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Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Office of the Secretary Of Defense **Date:** February 2020

Appropriation/Budget Activity 0400: <i>Research, Development, Test & Evaluation, Defense-Wide I BA 3: Advanced Technology Development (ATD)</i>	R-1 Program Element (Number/Name) PE 0604055D8Z I <i>Operational Energy Capability Improvement</i>
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COST (\$ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	39.788	44.362	64.900	0.000	-	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing
455: <i>Operational Energy Capability Improvement</i>	39.788	44.362	64.900	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing

Note

FY 2021 - FY 2025 funds were re-aligned for higher Department priorities under the Defense Wide Review (DWR).

A. Mission Description and Budget Item Justification

The U.S. military’s dependence on liquid fuel creates an enormous logistics burden that exposes forces to enemy attack and diverts operational resources from other mission areas to support delivery. GAO cited the department for its lack of (1) “visibility and accountability for achieving fuel reduction, (2) incentives and a viable funding mechanism to invest in the implementation of fuel demand reduction projects, and (3) guidance and policies that addressed fuel demand.”

The mission of this program element (PE) since these findings in 2012 has been to fund innovation to improve the Department of Defense’s (DoD) operational effectiveness via targeted operational energy science and technology (S&T) investments. OECIF fostered innovation to improve operational energy performance in two ways: first, to develop operational energy technologies and practices that improved the agility and resiliency of our ability to supply forces the energy they need; and second, to establish momentum for components to continue those innovations through ongoing collaboration with the Services, Joint Staff and Combatant Commands.

OECIF funds served as “seed money” to start or consolidate promising innovations to serve as proof of technological feasibility, with the goal of transitioning science and technology (S&T) into the acquisition process. The focus is on challenges or opportunities that are not Services specific, but rather cross Services, platforms and domains.

OECIF investments also highlighted areas of Departmental level interest or buy down risk to enable service-level commitments. The primary focus on 6.3 Investments facilitated joint solutions and incentivized cross Service collaboration to transition the acquisition valley of death. OSD investment (37%) in conjunction with investment from DLA, Army, Navy, and USMC of 22% represents almost 60% of the DoD-wide OE 6.3 investment budget. The Air Force contributes about 40% with 55% of their contribution focused on high-cost engine testing and architecture for high power systems.

OECIF investments are directly focused on the capability needs expressed in the NDS. Our ability to predict, detect, and mitigate an adversary’s ability to deny tactical and operational formations the energy needed to prosecute operations at tempo and scale throughout every phase of warfare and to enable freedom of action at all echelons, unencumbered by the challenges of delivering energy across an unbounded multi-domain and contested battlespace.

To achieve these goals, the selection process for investments relied on inputs from the Combatant Commands and Services each year through a competitive process. The OECIF decision process supports the National Security Strategy for energy dominance, all three National Defense Strategy priorities, the DoD Energy Strategy,

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Department Modernization Priorities, and the needs of the Joint Force and warfighters. The projects compete on the basis of greatest impact to the warfighter, criticality of operational need, least technical risk, least cost, and the shortest time to employment.

OECIF success has been measured by its impact. The overall aim has been to improve the agility, resilience, lethality, readiness, and operational effectiveness of the Joint Force. The key metric is the successful transition of technology from S&T to an acquisition or direct insertion into operations. Over 75% of OECIF investments have successfully transitioned to support the warfighter.

OECIF's efforts have complimented, not replaced or duplicated, Services investments and have provided a continually evolving program to rapidly address new and critical issues arising from emerging threats to our ability to supply the joint force.

Examples of current investments include moving power without mass (power beaming); world-record setting efficiencies for solar power conversion; use of energy scavenging within the warfighting environment, and use of sensors, data analytics and predictive methodologies with the promise of enabling unparalleled operational unpredictability to counter an adversaries "energy denial" operations. Additional leading technologies enabling extended remote operations without resupply through innovations in the use of energy storage, micro-grids, and nuclear power fuel innovation.

