U.S. Department *of* Defense

Department of Defense Plan to Reduce Greenhouse Gas Emissions

Office of the Under Secretary of Defense for Acquisition and Sustainment

April 2023

TABLE OF CONTENTS

APPENDICES

I. INTRODUCTION

This report is the Department's inaugural enterprise-wide greenhouse gas (GHG) emissions reduction plan and describes strategies for both military installations and operations. The Department's focus is to enhance capability and lethality while increasing the readiness and resilience of the force. Initiatives that reduce GHG emissions can also create warfighting advantage. For example, improving efficiency and deploying clean distributed generation and storage can strengthen the resilience of critical missions housed on military installations in the face of extreme weather, cyber attacks, and even kinetic attacks impacting electric grids. Improving the efficiency of combat platforms and operations can enable freedom of maneuver and mitigate risk, while increasing operational reach and endurance in contested logistics environments.

Pathways described in this report include reducing energy demand, substituting clean energy and materials, and potentially carbon sequestration. Rapid advancements in clean energy markets and technologies are creating opportunities for the Department to achieve its objectives—particularly on installations. At the same time, the Department is continually assessing those developments and market conditions to identify additional options for improving combat system GHG performance that align with capability and operational readiness.

This report also responds to Section 323(a) of the National Defense Authorization Act (NDAA) for Fiscal Year (FY) 2022 (Public Law 117-81), which requires the Secretary of Defense to submit a Department of Defense (DoD) Plan to Reduce Greenhouse Gas Emissions (Appendix A lists related statutes). Appendix B satisfies the Section 323(b) requirement for the Department to report annually on its progress toward meeting science-based emissions targets in the plan required by Section 323(a).

II. DOD GHG OVERVIEW

There are a number of statutory requirements and executive order (EO) instructions related to conserving energy, deploying renewable energy technologies, reducing fuel consumption, and using sustainable materials (see Appendix A). With respect to GHG accounting, Section 328 of the William M. (Mac) Thornberry National Defense Authorization Act for FY 2021 (Public Law 116-283) directed the Secretary of Defense to provide a report on the total level of GHG emissions for each of the last 10 FYs.[1]

In reporting GHG emissions, the Federal Government and DoD generally follow Greenhouse Gas Protocol standards for tracking and accounting for GHG emissions as applicable to the public sector. These standards define emissions as Scope 1, 2, or 3, depending on where the GHG emissions originate and the ability of a reporting organization to directly manage or influence those emission sources.[2]

GHG EMISSION SOURCES BY SCOPE

Scope 1: Direct emissions from sources that are owned or controlled by DoD, including fossil fuel combustion from stationary and mobile sources and fugitive emissions (such as refrigerant leaks).

Scope 2: Emissions resulting from the generation of electricity, heat, or steam purchased by DoD.

Scope 3: Emissions that result from DoD activities but are from sources not owned or directly controlled by DoD, such as DoD procurement of goods and services, including business travel, in addition to emissions from commuting.

Scope 1 and 2 standards and reporting frameworks are mature and widely accepted. The Department calculates its emissions in these categories through existing mechanisms such as utility bills or fuel procurement contracts, in coordination with the Department of Energy (DOE) Federal Energy Management Program (FEMP). DoD is working to improve GHG-related data collection to increase the accuracy of reporting and generate metrics to inform decision-making.

1 See https://www.congress.gov/116/plaws/publ283/PLAW-116publ283.pdf.
2 World Resources Institute, https://www.wri.org/initiatives/greenhouse-gas-protocol.

Scope 3 guidance for U.S. federal agencies is not as well developed, in part due to the challenges of inconsistent (or absent) standard requirements of data collection for all categories of Scope 3 emissions. Also, unlike Scope 1 and 2 emissions, Scope 3 emissions are outside of DoD's direct control. However, DoD actions and policies can influence Scope 3 emissions.

The Department has received feedback from several major prime contractors and from the General Services Administration (GSA) to better understand implications of carbon disclosure requirements, particularly Scope 3 GHG emissions. The Federal Acquisition Regulatory (FAR) Council, of which the Department serves as a voting member, published a proposed rule in November 2022 titled, "Disclosure of Greenhouse Gas Emissions and Climate-Related Financial Risk." The rule proposed to require major federal contractors to publicly disclose their GHG emissions, identify climate-related financial risks, and set science-based emissions reduction targets. The drafting team of the FAR Council is presently adjudicating comments submitted in response to the proposed rule.

CURRENT DOD GHG EMISSIONS

In FY 2021, DoD Scope 1 and Scope 2 emissions totaled 51 million metric tons of carbon dioxide equivalent ($MMTCO_2e$).[3,4]

- Of the total Scope 1 and 2 emissions, 19 $MMTCO_2e$ (37%) resulted from emissions at installations and 32 $MMTCO_2e$ (63%) resulted from emissions from operational sources.
- Most emissions result from fossil fuel combustion, particularly jet fuel. In FY 2021, jet fuel combustion accounted for 80% of operational emissions and 50% of total DoD emissions.
- The majority of installation emissions are from Scope 2 purchased electricity (60%), Scope 1 fuel combustion in buildings (28%), and Scope 1 fuel combustion in non-tactical vehicle fleet and equipment (7%).
- DoD's total Scope 1 and Scope 2 GHG emissions in 2021 are about 76% of total Federal Government emissions, equivalent to 1% of the total United States emissions in 2020.[5]
- Excluding operational emissions, DoD's scope 1 and 2 emissions from installations in 2021 were 28% of total Federal Government emissions, the equivalent of 0.3% of total U.S. emissions.

Figure 1 shows DoD's Scope 1 and 2 GHG emissions over time (the 2008 baseline plus the 2010–2021 reported values).

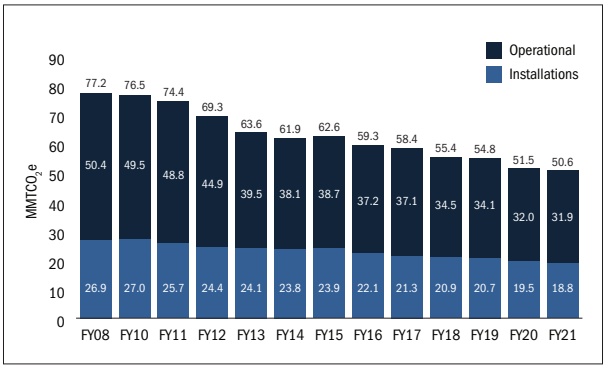

FIGURE 1. SCOPE 1 AND 2 EMISSIONS FROM FY 2010–2021, WITH THE 2008 BASELINE

DoD's emissions have trended downward since tracking and reporting began in 2010. Scope 1 and 2 emissions from installations[6] have decreased 30% since FY 2008. Emissions from operational energy (OE) have decreased by 37% and total emissions have decreased by 34%. The downward trend in OE-associated emissions is largely a product of the gradual reduction in combat operations in Iraq and Afghanistan and the curtailment of collective training in response to the COVID pandemic. The remainder of the decline can be attributed to improvements in enhancing energy efficiency and the deployment of renewable energy.

Scope 3 emissions are discussed in Section VII.

3 The Environmental Protection Agency (EPA) defines a CO_2 equivalent (CO_2e), as the number of metric tons of CO_2 emissions with the same global warming potential as one metric ton of another GHG, and is calculated using Equation A-1 in 40 Code of Federal Regulations (CFR) Part 98.

4 DOE FEMP, Comprehensive Annual Energy Data and Sustainability Performance, https://ctsedwweb.ee.doe.gov/Annual/Report/ComprehensiveGreenhouseGasGHGInventoriesByAgencyAndFiscalYear.aspx.

5 EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks, https://www.epa.gov/system/files/documents/2022-04/us-ghg-inventory-2022-main-text.pdf.

6 The federal reporting structure categorizes emissions as Standard Operations and Non-Standard Operations. For DoD, Standard Operations generally equate to Installation Energy and Non-Standard Operations equate to Operational Energy.

III. PLAN TO REDUCE GHG EMISSIONS FROM INSTALLATION ENERGY (IE) USE

The Department's primary objective is to increase the resilience of our installations to protect against natural and man-made disruptions. Our efforts to reduce GHG emissions help advance that objective and include:

- Reducing the Department's dependence on offsite energy sources by emphasizing on-site clean energy generation and storage, increasing efficiency measures, and incorporating cleanenergy-powered microgrids that enable resilience and reduce GHG emissions;
- Leveraging available data to inform decisions and measure progress;
- Identifying opportunities via the expertise of DoD's energy managers and master planners; and
- Leveraging all sources of funding, including third-party financing and appropriated funds, to rapidly deploy proven technologies.

