat Vehicle and Automotive Advanced Technology	Fuel Qualification and Certification Efforts	Assess the impact of using emerging alternative fuels in tactical/combat vehicles and other deployable assets, and identify changes needed in fuel specifications to implement alternative fuels into Army systems.	2040	02	H77	0602601A	730
Navy	Mobility Fuels	Alternative Fuels Test and Qualification	Develop technical data through the execution of laboratory, component, engine, fuel system, and weapon system tests, which evaluates the effects of changes in fuel chemistry and properties on the performance and reliability of Naval ship, aircraft, and fuel distribution systems.	1319	04	0838	0603724N	920
DLA Energy	Quality/Technical Directorate – Energy Readiness Program	Effect of Alternative Jet Fuels on Combustor Operability Limits	This project is evaluating specific alternative fuel samples in an auxiliary power unit (APU) combustor rig to develop an understanding of alternative fuel composition effects on combustor operability, particularly pertaining to criteria of engine lean blow out and altitude relief. Air Force Research laboratory is performing this work as part of a larger joint Air Force/FAA initiative, the National Jet Fuel Combustion Program.	0400	03		0603712S	500
Subtotal for Testing and Evaluating of Alternative / Non-Petroleum Fuels for Use in Military Fuel Systems								1,881
Total Alternative Fuels Related Expenditures in FY 2019								2,827

⁷ These initiatives include the procurement of alternative fuels to support testing and evaluation activities.

⁸ Estimate of non-financial contributions (e.g., salaries, background information, use of equipment)

Table 5. Approval Status for the Blending of Alternative / Non-Petroleum Fuels into Commercial Jet (Jet A and Jet A1), Military Jet (JP-8 and JP-5), and Naval Distillate (F-76) Fuels

Specification owner:		ASTM	USAF	DON	DON
Specification number:		D7566/D1655	MIL-DTL-83133J	MIL-DTL-5624W	MIL-DTL-16884P
Fuel Pathway	Maximum Blend	Jet A and Jet A1	JP-8 (Jet)	JP-5 (Jet)	F-76 (Distillate)
FT-SPK	50%	Sep 2009	Apr 2008	Jul 2013	Apr 2014
HEFA-SPK	50%	Jul 2011	Oct 2011	Jul 2013	Apr 2014
SIP	10%	Jun 2014		Mar 2016	
SIP	20%				Sep 2017
FT-SPK/A	50%	Nov 2015			
ATJ-SPK	30%	Apr 2016			

ATJ = Alcohol to Jet (derived from butanol)

FT = Fischer-Tropsch

HEFA (aka HRJ or HRD) = Hydroprocessed Esters and Fatty Acids (aka Hydroprocessed Renewable Jet or Diesel)

SIP (aka DSH) = Synthetic Isoparaffin (aka Direct Sugar to Hydrocarbon)

SPK/A = Synthetic Paraffinic Kerosene plus Aromatics

Appendix C: Operational Energy Capability Improvement Fund (OECIF)

Improving the use, conversion, and management of the energy that powers the Department of Defense’s (DoD) operational forces is vital to increasing operational warfighting capabilities and reducing the vulnerability of supply lines.

The OUSD(R&E) uses the Operational Energy Capability Improvement Fund (OECIF) to invest in science and technology (S&T) efforts that promote transformational improvements to military capabilities. These efforts are aligned to the Department’s *Operational Energy Strategy* and the R&E Modernization Priorities that include programs focused on autonomy, directed energy, space, artificial intelligence/machine learning, as well as fully networked command, control and communications.

The mission of the OECIF program is to guide operational energy innovation via targeted S&T investments in advanced technology development (Budget Activity 3 (Advanced Technology Development) appropriation (“6.3”)). The OECIF program seeks to develop and integrate subsystems and components into first-of-a-kind system capabilities. These efforts serve as proof of technological feasibility, intending to transition science and technology into the acquisition process.

OECIF operates in collaboration with the Services and is structured to leverage, not replicate, the existing infrastructure and organization in the Services. OECIF program funds are not a replacement for the Services’ 6.3 funds. Each Service’s operational energy lead office works collectively with OECIF to develop, select, and oversee the OECIF investments, generally in concert with co-Services investment.

OECIF Themes and Projects, FY2012-2019

Start Year	Theme	Projects Funded
FY 2012	Reducing energy load at expeditionary outposts	8
FY 2013	Using consortia to attack key operational energy problems	6
FY 2014	Developing operational energy analytical methods and tools	7
FY 2015	Improving fuel economy for the current tactical ground fleet	14*
FY 2016	Increasing the operational energy performance of unmanned systems	14*
FY 2017	1)Thermal and power management technologies for high pulse power systems; 2)Wireless transmission of energy in the far-field	16*
FY 2018	One-year studies to identify operational energy science and technology gaps in the near-, mid-, and far-term	9*
FY 2019	1) Enhanced Energy Storage for Autonomous Systems; 2) Nuclear Fuel & Reactor Study effort	14*

* Includes projects funded with a Congressional plus-up; topics vary

Since its inception, OECIF has funded nearly 90 projects across a range of specific operational themes, as shown in **Table 6**. Of the 46 projects that have closed, 35 were considered successful from a technical and transition perspective (76% transition rate). Seven projects lack sufficient documentation to assess transition (many of these occurred as demonstrations in Afghanistan during Operation Enduring Freedom). Due to organizational priorities (as opposed to project performance), five projects were prematurely terminated. The co-sponsor of two of these projects continue to provide funding and these two projects are expected to reach full transition. Lessons learned from each of the terminated projects continue to provide useful operational energy insight across the community.

Significant OECIF accomplishments in FY 2019 include:

- The Tactical Micro-grid Standards Consortium (TMSC) used an industry consortium approach to develop open and joint standards for tactical micro-grids. In FY 2019 the first-ever operational tactical micro-grid demonstrated coalition interoperability between Italy, Canada, and the United States as part of North Atlantic Treaty Organization Capable Logistician (CL) 2019 in Poland. Standardization of tactical micro-grids in a multinational context allows for power and energy sharing at forward locations, resulting in better sustainability, mobility, and fighting effectiveness while decreasing the logistics vulnerability of moving fuel around the battlespace. Fuel sharing optimizes the overall system use and results in reduced fuel demand.
- OECIF demonstrated first-of-a-kind, affordable electrical power generation and energy storage technology to retrofit key Army tactical vehicles. The Tactical Vehicle Electrification Kit (TVEK) was developed by the Army Ground Vehicle System Center (GVSC) to fiscally and responsibly reduce tactical vehicle fuel use. TVEK is a diesel engine anti-idle system that:
 - reduces engine idle by 80 percent,
 - doubles energy capacity for silent watch,
 - triples electrical power generation,
 - reduces total engine run time (60 percent in a typical use),
 - enables connectivity for base electrical power,
 - provides a high voltage power bus for advanced warfighting capabilities (directed energy weapons, radios, jamming, and other),
 - reduces fuel use by 25 percent, and
 - has a positive return on investment (approximately 2 years, and significantly less during on-going operations).

The results are extremely positive and the TVEK is being considered as the new standard configuration for over 200,000 tactical vehicles.

- Supported by OECIF, the Naval Postgraduate School provides military and civilian employees the opportunity to understand the complex issues facing the operational and installation energy segments of DoD. The Certificate is accredited by the

Western Association of Schools and Colleges and is comprised of courses in Physics, Electricity, Operational Energy, and Energy Security. Courses are offered one per quarter for four quarters. The first cohort of students began in April 2018, with 18 students completing the Certificate in March 2019. The second cohort of students started the program in April 2019.

- The Synthetic Theater Operations Research Model - Energy (STORM-E) project is a modeling and simulation effort that inserts campaign-level energy analysis into the Department's premier campaign simulation model. FY 2019 updates include modeling of operational energy storage build-ups, port operations, targetable airbase fuel hydrants, dynamic pipelines, explicit logistics support, improved logistics effects in existing units, air-to-air fuel burn, enhanced unit shortage effects, supply-vehicle energy consumption, ground alert close air support for aircraft and helicopters (energy impacts included), and support unit and airbase consumption. The U.S. Marine Corps used STORM to conduct OE-informed analysis in support of 10 U.S. Code § 2925(b)(2)(F). STORM-E was the analytic tool employed at the 2019 Joint Force Energy Wargame to evaluate Joint seams in the fuels supportability of operation plans and concepts.
- Warfighter testing and updates were completed on the Joint Deployment Energy Planning and Logistics Optimization Initiative (J-DEPLOI) effort. J-DEPLOI is a planning tool that facilitates energy analyses earlier into the Joint Planning Process (JPP). This project allows planners to rapidly build and visualize fuel networks on geo-referenced maps during the development of Course of Action (COA) planning. These efforts have fully transitioned to the Department's program of record for planning.

OECIF published a series of joint studies that built multi-Service advocacy, reduced redundant efforts across Service labs, and provided insight on operational energy gaps. These studies are being used to inform Service and DoD investment and as the analytical underpinning for energy strategies across the DoD. The value of the collaboration across Services during these efforts brought unprecedented sharing and alignment of information between the labs and warfighters and will result in the avoidance of duplication of efforts moving forward. Studies completed in FY 2019 include:

- The operational energy S&T gap studies completed in FY 2019 which includes an assessment of operational energy challenges in USINDOPACOM;
- An evaluation of Navy and Marine Corps fuel storage and distribution;
- An evaluation of operational energy-related capability gaps in the field of remote, autonomous refueling and recharging;
- the identification of the technologies required to enable semi-independent, longer duration, multi-domain operations by close combat Warfighters;

- a review of investments critical to providing space solar power to forward operating bases; and
- An analysis of existing and future vehicle and ground support equipment for battery voltage, power, size, weight and safety requirements; and the demonstration of Optical Communication Efficient Low-profile Terminal.

In addition to completing the projects noted above, OECIF invested \$41.5 million to initiate new projects, including:

- Twelve projects on energy storage, safety, and standardization that support OUSD(R&E)'s Autonomy modernization priority,
- Interagency efforts to establish nuclear fuel production pathways to meet future power and energy demands.

FY 2019 and FY 2020 investments in energy storage for autonomous systems focus on capabilities that provide enhanced lethality and safety. Tactical power generation and intelligent load management and distribution are the key enablers of any battlefield system that uses electricity. They are the linchpin for enabling multi-domain operations key concepts such as convergence, cross-domain maneuvers, and dis-integration of adversary capabilities. The Program Manager (PM) Expeditionary Energy and Sustainment Systems (E2S2) standard generator set of Advanced Medium-sized Mobile Power Systems (AMMPS) is an extremely mature power system with an operational reliability of greater than 1250 hours of meantime between failure (MTBF). These efforts are designed to improve energy storage technologies used in power systems and to address operational safety and enable their integration onto military platforms.

OECIF's technology focus and funding ensure that PM E2S2 can modernize the current generator set and distribution families to be even more efficient and reliable. For example, hybridization of the AMMPS Microgrid will allow the Army to achieve zero spinning reserve and fully optimize the Army's microgrid system. Hybridization will also enable an increase of operational range and endurance of current unmanned systems. Realization of critical, novel fire suppression techniques will address the need for safe military transport of Lithium-Ion batteries. Development of a Universal Power Gateway (comprised of a Universal Power Electronic Secondary Controller and advanced energy storage) will enable a seamless alternating current/direct current (AC/DC) power grid, giving the warfighter maximum operational flexibility, greater operational reliability, and reduced logistics footprint. Finally, the establishment of specifications and safety standards will document a standardized battery architecture that ensures commercial energy storage solutions are compatible for use with multiple DoD platforms.

Our future force must be capable of operating for long periods in austere locations with little to no logistical support. Enhancements to be realized are those that increase military

capability by increasing lethality and enhancing performance while also reducing the burdens and risks created by the need to sustain our forces with power and energy. Ultimately our future force will be able to operate equally well in urban and austere environments. Working together, OECIF and PME2S2 will enable the flexibility of a seamless AC/DC microgrid that supports any operational scenario from command and control on the move to the ability to connect to host nation grids.

The second FY 2019 OECIF topic highlights the DoD's interest in nuclear fuels and reactors and their potential role in resiliency and battlefield capabilities. Future mobile and modular nuclear reactors will require safer fuels. OUSD(R&E) is designated as the lead for the establishment of the tristructural isotropic (TRISO) particle fuel production line. The goal of this effort is to invert the paradigm of military energy by supplying reliable, abundant, and continuous energy through the deployment of mobile nuclear energy systems. The OECIF program manages OUSD(R&E)'s investment in nuclear fuels. To that end, OECIF is supporting technology development and demonstration as well as feasibility assessments to advance this area of technology in concert with the Special Capabilities Office (SCO), Defense Advanced Research Projects Agency, National Aeronautics and Space Administration (NASA), and DOE.

In FY 2019, earlier efforts focused on wireless transmission of energy in the far-field were expanded to focus on critical component technology advancement of solar collection, power beaming, and supporting technologies in the radio frequency (RF), laser, and millimeter spectrums. These efforts reduce the risk of the larger FY 2020 projects which demonstrate greater than one kilowatt of power projected over one kilometer. Both increased power levels and distances are expected to result over the next two years, which support powering both autonomous systems and difficult re-supply locations. This will result in safer logistics operations with decreased warfighter exposure to attack.

Power and Thermal Management. Other OECIF efforts focused on power and thermal management for high pulsed power weapons continue to be an underfunded technical area for the Services. In FY 2019, the focus of these efforts was on critical component development as well as modeling capability advancement. The goal of these efforts is to reduce the risk to future power and thermal management systems for directed energy weapons (DEWs) and their energy storage systems. Demonstrations included the successful testing of the autonomous power propulsion and thermal management system with a single aircraft mission, a two-phase cooling loop with an advanced control system and a thermal load emulator, and lithium battery overcharge and safety testing. Validated government modeling capabilities facilitate rapid assessment and optimization of thermal management systems for DEWs. In FY 2019, advancements included the first release of a dynamic, system-level modeling toolset for high-heat flux thermal management systems. These efforts will lead to the identification and mitigation of integration challenges, enabling the implementation of advanced power and thermal management systems across multiple platforms.