B. Program Change Summary (\$ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Previous President's Budget	45.478	70.536	41.261	-	41.261
Current President's Budget	44.362	64.900	0.000	-	0.000
Total Adjustments	-1.116	-5.636	-41.261	-	-41.261
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-10.636			
• Congressional Adds	-	5.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.108	-			
• Other Adjustments	-0.008	-	-3.337	-	-3.337
• Reduction for Defense Wide Review	-	-	-37.924	-	-37.924

Congressional Add Details (\$ in Millions, and Includes General Reductions)

Project: 455: *Operational Energy Capability Improvement*

Congressional Add: *Operational Energy Capability Improvement Program Increase*

	FY 2019	FY 2020
Congressional Add Subtotals for Project: 455	5.000	5.000
Congressional Add Totals for all Projects	5.000	5.000

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Appropriation/Budget Activity
0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3:
Advanced Technology Development (ATD)

R-1 Program Element (Number/Name)
PE 0604055D8Z / *Operational Energy Capability Improvement*

Change Summary Explanation

In FY 2020, the Congress reduced the program by -\$10.636 million for excess growth and provided a program increase of \$5.000 million.

FY 2021 included a reduction for higher priority DoD missions and included a Defense-Wide Review (DWR) reduction of \$37.924 million.

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Appropriation/Budget Activity 0400 / 3	R-1 Program Element (Number/Name) PE 0604055D8Z / <i>Operational Energy Capability Improvement</i>	Project (Number/Name) 455 / <i>Operational Energy Capability Improvement</i>
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COST (\$ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
<i>455: Operational Energy Capability Improvement</i>	39.788	44.362	64.900	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing

Note

FY 2021 - FY 2025 funds are realigned to higher priority DoD missions resulting from Defense Wide Review.

A. Mission Description and Budget Item Justification

The Operational Energy Capability Improvement Fund (OECIF) incentivizes science and technology (S&T) to promote long-term change in DoD capabilities so they are better aligned with the National Defense Strategy. OECIF fosters innovation to improve operational energy performance and has two key mission aspects: first, to develop operational energy technologies and practices that will improve DoD military capabilities or reduce costs; and second, to establish within the military Services institutional momentum to continue those innovations. OECIF serves as “seed money” to start or consolidate promising operational energy innovation to be sustained by the Services. Accordingly, OECIF generally emphasizes supporting or establishing programs rather than one-off projects.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2019	FY 2020	FY 2021
<p>Title: Operational Energy Capability Improvement Fund (OECIF)</p> <p>FY 2020 Plans: Operational Energy Capability Improvement (OECIF) will ramp down to allow existing projects to close out.</p> <p>FY 2017 projects for far-field wireless energy transmission will be completed. These include efforts across 3 modalities of power beaming (Laser, mmWave, and RF). World-records set in eye-safe Laser power will increase in power and distance. Efforts in mmWave, RF will demonstrate at least 1kW @ 1 km. World-record setting perovskite solar cell efforts will conclude with delivery and test of multi-junction cells. New manufacturing for space-based solar cells will transition to the Air Force partner to continue this effort for reducing costs applicable to all space launches by an order of magnitude.</p> <p>Complete/finalize the following efforts:</p> <ul style="list-style-type: none"> • Undersea thermal energy generation • Long duration UAX with a focus on INDOPACOM • Energy Sensing for efficiency • Ultra High Density Hybrid Energy Storage Module (HEMS) for Laser Weapon System and Electronic Warfare Operations • Power and Thermal Management for High Power / Pulse Power systems and integration <p>Deliver critical outcomes for: Hybridization of Energy Storage Hardware that increases range and endurance of current UAS. Results will be ready for flight test demonstrations.</p>	39.362	19.029	-