INSTALLATION EMISSIONS PROFILE

Installations represent 37% of the Department's total GHG emissions. The primary emissions are from fossil fuel used for on-site electricity and heat generation, grid-sourced electricity derived in part from fossil-fueled generation sources, and non-tactical transportation fleets that run on fossil fuels. Figure 2 summarizes the Department's IE-related Scope 1 and 2 emissions:

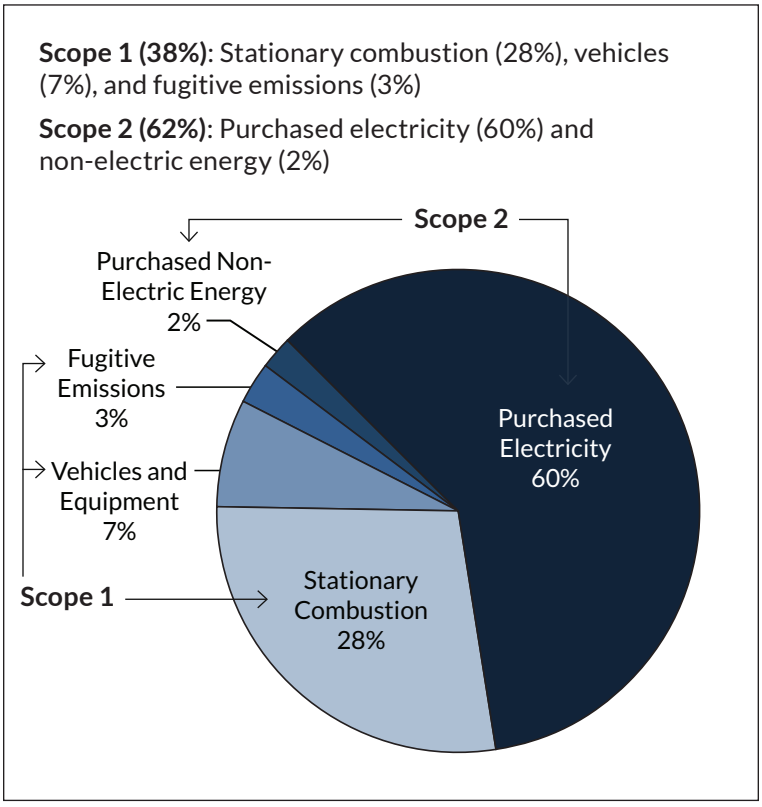

FIGURE 2. IE GHG EMISSIONS BY SOURCE

DoD spent $3.3 billion in FY 2021 to provide power, heat, and cooling to its 284,000 buildings and another $140 million to fuel its 180,000 vehicles. Purchased electricity and stationary combustion of fossil fuels, such as natural gas for heating and petroleum-based fuel for vehicles, comprise 95% of Scope 1 and 2 emissions. Accordingly, the Department's current plan focuses on emissions from those sources.

DoD is leveraging its scale and purchasing power to meet its goals. DoD efforts to reduce installation-related GHG emissions include reducing energy demand, scaling clean energy solutions, and leveraging technology innovations. These efforts all help to increase the resilience of DoD installations and mitigate risks associated with electricity supply disruptions, whether driven by extreme weather, cyber attacks, or kinetic attacks.

REDUCING IE DEMAND

Reducing energy demand is critical to enhancing resilience and reducing emissions. Planned efforts related to demand reduction include improving data availability, reducing gross facility footprint (square footage), and introducing efficiency upgrades.

Improved Data Availability

An important first step in reducing demand is improving the ability to measure or estimate the Department's energy consumption at installations. The Department has installed smart meters at thousands of its largest facilities and is now piloting means of obtaining and analyzing near-real-time data at the installation level to provide enterprise visibility of energy flows. Better meters and other technology can help track energy usage more accurately. Improving data collection can provide a more precise baseline to understand usage and enable the use of commercially available analytic tools to provide insights. It can also improve installation staff visibility into operations and give energy managers and leadership a better understanding of overall energy consumption.

Reducing Facility Footprints

Given the large number of DoD buildings, the Department has a continuing need to optimize its footprint. Increasing and analyzing building data can identify opportunities to consolidate assets to reduce energy demand. With a smaller footprint, DoD can reduce reliance on the commercial electric grid, better leverage limited funds to maintain/upgrade equipment and make efficiency improvements, and reduce emissions.

Upgrading Efficiency

In parallel with reducing its footprint, the Department will pursue energy efficiency in all of its buildings. The foundation of these efforts is the requirement for every installation to prepare a comprehensive installation energy plan (IEP) that identifies that installation's energy resilience needs and any energy-savings opportunities. IEP also identify resourcing options, such as activities that can be funded through third-party financing or can use appropriated funds such as Operations and Maintenance or Military Construction funds.

Over the last 10 years, the private sector has invested $5.5 billion to capitalize energy systems and provide expertise for DoD installations through third-party financing contracting vehicles, such as energy savings performance contracts (ESPCs) and utility energy services contracts (UESCs). By statute, all such projects must pay for themselves through energy savings. The Department plans to better quantify emissions reductions achieved through such contracts. The Department plans to continue using ESPC and UESC to achieve deeper energy reductions. Over 47 ESPC and UESC projects are under development (FY 2023 – FY 2024), with a potential award value of over $1.3 billion. DoD has provided funding to each of the Military Services to increase contracting and staffing capacity to expand the number and scope of third-party financed projects.

SCALING CLEAN ENERGY SOLUTIONS FOR INSTALLATION ENERGY

Scaling the Department's use of clean energy includes transitioning to a zeroemissions non-tactical vehicle (NTV) fleet; achieving installation energy resilience; achieving net-zero emissions buildings, campuses, and installations; and procuring 100% carbon pollution-free electricity (CFE).[7]

Pursuing Zero-Emission Vehicles and Charging Infrastructure

The Department is taking steps to achieve 100% acquisition of zero-emission vehicles (ZEVs), where they are available to fulfill mission requirements by 2035 consistent with the Federal Sustainability Plan. DoD's

7 From the Office of Management and Budget (OMB) Memorandum M-22-06, 8 December 2021: "'Carbon pollution-free electricity' or 'CFE' means electrical energy produced from resources that generate no carbon emissions including marine energy, solar, wind, hydrokinetic (including tidal, wave, current, and thermal), geothermal, hydroelectric, nuclear, renewably sourced hydrogen, and electrical energy generation from fossil resources to the extent there is active capture and storage of carbon dioxide emissions meeting EPA requirements."

ZEV transition has the potential to increase installation resilience over time, as bi-directional charging and the ability to connect to on-base micro grids could enable energy stored in vehicles to supply the installation power grid. In addition, vehicles with the ability to export on-board electrical power could reduce or eliminate the need for diesel, propane, or natural gas generators to make electricity at work sites, adding flexibility to base operations.

The Department's NTV fleet consists of approximately 110,000 light-duty, 50,000 medium-duty, and 20,000 heavy-duty vehicles. Initially, the Department will focus on the light-duty fleet by acquiring ZEVs through the GSA Fleet Leasing Program. That is consistent with the developments in the private sector where options for light-duty vehicle are rapidly expanding. There are currently fewer commercial ZEV alternatives to medium- and heavy-duty vehicles. Medium- and heavy-duty vehicles are often special purpose, stay in the inventory a longer time, and have limited use and high operating costs. To transition this portion of the fleet, the Department intends to work with the industry and other federal agencies to stimulate demand and pioneer new technology options.