Appendix D: Recommend Change in Organization or Authority

The Department has no recommendations for changes in organization or authority.

Appendix E: FY 2019 Operational Energy Initiatives (Dollars in Thousands)

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
USAF	Advanced Materials for Weapon Systems	2700F SiC SiC Composites for Turbine Hot Section Components	Program will develop, demonstrate subscale, and predict behavior and life of SiC/SiC composites for application in the hot-section of advanced turbine engines to 2700°F, and 3000°F with a coating. Additional applications are in liquid rocket engines, scramjet engines and thermal protection systems.	Increase Warfighter Capability	Materials and Design	3600	03	125	981	0
USAF	Advanced Materials for Weapon Systems	Enhanced Physics-based Prognosis and Inspection for CMCs (EPPIC)	Community desire for precompetitive collaboration on performance, life modeling, and NDE of CMCs. Need physics based tools for predictive damage tolerance approach (i.e., damage initiation and growth) that can capture nuances of sub-component/component features (e.g., ply drops).	Increase Warfighter Capability	Materials and Design	3600	03	0	0	6181
USAF	Advanced Materials for Weapon Systems	Next Generation Turbine Engine Disk System	Increase temperature capability of propulsion disk materials. Mature and implement site specific tech and tools. Increase T3 temperatures, increase efficiencies, mature joining technologies, provide critical design data and durability models.	Increase Warfighter Capability	Materials and Design	3600	03	1197	0	0
USAF	Aerospace Propulsion and Power Technology	Air Dominance Adaptive Propulsion Technology (ADAPT)	Design, fabricate, assemble, and test innovative turbine engine technologies that address future Air Superiority capability needs, that provide increased thrust, decreased weight, improved fuel consumption, and improved affordability. For 6.3 activities, this program will leverage existing test assets to conduct key core and rig tests in order to advance adaptive engine technologies in the engine core.	Increase Warfighter Capability	Propulsion Upgrades - Air	3600	03	8,304	3,876	20,410

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
USAF	Aerospace Propulsion	Aircraft Thermal Systems	Technologies to improve thermal acquisition, transport and rejection.	Increase Warfighter Capability	Platform Thermal Management	3600	02	9,389	5,889	26,239
USAF	Aerospace Propulsion and Power Technology	Aircraft Thermal Systems	Technologies to improve thermal acquisition, transport and rejection.	Increase Warfighter Capability	Platform Thermal Management	3600	03	13,621	1,497	3,949
USAF	B-52H Re-Engine	B-52 Commercial Engine Replacement Program (CERP)	This sustainment program will replace the current unsustainable TF33 engine with engines of similar size, weight, and thrust characteristics. The development, production and installation of new engines and related subsystems will replace legacy equipment on 76 B-52H a/c.	Enhance Mission Effectiveness	Propulsion Upgrades - Air	3600	07		10,000	1,459,200
USAF	Aircraft Sustainment	Composite Certification	Develop, apply, and demonstrate methodology for verifying the reliability of composite structures as predicted to allow a more widespread use of composite structures to future systems such as Future Air Dominance and Next Generation Mobility.	Increase Warfighter Capability	Materials and Design	3600	03	5,433	7,875	8,078
USAF	Aerospace Technology Development/ Demonstration	Composite Certification	Develop, apply, and demonstrate methodology for verifying the reliability of composite structures as predicted to allow a more widespread use of composite structures to future systems such as Future Air Dominance and Next Generation Mobility.	Increase Warfighter Capability	Materials and Design	3600	03	-	-	21,798
USAF	Aerospace Vehicle Technologies	Composite Certification	Develop, apply, and demonstrate methodology for verifying the reliability of composite structures as predicted to allow a more widespread use of composite structures to future systems such as Future Air Dominance and Next Generation Mobility.	Increase Warfighter Capability	Materials and Design	3600	02	11,331	8,283	36,648

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
USAF	Aerospace Vehicle Technologies	Composite Certification	Develop, apply, and demonstrate methodology for verifying the reliability of composite structures as predicted to allow a more widespread use of composite structures to future systems such as Future Air Dominance and Next Generation Mobility.	Increase Warfighter Capability	Materials and Design	3600	02	7,653	5,932	13,324
USAF	Materials	Composites Certification	Development, maturation & integration of processing, performance & lifting tools for advanced composite, hybrid & multifunctional materials to support transition & certification. Address cradle-to-grave certification. Enable transition/certification.	Increase Warfighter Capability	Materials and Design	3600	02	1,873	12	-
USAF	Advanced Materials for Weapon Systems	Composites Certification	Development, maturation & integration of processing, performance & lifting tools for advanced composite, hybrid & multifunctional materials to support transition & certification. Address cradle-to-grave certification. Enable transition/certification.	Increase Warfighter Capability	Materials and Design	3600	03	-	731	79
USAF	Aerospace Propulsion	Computational Engineering	Technologies, tools, and techniques for the system-level modeling of aircraft power and thermal management.	Increase Warfighter Capability	Modeling and Simulation (M&S), Studies, and Wargames	3600	02	3,833	3,796	18,638
USAF	Defense Research Sciences	Dynamic Data Driven Applications Systems	The DDDAS concept entails the ability to dynamically incorporate additional data into an executing application, and in reverse, the ability of an application to dynamically steer the measurement (instrumentation and control) components of the application system. DDDAS is a key concept for improving modeling of systems under dynamic conditions, more effective management of instrumentation systems, and is a key concept in building and controlling dynamic and heterogeneous resources, including, sensor networks, networks of embedded controllers, and other networked resources.	Increase Warfighter Capability	Power Controls and Distribution	3600	01	6,735	7,611	47,429

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
USAF	Defense Research Sciences	Dynamic Materials and Interactions	The objective of the Dynamic Materials and Interactions portfolio is to develop fundamental scientific knowledge of the dynamic chemistry and physics of complex materials, particularly energetic materials. The portfolio focuses on energetic materials science and shock physics of heterogeneous materials. Research supported by this portfolio seeks to discover, characterize, and leverage (1) fundamental chemistry, physics, and materials science associated with energetic materials; and (2) fundamental shock physics and materials science associated with complex, heterogeneous materials. The research will be accomplished through a balanced mixture of experimental, numerical, and theoretical efforts. This is required for revolutionary advancements in future Air Force weapons and propulsion capabilities including increased energy density and survivability in harsh environments.	Increase Warfighter Capability	Materials and Design	3600	01	5,527	5,243	32,671
USAF	Aerospace Propulsion	Efficient Medium Scale Propulsion	Address propulsion technologies for improved fuel burn and reduced cost of ownership for future subsonic turbines for Group 5 UAS in ISR platforms. The goal of the EMSP Phase I program is to use a common commercial core engine, in the 5,000 to 15,000 lb thrust range, and increase the platform power, demand power and thermal management capability. Additionally, development costs will be reduced.	Increase Warfighter Capability	Propulsion Upgrades -Air	3600	02	2,459	1,685	52,743
USAF	Aerospace Propulsion and Power Technology	Efficient Medium Scale Propulsion	Address propulsion technologies for improved fuel burn and reduced cost of ownership for future subsonic turbines for Group 5 UAS in ISR platforms. The goal of the EMSP Phase I program is to use a common commercial core engine, in the 5,000 to 1	Increase Warfighter Capability	Propulsion Upgrades - Air	3600	03	3,626	2,891	17,165
USAF	Aerospace Propulsion and Power Technology	Efficient Medium Scale Propulsion	Address propulsion technologies for improved fuel burn and reduced cost of ownership for future subsonic turbines for Group 5 UAS in ISR platforms. The goal of the EMSP Phase I program is to use a common commercial core engine, in the 5,000 to 1.	Increase Warfighter Capability	Propulsion Upgrades - Air	3600	03	-	-	24,213
USAF	Aerospace Propulsion	Efficient Small Scale Propulsion (ESSP)	Develop 10X propulsion capability for small engines that increase thrust to weight and decrease specific fuel consumption.	Increase Warfighter Capability	Propulsion Upgrades - Air	3600	02	2,373	691	31,171

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
USAF	Aerospace Propulsion	Efficient Small Scale Propulsion (ESSP)	Develop 10X propulsion capability for small engines that increase thrust to weight and decrease specific fuel consumption.	Increase Warfighter Capability	Propulsion Upgrades - Air	3600	02	-	-	4,436
USAF	Aerospace Propulsion	Electrical Power Systems	Technologies for robust, reliable, efficient power management and distribution.	Increase Warfighter Capability	Power Controls and Distribution	3600	02	7,009	5,469	39,373
USAF	Aerospace Propulsion and Power Technology	Electrical Power Systems	Technologies for robust, reliable, efficient power management and distribution.	Increase Warfighter Capability	Power Controls and Distribution	3600	03	1,219	10,972	5,492
USAF	Aerospace Propulsion	Electro-Mechanical Power Systems	Technologies to improve the size, weight, and energy efficiency of electro-mechanical energy transfer processes.	Increase Warfighter Capability	Power Controls and Distribution	3600	02	4,985	4,190	21,616
USAF	Aerospace Propulsion and Power Technology	Electro-Mechanical Power Systems	Technologies to improve the size, weight, and energy efficiency of electro-mechanical energy transfer processes.	Increase Warfighter Capability	Power Controls and Distribution	3600	03	3,049	-	-
USAF	Defense Research Sciences	Energy, Combustion and Non-Equilibrium Thermodynamics	This portfolio addresses energy needs for propulsion systems and their supporting sub-systems. The portfolio emphasizes three key attributes: Fundamental, Relevant, and Game-Changing, focusing on establishing fundamental understanding and quantifying rate-controlling processes in Air Force relevant energy processes, leading to game-changing concepts and predictive capabilities in Air Force relevant regimes. Multi-disciplinary collaborations and interactions are strongly desired, and joint experimental, theoretical and numerical efforts are highly appreciated.	Increase Warfighter Capability	Materials and Design	3600	01	8,174	7,819	48,722
USAF	Defense Research Sciences	Energy, Combustion and Non-Equilibrium Thermodynamics	MURI, DURIP, and PECASE efforts executed under the Energy, Combustion and Non-Equilibrium Thermodynamics program.	Increase Warfighter Capability	Materials and Design	3600	01	-	1,299	-

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
USAF	Materials	Enhanced Physics-based Prognosis and Inspection for CMCs (EPPIC)	Community desire for precompetitive collaboration on performance, life modeling, and NDE of CMCs. Need physics based tools for predictive damage tolerance approach (i.e., damage initiation and growth) that can capture nuances of sub-component/component features (e.g., ply drops).	Increase Warfighter Capability	Materials and Design	3600	02	-	4,575	14,013
USAF	Materials	Flexible Materials and Processing Research Team	Dev lightweight, flexible, and integrated mtl solutions for adv thin film energy harvesting and storage devices and integrated flexible electronic components. Applications include lightweight power for deployed operations, mechanically robust electronics, and devices for human perf monitoring.	Increase Warfighter Capability	Materials and Design	3600	02	2,481	2,403	15,134
USAF	Defense Research Sciences	Flow Interactions and Control	The Flow Interactions and Control portfolio supports basic research into the dynamics and control of aerodynamic shear flows, including the interactions of these flows with rigid and flexible surfaces. The portfolio is interested in aerodynamic interactions arising in both internal and external flows and extending over a wide range of Reynolds numbers. The portfolio seeks to advance fundamental understanding of complex, time-dependent flow interactions by integrating theoretical/analytical, numerical, and experimental approaches. The focus on the understanding of the fundamental flow physics is motivated by an interest in developing physically-based predictive models and innovative control concepts for these flows. Research in this portfolio is motivated, in part, by the unique fluid-structure interactions that are found in nature, in vortex and shear layer flows, and on novel aerodynamic configurations.	Increase Warfighter Capability	Platform Upgrades - Air	3600	01	5,324	5,578	34,757
USAF	Aerospace Propulsion	Fuel Assessment and Evaluation	Evaluate advanced fuels for performance, environmental impact and system operations,	Reduce Logistics Risks to Mission	Conventional Fuels Testing	3600	02	4,502	4,616	29,355
USAF	Aerospace Propulsion and Power Technology	Fuel Assessment and Evaluation	Demonstrate fuels for performance, environmental impact and system operations,	Increase Warfighter Capability	Conventional Fuels Testing	3600	03	2,262	2,302	14,794