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B. Accomplishments/Planned Programs (\$ in Millions)		FY 2019	FY 2020	FY 2021
<p>Validate and qualify Operation of Energy Efficient Multi-Mission Fuel/ISR/Strike Pods for UAVs for use, per COCOM direction.</p> <p>Transition critical, novel fire suppression techniques to enable the safe military transport of Lithium Ion batteries.</p> <p>Enable secondary controls for the use of source agnostic inverters and energy storage devices needed to stabilize the operation of any fielded micro-grid ensuring operational flexibility of the battle commander.</p> <p>Enable specifications and safety standards for a standardized battery architecture based on commercial technologies for compatibility with multiple DOD platforms.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: DWR: The decrease reflects internal re-alignments for higher DoD priorities under the Defense Wide Review.</p>				
<p>Title: Space Solar / Power Beaming</p> <p>Description: Previous FY 2017-FY 2019 P455 OEI investments focused on reducing weight and improving growth and performance of solar cells. Early investment also focused on technological advances to improve metrology for energy collection in space, and both efforts continue advancing. Success of previous OEI investments in laser safety and mmWave transmission has increased confidence for demonstrating a longer/larger project viability.</p> <p>The Space Solar / Power Beaming project implements a front-loaded sprint to recapture the lead in critical technologies with both near-term tactical and far-term strategic implications. Near-peer competitors are overmatching DoD in power beaming and space solar technologies for battlefield advantage, necessitating this effort to address the shortfalls. Per the findings and recommendations of the recent DoD study "Opportunities and Challenges for Space Solar for Remote Installations," measured, comprehensive investments will be made in key areas to accomplish demonstrations that jumpstart the effort.</p> <p>FY 2020 Plans: Complete efforts begun in FY 2017 for power beaming and space solar (see above). These elements advance efforts for power beaming and space solar capabilities to increase warfighter lethality and reduce logistical burdens.</p> <p>For ground-to-ground, elevated, high-altitude, low earth orbit, and higher orbits, the progression of power beaming capabilities to include longer links and higher powers will provide a credible path to an operational capability.</p> <p>(1) Space Solar Collection – Low-cost, lightweight photovoltaics through revolutionary production methods are key to manufacturing at scale.</p>		0.000	40.871	-

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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2019	FY 2020	FY 2021
<p>(2) Microwave Power Beaming Link Demonstration – Using existing sources, microwave power beaming will be demonstrated using rectenna receiver modules developed during FY 2020. This represents the first step towards an all-weather, global system..</p> <p>(3) Millimeter Power Beaming Link Demonstration – Leveraging proven non-lethal transmission sources, a tactically relevant power beaming demonstration will be undertaken using millimeter wave rectenna receiver modules developed during FY 2020.</p> <p>(4) Optical Power Beaming Link Demonstration – Integrating proven laser safety systems with appropriate directed energy assets will form the transmission segment for the optical demonstration. The optical receiver will be developed employing recent advances in monochromatic photovoltaic technology.</p> <p>(5) Architecture Analytics & Integrating Technologies – Scenario modeling of different means of energy conversion and ground and space segment approaches will focus investments and drive concept of operations development. Leap-ahead technologies in large area metrology, high-altitude receiver craft, thermal management, high voltage management, and airborne tether technologies will be examined for potential integration into near-term deployed power beaming and far-term space solar capabilities.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: DWR: The decrease reflects internal re-alignments for higher DoD priorities under the Defense Wide Review.</p>			
Accomplishments/Planned Programs Subtotals	39.362	59.900	-

	FY 2019	FY 2020
Congressional Add: Operational Energy Capability Improvement Program Increase	5.000	5.000
<p>FY 2019 Accomplishments: The Study on the Use of Mobile Nuclear Power Plants for Ground Operations concluded political support is essential in three key areas: nuclear fuel availability, supportive regulatory environment, and advanced reactor designs. Awarded a Tristructural-Isotropic (TRISO) fuel production subcontract to demonstrate TRISO fuel production at engineering scale. Invested in Air Force SBIR on strontium based source for terrestrial and space applications.</p> <p>FY 2020 Plans: Developing initial innovation toward an industrial-scale capability to produce TRISO fuel with the capability of producing a variety of kernel sizes and types, and at all levels of enrichment. This funding allows for initial innovative work to kick-start a larger program necessary to produce necessary quantities of total qualified TRISO by the end of FY 2020.</p>		
Congressional Adds Subtotals	5.000	5.000

C. Other Program Funding Summary (\$ in Millions)

N/A

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C. Other Program Funding Summary (\$ in Millions)

Remarks

D. Acquisition Strategy

N/A