Light-Duty Vehicles

As of July 2022, the Department had ordered more than 1,400 light-duty ZEVs. That number is less than half the number of ZEVs initially requested with the reduction due to supply chain limitations. The Department will acquire additional ZEVs as they become available. In the interim, DoD is pursuing opportunities to expand installation charging infrastructure and maximize use of existing charging ports on DoD installations. Some key ZEV-related efforts include:

- In January 2022, the Deputy Secretary of Defense established a ZEV/Electric Vehicle Supply Equipment (EVSE) Working Group to improve coordination of ZEVs/EVSE deployment. This working group analyzed where barriers exist to implement ZEVs, especially where deployment may require changes in policy, strategy, design standards, or training.
- DoD is optimizing new ZEV allocations with turnover of existing vehicle fleet, assigning ZEVs to locations with existing electric vehicle chargers.
- DoD is acquiring portable, solar-powered charging equipment at some locations to allow flexibility in siting chargers as new ZEVs arrive. This equipment uses solar power to generate zero-emissions electricity for all charging; does not impact distribution systems with charging loads; can be almost immediately implemented upon receipt; and can be relocated to optimize use as charging patterns change.
- DoD is coordinating with GSA and auto makers to obtain special-purpose pursuit-rated law enforcement ZEVs as appropriate to potentially fill the Department's requirement for more than 3,500 law enforcement vehicles by 2026.
- DoD is organizing related facility design guidance into a single set of instructions to streamline installation access to electric vehicle charging planning and engineering information.
- DoD is working to establish subject matter experts in each military Service to provide centralized support and expertise, share lessons learned, and disseminate information about procurement pathways to help plan and deploy charging infrastructure (e.g., through state-level programs that facilitate ZEV adoption).

Medium- and Heavy-Duty Vehicles

DoD's medium- and heavy-duty vehicle fleet range from cargo vans and buses to airfield support equipment, construction equipment, and emergency response vehicles. These vehicles often operate in harsh environments where reliability and uptime are mission priorities. For some use cases (e.g., cargo vans, buses), viable ZEV alternatives exist in the marketplace and DoD is beginning to capitalize on this opportunity. For use cases that do not currently have a viable ZEV alternative available, DoD is working with industry partners and intends to test and demonstrate offerings as they develop.

DoD will continue to provide a demand signal to the industry to develop medium- and heavy-duty ZEV alternatives. For example:

- The Air Force and Navy plan to demonstrate the viability of electrified support equipment for flightline use, where diesel-powered equipment currently operates for many hours a day in harsh environments.
- The Department is evaluating the viability of battery-powered heavy-duty modular mobility platforms that can be configured and re-configured for a variety of tasks, from construction to cargo handling.
- The Department is interested in transitioning some medium/heavy vehicles to hydrogen. As DOE-led research moves this technology closer to commercialization, the Department is postured to support DOE's efforts in this area by early-stage demonstration and deployment in its medium- and heavy-duty vehicle fleets.

Achieving Installation Energy Resilience Through the Energy Resilience and Conservation Investment Program

Efforts to achieve GHG emissions reduction goals align with the Department's need to improve mission resilience. For example, the Energy Resilience and Conservation Investment Program (ERCIP) provides military construction funding that can be used to improve resilience and increase the Department's ability to operate in a contested homeland while also reducing GHG emissions. The Department is focusing ERCIP funding to improve energy efficiency and construct cyber-secure microgrids integrating advanced power management features, on-site generation, and energy storage. The Department intends to deploy microgrids at mission-critical installations first and is pursuing opportunities that add value to other projects, such as those funded via third-party contracts or through on-site power purchase agreements.

Marine Corps Air Station (MCAS) Miramar is a prime example of an installation that has leveraged ERCIP funds to deploy a resilience-improving microgrid (Figure 3) supported by renewable energy generated by an adjacent power plant running on landfill gas and on-site solar photovoltaics (PV).

As DoD electrifies its NTV fleet, there may be new opportunities to integrate ZEVs with installation microgrids to enhance mission resilience through mobile backup power.

FIGURE 3. MCAS MIRAMAR – ERCIP-FUNDED INSTALLATION LEVEL MICROGRID

Achieving Net-Zero Emissions Buildings, Campuses, and Installations

Consistent with EO 14057, DoD intends to achieve net-zero emissions at the installation rather than the individual building level. However, all new construction and major modernization projects larger than 25,000 gross square feet entering the planning stage will be designed, constructed, and operated to be net-zero emissions by 2030—and where feasible, net-zero water and waste as well. Net-zero installations will be achieved by improving building performance; deploying on-site generation and storage; and purchasing electricity from carbon-free generation sources.

To improve the performance of DoD's building portfolio, the Department is undertaking efforts to improve design and construction standards, updating policies and the Unified Facilities Criteria (UFC). DoD is also working with DOE to accelerate the development and deployment of new advanced building technologies, construction techniques, and materials, such as cold-climate heat pumps that work in the extremes of winter. Additionally, the Department is exploring ways in which construction techniques and materials can sequester carbon. For example, the Department was an early adopter of cross-laminated timber (CLT) construction techniques that have lower embodied GHG emissions.[8] DoD is seeking to expand this approach to include steel, concrete, and other advanced materials. DoD is examining the potential for permanent biosequestration of carbon on its lands and waters. Programs like Readiness and Environmental Protection Integration (REPI), which combat encroachment by preserving land uses that are compatible with military missions and natural habitats near installations and ranges, are potential tools to support these objectives.

> To date, the DoD has constructed four CLT hotels, totaling over 350,000 square feet, at four installations: Redstone Arsenal, AL; Fort Drum, NY; Joint Base Lewis-McChord, WA; and Fort Jackson, SC. Working with a privatized Army lodging partner and construction firm, these projects illustrate two central benefits of using CLT as an emissions reduction measure: construction efficiency and speed of execution.

Procuring 100% Carbon Pollution-Free Electricity

Consistent with EO 14057, the Department intends to transition its electricity use to 100% CFE on an annual basis by 2030, with at least 50% matched to a CFE regional supply on an hourly basis. The Department has begun evaluating how to revise its purchasing methods.

The Department anticipates close coordination with other government agencies, especially GSA and DOE, to achieve a "whole-of-government" approach to leverage the purchasing power of the U.S. Government. Other planned actions include the following:

- Pursue on-site clean energy generation technologies, including advanced nuclear power, next-generation geothermal and traditional renewables, in order to reduce emissions and strengthen mission resilience.
- Expand consultation with CFE suppliers and state regulators to better understand the regulatory environment and identify cost-effective CFE solutions.
- Evaluate and modify existing utility contracts as needed to incorporate evolving CFE and other lowcarbon requirements.
- Partner with the Defense Logistics Agency—Energy Office (DLA-E) to aggregate demand across multiple DoD sites to procure 100% CFE solutions at lower cost in regulated and deregulated markets, to establish a repeatable mechanism for widespread deployment.
- Create a center of excellence at DLA-E with additional staff to expand energy contracting expertise and capacity to support CFE and other sophisticated procurements of sustainable and resilient energy to meet mission requirements.
- Pursue innovative, on-site clean energy generation technologies, such as advanced nuclear power and advanced geothermal power. The Department expects these technologies to provide additional options for CFE and heat generation and significantly contribute to IE resilience.

8 See https://www.climatehubs.usda.gov/hubs/northeast/topic/climate-smart-buildings-ahead.

IV. PLAN TO REDUCE GHG EMISSIONS FROM OPERATIONAL ENERGY USE

The 2022 National Defense Strategy includes the imperative to reduce operational energy demand to enable operations in contested environments. For instance, the NDS states that the Department "will make reducing energy demand a priority, and seek to adopt more efficient and clean-energy technologies that reduce logistics requirements in contested or austere environments."[9] In April 2022, the Deputy Secretary of Defense directed that the Department's capability development activities increase energy supportability and reduce energy demand across all capability solutions.[10] To enhance energy supportability and drive energy demand reduction across the Joint Force, the Department is assessing how capabilities in Major Capability Acquisition programs, capability modernization efforts, and other technology development programs can improve energy supportability, reduce operational energy demand, and enhance combat capability.

The Department's approach includes the following:

- Reducing OE demand by increasing platform efficiency; exploring new operating concepts; and fielding new, more capable equipment;
- Substituting current fuels with sustainable liquid fuels, preferably produced in a distributed manner, and pursuing alternative power generation technologies;
- Pursuing technology innovation and adoption; and
- Leveraging GHG offsets and sequestration (see Section VII).

OPERATIONAL EMISSIONS PROFILE

The Department's emissions from OE are 76% from aircraft, 17% from ships, and 6% from tactical vehicles and contingency bases. Figure 4 shows Department-wide OE use in FY 2021; the inner ring shows OE usage by military Service, and the outer ring shows usage by type of military platform.