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
USAF	Defense Research Sciences	GHz-THz Electronics and Materials	The objectives of this program include development of low-power electronics based on two-dimensional materials, such as graphere, MoS2, and BN. Such electronics can greatly reduce energy consumption and reduce component sizes, allowing addition of more payloads and weapons. It also includes research on ultrawide-bandgap semiconductors, which could lead to higher-efficiency, higher-power components, including directed-energy weapons.	Increase Warfighter Capability	Materials and Design	3600	01	6,651	6,708	41,797
USAF	Materials	Integrated Comp Methods for Composite Materials (ICM2)	This Integrated Computational Materials Engineering program will demonstrate the ICME methodology of linking composite material processing, property, structure relationships for material design to account for processability, manufacturability, system performance and sustainability.	Increase Warfighter Capability	Materials and Design	3600	02	2,456	-	-
USAF	Aerospace Propulsion	Integrated Vehicle Energy Tech (INVENT)	Develop an integrated suite of efficient, mission adaptive, robust electrical and thermal management systems to reduce aircraft energy demand.	Increase Warfighter Capability	Platform Thermal Management	3600	02	632	731	3,552
USAF	Aerospace Propulsion	ITEMS	Suite of technologies designed to improve the thermal management of air-breathing propulsion systems.	Increase Warfighter Capability	Propulsion Upgrades - Air	3600	02	1,909	2,079	-
USAF	KC-135 C-PUP	KC-135 CFM-56 Propulsion Upgrade Program	CFM Propulsion Upgrade Program (C-PUP) inserts modern technology into F-108 engine. Initiative will change/upgrade the high pressure (HP) turbine nozzle, turbine shroud assembly, turbine blades and compressor blades/vanes.	Enhance Mission Effectiveness	Propulsion Upgrades - Air	3400	02	-	429,562	2,571,338
USAF	Aerospace Vehicle Technologies	Legacy Fleet Energy Efficiency	Develops fuel burn reduction technologies for the legacy and future fleets.	Enhance Mission Effectiveness	Platform Upgrades - Air	3600	02	576	-	1,572
USAF	Aerospace Vehicle Technologies	Legacy Fleet Energy Efficiency	Develops fuel burn reduction technologies for the legacy and future fleets.	Enhance Mission Effectiveness	Platform Upgrades - Air	3600	03	576	-	1,572
USAF	Aerospace Technology Development/ Demonstration	Legacy Fleet Energy Efficiency	Demonstrate improved alloys, process and life prediction methods for engine disks.	Enhance Mission Effectiveness	Platform Upgrades - Air	3600	03	722	-	1,815

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
USAF	Defense Research Sciences	Low Density Materials	The AFOSR Low Density Materials portfolio supports transformative, basic research in materials design and processing to enable weight reductions with concurrent enhancements in performance and function. Such materials can transform the design of future U.S. Air Force aerospace and cyber systems for applications which include airframes, space vehicles, satellites, and load-bearing components and systems.	Increase Warfighter Capability	Materials and Design	3600	01	7,395	7,003	43,640
USAF	Defense Research Sciences	Mechanics of Multifunctional Materials + Microsystems	The main goals of this program are (a) to promote the utilization of newly emerging materials, nano-devices and microsystems in multifunctional design of advanced structures for higher system efficiency, (b) to bridge the gap between the viewpoints from materials science on one side and structural engineering on the other in forming a scientific basis for the materials development and integration criteria, and thereby (c) to establish safer, more maneuverable aerospace vehicles and platforms with unprecedented performance characteristics.	Increase Warfighter Capability	Materials and Design	3600	01	7,573	7,169	44,671
USAF	Aerospace Propulsion	Megawatt Aircraft Power and Thermal	Developing flexible and adaptive Power and Thermal components that allow for synergetic architectures that leverage advanced engine capabilities and energy storage.	Increase Warfighter Capability	Platform Thermal Management	3600	02	6,081	7,071	70,603
USAF	Aerospace Propulsion and Power Technology	Megawatt Aircraft Power and Thermal	Integrating new developments in Power and Thermal components to demonstrate advanced architectures to enable high powered mission systems for future Air Superiority platforms while maintaining energy efficiency. Technology maturation in advanced power and thermal architecture, modeling and simulation, and integration.	Increase Warfighter Capability	Platform Thermal Management	3600	03	-	-	1,895
USAF	Aerospace Propulsion and Power Technology	Megawatt Aircraft Power and Thermal	Integrating new developments in Power and Thermal components to demonstrate advanced architectures to enable high powered mission systems for future Air Superiority platforms while maintaining energy efficiency. Technology maturation in advanced power and thermal architecture, modeling and simulation, and integration.	Increase Warfighter Capability	Platform Thermal Management	3600	03	1,242	10,346	114,378

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
USAF	Materials	Modeling for Affordable, Sustainable Composites (MASC)	ICME tools will be applied toward the manufacturing and sustainment of affordable, lightweight composite materials for aircraft components.	Increase Warfighter Capability	Materials and Design	3600	02	-	10,059	5,568
USAF	Defense Research Sciences	Molecular Dynamics and Theoretical Chemistry	This program seeks a molecular-level description of reaction mechanisms and energy transfer processes related to the efficient storage and utilization of energy. The program supports cutting-edge experimental and joint theory-experiment studies that address key, fundamental questions in these areas. There are four major focus areas in the program: Catalytic Reactivity and Mechanisms; Novel Energetic Material Concepts; Dynamics of Energy Transfer and Transport; and Chemistry in Extreme Environments.	Increase Warfighter Capability	Propulsion Upgrades - Air	3600	01	12,006	11,771	73,347
USAF	Aerospace Vehicle Technologies	Next Generation Mobility	Next Generation Mobility efficient aerodynamics, propulsion integration technology maturation, and advanced structures technology maturation. The objective of this program is to develop and mature advanced aerodynamics technologies for Next Generation Tanker and Next Generation Transport concepts. The objective of this program is to develop and mature advanced lightweight and adaptive structures technologies for Next Generation Tanker and Next Generation Transport concepts.	Increase Warfighter Capability	Materials and Design	3600	02	4,722	4,548	34,810
USAF	Aerospace Vehicle Technologies	Next Generation Mobility	Next Generation Mobility efficient aerodynamics, propulsion integration technology maturation, and advanced structures technology maturation. The objective of this program is to develop and mature advanced aerodynamics technologies for Next Generation Tanker and Next Generation Transport concepts. The objective of this program is to develop and mature advanced lightweight and adaptive structures technologies for Next Generation Tanker and Next Generation Transport concepts.	Increase Warfighter Capability	Materials and Design	3600	02	-	-	25,101

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
USAF	Aerospace Technology Development/ Demonstration	Next Generation Mobility	Next Generation Mobility efficient aerodynamics and propulsion integration technology maturation. The objective of this program is to develop and mature advanced aerodynamics technologies for Next Generation Tanker and Next Generation Transport concepts.	Increase Warfighter Capability	Materials and Design	3600	03	202	606	50,089
551130 4USAF	Advanced Materials for Weapon Systems	Next Generation Turbine Engine Disk System	Increase temperature capability of propulsion disk materials. Mature and implement site specific tech and tools. Increase T3 temperatures, increase efficiencies, mature joining technologies, provide critical design data and durability models.	Increase Warfighter Capability	Materials and Design	3600	03	2,298	1,197	-
USAF	Advanced Materials for Weapon Systems	Next Generation Turbine Engine Disk System II	Increase temperature capability of propulsion disk materials. Mature and implement site specific tech and tools. Increase T3 temperatures, increase efficiencies, mature joining technologies, provide critical design data and durability models.	Increase Warfighter Capability	Materials and Design	3600	03	-	50	5,212
USAF	Advanced Materials for Weapon Systems	OMC Processing-to-Performance Evaluation Research and Analysis (OPPERA)	New manufacturing methods (bonded, infusion) and material forms (textiles, 3-D braiding) are being proposed to enhance future systems. Current SOTA tools do not account for multiphysics interactions or environmental effects in addition to thermomechanical structural response.	Increase Warfighter Capability	Materials and Design	3600	03	-	-	67
USAF	Materials	OMC Processing-to-Performance Evaluation Research and Analysis (OPPERA)	New manufacturing methods (bonded, infusion) and material forms (textiles, 3-D braiding) are being proposed to enhance future systems. Current SOTA tools do not account for multiphysics interactions or environmental effects in addition to thermomechanical structural response.	Increase Warfighter Capability	Materials and Design	3600	02	-	-	16,049

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
USAF	Defense Research Sciences	Organic Materials Chemistry	<p>The goal of this research area is to achieve unusual properties and behaviors from polymeric and organic materials and their inorganic hybrids through a better understanding of their chemistry, physics and processing conditions. This understanding will lead to development of advanced organic and polymeric materials for future U.S. Air Force applications. This program's approach is to study the chemistry and physics of these materials through synthesis, processing control, characterization and establishment of the structure properties relationship of these materials. There are no restrictions on the types of properties to be investigated but heavy emphases will be placed on unusual, unconventional and novel properties. Research concepts that are novel, high risk with potential high payoff are encouraged. Both functional properties and properties pertinent to structural applications will be considered. Materials with these properties will provide capabilities for future Air Force systems to achieving global awareness, global mobility, and space operations.</p>	Increase Warfighter Capability	Materials and Design	3600	01	8,195	7,406	46,147
USAF	Defense Research Sciences	Plasma and Electro-Energetic Physics	<p>The objective of this program is to understand and control the interaction of electromagnetic energy and charged particles to produce useful work in a variety of arenas, including directed energy weapons, sensors and radar, electronic warfare, communications, novel compact accelerators, and innovative applications of plasma chemistry, such as plasma-enhanced combustion. While the focus of this effort is the generation and collective interaction of electromagnetic fields and plasmas, advances in the enabling technology of compact pulsed power, including innovative dielectric and magnetic materials for high-density energy storage, switching devices, and non-linear transmission lines are also of fundamental interest.</p>	Increase Warfighter Capability	Materials and Design	3600	01	11,004	10,838	67,533

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
USAF	Defense Research Sciences	Quantum Electronic Solids	Explores new superconductors, metamaterials, and on nanoscopic electronic devices with low power dissipation and the ability to provide denser non-volatile memory, logic and/or sensing elements.	Increase Warfighter Capability	Materials and Design	3600	01	6,300	5,974	37,221
USAF	Defense Research Sciences	Space Power and Propulsion	Research activities are focused as multi-disciplinary, multi-physics, multi-scale approach to complex problems, and fall into four areas: Coupled Material and Plasma Processes Far From Equilibrium, Nanoenergetics, High Pressure Combustion Dynamics, and Electrospray Physics.	Increase Warfighter Capability	Materials and Design	3600	01	5,267	5,294	32,990
USAF	Human Effectiveness Applied Research	Support for Planning of Air Refueling Tasking and Allocation (SPARTA) Phase 2	Provide next generation decision support tools to enable more efficient air refueling.	Enhance Mission Effectiveness	Current Operations Tools	3600	03	99	89	-
USAF	Aerospace Propulsion and Power Technology	Surfing Aircraft Vortices for Energy (SAVE) Formation Flight Advanced Technology	This ATD will build upon the Surfing Aircraft Vortices for Energy (SAVE) flight demonstration conducted on the C-17 Block 18 aircraft.	Enhance Mission Effectiveness	Current Operations Tools	3600	03	607	-	-
USAF	Materials	Tools for PMC Certification	Objective: enhance modeling tools & address AF airworthiness, sustainment, & SLEP for PMCs. Tasks: 1-modeling bonded assemblies capturing effects of processing of joints & damage/adhesive fracture, and 2-efficient discrete damage modeling for DaDT of PMCs at subcomponent/component level.	Increase Warfighter Capability	Materials and Design	3600	02	8,021	1,263	724
USAF	Advanced Materials for Weapon Systems	Tools for PMC Certification	Objective: enhance modeling tools & address AF airworthiness, sustainment, & SLEP for PMCs. Tasks: 1-modeling bonded assemblies capturing effects of processing of joints & damage/adhesive fracture, and 2-efficient discrete damage modeling for DaDT of PMCs at subcomponent/component level.	Increase Warfighter Capability	Materials and Design	3600	03	327	324	-
USAF	Aerospace Propulsion	UAS Power and Control Product Area	Advanced power and control technologies for expanded and enhanced UAS capabilities.	Increase Warfighter Capability	Power Controls and Distribution	3600	02	4,605	5,837	14,324

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
USAF	University Research Initiative	URI - Aerospace Materials for Extreme Environments	MURI, DURIP, and PECASE efforts executed under the Aerospace Materials for Extreme Environments program.	Increase Warfighter Capability	Materials and Design	3600	01	3,672	6,901	13,132
USAF	University Research Initiative	URI - Dynamic Data Driven Applications Systems	MURI, DURIP, and PECASE efforts executed under the Dynamic Data Driven Applications Systems.	Increase Warfighter Capability	Power Controls and Distribution	3600	01	764	879	855
USAF	University Research Initiative	URI - Dynamic Materials and Interactions	MURI, DURIP, and PECASE efforts executed under the Dynamic Materials and Interactions program.	Increase Warfighter Capability	Materials and Design	3600	01	600	649	-
USAF	University Research Initiative	URI - Flow Interactions and Control	MURI, DURIP, and PECASE efforts executed under the Flow Interactions and Control program.	Increase Warfighter Capability	Platform Upgrades - Air	3600	01	749	898	436
USAF	University Research Initiative	URI - GHz-THz Electronics and Materials	MURI, DURIP, and PECASE efforts executed under the GHz-THz Electronics and Materials.	Increase Warfighter Capability	Materials and Design	3600	01	2,345	3,093	4,088
USAF	University Research Initiative	URI - Low Density Materials	MURI, DURIP, and PECASE efforts executed under the Low-Density Materials program.	Increase Warfighter Capability	Materials and Design	3600	01	1,162	218	218
USAF	University Research Initiative	URI - Mechanics of Multifunctional Materials + Microsystems	MURI, DURIP, and PECASE efforts executed under the Mechanics of Multifunctional Materials + Microsystems program.	Increase Warfighter Capability	Materials and Design	3600	01	533	675	872
USAF	University Research Initiative	URI - Molecular Dynamics and Theoretical Chemistry	MURI, DURIP, and PECASE efforts executed under the Molecular Dynamics and Theoretical Chemistry program.	Increase Warfighter Capability	Propulsion Upgrades - Air	3600	01	2,200	4,918	8,202
USAF	University Research Initiative	URI - Organic Materials Chemistry	MURI, DURIP, and PECASE efforts executed under the Organic Materials Chemistry program.	Increase Warfighter Capability	Materials and Design	3600	01	2,602	3,256	-
USAF	University Research Initiative	URI - Plasma and Electro-Energetic Physics	MURI, DURIP, and PECASE efforts executed under the Plasma and Electro-Energetic Physics program.	Increase Warfighter Capability	Materials and Design	3600	01	5,523	5,128	12,645

