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Analysis of Pathways to Reach Net-Zero Naval Operations by 2050

Fletcher, Kristen; Johnson, Bonnie; Naylor, Brandon

Monterey, California: Naval Postgraduate School

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NPS NRP Executive Summary

Analysis of Pathways to Reach Net-Zero Naval Operations by 2050

Period of Performance: 10/24/2021 – 10/23/2022

Report Date: 10/23/2022 | Project Number: NPS-22-N258-A

Naval Postgraduate School, Energy Academic Group (EAG)



NAVAL RESEARCH PROGRAM

NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

ANAYLYSIS OF PATHWAYS TO REACH NET-ZERO NAVAL OPERATIONS BY 2050

EXECUTIVE SUMMARY

Principal Investigator (PI): Ms. Kristen Fletcher, Energy Academic Group

Additional Researcher(s): Ms. Marina Lesse, Energy Academic Group; and Mr. Brandon Naylor, Energy Academic Group; Dr. Bonnie Johnson, Systems Engineering (SE)

Student Participation: MAJ Joseph Lucas, US Army, SE; MAJ Steven Moore, US Army, SE; CPT Justin Strait, US Army, SE; CPT Eric Forsgren, US Army, SE; CPT Brian Jernigan, US Army, SE; and Cpt John Hohng, US Army, SE

Prepared for:

Topic Sponsor Lead Organization: N9 - Warfare Systems

Topic Sponsor Name(s): Mr. Cayle Bradley, Requirements Officer, OPNAV N94

Topic Sponsor Contact Information: cayle.a.bradley1@navy.mil; 360-720-4608



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Project Summary

With the backdrop of net-zero emissions as an essential element of national security, this study undertook an analytical approach to evaluate current Department of the Navy (DON) emissions and understand energy needs to support mission readiness while reducing emissions over time. In this report, researchers present current and proposed low-carbon energy sources as possible pathways for shifting DON to net zero by 2050 with models showing four pathway options. Strategies toward net-zero emissions for the DON include alternative fuels, hydrogen, unmanned systems, batteries, improved operational efficiencies, nuclear energy, renewable energy, and carbon capture and sequestration. The research leverages existing net-zero strategies and findings developed in the public and private sectors. It identifies challenges and gaps to advance future research and analysis to further emissions reduction by the DON.

Keywords: *net-zero emissions, carbon emissions, climate change, energy security*

Background

This report is based on a broad study of strategies for the DON to achieve net-zero global emissions by 2050 to comply with recent executive orders and goals set out for the Department of Defense (DOD) and the DON. Executive Order No. 14008 (2021) calls for a government-wide approach for meeting climate-related challenges in the U.S. and set goals for agencies. Executive Order No. 14057 (2021) sets the specific goal of net-zero emissions for overall federal operations, including the DOD, by 2050 and a 65% emissions reduction by 2030.

These are challenging targets for the DOD: in 2019, DOD consumed 682 trillion BTUs, which represents up to 77% of federal government energy use. Up to three quarters of that energy use is operational; for the DON, that means ships and planes, which are two of the most difficult sectors to decarbonize. This research is critical in moving the DON toward these required goals.

With the backdrop of net-zero emissions as an essential element of national security, this study undertook an analytical approach to evaluate current DON emissions and understand energy needs to support mission readiness while reducing emissions over time. Researchers worked with the Navy Climate Change Working Group and the Climate Strategy Working Group focused on Training and Equipping for Climate Resilience to understand the current state of energy demand, sources of energy in use, and technology employed and in development for reducing emissions. Research into future demand was conducted within the context of the DON's plans for ships and planes, including unmanned systems. The team also worked with subject matter experts from other agencies and the private sector to identify and analyze the pathways under consideration in other sectors, their likelihood for success, and their relevance in the military sector.

Findings and Conclusions

Given the breadth of the topic, researchers needed to ensure the model pathways to net-zero emissions were placed into context. Because net-zero emissions are defined differently around the world and even within the DOD, identifying a clear definition was critical. Researchers relied on this definition of net-zero emissions: “a condition achieved when anthropogenic emissions of greenhouse gases to the atmosphere are balanced by anthropogenic removals of those same gases over a specified period” (U.S. Army, 2022). Similarly, while the report includes references to emissions-related savings at installations, the focus is on peacetime and deterrence operations.



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The report presents strategies for reaching net zero, including hydrogen, unmanned systems, batteries, improved efficiencies, nuclear, renewable energy, and carbon capture and sequestration. Analysis of each strategy includes background information showing the relevancy of the strategy to emissions, advantages to using the strategy in the context of DON priorities, challenges to the strategy, and the percent of emissions reduction that may be expected over time. Key findings include the difficulties in decarbonizing ships and planes, especially when those platforms are for military use; strategies such as hydrogen, unmanned systems, and efficiencies are seeing growth and future potential.

These strategies make up four models of possible pathways to net-zero emissions. The four models are sand charts that show the role that each strategy will have in four scenarios: (1) baseline or status quo; (2) pushing technology and operations; (3) aggressive advances; and (4) aspirational and aggressive advances.

This report contributes possible solutions to the complex challenges facing the DON, DOD, U.S. government, and the country as a whole as emission reduction strategies are considered and executed. The work will inform current efforts within N94 as it maps future energy demand and strategies for emissions reduction and within the DON, including the Navy Climate Change Working Group and working groups under the Navy Climate Strategy. These concepts, over time, can also benefit the DOD through incorporation into the National Defense Strategy and by informing metrics and actionable goals to support reductions in emissions or carbon emission credit programs.

Recommendations for Further Research

Researchers found significant gaps in data and information relevant to reaching net-zero emissions by 2050. Due to these gaps, researchers had to make certain assumptions to calculate potential emissions savings. Given this, the pathway models could benefit from improved underlying data for: additional operational efficiencies in ships and planes, advances in low-carbon fuels, ability of hydrogen-based systems to scale up, emissions savings from the use of unmanned systems, battery storage capabilities, operational use of renewable energy, and carbon capture and sequestration, especially in submerged lands of naval installations.

Research is ongoing in these areas, and as the report's models reflect, data for each strategy can be updated to recalculate revised sand charts and identify future pathways to net-zero emissions. This would allow recalculations based on advances in one or more energy sources or a new technology introduced into DON operations.

Working with the topic sponsor, research is underway on a year two Naval Research Program project entitled *Advancing Pathways to Net Zero for the Operational Navy*. This research builds on the current report to move from pathway identification to prioritization and operationalization. The team will develop requirements for priority pathways to identify ways to operationalize them by researching the following questions: What are the most significant challenges for reaching net-zero emissions for the operational Navy? What are the requirements needed to operationalize the pathways to meet mission and reduce emissions?

These findings will contribute to the interdisciplinary work underway within the DON and DOD as the community makes strides to reach net-zero emissions by 2050.



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Acronyms

DOD Department of Defense

DON Department of the Navy