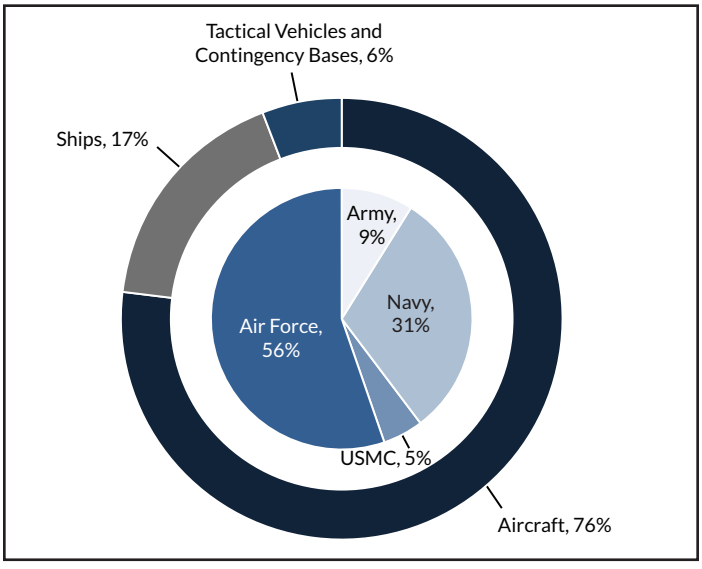

FIGURE 4. FY 2021 OPERATIONAL ENERGY USE BY SERVICE AND TYPE OF EQUIPMENT

REDUCING OPERATIONAL ENERGY DEMAND

Reducing demand for OE can bolster warfighting capability and energy resilience in contested operating environments. A Joint Force that reduces the energy (typically petroleum) to execute its missions can reduce the risks associated with deploying, employing, and sustaining Joint Forces in contested operating environments. The ability to operate for extended periods, over long distances, with greater speed and payload, or in more locations directly increases our capability and reduces an adversary's ability to disrupt the provision of energy for sustained operations.

9 Department of Defense, National Defense Strategy, 27 October 2022, p. 20.
10 Kathleen Hicks, Deputy Secretary of Defense, Energy Supportability and Demand Reduction in Capability Development, 21 April 2022.

The Department will reduce OE demand by improving the efficiency of existing platforms; acquiring new, more energy efficient replacement platforms; and adapting operational practices and procedures, as described below.

Enhancing Efficiency of Existing Platforms/Acquiring New Platforms

The Department's approach to efficiency encompasses all current platforms but will be weighted significantly toward the largest users of energy in the Department (i.e., large, multi-engine aircraft and ships). Department initiatives to improve operational energy efficiency performance, are shown in Table 1.

TABLE 1. PLATFORM EFFICIENCY INITIATIVES ACROSS DOD

TYPE	SERVICE	DETAILS
Large Aircraft	**Air Force**	The Department will continue to pursue improvements to airlift, aerial refueling, and bomber aircraft to reduce energy demand. Large airlift and tanker aircraft conduct hundreds of training and operational sorties each day and represent a substantial portion of the Department's OE usage. To date, the Department has pursued a range of improvements to propulsion and aerodynamic drag that, scaled across a large force with high operations tempo, can yield significant reductions in energy use. For instance, the Air Force is prototyping, demonstrating, and procuring low-risk technologies, like C-17 microvanes, C-130 finlets, KC-135 vertical windshield wipers, C-17 engine pylon fairings, and flight control surface fine-tuning, and pursuing new engine wash technologies that improve engine performance, reduce temperatures, and decrease fuel burn. The Department will continue this comprehensive approach to airlift and tanker aircraft, while also supporting the B-52 Commercial Engine Replacement Program, which replaces aging engines with a new commercial-based engine that will be 20% more efficient, enables upgrades to various mission systems, and yields substantial improvements in both maintainability and readiness. The Department, alongside private industry and the investment community, is embarking on a multi-year effort to design, prototype, and build a Blended Wing Body cargo jet. This revolutionary technology has the potential to increase range and payload while decreasing fuel burn, achieving up to 60% efficiency from wide-body aircraft and engine upgrades.
Electrification of Rotorcraft and Small Mobility Aircraft	**Air Force**	Agility Prime is an Air Force-led innovation program exploring the electrification of rotorcraft and small mobility aircraft. The program pursues prototype projects to help the government assess the transformative vertical flight market and applicable hybrid or electric vertical takeoff and landing aircraft technologies. These platforms decrease fuel logistics risk while pushing resupply and recovery capabilities closer to the front lines of a conflict.
Tactical Fighter Propulsion	**Air Force**	New and scalable propulsion technologies can change the landscape of future operations and enhance warfighting capabilities while reducing energy needs. The Air Force will continue to invest in the Adaptive Engine Transition Program to develop flight-ready prototypes of three-stream adaptive engines and support a Department decision on retrofitting F-35A and F-35Cs. Recent prototype engine tests have validated that adaptive engines achieve 10% higher thrust response, reduce fuel consumption by 25%, increase efficiency during cruise, and significantly enhance power and thermal management capabilities when compared to current 5th-generation fighter engines.

TYPE	SERVICE	DETAILS
Rotary Wing Propulsion	**Army**	The Army will continue investing in the Improved Turbine Engine Program to increase operational capabilities at higher altitudes and hotter conditions and increase loiter time. Integrated diagnostics, predictive maintenance systems and reduced fuel demand will also improve overall reliability. The Army expects a 13–25% reduction in fuel consumption from current Blackhawk and Apache engines and expects to begin procurement of the new engine in FY 2024.
Ships	**Navy**	The Navy has made significant improvements across the surface fleet and is sustaining platform and propulsion upgrades to DDG-51, LPD-17, and TAO-205 surface vessels. The Department will continue to explore innovative propulsion options for the Navy's surface fleet that reduce energy demand and increase the ability to support future upgrades and capability enhancements. Integration of hybrid propulsion increases the flexibility of power management between propulsion and other onboard mission loads. Decreased liquid fuel demand reduces the frequency of replenishment at sea increases operational reach.
Ground Vehicles	**DoD-wide**	The Department will make significant efforts to implement next-generation anti-idle and hybrid propulsion. The Department will continue to develop, test, and integrate new energy-saving technologies that improve the current fleet, including testing anti-idle technologies on the Joint Light Tactical Vehicle (JLTV), Medium Tactical Vehicle, Heavy Tactical Vehicle, and High-Mobility Multipurpose Wheeled Vehicle (HMMWV) as a prelude to retrofitting the fleet. Anti-idle technology reduces liquid fuel demand and provides important tactical advantages. While stationary, vehicles draw electric power, reducing noise and heat signatures. This "silent watch" allows the crew to maintain mission critical communication and weapons platforms. In addition, the Department will build on the first hybrid-electric Bradley Infantry Fighting Vehicle demonstrator that began testing in January 2022 and acquire hybrid electric drive demonstrators for the JLTV and HMMWV. Hybrid-electric vehicles provide survivability and lethality benefits. In addition to silent watch while idling, hybrid-electric vehicles provide silent mobility and improved sprint speed. High-voltage batteries also provide auxiliary power for critical equipment and support directed energy weapons.

Operational Practices and Procedures

While improving the end use of energy in tactical equipment is the primary means of reducing demand, the Department also is pursuing rapid deployment of technology and a data-driven approach to optimize OE. In this way, the Department is deploying and operating the force to provide the same or better warfighting effect while using less energy.

Examples include Air Force support to automated planning tools for the Combined Air Operations Center in U.S. Central Command. Software like the "Jigsaw" aerial refueling planning tool helped increase the effectiveness of each tanker sortie by increasing the average offload per flight hour and enabled the Air Force to meet mission requirements with 180,000 fewer gallons of aviation fuel per week and nine fewer aircrews. In 2020, the Air Force continued developing the tool's next iteration, known as "Pythagoras," which interfaces with existing air operation center systems to automatically match tankers to receivers. The Air Force estimates these improvements will save an additional 400,000 gallons per week (depending on operations tempo) while reducing scheduling time from hours to minutes and lowering the number of aircrews, maintenance crews, and support infrastructure required in a theater.

In parallel, the Navy also is enhancing planning tools for the surface fleet. For instance, the Global Energy Information System improves energy and maintenance planning and operational decision-making by taking into account the effect of energy use on operations. Separately, the Replenishment at Sea Planner optimizes underway replenishment and logistics re-supply more broadly and reduces energy demand for distributed operations in contested environments.

IDENTIFYING AND SCALING OPERATIONAL ENERGY SUBSTITUTES

Petroleum or other liquid fuels will continue to be used in tactical systems and pose a range of challenges to operations in contested environments. In addition to reducing the use of liquid fuels through efficiency improvements, the Department will adopt clean energy technologies where such changes make sense to reduce logistical burdens or provide additional military capability. Furthermore, the Department places significant emphasis on developing a range of fossil fuel alternatives and is cooperating with the private sector to ensure we are prepared to use viable sustainable fuels as they become available in the global market.