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
USAF	University Research Initiative	URI - Quantum Electronic Solids	MURI, DURIP, and PECASE efforts executed under the Quantum Electronic Solids program.	Increase Warfighter Capability	Materials and Design	3600	01	-	8803	15,913
USAF	University Research Initiative	URI - Space Power and Propulsion	MURI, DURIP, and PECASE efforts executed under the Space Power and Propulsion program.	Increase Warfighter Capability	Materials and Design	3600	01	-	2263	7,766
USAF	Advanced Materials for Weapon Systems	2700F SiC SiC Composites for Turbine Hot Section Components	Program will develop, demonstrate subscale, and predict behavior and life of SiC/SiC composites for application in the hot-section of advanced turbine engines to 2700°F, and 3000°F with a coating. Additional applications are in liquid rocket engines, scramjet engines and thermal protection systems.	Increase Warfighter Capability	Materials and Design	3600	03	1,606	125	981
USAF	Materials	2700F SiC SiC Composites for Turbine Hot Section Components	Program will develop, demonstrate subscale, and predict behavior and life of SiC/SiC composites for application in the hot-section of advanced turbine engines to 2700°F, and 3000°F with a coating. Additional applications are in liquid rocket engines, scramjet engines and thermal protection systems.	Increase Warfighter Capability	Materials and Design	3600	02	1,828	83	-
USAF	Aerospace Propulsion	Adaptive Engine Transition Program (AETP)	Mature adaptive engine technologies to TRL 6+ for future integration and flight, while significantly improving fuel consumption. Note: 9 of 10 critical technology elements (CTEs) are scheduled to hit TRL 6; 1 CTE is scheduled to hit TRL 7. **Many of the key component technologies, flow paths and design parameters are either ITAR controlled or classified.	Increase Warfighter Capability	Propulsion Upgrades - Air	3600	04	285,057	592,851	2,306,454

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
USAF	Defense Research Sciences	Aerospace Materials for Extreme Environments	The objective of basic research in Aerospace Materials for Extreme Environments is to provide the fundamental knowledge required to enable revolutionary advances in future U.S. Air Force technologies through the discovery and characterization of materials for extreme temperatures (exceeding 1000°C), other extreme environments of stress-, magnetic-, electric-, microwave-, and ultrasound fields. Interest domain includes the fundamental science of single crystals, heterogeneous structures, interface of phases and grain boundaries. Materials of interest are ceramics, metals, hybrid systems including inorganic composites that exhibit superior structural, functional and/or multifunctional performance.	Increase Warfighter Capability	Materials and Design	3600	01	9,457	9,338	58,186
USAF	Aerospace Propulsion	Air Dominance Adaptive Propulsion Technology (ADAPT)	Design, fabricate, assemble, and test innovative turbine engine technologies that address future Air Superiority capability needs, that provide increased thrust, decreased weight, improved fuel consumption, and improved affordability. For 6.2 activities, provide additional adaptive engine technologies by analyzing variable core technology and testing advanced materials systems.	Increase Warfighter Capability	Propulsion Upgrades - Air	3600	02	1,918	2,241	31,439
USAF	Aerospace Propulsion	Air Dominance Adaptive Propulsion Technology (ADAPT)	Design, fabricate, assemble, and test innovative turbine engine technologies that address future Air Superiority capability needs, that provide increased thrust, decreased weight, improved fuel consumption, and improved affordability. For 6.2 activities, provide additional adaptive engine technologies by analyzing variable core technology and testing advanced materials systems.	Increase Warfighter Capability	Propulsion Upgrades - Air	3600	02	8,708	12,626	87,190
USAF	Aerospace Propulsion and Power Technology	Air Dominance Adaptive Propulsion Technology (ADAPT)	Design, fabricate, assemble, and test innovative turbine engine technologies that address future Air Superiority capability needs, that provide increased thrust, decreased weight, improved fuel consumption, and improved affordability. For 6.3 activities, this program will leverage existing test assets to conduct key core and rig tests in order to advance adaptive engine technologies in the engine core.	Increase Warfighter Capability	Propulsion Upgrades - Air	3600	03	8,488	7,446	102,141

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
USAF	Aerospace Propulsion and Power Technology	Air Dominance Adaptive Propulsion Technology (ADAPT)	Design, fabricate, assemble, and test innovative turbine engine technologies that address future Air Superiority capability needs, that provide increased thrust, decreased weight, improved fuel consumption, and improved affordability. For 6.3 activities, this program will leverage existing test assets to conduct key core and rig tests in order to advance adaptive engine technologies in the engine core.	Increase Warfighter Capability	Propulsion Upgrades - Air	3600	03	8,304	3,876	20,410
ARMY	Chinook Product Improvement Program	Chinook Transportable Flight Proficiency Simulator (TFPS)	Chinook Transportable Flight Proficiency Simulator saves (TFPS).	Enhance Mission Effectiveness	Training and Education	2040	07	9915	3723	1000
ARMY	Combat Service Support Systems - ED	Force Provider	Base Camp Integration Lab (BCIL) Fort, Devens / Net Zero / Zero Footprint.	Enhance Mission Effectiveness	Contingency Basing	2040	05	3594	4362	0
ARMY	Contingency Basing Infrastructure (CBI)	Contingency Basing Infrastructure (CBI)	Optimize recommendations for materiel used to establish, maintain, and operate contingency basing.	Enhance Mission Effectiveness	M&S, Studies, and Wargames	2040	05	3789	3061	0
ARMY	Distribution Systems, Petroleum and Water	Early Entry Fluid Distribution System (E2FDS)	More efficient fuel/non-potable water distribution in the battlespace.	Reduce Logistics Risks to Mission	Fuel Infrastructure	2035	03	5226	4852	37730
ARMY	Distribution Systems, Petroleum and Water	Expeditionary Water Packaging System (EWPS)	EWPS provides localized production of bottle water. Reduced reliance on shipping water into theater.	Enhance Mission Effectiveness	Contingency Basing	2035	03	2768	0	0
ARMY	Distribution Systems, Petroleum and Water	Modular Fuel System (MFS)	More efficient fuel distribution in the battlespace.	Enhance Mission Effectiveness	Fuel Infrastructure	2035	03	9897	10186	120490
ARMY	Engine Driven Gen ED	Improved Power Distribution Illumination Systems Electrical (IPDISE)	More efficient power distribution.	Enhance Mission Effectiveness	Contingency Basing	2040	05	800	1800	11500

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
ARMY	Engine Driven Gen ED	Large Advanced Mobile Power Sources (LAMPS)	Large Advanced Mobile Power Sources (LAMPS).	Enhance Mission Effectiveness	Contingency Basing	2040	05	4100	0	10800
ARMY	Engine Driven Gen ED	Small Tactical Electrical Power (STEP)	Small Tactical Electrical Power (STEP).	Increase Warfighter Capability	Contingency Basing	2040	05	0	0	38100
ARMY	Field Feeding Equipmet	Battlefield Kitchen	Energy efficient burners and appliances save 20% in fuel vs. legacy appliances.	Increase Warfighter Capability	Materials and Design	2035	03	0	2024	0
ARMY	Force Provider	Force Provider	Force Provider procurement.	Enhance Mission Effectiveness	Contingency Basing	2035	03	0	0	28200
ARMY	Generators and Associated Equipment	Advanced Mobile Medium Power Sources (AMMPS) Generator Sets - Both skid and trailer mounted.	Purchase of the improved medium generator sets using 21% less fuel.	Enhance Mission Effectiveness	Contingency Basing	2035	03	97149	122322	243528
ARMY	Generators and Associated Equipment	Improved Power Distribution Illumination Systems Electrical (IPDISE)	More efficient power distribution.	Enhance Mission Effectiveness	Contingency Basing	2035	03	11707	2104	38151
ARMY	Generators and Associated Equipment	Large Advanced Mobile Power Sources (LAMPS)	Large Advanced Mobile Power Sources (LAMPS)	Enhance Mission Effectiveness	Contingency Basing	2035	03	500	1976	16918
ARMY	Generators and Associated Equipment	Small Tactical Electrical Power (STEP)	Small Tactical Electric Power (STEP)	Increase Warfighter Capability	Contingency Basing	2035	03	6325	7939	39506
ARMY	Ground Soldier System	Nett Warrior	Reduces Soldier Load, improved battery output, reduced weight, and ability to recharge them from alternative energy sources.	Enhance Mission Effectiveness	Individual/ Warfighter Power	2035	03	9152	4252	81930
ARMY	Heaters and ECUs	Improved Environmental Control Unit (IECU)	Heaters and Improved Environmental Control Unit (IECU) family.	Enhance Mission Effectiveness	Contingency Basing	2035	03	7675	10122	39864

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
ARMY	Improved Environmental Control Unit (IECU) - ED	Improved Environmental Control Unit (IECU)	Heaters and Improved Environmental Control Unit (IECU) family.	Enhance Mission Effectiveness	Contingency Basing	2040	05	1873	2262	8838
ARMY	Improved Turbine Engine Program (ITEP)	Improved Aircraft Engine	More efficient helicopter engine. The Army expects 13% to 25% fuel reduction from current Blackhawk/Apache engines. Flies at higher altitudes, in hotter temperatures and increased range.	Increase Warfighter Capability	Propulsion Upgrades - Air	2040	07	167532	196074	1074196
ARMY	Integrated Soldier Power Data System - Core (ISPDS-C)	Integrated Soldier Power Data System - Core (ISPDS-C)	Reduces Soldier Load, improved battery output, reduced weight, and ability to recharge them from alternative energy sources.	Enhance Mission Effectiveness	Individual/Warfighter Power	2040	05	6671	2767	5188
ARMY	Joint Light Tactical Vehicle	Joint Light Tactical Vehicle (JLTV)	More efficient light vehicle - ~30% improvement in stationary fuel consumption over the baseline HMMWV.	Enhance Mission Effectiveness	Platform Upgrades - Land	2040	05	0	0	49
ARMY	Joint Light Tactical Vehicle	Joint Light Tactical Vehicle (JLTV)	More efficient light vehicle - ~30% improvement in stationary fuel consumption over the baseline HMMWV.	Enhance Mission Effectiveness	Platform Upgrades - Land	2035	01	10856	17252	71452
ARMY	M1 Abrams Tank MOD	Improved Abrams	Advanced Reliability & Cost Savings (ARCS) for the AGT-1500 Turbine Engine.	Enhance Mission Effectiveness	Platform Upgrades - Land	2033	01	3200	300	0
ARMY	Howitzer, MED SP FT 155MM M109A6	M109 Family of Vehicles (FOV) Paladin Integrated Management (PIM)	An alternative transmission that could provide 8 – 25% increase in range.	Enhance Mission Effectiveness	Propulsion Upgrades - Land	2033	01	3381	0	0
ARMY	Paladin PIM MOD In Service	M109 Family of Vehicles (FOV) Paladin Integrated Management (PIM)	An alternative transmission that could provide 8 – 25% increase in range.	Enhance Mission Effectiveness	Propulsion Upgrades - Land	2033	01	52500	53700	203000
ARMY	Mobile Soldier Power	Platoon Power Generation (PPG)	Platoon Power Generation	Enhance Mission Effectiveness	Individual/Warfighter Power	2035	03	0	0	10424
ARMY	Mobile Soldier Power	Integrated Soldier Power/Data System - Core (ISPDS-C)	Reduces Soldier Load, improved battery output, reduced weight, and ability to recharge them from alternative energy sources.	Enhance Mission Effectiveness	Individual/Warfighter Power	2035	03	4533	22318	35332

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
ARMY	Mobile Soldier Power	Universal Battery Charger (UBC)	Reduces Soldier Load, improved battery output, reduced weight, and ability to recharge them from alternative energy sources.	Enhance Mission Effectiveness	Individual/Warfighter Power	2035	03	1898	8456	19941
ARMY	Soldier Power	Platoon Power Generation (PPG)	Platoon Power Generation	Enhance Mission Effectiveness	Individual/Warfighter Power	2040	05	6306	5273	1419
ARMY	Soldier Power Generator	Squad Power Manager (SPM)	Reduces Soldier Load, improved battery output, reduced weight, and ability to recharge them from alternative energy sources.	Enhance Mission Effectiveness	Individual/Warfighter Power	2040	05	0	318	0
ARMY	Stryker Improvement	Improved Stryker	More efficient Stryker, increased horsepower, electrical output, upgraded suspension, and in-vehicle network.	Enhance Mission Effectiveness	Propulsion Upgrades - Land	2040	07	25400	5000	7600
ARMY	Stryker Upgrade	Improved Stryker	More efficient Stryker, increased horsepower, electrical output, upgraded suspension, and in-vehicle network.	Enhance Mission Effectiveness	Propulsion Upgrades - Land	2033	01	633000	265300	2750000
ARMY	UH-60 Black Hawk (MYP)	Black Hawk Aircrew Simulators	The Blackhawk simulator saves fuel and enhances safety.	Enhance Mission Effectiveness	Training and Education	2031	01	11329	0	0
ARMY	UH-60 Black Hawk A and L Models	Black Hawk Aircrew Simulators	The Blackhawk simulator saves fuel and enhances safety.	Enhance Mission Effectiveness	Training and Education	2031	01	0	0	44925
ARMY	Universal Battery Charger (UBC)	Universal Battery Charger (UBC)	Reduces Soldier Load, improved battery output, reduced weight, and ability to recharge them from alternative energy sources.	Enhance Mission Effectiveness	Individual/Warfighter Power	2040	05	1663	1361	4711
ARMY	Water and Petroleum Distribution - AD	Early Entry Fluid Distribution System (E2FDS)	More efficient fuel/non-potable water distribution in the battlespace.	Reduce Logistics Risks to Mission	Fuel Infrastructure	2040	04	2985	0	0
ARMY	Water and Petroleum Distribution - ED	Early Entry Fluid Distribution System (E2FDS)	More efficient fuel/non-potable water distribution in the battlespace.	Reduce Logistics Risks to Mission	Fuel Infrastructure	2040	05	747	4885	0
ARMY	Contr. Logistics & Technical Support	Fuel Infrastructure	More efficient bulk fuel distribution in the battlespace.	Reduce Logistics Risks to Mission	Contingency Basing	2020	02	519.268	561.801	3535.944
ARMY	NAVSEA Penn State ARL	Fuel Infrastructure	More efficient bulk fuel distribution in the battlespace.	Reduce Logistics Risks to Mission	Contingency Basing	2020	02	337	362.672	2040.749

