SURGE

ENERGY ACADEMIC GROUP QUARTERLY NEWSLETTER SPRING 2025

Highlights

DEFENSE ENERGY

The Critical Role of Operational Energy in Military Readiness and Resilience

By Brenda Shaffer, Faculty Associate-Research, Energy Academic Group

On February 27th, the Atlantic Council's Global Energy Center and the Scowcroft Center for Strategy and Security's Forward Defense Program hosted a panel on the role of operational energy in U.S. military readiness and resilience. The panel discussed how U.S. adversaries — Russia, Iran and China — plan on disrupting U.S. operational energy supplies, including through attacks on U.S. domestic energy infrastructure. Professor Brenda Shaffer pointed out that traditionally operational energy has two sides: providing energy for war fighting and disrupting the energy supplies of one's adversary. However, in her current assessment, the U.S. focuses on provision of energy and not enough on disruption of enemy energy supplies. In contrast, U.S. adversaries focus on disruption of U.S. supplies. The panel also examined the specific challenges to supplying U.S. military operations in the Asian theater.

Panelists also presented various new energy systems under development and study for deploying to serve the U.S. military. Deputy Assistant Secretary Rebecca Isacowitz spoke about how DoD is working to support the administration's larger energy dominance goals. Additionally, Prof. Shaffer presented findings from the textbook *Operational Energy,* which was published last year and is co-authored by Dr. Daniel Nussbaum and Mr. Alan Howard of the Naval Postgraduate School's Energy Academic Group.

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See the full panel discussion: **https://www.atlanticcouncil.tv/videos/the-critical-role-of-operational-energy-in-military-readiness-and-resilience-02-27-2025-20-06-26.**

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From the Chair

Dan Nussbaum, Chair of the Energy Academic Group

I asked the question in my prior *Surge* articles, "Will we have enough energy in the future to meet our needs?" I asked this, purposefully provocative, since it is likely our total annual global energy consumption will continue to grow, stressing already constrained resources. The drivers of this presumptive growth include rising living standards, increasing populations, reshoring of manufacturing, increasing use of AI, and growth in data centers. I concluded that there is a case to be made that the answer is "no", there will not be enough energy in the future to meet our needs.

We have two articles addressing this issue, one from the distinguished scholars Daniel Yergin, Peter Orszag, and Atul Arya, in *The Troubled Energy Transition; How to Find a Pragmatic Path Forward*, (Foreign Affairs, March/April 2025, Vol 2, Num. 104); and the other from the *Axios AM Thought Bubble* newsletter (March 11, 2025).

The *Foreign Affairs* article analyzes the troubled state of the energy transition, arguing that it is currently more of an energy addition than a replacement of fossil fuels, with both renewables and hydrocarbons reaching record production levels. That is, the aggregate energy-pie-chart is increasing, rather than renewable displacing more traditional energy sources, and the global energy mix has not fundamentally shifted away from hydrocarbons. The article highlights challenges hindering a rapid shift to low-carbon sources, including economic costs, energy security concerns, geopolitical competition, and the increasing demand for electricity. It emphasizes the divergent priorities between developed and developing nations, particularly regarding economic growth versus climate action, and the significant obstacles related to critical mineral supply chains and the various permitting processes. Ultimately, the article advocates for a more pragmatic approach that acknowledges these complexities and trade-offs to ensure a realistic and sufficient energy future. The article concludes that navigating to a sufficiently supplied energy future requires acknowledging and managing various trade-offs, including those between cost and supply chain security. The transition will likely be a long, complex, and non-linear process involving ongoing investment in "all of the above" sources.

Similarly, the *Axios AM Thought Bubble* newsletter (March 11, 2025) highlights a shift toward "energy pragmatism" in the presentations and discussions at CERAWeek, the influential energy conference in Houston. This year's event reflects a growing recognition of challenges, as executives acknowledge the need for balance and realism in the energy arena. In particular, the previous optimism surrounding the prospects for rapid decarbonization is fading as industry leaders face mounting obstacles. Additionally, policies are encountering a "harsh reality check" due to shifting political landscapes, surging global energy demand, and the sluggish pace of zero-carbon energy adoption. While renewables remain a key part of the conversation, major energy players now stress the necessity of an all-of-the-above strategy that includes oil, gas, nuclear, and renewables. Even tech companies, once vocal advocates for renewables, are now prioritizing energy availability over sustainability. Data centers, crucial for AI and cloud computing, require vast and stable power sources, shifting the balance between concerns for reliability and concerns for carbon neutrality. The overarching message is that the path to the energy future will require pragmatism, flexibility, and a willingness to embrace all available energy sources.