Sustainable Aviation Fuel

The Department has a process for certifying low and no-carbon liquid fuels for use in DoD platforms and infrastructure. Sustainable Aviation Fuel (SAF) have the potential to provide operational flexibility and significantly reduce the department's carbon footprint, while requiring no changes to military equipment or infrastructure.

To date, ASTM International – a worldwide standards-setting body that includes the U.S. (including DoD), foreign government agencies, and worldwide original equipment manufacturers – has approved SAF that can make up 10–50% of a unit of fuel and be produced from a range of feedstocks, including synthesis gas (syngas); fats, oils, and greases; sugars; and alcohols.[11] DoD conducts testing and certification to confirm the drop-in compatibility of commercially available alternative fuels with DoD equipment. This approach enables the Department to purchase locally available, compatible fuels throughout existing supply chains, supporting warfighter readiness and operational flexibility.

DoD has approved two low-carbon-fuel pathways for use across the entire Department in tactical ground systems and aircraft.[12] The Army approved two additional low-carbon-fuel pathways for use in Army aircraft, while the Navy and Marine Corps approved one additional pathway. DLAE made three awards in FY 2015–2018 for drop-in compatible, cost-competitive alternative marine diesel, blended with Naval Distillate Fuel, for operational use in ships. In FY 2022, the Department began the certification process for up to four additional SAF pathways already approved in the commercial market, as well as additional pathways in the ASTM approval pipeline.

While these activities are intended to position DoD to be able to use any SAF available on the market, price and availability barriers currently prevent the Department from purchasing SAF or other lower carbon fuels in operational quantities.[13] Notwithstanding those challenges, the Department is taking steps to strengthen its ability to procure and use drop-in compatible and cost-competitive SAF, including the following:

- **Align with Commercially Approved SAF Pathways:** As ASTM International approves additional SAF pathways and these fuels enter supply chains around the world, the Department needs to confirm its ability to use these fuels across all equipment types. The Department will sustain the required testing, certification, and qualification activities needed to confirm the drop-in compatibility of fuels approved by ASTM International.
- **Support the SAF Grand Challenge:** In September 2021, DOE, the Department of Transportation, the Department of Agriculture, and the Environmental Protection Agency (EPA) launched the SAF Grand Challenge to increase U.S. SAF production to 3 billion gallons per year by 2030 and meet 100% of aviation fuel by 2050, projected to be 35 billion gallons.[14] The Department is developing the interagency SAF Grand Challenge Roadmap and will provide technical, material, and other assistance to achieve the approved objectives.

11 DOE, Bioenergy Technologies Office. Sustainable Aviation Fuel Review of Technical Pathways. DOE/EE–2041. September 2020. pp. vi-vii.
12 Current ASTM-approved SAF pathways include a maximum of 50% SAF. The U.S. interagency SAF Grand Challenge includes a workstream to enable drop-in compatible 100% SAF. DOE, the Department of Transportation, the Department of Agriculture, and the EPA. SAF Grand Challenge Roadmap: Flight Plan for Sustainable Aviation Fuel. September 2022. p. 11.
13 Title 10 of the United States Code (USC) Section (§) 2922h prohibits DoD from making a bulk purchase of a drop-in fuel for operational purposes unless the fully burdened cost of that drop-in fuel is cost competitive with the fully burdened cost of a traditional fuel. In addition, Title 10 USC § 2306b, implemented through Federal Acquisition Regulation (FAR) 17.204, limits the length of supply contracts to five years, preventing DoD from entering into long-term commitments needed to incentivize alternative fuels production.
14 Department of Energy, Sustainable Aviation Fuel Grand Challenge. 21 Nov 2022.

- **Investments in SAF Development and Production:** The Department will continue to sustain a mission-focused portfolio of projects to increase the drop-in compatibility and cost competitiveness of SAF. Through research, development, testing, and qualification, the Department will support the development of 100% SAF.
- **Assess On-Site Refining:** Over the long term, synthetic fuels derived from carbon captured from air or water could improve accessibility to fuel in remote and contested environments. On behalf of the Air Force, the Defense Innovation Unit (DIU) is currently managing a Synthetic Fuels for Contested Environments project to create a highly agile, rapidly deployable synthetic fuel production system (leave-behind or onboard) that could be dispersed throughout any area of responsibility to produce just-in-time fuel at the edge.

Electricity

Increasing the use of electricity to power land, sea (surface and subsurface), air, and dismounted soldier platforms has the potential to improve efficiency and could expand options for powering the force. Options for generating or accessing electricity include traditional fossil-fueled generators, fuel cells, advanced nuclear power, on-site PV or wind, and tapping into local electrical grids. The ability to use multiple sources of electricity—many of which may be low carbon—can increases resilience against the disruption of any single source. Furthermore, as commercial markets shift away from fossil fuels, electrifying DoD forces will reduce dependencies on potentially outdated technologies and supply chains. Electrification can also deliver operational capabilities by, for example, enabling flexible power to support an increasing number of lethality and survivability systems integrated into vehicles and other platforms.

The Department will pursue the following initiatives to further electrify Joint Forces:

- **Tactical Vehicles:** The Department has applied anti-idle and sequential hybridization to land platforms to increase fuel economy significantly and improve combat effectiveness through silent watch and mobility and increased sprint speed. The Operational Energy Prototyping Fund (OEPF) and DIU are funding retrofits to existing fleets that support onboard power storage for electronic warfare and command and control systems; heating, ventilation, and air conditioning; and vehicle-to-grid/vehicle-to-vehicle power sharing. The Army fields the bulk of the Department's tactical vehicles, and the Department is supporting the Army's efforts to field purpose-built hybrid-drive tactical vehicles by 2035 and fully electric tactical vehicles by 2050.
- **Sea Systems:** The Navy is developing Next Generation Integrated Power and Energy System technology to support current and future weapons systems (e.g., directed energy systems) and enable power sharing between propulsion and systems loads, resulting in significant efficiencies in fuel consumption.
- **Air Systems:** Building on a broad portfolio of research and development efforts, the Department is pursuing electrification and high-density power delivery technologies that could deliver dramatic improvements to aircraft engines and unmanned aerial vehicles (UAVs). Additionally, the Department is pursuing opportunities across Aircraft efficiencies. The Operational Energy Capability Improvement Fund (OECIF) is innovating across light-weighting, energy information for Command and Control, and electrification of Aircraft Support Equipment.

Nuclear Power

Advanced very small modular reactors have the potential to provide energy resilience through dependable access to reliable, quality power to support critical missions and remote operations. As a parallel effort to a stationary microreactor demonstration program, the Department is funding development of a future mobile microreactor tailored to the stressing demands of remote contingency locations.

Project Pele is led by the Strategic Capabilities Office (SCO) in close collaboration with the DOE, Nuclear Regulatory Commission, and industry partners, with the objective to design, build, and demonstrate a prototype mobile nuclear reactor. SCO selected a single vendor in 2022 to assemble and test the reactor by the end of 2024. The reactor will then be shipped to Idaho National Laboratory, where it will be fueled and will reach full power for the first time in 2025. The demonstration reactor will be designed to be transported by the DoD and able to deliver 1–5 megawatts of electrical power for a minimum of three years of full power operation. The Department will evaluate the cost and warfighting effectiveness of using nuclear power to support operations across the battlespace based in part on this demonstration project.

V. TECHNOLOGY INNOVATION AND ADAPTATION

The Department's efforts to enhance capability and resilience and to reduce GHG emissions include supporting public and private-sector innovations. The Department coordinates and funds innovations through research, development, testing, and evaluation (RDT&E) activities (by industry, universities, federal laboratories, and others) and leveraging interagency collaborations. For example, DoD is supporting the development of technologies that improve the energy efficiency of existing buildings and solutions that enable DoD to manage electrical demand. DoD is also supporting the development and validation of technology to permanently store carbon in natural and built infrastructure.

The Department is also investing in technology innovations and leveraging commercial technologies that enhance capability and mitigate risk by reducing operational energy use. DoD intends to work with the United States' technology base to better understand energy operating profiles, transition the Joint Force from a reactive to a predictive posture for energy management and control, and develop forward-operating power systems and high-efficiency platforms. Across tactical, operational, and strategic echelons, timely and accurate visibility in the joint energy supply and demand is essential to make effective decisions, reduce operational risk, and prioritize resources. Fielding technologies to fill mission capability gaps improves in lethality, operational agility, and resilience.