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ARMY	TARDEC Engering Support	Fuel Infrastructure	More efficient bulk fuel distribution in the battlespace.	Reduce Logistics Risks to Mission	Contingency Basing	2020	02	127.157	134.327	746.816
ARMY	IPDS Fuel Unit COSIS	Fuel Infrastructure	More efficient bulk fuel distribution in the battlespace.	Reduce Logistics Risks to Mission	Contingency Basing	2020	02	983.106	310.943	1779.178
ARMY	IPDS Pipeline Con Asbly PLCA COSIS	Fuel Infrastructure	More efficient bulk fuel distribution in the battlespace.	Reduce Logistics Risks to Mission	Contingency Basing	2020	02	0	0	158.624
ARMY	IPDS Pipeline Spt Equip PSE COSIS	Fuel Infrastructure	More efficient bulk fuel distribution in the battlespace.	Reduce Logistics Risks to Mission	Contingency Basing	2020	02	0	0	257.677
ARMY	IPDS Pump Station COSIS	Fuel Infrastructure	More efficient bulk fuel distribution in the battlespace.	Reduce Logistics Risks to Mission	Contingency Basing	2020	02	978.325	1032.329	4903.298
ARMY	IPDS 5 Mile Pipeline Set COSIS	Fuel Infrastructure	More efficient bulk fuel distribution in the battlespace.	Reduce Logistics Risks to Mission	Contingency Basing	2020	02	1073.148	1087.208	4168.341
ARMY	IPDS ISO/TRICON Repair/Replac e/Cert.	Fuel Infrastructure	More efficient bulk fuel distribution in the battlespace.	Reduce Logistics Risks to Mission	Contingency Basing	2020	02	300	316.56	2085
ARMY	IPDS JTX Set SUPPORT	Fuel Infrastructure	More efficient bulk fuel distribution in the battlespace.	Reduce Logistics Risks to Mission	Contingency Basing	2020	02	350	369.32	1924.37
ARMY	210K Bulk Fuel Tank Assy Replace.	Fuel Infrastructure	More efficient bulk fuel distribution in the battlespace.	Reduce Logistics Risks to Mission	Contingency Basing	2020	02	0	0	39926.76
ARMY	Pump Station Engine Sustainment Pgm	Fuel Infrastructure	More efficient bulk fuel distribution in the battlespace.	Reduce Logistics Risks to Mission	Contingency Basing	2020	02	1211.462	2789.094	13273.31
ARMY	800 GPM Engine installation Kit	Fuel Infrastructure	More efficient bulk fuel distribution in the battlespace.	Reduce Logistics Risks to Mission	Contingency Basing	2020	02	1000	2279.232	4609.872

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
ARMY	Pipeline Gasket Replace Sust Pgm	Fuel Infrastructure	More efficient bulk fuel distribution in the battlespace.	Reduce Logistics Risks to Mission	Contingency Basing	2020	02	2860	3017.872	5965.09
USMC	Advanced Power Sources	SPACES. GREENS, RPAs	Advanced Power Sources is a family of small power devices to provide portable electric power for legacy and future weapons, optics, sensors, medical, intelligence and communications systems. The Family consists of multiple suites, to include: Family of USMC Standard Power Supplies, Family of Radio Power Adaptors, Battery Management and Sustainment Systems, Communications / Electronics batteries, Lead acid batteries Battery Chargers and Analyzers, Solar and Renewable Energy Systems, Mobile Electric Hybrid Power Systems (MEHPS), Emerging requirements that involve standardizations, and Naval Lithium Battery Safety Program management.	Enhance Mission Effectiveness	Individual/ Warfighter Power	1106	01	501	659	3500
USMC	Advanced Power Sources	SPACES. GREENS, RPAs	Advanced Power Sources is a family of small power devices to provide portable electric power for legacy and future weapons, optics, sensors, medical, intelligence and communications systems. The Family consists of multiple suites, to include: Family of USMC Standard Power Supplies, Family of Radio Power Adaptors, Battery Management and Sustainment Systems, Communications / Electronics batteries, Lead acid batteries Battery Chargers and Analyzers, Solar and Renewable Energy Systems, Mobile Electric Hybrid Power Systems (MEHPS), Emerging requirements that involve standardizations, and Naval Lithium Battery Safety Program management.	Enhance Mission Effectiveness	Individual/ Warfighter Power	1106	01	0	0	0

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
USMC	Advanced Power Sources	GREENS/MEHPS	Advanced Power Sources is a family of small power devices to provide portable electric power for legacy and future weapons, optics, sensors, medical, intelligence and communications systems. The Family consists of multiple suites, to include: Family of USMC Standard Power Supplies, Family of Radio Power Adaptors, Battery Management and Sustainment Systems, Communications / Electronics batteries, Lead acid batteries Battery Chargers and Analyzers, Solar and Renewable Energy Systems, Mobile Electric Hybrid Power Systems (MEHPS), Emerging requirements that involve standardizations, and Naval Lithium Battery Safety Program management.	Enhance Mission Effectiveness	Individual/Warfighter Power	1109	06	1425	9782	68605
USMC	Advanced Power Sources	GREENS/MEHPS	Advanced Power Sources is a family of small power devices to provide portable electric power for legacy and future weapons, optics, sensors, medical, intelligence and communications systems. The Family consists of multiple suites, to include: Family of USMC Standard Power Supplies, Family of Radio Power Adaptors, Battery Management and Sustainment Systems, Communications / Electronics batteries, Lead acid batteries Battery Chargers and Analyzers, Solar and Renewable Energy Systems, Mobile Electric Hybrid Power Systems (MEHPS), Emerging requirements that involve standardizations, and Naval Lithium Battery Safety Program management.	Enhance Mission Effectiveness	Individual/Warfighter Power	1109	06	0	0	0

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
USMC	Advanced Power Sources	MEHPS	Advanced Power Sources is a family of small power devices to provide portable electric power for legacy and future weapons, optics, sensors, medical, intelligence and communications systems. The Family consists of multiple suites, to include: Family of USMC Standard Power Supplies, Family of Radio Power Adaptors, Battery Management and Sustainment Systems, Communications / Electronics batteries, Lead acid batteries Battery Chargers and Analyzers, Solar and Renewable Energy Systems, Mobile Electric Hybrid Power Systems (MEHPS), Emerging requirements that involve standardizations, and Naval Lithium Battery Safety Program management.	Enhance Mission Effectiveness	Individual/Warfighter Power	1109	06	1784	1832	9726
USMC	Advanced Power Sources	MEHPS	Advanced Power Sources is a family of small power devices to provide portable electric power for legacy and future weapons, optics, sensors, medical, intelligence and communications systems. The Family consists of multiple suites, to include: Family of USMC Standard Power Supplies, Family of Radio Power Adaptors, Battery Management and Sustainment Systems, Communications / Electronics batteries, Lead acid batteries Battery Chargers and Analyzers, Solar and Renewable Energy Systems, Mobile Electric Hybrid Power Systems (MEHPS), Emerging requirements that involve standardizations, and Naval Lithium Battery Safety Program management.	Enhance Mission Effectiveness	Individual/Warfighter Power	1109	06	0	0	0

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
USMC	Advanced Power Sources	SPACES. GREENS, RPAs	Advanced Power Sources is a family of small power devices to provide portable electric power for legacy and future weapons, optics, sensors, medical, intelligence and communications systems. The Family consists of multiple suites, to include: Family of USMC Standard Power Supplies, Family of Radio Power Adaptors, Battery Management and Sustainment Systems, Communications / Electronics batteries, Lead acid batteries Battery Chargers and Analyzers, Solar and Renewable Energy Systems, Mobile Electric Hybrid Power Systems (MEHPS), Emerging requirements that involve standardizations, and Naval Lithium Battery Safety Program management.	Enhance Mission Effectiveness	Individual/ Warfighter Power	1106	01	165	1	5
USMC	Advanced Power Sources	SPACES. GREENS, RPAs	Advanced Power Sources is a family of small power devices to provide portable electric power for legacy and future weapons, optics, sensors, medical, intelligence and communications systems. The Family consists of multiple suites, to include: Family of USMC Standard Power Supplies, Family of Radio Power Adaptors, Battery Management and Sustainment Systems, Communications / Electronics batteries, Lead acid batteries Battery Chargers and Analyzers, Solar and Renewable Energy Systems, Mobile Electric Hybrid Power Systems (MEHPS), Emerging requirements that involve standardizations, and Naval Lithium Battery Safety Program management.	Enhance Mission Effectiveness	Individual/ Warfighter Power	1106	01	0	0	0

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
USMC	Advanced Power Sources	Next Generation SPACES, GREENS	Advanced Power Sources is a family of small power devices to provide portable electric power for legacy and future weapons, optics, sensors, medical, intelligence and communications systems. The Family consists of multiple suites, to include: Family of USMC Standard Power Supplies, Family of Radio Power Adaptors, Battery Management and Sustainment Systems, Communications / Electronics batteries, Lead acid batteries Battery Chargers and Analyzers, Solar and Renewable Energy Systems, Mobile Electric Hybrid Power Systems (MEHPS), Emerging requirements that involve standardizations, and Naval Lithium Battery Safety Program management.	Increase Warfighter Capability	Individual/Warfighter Power	1319	07	871	2289	12236
USMC	Advanced Power Sources	Next Generation SPACES, GREENS	Advanced Power Sources is a family of small power devices to provide portable electric power for legacy and future weapons, optics, sensors, medical, intelligence and communications systems. The Family consists of multiple suites, to include: Family of USMC Standard Power Supplies, Family of Radio Power Adaptors, Battery Management and Sustainment Systems, Communications / Electronics batteries, Lead acid batteries Battery Chargers and Analyzers, Solar and Renewable Energy Systems, Mobile Electric Hybrid Power Systems (MEHPS), Emerging requirements that involve standardizations, and Naval Lithium Battery Safety Program management.	Increase Warfighter Capability	Individual/Warfighter Power	1319	07	0	0	0

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
USMC	Advanced Power Sources	SPACES. GREENS, RPAs	Advanced Power Sources is a family of small power devices to provide portable electric power for legacy and future weapons, optics, sensors, medical, intelligence and communications systems. The Family consists of multiple suites, to include: Family of USMC Standard Power Supplies, Family of Radio Power Adaptors, Battery Management and Sustainment Systems, Communications / Electronics batteries, Lead acid batteries Battery Chargers and Analyzers, Solar and Renewable Energy Systems, Mobile Electric Hybrid Power Systems (MEHPS), Emerging requirements that involve standardizations, and Naval Lithium Battery Safety Program management.	Enhance Mission Effectiveness	Individual/ Warfighter Power	1106	03	105	107	565
USMC	Advanced Power Sources	SPACES. GREENS, RPAs	Advanced Power Sources is a family of small power devices to provide portable electric power for legacy and future weapons, optics, sensors, medical, intelligence and communications systems. The Family consists of multiple suites, to include: Family of USMC Standard Power Supplies, Family of Radio Power Adaptors, Battery Management and Sustainment Systems, Communications / Electronics batteries, Lead acid batteries Battery Chargers and Analyzers, Solar and Renewable Energy Systems, Mobile Electric Hybrid Power Systems (MEHPS), Emerging requirements that involve standardizations, and Naval Lithium Battery Safety Program management.	Enhance Mission Effectiveness	Individual/ Warfighter Power	1106	03	0	0	0
USMC	Advanced Technology Demo	Marine Corps Operational Energy: Energy Optimization and Logistic Burden Reduction	Advanced Technology Demonstration research to optimize energy usage and/or meet operational energy demand with renewable energy sources and reduce excess capacity or reduce logistic footprint/burden energy sources. Develop, optimize, integrate, and demonstrate at least 15% fuel efficiency improvement over the existing MTRV.	Increase Warfighter Capability	Individual/ Warfighter Power	1319	03	9501	5950	27664