The Department uses a range of Defense-wide and Service-specific RDT&E accounts to support energy innovation and reduce GHG emissions. Significant Defense-wide RDT&E programs and investment priorities include:

- The Environmental Security Certification and Technology Program (ESTCP) is sponsoring activities to:
  - Improve energy efficiency by adapting commercial lighting, heating/ventilation/air conditioning, building envelope, and energy management and controls;
  - Improve control systems cybersecurity; and
  - Prototype low carbon-footprint building materials.
- The OECIF and an OEPF are investing in technology development to:
  - Improve efficiency of current systems and platforms;
  - Employ renewable energy sourcing for the warfighter at or nearest to the point of operations;
  - Enable energy storage in combination with electrification across the battlespace for platform use and distribution; and
  - Improve battlespace awareness of energy supplies, requirements, networks, and enemy action.

The Defense Innovation Unit (DIU) is a DoD organization focused exclusively on fielding and scaling commercial technology across the U.S. military at commercial speeds. DIU established an energy portfolio in 2021 and is sponsoring nearly 30 prototyping efforts for dual-use commercial technologies in the energy sector and the associated material requirements. These efforts are on behalf of all of the military Services; include multiple interagency partners; and cover IE and OE gaps, including:

- Tactical vehicle electrification
- Electric vehicle support equipment
- Advanced batteries
- Arctic energy storage
- Sustainable Aviation Fuel
- Solar UAVs
- Austere and operational microgrid management
- Installation power and water monitoring
- Long-duration storage
- Geothermal energy generation
- Efficient waste disposal
- Tactical refueling systems
- Hydrogen generation and usage at the tactical edge

The Department is also leveraging expertise from DOE to accelerate innovation for DoD installation and operational GHG emissions reduction. Standing Memoranda of Understanding with DOE enable collaboration with the Advanced Research Projects Agency – Energy (ARPA-E), National Nuclear Security Administration (NNSA), and national laboratories on renewable energy, energy storage, intelligent microgrids, nuclear energy, and other technologies that support energy resilience.

VI. REDUCING NON-CO_2 GHG EMISSIONS

Non-CO_2 gases such as methane (CH_4), hydrofluorocarbons (HFCs), nitrous oxide (N_2O), and others contribute significantly to global warming; methane alone contributes fully half of current net global warming of 1.0°C emissions.[15] Some Scope 1 and 2 GHG emissions come from activities that use HFCs and other refrigerants.

DoD's Scope 1 and Scope 2 fugitive emissions (largely methane) are about 3% of the Department's total emissions (Figure 2). Some non-CO_2 GHG emissions result from activities not owned or controlled by DoD (Scope 3 emissions).

Reducing non-CO_2 emissions is an important part of DoD's plan to reduce GHG emissions, especially high Global Warming Potential[16] (GWP) gases, as noted in Section I. For example, the Department will reduce HFC consumption in accordance with the American Innovation and Manufacturing Act, which seeks to reduce HFC consumption by 90% across the United States.[17] The Department established Mission-Critical Military End Uses (MCMEUs) for HFCs and annually reports on them to EPA. Based on DoD's reports, EPA authorizes allocations to DoD's HFC providers. At the same time, DoD is investing in alternatives to MCMEUs to reduce the need for HFCs.

DoD is also investing in low-GWP alternatives to HFCs via its R&D programs. For example, in FY 2022, DoD's Strategic Environmental Research and Development Program (SERDP) funded the final year of an ongoing development effort related to environmentally safe alternatives to HFCs (which are GHGs with high GWP). If these efforts are successful, DoD's ESTCP will further demonstrate and validate these technologies.

VII. REDUCING SCOPE 3 GHG EMISSIONS

Scope 3 emissions include those from the defense industrial base and from DoD activities such as business travel, commuting, and offsite waste disposal. Scope 3 emissions from such activities may be equal to or greater than the Department's Scope 1 and 2 emissions.

REDUCE SCOPE 3 EMISSIONS FROM ACQUISITION, PROCUREMENT, AND SUPPLY CHAINS

Scope 3 GHG emissions occur across the defense industrial base and supply chain and DoD is engaging in an effort to assess those emissions. The Department issued Requests for Information in FY2022 to inform DoD on industry practices to benchmark Scope 3 GHG emissions and capabilities for conducting supply chain analysis and emissions reporting.

In addition, in November 2022, the Federal Acquisition Regulatory Council issued the proposed rule, "Disclosure of Greenhouse Gas Emissions and Climate-Related Financial Risk," which includes guidance for major federal suppliers to disclose Scope 1, 2, and 3 emissions. GHG-related efforts will be informed by the final rule.

The Department is also committed to expanding the application of sustainable chemistry principles to improve the design of products and processes to reduce or eliminate embodied emissions[18] across product design, manufacture, use, and disposal. DoD is partnering with the White House Office of Science

15 Executive Office of the President, Long-Term Strategy of the United States. Pathways to Net-Zero Greenhouse Gas Emissions by 2050, November 2021.
16 Chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs), hydrochlorofluorocarbons (HCFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF6) are sometimes called high-GWP gases because, for a given amount of mass, they trap substantially more heat than CO_2. See https://www.epa.gov/ghgemissions/understanding-global-warming-potentials.
17 The phase down is of 90% of the aggregate global warming potential of HFCs across the United States, not including recycled or reused HFCs.
18 Embodied emissions from producing chemicals, electronics, machinery, steel, metals, textiles, and other products in the United States accounts for approximately one-third of our nation's energy-related CO_2 emissions (from DOE's Industrial Decarbonization Roadmap Fact Sheet, September 2022).

and Technology Policy to develop a Federal Sustainable Chemistry Strategic Plan and develop sustainable chemistry metrics to accelerate decarbonization efforts.

The Department intends to leverage its procurement programs to reduce embodied GHG emissions from the products it buys. This includes using authorities contained in Department of Defense Instruction (DoDI) 4105.72, Procurement of Sustainable Goods and Services, to reduce both lifecycle costs to DoD and GHG emissions. The Department is also developing a process to standardize carbon disclosure requirements for suppliers as part of its procurement processes, increasing awareness and use of commercially available sustainable alternatives and providing the mechanisms necessary to implement these alternatives.

BUSINESS TRAVEL, COMMUTING, AND TELEWORK

Business travel, commuting, and telework—and the effect, positive or negative, that these actions will have emissions they produce (or reduce)—are defined as Scope 3 emissions. DoD reporting of Scope 3 emissions was suspended in FY 2016.[19] EO 14057 required agencies to resume tracking and reporting of Scope 3 emissions in 2022.

The Department will set a 2030 Scope 3 reduction target along with annual progress targets pursuant to GSA guidance.

VIII. CLOSING THE GAP: OPTIONS TO LEVERAGE OFFSETS, SEQUESTRATION, AND TARGETED EXEMPTIONS

Combining GHG emissions reduction measures as described above will significantly reduce the Department's GHG footprint. The Department will seek ways to offset residual emissions by other means, including leveraging carbon offsets, implementing permanent sequestration activities on DoD lands, using carbon-neutral or negative construction techniques.[20] Methods such as technological (e.g., carbon mineralization in building materials or injecting CO_2 into deep geological formations) and permanent (rather than ephemeral) biological sequestration methods have the potential to compensate for emissions that occur elsewhere.

Carbon capture, utilization, and sequestration (CCUS) refers to technologies that remove carbon pollution from the ambient air or from point sources like smokestacks and permanently store the carbon. CCUS technologies capture CO_2 from fuel combustion or industrial processes, transport this CO_2 via vehicle or pipeline, and either use it to create products or services or permanently store it deep underground in geological formations.

Peer-reviewed research indicates CCUS faces challenges, including:

- Achieving GHG emissions reductions may be impractical at scales large enough to be effective at offsetting sufficient emissions to avoid the 1.5°C increase in global average temperature that could reduce the likelihood of unmanageable climate impacts;
- High capital and lifecycle costs may be uneconomical; and
- Uncertainties and potential adverse or unintended consequences (e.g., induced seismicity) could have safety impacts.

To overcome these challenges, DoD will continue to support advanced technological solutions, as well as CCUS projects within the supply chain, which do not yet exist at commercial scale. DoD will invest in

19 In FY 2016, business travel emissions totaled 2.1 MMTCO2e and commuting emissions totaled 3.4 MMTCO2e.
20 A targeted exemption is one with a high specificity. For example, rather than claiming an exemption for all data centers, a targeted exemption would identify specific data centers in specific climate zones given specific energy requirements and the specific limitations of currently available technologies.

research and development; support first-of-a-kind demonstration projects; and develop procurement initiatives that leverage DoD's purchasing power to build early markets for low-carbon industrial products like concrete and other construction and product materials. Likewise, the Department will partner with private industry and other federal agencies to explore ways to store large amounts of carbon in rock or salt formations beneath DoD lands.