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
USMC	Advanced Technology Demo	Marine Corps Operational Energy: Energy Optimization and Logistic Burden Reduction	Advanced Technology Demonstration research to optimize energy usage and/or meet operational energy demand with renewable energy sources and reduce excess capacity or reduce logistic footprint/burden energy sources. Develop, optimize, integrate, and demonstrate at least 15% fuel efficiency improvement over the existing MTRV.	Increase Warfighter Capability	Individual/Warfighter Power	1319	03	0	0	0
USMC	Applied Research	Marine Corps Operational Energy: Energy Efficiency and Demand Reduction	Applied Research to increase energy efficiency in weapons systems, platforms, vehicles and equipment and extend tactical range/operational reach. Develop, optimize, integrate, and demonstrate at least 15% fuel efficiency improvement over the existing MTRV.	Increase Warfighter Capability	Individual/Warfighter Power	1319	02	2950	2450	10518
USMC	Applied Research	Marine Corps Operational Energy: Energy Efficiency and Demand Reduction	Applied Research to increase energy efficiency in weapons systems, platforms, vehicles and equipment and extend tactical range/operational reach. Develop, optimize, integrate, and demonstrate at least 15% fuel efficiency improvement over the existing MTRV.	Increase Warfighter Capability	Individual/Warfighter Power	1319	02	0	0	0
USMC	Environmental Control Equipment	Improved Environmental Control Units	Family includes ECUs. Portfolio is horizontal/vertical configured MC Standard air conditioners. ECUs range fr 9,000 to 120,000 BTUs for 50/60/400HZ. EECU provides ~17% increased efficiency across the portfolio of systems.	Increase Warfighter Capability	Contingency Basing	1319	07	507	518	2760
USMC	Environmental Control Equipment	Improved Environmental Control Units	Family includes ECUs. Portfolio is horizontal/vertical configured MC Standard air conditioners. ECUs range fr 9,000 to 120,000 BTUs for 50/60/400HZ. EECU provides ~17% increased efficiency across the portfolio of systems.	Increase Warfighter Capability	Contingency Basing	1319	07	0	0	0
USMC	Environmental Control Equipment	Improved Environmental Control Units	Family includes ECUs. Portfolio is horizontal/vertical configured MC Standard air conditioners. ECUs range fr 9,000 to 120,000 BTUs for 50/60/400HZ. EECU provides ~17% increased efficiency across the portfolio of systems.	Enhance Mission Effectiveness	Contingency Basing	1109	06	0	495	1964

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
USMC	Environmental Control Equipment	Improved Environmental Control Units	Family includes ECUs. Portfolio is horizontal/vertical configured MC Standard air conditioners. ECUs range fr 9,000 to 120,000 BTUs for 50/60/400HZ. EECU provides ~17% increased efficiency across the portfolio of systems.	Enhance Mission Effectiveness	Contingency Basing	1109	06	0	0	0
USMC	Environmental Control Equipment	Improved Environmental Control Units	Family includes ECUs. Portfolio is horizontal/vertical configured MC Standard air conditioners. ECUs range fr 9,000 to 120,000 BTUs for 50/60/400HZ. EECU provides ~17% increased efficiency across the portfolio of systems.	Enhance Mission Effectiveness	Contingency Basing	1106	01	0	66	354
NAVY	Integrated Condition Assessment System	Integrated Condition Assessment System	The Integrated Condition Assessment System is a combination of hardware and software that allows for remote monitoring of shipboard engineering systems. This data is used for condition based maintenance planning, trouble shooting, and input to the Energy Dashboard.	Enhance Mission Effectiveness	Metering and Monitoring	1810	01	745	759	0
NAVY	Ship Preliminary Design and Feasibility Studies	Improved Metering and Monitoring	Design of work packages for fuel meters and shore power meters. This fuel metering technology corrects for density, temperature and air entrapment. A Shore Power Monitor stores energy and power quality data including cumulative kWh, peaks, and several power quality metrics. The compiled data enables MSC to monitor and manage shore power usage and implement appropriate energy conservation measures. The combination of these meters will feed into an Energy Dashboard used to monitor real time energy usage, which will enable ship operators to make operational changes that decrease overall energy usage.	Enhance Mission Effectiveness	Metering and Monitoring	1319	04	150	0	1374
NAVY	Ship Preliminary Design and Feasibility Studies	Route Planning & Optimization	Developing route planning programs, such as the Replenishment At Sea Planner (RASP), that can improve MSC's scheduling of ships between ports and underway combatant customer ships, thereby reducing fuel consumption. Once underway, ship optimization tools can be used to optimize the ship's equipment to further reduce fuel consumption.	Enhance Mission Effectiveness	Current Operations Tools	1319	04	350	0	125

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
NAVY	Ship Preliminary Design and Feasibility Studies	Hull Coatings	Testing and prototyping the application of commercially available hull coatings to better match hull coating to ship operational tempo. The goal is to prevent biofouling so that propulsive efficiency is maximized.	Enhance Mission Effectiveness	Platform Upgrades - Sea	1319	04	686	555	2968
NAVY	Ship Preliminary Design and Feasibility Studies	HVAC&R Efficiency Improvement	Design and research of ways of automating plant control systems, matching plant generation to demand, and using Variable Air Volume design; HVAC&R plants can be made efficient through a range of conditions and still retain the full maximum capacity. Examples of HVAC&R initiatives include T-AKE Intelligent HVAC, auxiliary pre-stage refrigeration units and the implementation of intelligent HVAC on other ship classes.	Enhance Mission Effectiveness	Platform Upgrades - Sea	1319	04	1104	0	4976
NAVY	Energy Conservation	Hull Husbandry	This project will be utilized to identify and evaluate new underwater hull coating systems and underwater hull cleaning and maintenance techniques to reduce hydrodynamic drag on the hull and thereby increase fuel efficiency.	Increase Warfighter Capability	Platform Upgrades - Sea	1319	04	0	0	958
NAVY	Hybrid Electric Drive (HED)	HED Backfit for DDG 51 CL FL IIA	The Hybrid Electric Drive (HED) consists of an electric motor which can be coupled to the propulsion reduction gear to provide propulsion power from the ship service gas turbine generators (SSGTGs) during low speed operations. This will permit the securing of one or more propulsion gas turbines and allow higher power loading resulting in more efficient operation of the SSGTGs, which will be generating electric power for the HED as well as ship service power. In addition to reducing fuel consumption and the associated costs, HED results in the additional benefits of increasing the ship's range, increased time on station performing its mission, and reducing the frequency of fuel replenishment.	Enhance Mission Effectiveness	Propulsion Upgrades - Sea	1319	05	982	0	0
NAVY	Fleet Energy Managers	Fleet Energy Managers	Fleet Energy Managers (FEMS) support development of policy and oversight for Operational Energy program at the Fleet levels.	Enhance Mission Effectiveness	Metering and Monitoring	1804	01	2198	0	0

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
NAVY	Common Group Equipment	Simulator Upgrades	Implements capability and capacity upgrades required to maximize T&R simulation for F/A-18E/F, EA-18G, and MH-60R/S aircraft given fiscal, technological, and minimum flight time limitations as identified in the Navy Aviation Simulator Master Plan (NASMP).	Enhance Mission Effectiveness	Simulators Aviation	1506	07	74066	74147	74327
NAVY	Maritime Energy Initiatives (MEI)	DDG 51 FLT IIA Shipboard Energy Dashboard (SED FLT IIA)	Shipboard tool providing real-time situational awareness of the energy demand associated with equipment line-ups and mission for DDG FLT IIA platforms.	Increase Warfighter Capability	Platform Upgrades - Sea	1810	01	174	0	0
NAVY	Maritime Energy Initiatives (MEI)	DDG 51 FLT IIA Bulbous Bow	Modifies bow shape to reduce hull wave drag without an increase in hull resistance. Alteration reduces fuel consumption and emissions, and increases range, time-on-station and periods between refueling.	Increase Warfighter Capability	Platform Upgrades - Sea	1810	01	259	0	0
NAVY	Maritime Energy Initiatives (MEI)	DDG 51 Hangar Bay SSL	Replaces 50W and 110W incandescent globes fixtures and 1, 2, and 3 lamp fluorescent bulbs with LEDs to reduce energy usage. Install also reduces electrical lighting load, maintenance actions, HAZMAT, and space needed for spare parts.	Increase Warfighter Capability	Platform Upgrades - Sea	1810	01	363	170	0
NAVY	Maritime Energy Initiatives (MEI)	DDG 51 Variable Speed Drive for Collective Protection System (VSD CPS)	Incorporates modern VSD controls to adjust fan speeds to suit conditions and reduce energy consumption under normal operating conditions. VSDs used to control CPS supply fans to optimize supply air flow so that energy savings from fan motors and reduced HVAC loads can be realized. Alteration also provides greater situational awareness of CPS and simplifies maintenance.	Increase Warfighter Capability	Platform Upgrades - Sea	1810	01	2805	0	0
NAVY	Maritime Energy Initiatives (MEI)	DDG 51 Solid State Lighting (SSL)	Replaces 50W and 110W incandescent globes fixtures and 1, 2, and 3 lamp fluorescent bulbs with LEDs to reduce energy usage. Install also reduces electrical lighting load, maintenance actions, HAZMAT, and space needed for spare parts.	Increase Warfighter Capability	Platform Upgrades - Sea	1810	01	5114	1123	0
NAVY	Maritime Energy Initiatives (MEI)	DDG 51 Thermal Management Control System (TMCS)	Provides centralized control and monitoring of space temps at design set-points for each compartment throughout the ship. Technology enables improved operational efficiency of the HVAC system, thereby lowering AC loads and reducing electrical demand.	Increase Warfighter Capability	Platform Upgrades - Sea	1810	01	5609	0	0

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
NAVY	Amphib Solid State Lighting (SSL)	Amphib Solid State Lighting (SSL)	Replaces 50W and 110W incandescent globes fixtures and select lamp fluorescent bulbs with LEDs to reduce energy usage. Install also reduces electrical lighting load, maintenance actions, HAZMAT, and space needed for spare parts.	Increase Warfighter Capability	Platform Upgrades - Sea	1810	01	678	6406	0
NAVY	Ship Preliminary Design and Feasibility Studies	Operational Energy, Logistics, and Total Ownership Cost Reduction Broad Agency Announcement for CLF Ships	Naval Surface Warfare Center Carderock Division's (NSWCCD) Broad Agency Announcement (BAA) is intended to solicit industry, academia, and government agencies to discover new, cost-effective, and innovative ways of using less energy, lowering ownership cost, and improving ship logistics through new equipment or technology. The BAA is a vehicle to help identify, research, and develop future initiatives to the point where they can be directly applied to ship-based environments.	Increase Warfighter Capability	Platform Upgrades - Sea	1319	04	150	0	3332
NAVY	Ship Preliminary Design and Feasibility Studies	Auditing, Modeling & Savings Analysis	Conduct shipboard energy audits to analyze energy usage onboard ships, facilitate and optimize energy reduction methods, and analyze the alternatives to reduce energy costs. This data will feed into the ENCON Calibrated Baseline Model for each ship class. Once calibrated through audit data input, the model serves as an accurate and flexible tool to generate baseline energy usage profiles for various missions, load-outs, area or operations, and operating conditions. Highlights in this effort include: shipboard measurement and verification protocol, class energy profile exercises, and retro-commissioning.	Increase Warfighter Capability	Metering and Monitoring	1319	04	50	50	0
NAVY	Future Naval Capabilities Applied Research	Shipboard Gas Turbine Marinization Package for Higher Temperature, Higher Pressure Operation (FNC)	A package of advanced materials that will realize an improvement of 3X or more in engine life at higher operating temperatures.	Increase Warfighter Capability	Materials and Design	1319	02	1700	800	0

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
NAVY	Future Naval Capabilities Advanced Tech Dev	Shipboard Gas Turbine Marinization Package for Higher Temperature, Higher Pressure Operation (FNC)	A package of advanced materials that will realize an improvement of 3X or more in engine life at higher operating temperatures.	Increase Warfighter Capability	Materials and Design	1319	03	645	3683	2508
NAVY	Defense Research Sciences	Heat Transfer & Thermal Management Science	Advance thermal science and technology through fundamental studies of multi-phase heat transfer, fluid dynamics, and nanostructured materials to efficiently acquire, transport, and reject heat and enable higher power density electronic systems.	Increase Warfighter Capability	Platform Thermal Management	1319	01	1644	1848	9463
NAVY	Defense Research Sciences	Energy Storage and Power Management	Advancing power and energy science through fundamental research in the areas of conductor and permanent magnet materials, energy conversion, combustion, and cyber physical system modeling.	Increase Warfighter Capability	Platform Upgrades - Sea	1319	01	2194	2532	12970
NAVY	Force Protection Applied Research	Energy Efficiency & Alternative Energy Technologies	Applied research on unmanned vehicle fuel cell power systems, high temperature energy systems, photovoltaics, wave energy testing, and microgrid analyses.	Increase Warfighter Capability	Platform Upgrades - Sea	1319	02	14594	16193	85139
NAVY	Force Protection Applied Research	Next Generation Integrated Power System	Applied Research supporting activities linked with newly established Combat Power and Energy Systems (CPES) led by NAVSEA and PEO(Ships), including research on complex energy network controls in coordination with PMS320.	Increase Warfighter Capability	Platform Upgrades - Sea	1319	02	775	956	4764
NAVY	Undersea Warfare Applied Research	Undersea Weaponry (USW) - Power & Energy	Applied research to develop component, subsystem and system technologies that are the critical building blocks for advanced high-energy-density and power-density propulsion systems, enabling increased endurance (days/weeks/months) and reliability in an air-independent environment. Approaches include modeling and simulation, fuel cells, engines, novel fuels/oxidizers and reactant storage/delivery systems.	Increase Warfighter Capability	Propulsion Upgrades - Sea	1319	02	1410	1200	6072

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
NAVY	Warfighter Sustainment Applied Research	Bioengineering and Life Sciences (Energy)	Applied research to develop practical full fuel cell devices implementing (1) novel oxygen reduction reaction (ORR) catalysts, that show record high half-cell performance in a laboratory setting, and (2) novel supports for these platinum-based ORR catalysts.	Increase Warfighter Capability	Materials and Design	1319	02	408	625	869
NAVY	Warfighter Sustainment Applied Research	Tech Candiates (Energy)	Applied research to develop practical full fuel cell devices implementing (1) novel oxygen reduction reaction (ORR) catalysts, that show record high half-cell performance in a laboratory setting, and (2) novel supports for these platinum-based ORR catalysts.	Increase Warfighter Capability	Materials and Design	1319	02	198	0	0
NAVY	Defense Research Sciences	Bioengineering and Life Sciences (Energy) - Biofabrication	Basic research exploring bio-fabrication for generation of inorganic energy harvesting/conversion materials; bacterial-inorganic hybrid materials for fuel cells; nano-biomaterials for generating high intensity light sources; and silk-based materials as the foundation of a new generation of eco- or bio-resorbable energy harvesting/conversion devices (photoactive devices, fuel cells, and batteries).	Increase Warfighter Capability	Materials and Design	1319	01	475	518	321
NAVY	Defense Research Sciences	Basic Catalysis	Basic research exploring chemical transformations via catalytic processes, including the production of hydrogen from precursor molecules.	Increase Warfighter Capability	Materials and Design	1319	01	705	816	0
NAVY	Defense Research Sciences	Bioengineering and Life Sciences (Energy)	Basic research exploring the fundamental mechanism of bacterial spores' water-responsive behaviors in order to develop practical applications using the evaporation energy harvesting technique, and next generation actuators.	Increase Warfighter Capability	Alternative Power Sources	1319	01	66	218	274
NAVY	Defense Research Sciences	Bioengineering and Life Sciences (Energy)	Basic research investigating silk-based materials as the foundation of a new generation of eco- or bio-resorbable energy harvesting/conversion devices (photoactive devices, fuel cells, and batteries).	Increase Warfighter Capability	Materials and Design	1319	01	523	0	0
NAVY	Defense Research Sciences	ONRG International Research	Basic research with international principle investigators doing collaborative and cooperative research with the Naval research enterprise.	Increase Warfighter Capability	Alternative Power Sources	1319	01	204	200	1000

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
NAVY	Future Naval Capabilities Applied Research	Torpedo Advanced Propulsion System (TAPS) (FNC)	Develop and demonstrate a prototype torpedo propulsion module (aft section) to evolve the current Mk-48 Advanced Capability Heavyweight Torpedo (ADCAP HWT) to a covert, extended-range weapon for Anti-Surface Warfare (ASuW), Anti-Submarine Warfare (ASW), or limited Precision Strike (PSTK) missions.	Increase Warfighter Capability	Propulsion Upgrades - Sea	1319	02	3700	1000	0
NAVY	Future Naval Capabilities Advanced Tech Dev	Torpedo Advanced Propulsion System (TAPS) (FNC)	Develop and demonstrate a prototype torpedo propulsion module (aft section) to evolve the current Mk-48 Advanced Capability Heavyweight Torpedo (ADCAP HWT) to a covert, extended-range weapon for Anti-Surface Warfare (ASuW), Anti-Submarine Warfare (ASW), or limited Precision Strike (PSTK) missions.	Increase Warfighter Capability	Propulsion Upgrades - Sea	1319	03	1953	3316	0
NAVY	Innovative Naval Prototypes (INP) Applied Res	Large Displacement Unmanned Undersea Vehicle (LDUUV)	Develop and demonstrate TRL 6 scalable air-independent technology to significantly increase the endurance of UUVs to 70+ days to gain persistent access to areas denied to manned platforms, act as a force multiplier and decrease platform and personnel vulnerabilities due to the frequent energy section refresh required in current UUVs.	Increase Warfighter Capability	Propulsion Upgrades - Sea	1319	02	8128	9000	0
NAVY	Future Naval Capabilities Applied Research	Robust Combat Power Control	Develop Combat Power and Energy Control System to anticipate, align and configure shipboard resources based on system state and mission context.	Increase Warfighter Capability	Power Controls and Distribution	1319	02	3000	1500	4500
NAVY	Future Naval Capabilities Applied Research	High Power Solid State Circuit Protection for Power Distribution and Energy Storage (FNC)	Develop components and methods to quickly detect and clear electrical faults, replacing slow-acting circuit breakers and protective relays for medium voltage (MV) DC applications.	Increase Warfighter Capability	Power Controls and Distribution	1319	02	4498	0	0
NAVY	Future Naval Capabilities Advanced Tech Dev	High Power Solid State Circuit Protection for Power Distribution and Energy Storage (FNC)	Develop components and methods to quickly detect and clear electrical faults, replacing slow-acting circuit breakers and protective relays for medium voltage (MV) DC applications.	Increase Warfighter Capability	Power Controls and Distribution	1319	03	0	500	498

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
NAVY	Warfighter Sustainment Applied Research	ONRG International Research	Early applied research with international principle investigators doing collaborative and cooperative research with the Naval research enterprise.	Increase Warfighter Capability	Alternative Power Sources	1319	02	169	150	750
NAVY	Future Naval Capabilities Advanced Tech Dev	Air Independent Propulsion System (FNC)	Enable energy dense propulsion systems to support long endurance undersea vehicle missions.	Increase Warfighter Capability	Propulsion Upgrades - Sea	1319	03	1911	0	0
NAVY	Defense Research Sciences	Power and Energy Materials Research	Energy storage and power generation materials basic research.	Increase Warfighter Capability	Materials and Design	1319	01	7551	8808	45111
NAVY	Future Naval Capabilities Advanced Tech Dev	Compact High Density Tactical Energy Storage (FNC)	Energy Storage system that is adaptable/scalable for multiple USMC system operations with following characteristics: (1) Reduces need for fuel resupply, (2) Supports future high pulse loads, and (3) Common use, transportable, high density.	Increase Warfighter Capability	Power Controls and Distribution	1319	03	1341	0	0
NAVY	Future Naval Capabilities Advanced Tech Dev	Multi-Function High Density Shipboard Energy Storage (FNC)	Energy Storage System that enables multiple load operation from minimal total installed storage with the following characteristics: Enables High pulse weapons and sensor loads, (2) Reduces fuel consumption, and (3) Safe, reliable, standardized, power-dense package.	Increase Warfighter Capability	Power Controls and Distribution	1319	03	3408	4691	698
NAVY	Innovative Naval Prototypes (INP) Applied Res	Forward Deployed Energy & Communications Outpost (FDECO) - Energy	FDECO will prototype open, scalable and coordinated undersea energy , data and communications infrastructure for undersea vehicles and sensors. FDECO presents a scalable underwater replenishment network in the form of modularized, platform-independent outposts, "hotspots" for energy, secure communications, and data sharing between undersea platforms. FDECO energy (50% of total FDECO funding) is assigned to Energy portfolio. INP-FDECO starts in FY16.	Increase Warfighter Capability	Mobile Fuel Assets	1319	02	1793	0	0

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
NAVY	Innovative Naval Prototypes (INP) Adv Tech Dev	Forward Deployed Energy & Communications Outpost (FDECO) - Energy	FDECO will prototype open, scalable and coordinated undersea energy, data and communications infrastructure for undersea vehicles and sensors. FDECO presents a scalable underwater replenishment network in the form of modularized, platform-independent outposts, "hotspots" for energy, secure communications, and data sharing between undersea platforms. FDECO energy (50% of total FDECO funding) is assigned to Energy portfolio. INP-FDECO starts in FY16	Increase Warfighter Capability	Alternative Power Sources	1319	03	4571	0	0
NAVY	Defense Research Sciences	Distribution/Control of Power Science	Fulfill the power and energy needs of the Navy's next-generation weapons and platforms by improving (1) Education, (2) Reliability of power electronic devices, (3) Power density of power systems, and (4) Power Electronics Manufacturing costs.	Increase Warfighter Capability	Platform Upgrades - Sea	1319	01	2009	2464	12618
NAVY	Defense Research Sciences	NRL - Energy	Long term Basic and Applied research into phenomena and mechanisms allowing for more efficient conversion of power; generation of power from solar illumination; from hydrogen conversion in fuel cells; storage of energy in improved battery technologies; augmentation of liquid fuels for greater energy density and exploitation of biological mechanisms for long-duration energy sources.	Increase Warfighter Capability	Contingency Basing	1319	01	350	350	0
NAVY	Defense Research Sciences	NRL - Energy	Long term Basic and Applied research into phenomena and mechanisms allowing for more efficient conversion of power; generation of power from solar illumination; from hydrogen conversion in fuel cells; storage of energy in improved battery technologies; augmentation of liquid fuels for greater energy density and exploitation of biological mechanisms for long-duration energy sources.	Increase Warfighter Capability	Alternative Power Sources	1319	01	4438	5366	29900
NAVY	Power Projection Applied Research	NRL - Energy	Long term Basic and Applied research into phenomena and mechanisms allowing for more efficient conversion of power; generation of power from solar illumination; from hydrogen conversion in fuel cells; storage of energy in improved battery technologies; augmentation of liquid fuels for greater energy density and exploitation of biological mechanisms for long-duration energy sources.	Increase Warfighter Capability	Individual/Warfighter Power	1319	02	1215	0	6396

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
NAVY	Force Protection Applied Research	NRL - Energy	Long term Basic and Applied research into phenomena and mechanisms allowing for more efficient conversion of power; generation of power from solar illumination; from hydrogen conversion in fuel cells; storage of energy in improved battery technologies; augmentation of liquid fuels for greater energy density and exploitation of biological mechanisms for long-duration energy sources.	Increase Warfighter Capability	Alternative Power Sources	1319	02	2279	2137	11144
NAVY	Warfighter Sustainment Applied Research	NRL - Energy	Long term Basic and Applied research into phenomena and mechanisms allowing for more efficient conversion of power; generation of power from solar illumination; from hydrogen conversion in fuel cells; storage of energy in improved battery technologies; augmentation of liquid fuels for greater energy density and exploitation of biological mechanisms for long-duration energy sources.	Increase Warfighter Capability	Alternative Power Sources	1319	02	566	0	2987
NAVY	Ocean Warfighting Environment Applied Research	NRL - Energy	Long term Basic and Applied research into phenomena and mechanisms allowing for more efficient conversion of power; generation of power from solar illumination; from hydrogen conversion in fuel cells; storage of energy in improved battery technologies; augmentation of liquid fuels for greater energy density and exploitation of biological mechanisms for long-duration energy sources.	Increase Warfighter Capability	Alternative Power Sources	1319	02	968	1077	5617
NAVY	Undersea Warfare Applied Research	NRL - Energy	Long term Basic and Applied research into phenomena and mechanisms allowing for more efficient conversion of power; generation of power from solar illumination; from hydrogen conversion in fuel cells; storage of energy in improved battery technologies; augmentation of liquid fuels for greater energy density and exploitation of biological mechanisms for long-duration energy sources.	Increase Warfighter Capability	Individual/ Warfighter Power	1319	02	550	0	2903

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
NAVY	Advance Surface Machinery Sys	Advanced Power Generation Module	Advanced Power Generation Module (APGM) includes back fit and forward fit developments including the AG9160RF, 25MW Gas Turbine Generator (GTG), and Gas Turbine (GT) efficiency upgrades. The AG9160RF Gas Turbine Generator (GTG) is an upgrade to the DDG1000 auxiliary gas turbine and will provide increased power to meet DDG51 Flight III requirements for advanced sensors and future weapons with reduction in life cycle costs through increased fuel efficiency over legacy gas turbine generator sets. 25MW GTGs will adapt an aero derivative fuel-efficient GT to improve fuel efficiency over current single shaft GTs, reduce total ownership costs, and increase time on station. GT upgrades will provide operational readiness and fuel efficiency improvements to existing GT engines for both back fit and new construction ships.	Increase Warfighter Capability	Platform Upgrades - Sea	1319	04	1300	1000	5000
NAVY	Advance Surface Machinery Sys	Energy Storage and Distribution	Development of Next Generation Integrated Power and Energy System (NGIPES) technology aboard Navy ships to enable current and future weapons and sensor systems.	Increase Warfighter Capability	Power Controls and Distribution	1319	04	13703	11910.5	93002.8
NAVY	Future Naval Capabilities Advanced Tech Dev	Combat Power and Energy Control System	Combat Power & Energy Control System that enables high power electric weapons and sensors through the automated control of distributed, shared energy generation and storage resources.	Increase Warfighter Capability	Power Controls and Distribution	1319	03	0	0	0
NAVY	Defense Research Sciences	Naval Biosciences - Microbial and Biomolecular Fuel Cell	Microbial fuel cells (MFC) provide electricity harvested from specialized natural bacteria that use non-hazardous organic compounds as fuel, and then provide electrical current to an electrode. Can be used to sustainably power seafloor sensors/systems in place of batteries.	Increase Warfighter Capability	Alternative Power Sources	1319	01	904	950	4041
NAVY	Force Protection Applied Research	Electric Ship Research & Development Consortium	ONR sponsors the Electric Ship Research and Development Consortium (ESRDC), composed of eight leading universities. The ESRDC is focused on afloat power systems, and leads efforts to address a national shortage of electric power engineers, and ensure U.S. superiority in electric systems.	Increase Warfighter Capability	Platform Upgrades - Sea	1319	02	9194	11243	55983

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
NAVY	Defense Research Sciences	Sea Based Aviation Propulsion Basic Research	This Program provides long-term basic research that discovers new phenomena related power propulsion and thermal management, with the intent that they mature to provide transition opportunities for the associated applied research program. This Program also supports university research in these areas and the associated graduate student support to help build the number and quality of Scientists and Engineers with relevant skills to help further develop power and propulsion systems for future Sea Based Aviation platforms and weapon systems.	Increase Warfighter Capability	Propulsion Upgrades - Air	1319	01	2312	1883	9496
NAVY	Force Protection Applied Research	Sea Based Aviation Propulsion Applied Research	This Program provides medium-term, applied research to demonstrate advanced engine technologies applicable to engine components for naval aviation platforms in propulsion-related technology areas. The specific areas addressed in this program are: (1) Propulsion Cycles, Subsystems, and Engine-Airframe Integration (2) High Stage-Loading, Variable-Geometry, and Enhanced Durability Turbomachinery (3) Jet Noise Reduction for tactical aircraft (4) Hot Section Materials and Coatings, (5) Higher Power Density and Stability Combustion Systems, and (6) Small Propulsion Engine Technology for Autonomous Air Vehicles.	Increase Warfighter Capability	Propulsion Upgrades - Air	1319	02	3594	3672	18514
NAVY	Energy Conservation	Hull Hydrodynamics	This project area will accomplish development, modeling, laboratory and Fleet testing of ship modifications to propellers such as fouling release coatings and/or hull appendages to determine overall mission and cost effectiveness of these improvements.	Increase Warfighter Capability	Platform Upgrades - Sea	1319	04	0	0	1478
NAVY	Energy Conservation	Thermal Management	This project will be utilized to identify and evaluate potential uses for Thermal Management techniques designed to reduce overall shipboard heat generation and reduce the shipboard electrical demand on HVAC systems.	Increase Warfighter Capability	Platform Upgrades - Sea	1319	04	0	413	2505
NAVY	Energy Conservation	Energy Monitoring & Assessment	This project area will focus on methods of capturing and displaying energy related data to shipboard personnel as actionable information for ships force to employ energy conservation measures underway and in port as mission requirements permit.	Increase Warfighter Capability	Metering and Monitoring	1319	04	7769	5076	24320