In addition to seeking ways to embed carbon in construction, the Department will explore options to permanently sequester carbon through biosequestration. For example, tree planting is one method of offsetting emissions through sequestration of carbon and can also reduce urban heat island impacts and help reduce energy demand on installations. Biosequestration is a highly dynamic process and cannot be assumed to be entirely permanent or steady throughout the lifecycle of the ecosystem. Urban trees take approximately 30 years to attain carbon neutrality, suggesting that older trees need to be preserved.

Carbon sequestered in trees, grasslands, and marshes can be released directly due to wildfire and indirectly due to the adverse impacts of invasive species, drought, and submergence. Measures that enhance the ability of rangelands and forestlands to act as permanent carbon sinks will be evaluated for use in DoD Natural Resources Management.

The Department is leveraging its leadership role within the Federal Government as a testbed for new technology supporting GHG emissions reduction from carbon storage. Research and development activities provide opportunities for DoD to leverage its unique capabilities and investments. Projects initiated by the National Defense Center for Energy and Environment,[21] and programs like SERDP, and ESTCP[22] demonstrate and help field viable, mission-driven solutions that can reduce total ownership costs and fulfill DoD environmental, energy, health, and sustainability requirements. For example, all ESTCP IE and water-related projects are required to include performance objectives such as cost avoidance, energy, and water conservation, and GHG reduction.

IX. CONCLUSION

DoD's combined efforts—reducing operational and installation energy demand, using distributed, alternative energy supplies, and pursuing technology innovation—will help reduce risk in contested environments, improve installation resilience, and enhance operational flexibility while also reducing GHG emissions. Through these initiatives and investments, the Department is making important progress toward the Federal Government's goal of a net-zero economy by mid-century. Partnership with other executive branch agencies, Congress, academia, and industry will remain critical to achieving DoD's objectives.

21 See https://www.denix.osd.mil/ndcee/.
22 See https://www.serdp-estcp.org/.

APPENDIX A. STATUTORY REQUIREMENTS TO REDUCE GHG EMISSIONS AND RELATED EXECUTIVE ORDERS

The Department of Defense's (DoD's) activities to reduce greenhouse gas (GHG) emissions are guided by a large and growing list of statutes and Executive Orders (EOs), as reflected below. Differences in definitions, goals, and metrics across these various requirements complicate the Department's planning, management, and reporting efforts. The Department welcomes any efforts to unify, update, and streamline these requirements.

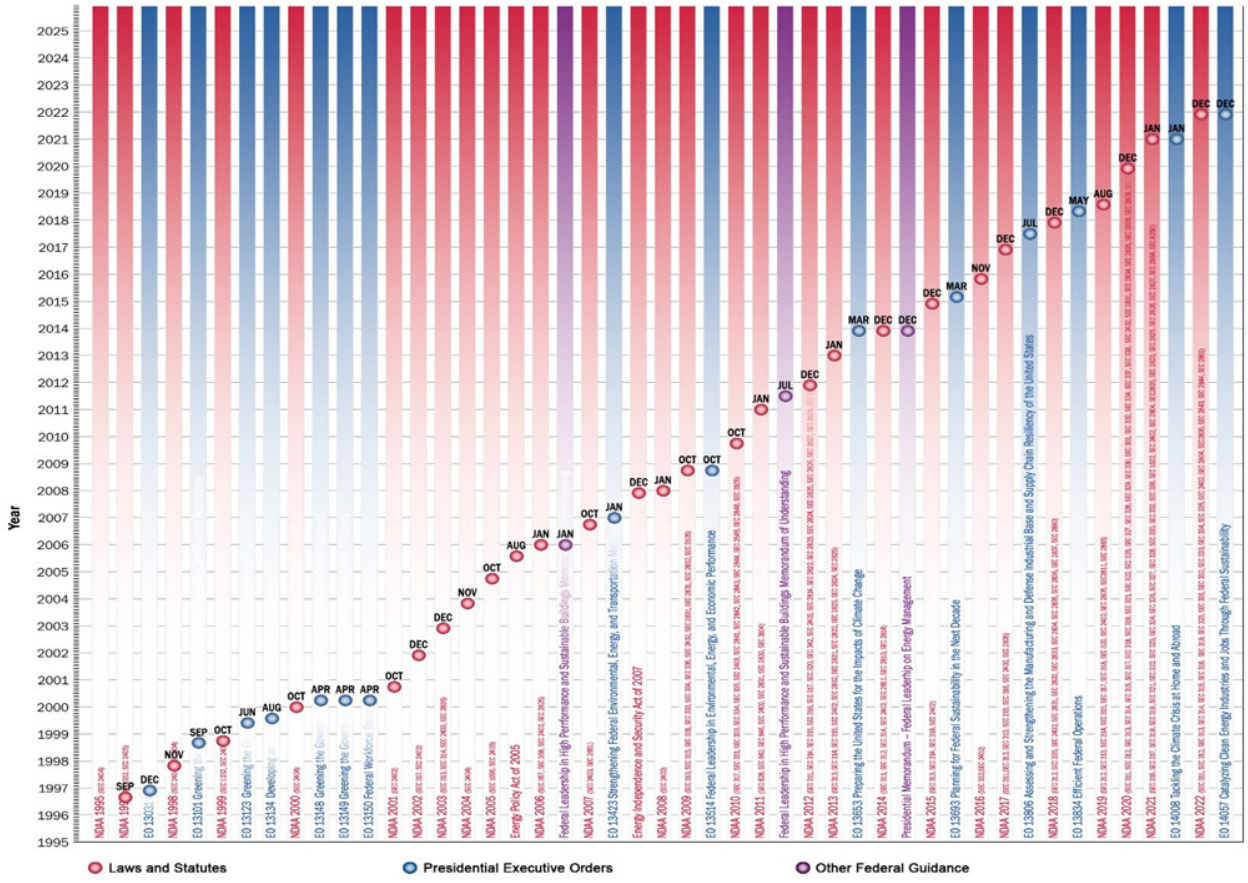

FIGURE 5. EVOLUTION AND TRENDS IN STATUTORY REQUIREMENTS

A.1. STATUTORY REQUIREMENTS RELEVANT TO GHG EMISSIONS REDUCTION

- 10 United States Code (USC) 101, Definitions
- 10 USC 2662, Real property transactions: reports to congressional committees
- 10 USC 2667, Leases: non-excess property of military departments and Defense Agencies
- 10 USC 2668, Easements for rights-of-way
- 10 USC 2679, Installation-support services: intergovernmental support agreements
- 10 USC 2684, Cooperative agreements for management of cultural resources
- 10 USC 2686, Utilities and services: sale; expansion and extension of systems and facilities
- 10 USC 2688, Utility systems: conveyance authority
- 10 USC 2802, Military construction projects
- 10 USC 2805, Unspecified minor construction
- 10 USC 2807, Architectural and engineering services and construction design
- 10 USC 2864, Master plans for major military installations
- 10 USC 2867, Energy monitoring and utility control system specification for military construction and military family housing activities
- 10 USC 2872 (a), Utilities and services
- 10 USC 2911, Energy policy of the Department of Defense
- 10 USC 2911 note, Consideration of fuel logistics support requirements in planning, requirements, development, and acquisition processes
- 10 USC 2912, Availability and use of energy cost savings
- 10 USC 2913, Energy savings contracts and activities
- 10 USC 2914, Military construction projects for energy resilience, energy security, and energy conservation
- 10 USC 2915, Facilities: use of renewable forms of energy and energy efficient products
- 10 USC 2916, Sale of electricity from alternate energy and cogeneration production facilities
- 10 USC 2917, Development of geothermal energy on military lands
- 10 USC 2918, Fuel sources for heating systems: prohibition on converting certain heating facilities
- 10 USC 2919, Department of Defense participation in programs for management of energy demand or reduction of energy usage during peak periods
- 10 USC 2920, Energy resilience and energy security measures on military installations
- 10 USC 2922, Liquid fuels and natural gas: contracts for storage, handling, or distribution
- 10 USC 2922 (h), Limitation on procurement of drop-in fuels
- 10 USC 2925, Annual Department of Defense energy management reports
- 10 USC 2926, Operational energy
- 10 USC 2926 (b), Responsibilities
- 10 USC 2926 (c), Functions of the Assistant Secretary of Defense for Energy, Installations, and Environment
- 10 USC 2926 (d), Working Group
- 10 USC 2926 (e), Operational energy strategy
- 10 USC 2391, Military base reuse studies and community planning assistance
- 40 USC 501, Services for executive agencies
- 42 USC 6834, Federal building energy efficiency standards
- 42 USC 6835, Federal compliance
- 42 USC 8253, Energy and water management requirements
- 42 USC 8256, Incentives for agencies
- 42 USC 8257, Interagency Energy Management Task Force
- 42 USC 8258, Reports
- 42 USC 8259, 8262, Definitions
- 42 USC 8287, Authority to enter into contracts
- 42 USC 15852, Federal purchase requirement
- 42 USC 17091, Leasing
- 42 USC 17112, Energy efficiency for data center buildings

- FY 2020 National Defense Authorization Act (NDAA), Sec 331, Agreements to share monitoring data relating to Perfluoroalkyl and Polyfluoroalkyl Substances and Other Contaminants of Concern
- FY 2021 NDAA, Sec 334, Research and development of alternative to aqueous film-forming foam
- FY 2022 NDAA, Subtitle D (Sec 341–349), Treatment of Perfluoroalkyl and Polyfluoroalkyl Substances
- FY 2022 NDAA, Sec 323, Department of Defense plan to reduce greenhouse gas emissions
- FY 2022 NDAA Sec 352, Global bulk fuel management and delivery

A.2. EXECUTIVE ORDERS AND OTHER DIRECTIVES

These include directives from Office of Management and Budget (OMB) that require GHG emissions reductions.

- EO 13990, Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis, January 20, 2021
- EO 14008, Tackling the Climate Crisis at Home and Abroad, January 27, 2021
- EO 14030, Climate-Related Financial Risk, May 20, 2021
- EO 14057, Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability, December 8, 2021
- EO 14072, Strengthening the Nation's Forests, Communities, and Local Economies, April 22, 2022
- M-22-06, Memorandum for the Heads of Executive Departments and Agencies from Director, OMB, Chair, Council on Environmental Quality, and the National Climate Advisor, Climate Policy Office, December 8, 2021

A.3. DOD ISSUANCES THAT REQUIRE GHG EMISSIONS REDUCTIONS AND EFFICIENCY IMPROVEMENTS

A.3.1. DOD DIRECTIVES

- DoD Directive (DoDD) 3020.40, Mission Assurance
- DoDD 4180.01, DoD Energy Policy

A.3.2. DOD INSTRUCTIONS

- DoD Instruction (DoDI) 3020.45, Mission Assurance Construct
- DoDI 3030.03, Joint Land Use Study (JLUS) Program
- DoDI 3200.21, Sustaining Access to the Live Training Domain
- DoDI 4105.72, Procurement of Sustainable Goods and Services
- DoDI 4165.70, Real Property Management
- DoDI 4170.11, Installation Energy Management
- DoDI 4715.05, Environmental Compliance at Installations Outside the United States
- DoDI 4715.06, Environmental Compliance in the United States
- DoDI 4715.21, Climate Change Adaptation and Resilience
- DoDI 4715.23, Integrated Recycling and Solid Waste Management
- DoDI 4715.24, The Readiness and Environmental Protection Initiative Program and Encroachment Management
- DoDI 6055.17, DoD Emergency Management (EM) Program

A.3.3. DOD MANUALS

- DoD Manual (DoDM) 4715.03, Integrated Natural Resources Management Plan (INRMP) Implementation Manual

APPENDIX B. SCIENCE-BASED EMISSIONS REDUCTIONS TARGETS

10 U.S.C. § 2911 - Energy Policy of the Department of Defense

SEC. 323. DEPARTMENT OF DEFENSE PLAN TO REDUCE GREENHOUSE GAS EMISSIONS

(a) PLAN REQUIRED. –Not later than September 30, 2022, the Secretary of Defense shall submit to Congress a plan to reduce the greenhouse gas emissions of the Department of Defense.

(b) BRIEFINGS.-The Secretary shall provide to the Committees On Armed Services of the House of Representatives and the Senate Annual briefings on the progress of the Department of Defense toward meeting science-based emissions targets in the plan required by subsection (a).

Carbon emissions targets are defined as science-based if aligned with the scale of reductions required to limit global warming below 2°C above pre-industrial temperatures and pursue efforts to limit warming to 1.5°C. Science-based targets for Scope 1 and Scope 2 greenhouse gas (GHG) emissions have stimulated a growing market for the private sector and nongovernmental organizations to produce frameworks, assessments, and certifications. Recently, these entities have expanded into Scope 3 emissions.

Executive Order (EO) 14057 set the goal of a net-zero economy by mid-century, which is grounded in science-based targets, and agencies are currently implementing the Federal Sustainability Plan through a government-wide process aligned with the science-based approach. For example, agencies are setting interim targets for carbon pollution-free electricity, zero-emission vehicles, and net-zero emission buildings that reflect agencies' missions and are based on the unique data available. Agency targets will evolve as more data becomes available, in alignment with the science-based approach.

The Department of Defense (DoD) is currently working with interagency partners to set overall GHG emissions reductions targets. The Council on Environmental Quality (CEQ) and Office of Management and Budget (OMB) are responsible for issuing guidance to federal agencies for setting initial targets, and federal agencies must propose targets for review and approval by CEQ and OMB within 90 days of receiving target setting guidance, unless the guidance directs otherwise.

DoD anticipates GHG target-setting guidance in calendar year 2023, and at the appropriate time DoD will use Department of Energy-Federal Energy Management Program (DOE-FEMP) tools and associated data and analysis in the projecting progress, consistent with Section 509(c) of EO 14057. In subsequent reports to Congress, DoD will illustrate progress toward meeting the science-based GHG emissions targets developed as part of this interagency process.

APPENDIX C. ACRONYM LIST

AETP	Adaptive Engine Transition Program
ASTM	American Society for Testing and Materials
CCUS	Carbon Capture, Utilization, and Sequestration
CEQ	Council on Environmental Quality
CFC	Chlorofluorocarbon
CFE	Carbon Pollution-Free Electricity
CH_4	Methane
CLT	Cross-Laminated Timber
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
COVID-19	Coronavirus Disease 2019
CWG	Climate Working Group
DIU	Defense Innovation Unit
DLA-E	Defense Logistics Agency—Energy Office
DoD	Department of Defense
DoDI	Department of Defense Instruction
DOE	Department of Energy
EO	Executive Order
EPA	Environmental Protection Agency
ERCIP	Energy Resilience and Conservation Investment Program
ESPC	Energy Savings Performance Contract
ESTCP	Environmental Security Certification and Technology Program
EVSE	Electric Vehicle Supply Equipment
FAR	Federal Acquisition Regulation
FEMP	Federal Energy Management Program
FY	Fiscal Year
GHG	Greenhouse Gas
GSA	General Services Administration
GWP	Global Warming Potential
HCFC	Hydrochlorofluorocarbons
HFC	Hydrofluorocarbon
HMMWV	High-Mobility Multipurpose Wheeled Vehicle
IE	Installation Energy
IEP	Installation Energy Plan
INRMP	Integrated Natural Resources Management Plan

JLTV	Joint Light Tactical Vehicle
MCAS	Marine Corps Air Station
MCMEU	Mission Critical Military End Use
$MMTCO_2e$	Million Metric Tons of Carbon Dioxide Equivalent
N_2O	Nitrous Oxide
NDAA	National Defense Authorization Act
NTV	Non-Tactical Vehicle
OE	Operational Energy
OECIF	Operational Energy Capability Improvement Fund
OEPF	Operational Energy Prototyping Fund
OMB	Office of Management and Budget
PFC	Perfluorocarbons
PV	Photovoltaics
RDT&E	Research, Development, Test, and Evaluation
REPI	Readiness and Environmental Protection Integration
SAF	Sustainable Aviation Fuel
SBT	Science-Based Target
SCO	Strategic Capabilities Office
SERDP	Strategic Environmental Research and Development Program
SF6	Sulfur hexafluoride
SPR	Strategic Portfolio Review
U.S.	United States
UAV	Unmanned Aerial Vehicle
UESC	Utility Energy Services Contract
USC	United States Code
ZEV	Zero-Emission Vehicle