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
NAVY	Mobility Fuels	Tactical Fuels Research and Development	This program develops technical data through the execution of laboratory, component, engine, fuel system, and weapon system tests, which evaluates the effects of changes in fuel chemistry and properties on the performance and reliability of Naval ship, aircraft, and fuel distribution systems.	Reduce Logistics Risks to Mission	Conventional Fuels Testing	1319	04	7782	7921	42617
NAVY	Aircraft Energy Conservation	Air ENCON	Develop, implement and sustain Aircraft Energy Conservation Program Office to identify, validate, disseminate and incentivize energy conservation best practices within the Naval Aviation community. Targets include culture, fueling, mission planning, and maintenance.	Enhance Mission Effectiveness	Current Operations Tools	1319	04	1400	1600	9000
NAVY	Aircraft Energy Conservation	F-35 Engine Efficiency	Optimize the fuel efficiency of the F-35 engine with various technologies, including Advanced Technology HPC, Optimized Turbine Cooling, Advanced Technology HPT, Turbine Clearance Control, and Fuel Burn Optimized Control Mode. These technologies will be forward fit in F-35 Block 5 (2020) and beyond.	Increase Warfighter Capability	Propulsion Upgrades - Air	1319	04	124	0	0
NAVY	Aircraft Energy Conservation	MQ-8C Engine Efficiency	Optimize the M250 engine utilizing an advanced recuperator design enabling 25% reduced specific fuel consumption (SFC). Reduced SFC provides extended time on station improvement of 25 - 35%, critical to ISR mission. These technologies will be forward and retro fit in MQ-8C platform.	Increase Warfighter Capability	Propulsion Upgrades - Air	1319	04	200	1000	100
NAVY	Aircraft Energy Conservation	Enhanced Core Development	Optimize the fuel efficiency of the engine core with various technologies, including ceramic matrix composites (CMC), performance seeking controls (PSC), advanced seals, advanced aerodynamics, and other. Studies are in work to determine platform of interest to include F/A-18E/F and E/A-18G platform and/or NGAD.	Increase Warfighter Capability	Propulsion Upgrades - Air	1319	04	2100	1000	2500
NAVY	Aircraft Energy Conservation	F/A-18 Trim-Optimizing Flight Control	By optimizing aircraft trim configuration across a variety of flight conditions, a control algorithm developed by NASA Dryden was able to reduce F/A-18A fuel consumption by 3.5% across three test flights without negatively impacting transient performance. Technology transition efforts are focused on the F/A-18 E/F and E/A-18 G.	Increase Warfighter Capability	Platform Upgrades - Air	1319	04	2600	1600	350

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
NAVY	Force Protection Applied Research	Propulsion Task Force Energy (TFE)	This Program, in partnership with the Variable Cycle Advance Technology (VCAT) program, has the objective to develop variable geometry and adaptive cycle gas turbine engine technology for next generation air dominance aircraft. The benefits of these technologies are anticipated to be reduced fuel consumption and hence greater operational range and reduced logistics tail, mostly by reducing the demand for deployed fuel and tanker aircraft support.	Increase Warfighter Capability	Propulsion Upgrades - Air	1319	02	7488	8794	44482
NAVY	Unmanned Undersea Vehicle (UUV) Core Technologies	Aluminum-Seawater Power System for Autonomous Underwater Vehicles	Fuel cell powered by utilization of Aluminum's Hydrogen Storage ability. The project builds a prototype fuel cell with enough capability to maintain a L/XLUUV for extended endurance and stealth for payload delivery. This is an air independent alternative and provides a significant capability increase to the Navy once proven and integrated into the UUV fleet.	Increase Warfighter Capability	Alternative Power Sources	1319	04	500	500	0
NAVY	Unmanned Undersea Vehicle (UUV) Core Technologies	LDUUV/XLUUV Advanced Energy	The Navy is developing several innovative next generation energy sources for the LDUUV and XLUUV programs (fuel cells, aluminum water combustor technologies). These energy projects range in maturity, yet provide step capability increases in both endurance and stealthiness. Current XLUUV and LDUUV CONOPs are limited by the time that these vehicles can remain stealthy and submerged; thus, safe and reliable air independent energy solutions are needed to meet these demands.	Increase Warfighter Capability	Alternative Power Sources	1319	04	780	780	20244
NAVY	Unmanned Undersea Vehicle (UUV) Core Technologies	Li-Ion Battery Development and Submarine Certification	Effort to certify Lithium-Ion batteries to support UUVs hosted on submarines. Li-Ion batteries are a relatively mature technologies that provide a high density, air independent and silent energy solution with the ability to recharge. The path forward includes development and integration of propagation resistant battery architecture as well as efforts related to safety and response in the event of a casualty while hosted onboard a submarine. Other efforts include development of a reliable supply base and QA of cells.	Increase Warfighter Capability	Alternative Power Sources	1319	04	0	1900	76956

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
NAVY	Ship Preliminary Design and Feasibility Studies	Distributed Fueling Technology Development	Developing concepts to aid in the new distributed fueling at sea and over the shore operations (e.g., JOFF, SPDS, CONSOL, iMFDS).	Reduce Logistics Risks to Mission	Fuel Infrastructure	1319	04	2475	5277	33428
NAVY	Ship Preliminary Design and Feasibility Studies	E-Stream	E-STREAM, or Electric-Standard Tensioned Replenishment Alongside Method, reduces energy use during underway replenishments. The variable frequency driven electric motors with PLC controllers that replace the hydraulic winches and sliding block saves energy, improves replenishment speed and saves on maintenance costs.	Reduce Logistics Risks to Mission	Platform Upgrades - Sea	1319	04	6354	3100	1501
NAVY	Defense Research Sciences	Synthetic Biology for Sensing & Energy Production	Develop transformational approaches using living organisms to produce, fuels or other high-value compounds.	Reduce Logistics Risks to Mission	Alternative Fuels Production	1319	01	363	0	0
NAVY	Warfighter Sustainment Applied Research	Biocentric Technology (Energy)	Program focuses on microbes that produce electricity from organic matter found in sediment or wastewater, and is targeting two distinct naval applications: (1) Powering of undersea devices and sensors for environmental monitoring, and (2) shipboard desalination and wastewater degradation	Reduce Logistics Risks to Mission	Alternative Power Sources	1319	02	1189	1363	6980
NAVY	Warfighter Sustainment Applied Research	Tech Candidates (Energy)	Program focuses on powering of undersea devices and sensors for environmental monitoring in a range of depths and salinities. Customers include PMS 485 and SOUTHCOMM,	Reduce Logistics Risks to Mission	Alternative Power Sources	1319	02	339	400	0
NAVY	Aircraft Energy Conservation	Opportunity Studies	The aircraft energy conservation RDTE project identifies, evaluates, validates and advocates for implementation of energy savings initiatives for legacy aircraft by engaging technical experts from across Naval aviation, other services, allies, industry, and academia.	Increase Warfighter Capability	Platform Upgrades - Air	1319	04	1190	5342	43982
NAVY	Ready Reserve Force	Lighting Upgrades	Installation of High Efficiency Lighting and motion detected lights for cargo holds.	Enhance Mission Effectiveness	Platform Upgrades - Sea	1804	02	220	220	3744
NAVY	Ready Reserve Force	HVAC Efficiency Improvements	Energy Efficient HVAC Systems to include A/C System Replacement (Long Range Life) and upgrades to the cargo ventilation system.	Enhance Mission Effectiveness	Platform Upgrades - Sea	1804	02	890	1780	7000

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
NAVY	Ready Reserve Force	Propulsion Systems	Includes upgrades to Main Propulsion/Engine control systems; engine room konsberg/autronica monitoring system; CPP System; new fuel purifiers; plate coolers for LO cooling (overhaul)	Enhance Mission Effectiveness	Platform Upgrades - Sea	1804	02	1890	500	0
NAVY	Ship Prepositioning and Surge	Hull Coatings	Application of tested commercially available hull coatings to better match coating to ship optempo. The goal is to prevent biofouling so that propulsive efficiency is maximized.	Enhance Mission Effectiveness	Platform Upgrades - Sea	1804	02	0	0	425
NAVY	Ship Prepositioning and Surge	Future Initiatives	Project funds initiatives currently unidentified that will be developed from the Broad Agency Announcement and Energy Initiative Studies and Development.	Enhance Mission Effectiveness	Platform Upgrades - Sea	1804	02	0	0	1806
NAVY	Ship Prepositioning and Surge	Route Planning & Optimization	Implementing route planning programs, such as the Replenishment At Sea Planner (RASP), that can improve MSC's scheduling of ships between ports and underway combatant customer ships, thereby reducing fuel consumption. Once underway, ship optimization tools can be used to optimize the ship's equipment to further reduce fuel consumption.	Enhance Mission Effectiveness	Current Operations Tools	1804	02	125	796	2930
NAVY	Ship Prepositioning and Surge	Improved Metering and Monitoring	Installation of fuel meters and shore power meters. This fuel metering technology corrects for density, temperature and air entrapment. A Shore Power Monitor stores energy and power quality data including cumulative kWh, peaks, and several power quality metrics. The compiled data enables MSC to monitor and manage shore power usage and implement appropriate energy conservation measures. The combination of these meters will feed into an Energy Dashboard that will be used to monitor real time energy usage, which will enable ship operators to make operational changes that decrease overall energy usage.	Enhance Mission Effectiveness	Metering and Monitoring	1804	02	779	745	1512
NAVY	Ship Prepositioning and Surge	Pump & Motor Efficiency Improvements	Implementing the use of variable speed technology to increase the efficiency of existing pumps and motors to better match actual demand. Also installing newer, more efficient pump and motor options.	Enhance Mission Effectiveness	Platform Upgrades - Sea	1804	02	1155	1865	11893

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
NAVY	Ship Prepositioning and Surge	Lighting Upgrades	Upgrade currently installed lighting with newer technologies to increase energy efficiency. Initiatives include using Light Emitting Diode (LED) technology, installing light switches and intelligent lighting technology such as motion and occupancy sensors.	Enhance Mission Effectiveness	Platform Upgrades - Sea	1804	02	1213	969	2329
NAVY	Ship Prepositioning and Surge	HVAC&R Efficiency Improvement	Implementation of automating plant control systems, matching plant generation to demand, and using Variable Air Volume design; HVAC&R plants can be made efficient through a range of conditions and still retain the full maximum capacity. Examples of initiatives include T-AKE Intelligent HVAC, auxiliary pre-stage refrigeration units and the implementation of intelligent HVAC on other ship classes.	Enhance Mission Effectiveness	Platform Upgrades - Sea	1804	02	1625	3450	21194
NAVY	Ship Prepositioning and Surge	Propulsion Upgrades	Includes upgrades to: Main Propulsion/Engine control systems; propeller.	Enhance Mission Effectiveness	Platform Upgrades - Sea	1804	02	0	945	2267
NAVY	Amphib Energy Initiatives	LSD Stern Flap and Propeller Coatings	Stern flap includes a steel plate appendage welded to the transom that extends from the hull bottom surface to modify the flow field under the hull after-body resulting in reduced drag. Propeller coatings reduce blades roughness and bio-fouling build-up to maximize propeller efficiency and reduce fuel consumption.	Increase Warfighter Capability	Platform Upgrades - Sea	1804	01	4520	2770	0
NAVY	SS Petersburg Service Life Extension	SS Petersburg – OPDS	Investment will fund a Dry Dock Overhaul for PETERSBURG, and equipped offshore petroleum discharge system (OPDS), to extend her service life from FY 20 to FY 23.	Reduce Logistics Risks to Mission	Fuel Infrastructure	1804	02	0	0	15000
DLA	Battery Network (BATTNET)	IP ManTech	Battery Network (BATTNET) is one element of DLA's Improving Industrial Base Manufacturing Processes' strategic focus area and will improve the supply and reduce the cost of procured batteries used in fielded weapon systems, such as communication radios and armored vehicles. Batteries exhibit dynamic challenges for military logistics. BATTNET relies on a community of battery supply chain members, engineering support activities, researchers, and users to conduct research and development on sustainment issues or risks, and bridge technical solutions for specific groups of batteries.	Reduce Logistics Risks to Mission	Alternative Power Sources	0400	03	4.115	3.787	19.126

ORG	OE Program Title	OE Initiative Title	OE Project Description	OE Strategy Objective	OE Activity Class	Treas Code	BA Code	FY 2018	FY 2019	Five Year Defense Plan (FYDP)
DLA	Energy Readiness Program	Log R&D	Energy Readiness Program (ERP) addresses current and future issues connected to areas encompassing the Class III Bulk (Petroleum, Oils and Lubrication) fuel supply system in order to maintain and improve current Warfighter product requirements.	Reduce Logistics Risks to Mission	Alternative Fuels Certification and Testing	0400	03	1.103	2.122	10.997
							Total	3,097,336	2,956,875	13,977,287