In summary, we need to recognize the centrality of energy and the importance of understanding the roles of energy. Specifically, Energy Security has re-emerged as a critical concern, especially following geopolitical events that disrupted global energy markets. Governments prioritize stable and affordable energy supplies, which necessitates a continued role for traditional sources of energy for a longer duration than initially anticipated, and consequently generating requirements for ongoing investment in these sectors.

As I announce my retirement, effective May 31, 2025, I cannot help but feel the loss of cherished friendships and professional challenges keenly. It has been an honor to work alongside such dedicated and talented colleagues. I encourage all of you to continue to teach others and to understand the tremendous impact that energy brings to the defense of our nation. Our collective efforts have made a difference, and I trust that you will carry on this vital work with continued passion and commitment. Thank you for your support and camaraderie throughout these years.

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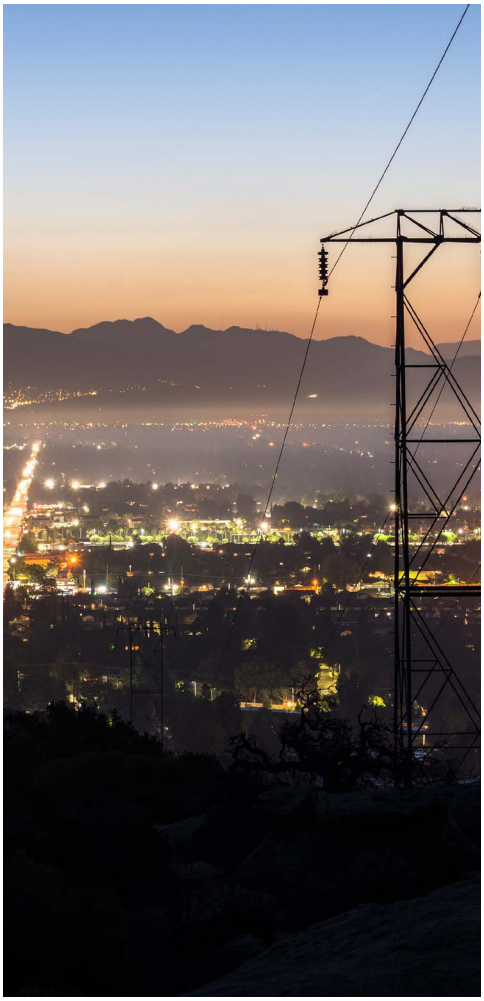

ENERGY SECURITY

Energy Security for Practitioners

By Mike Davis, Faculty Associate-Research, Energy Academic Group

Access to energy is essential for human advancement, and the stability of the global order depends on a stable energy market. As Americans, our way of life is wholly dependent upon the availability of affordable energy. Additionally, as military leaders and planners, we see Operational Energy is a critical enabler of our military operations whether at home or abroad. Officers across the joint force a must have a working knowledge of energy security. Whether considering the development needs of populations as they try to stabilize conflict areas in Africa, advising NATO leaders about the real operational impacts of reverse-flow, networked pipelines, or considering Chinese investment in Middle Eastern oil infrastructure, military professionals, like their industrial and diplomatic colleagues, must be learned in the many aspects of energy security. The link below shares several energy security thoughts for practitioners in an attempt to frame the modern energy security debates by providing a brief, yet comprehensive, presentation of the key components and arguments in the energy arena to spur thought and interest in this important focus area.

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The full article can be viewed at **https://tinyurl.com/3bus32vh**.

Energy Academic Group Welcomes New Team Member

Kirk Waltz is an environmental engineer with over fifteen years of experience as an environmental consultant and field engineer in commercial maritime and heavy industry from upstream energy production, midstream transport and refining, to fuel consumption and disposal. Kirk's role prior to coming onboard NPS was leading business development for the American Bureau of Shipping (ABS) focused on maritime energy transition, decarbonization and alternative energy R&D, and novel technology commercialization. Kirk has both a Bachelor of Science and Master of Science degree in Civil and Environmental Engineering from California Polytechnic State University of San Luis Obispo, and an MBA from Rice University. Feel free to contact Kirk at **kirk.waltz@nps.edu**.

Kirk Waltz

Portsmouth Naval Shipyard (US Navy photo)

ENERGY INFRASTRUCTURE

Powering the Production of US Civil Nuclear Maritime Energy Dominance

By Eric Hahn, Faculty Associate-Research, Energy Academic Group

A recent Defense Energy Seminar at the Naval Postgraduate School (NPS) presented advanced civil nuclear technologies, maritime manufacturing, and shipyard development in the context of Floating Nuclear Power Plant (FNPP) production. Modernizing existing U.S. shipyards to build FNPPs offers advantages like existing infrastructure and experienced workforce but can also face challenges like power availability and community resistance. Location-specific considerations include geographic constraints, regulatory challenges, and public perception issues. However, a well-chosen U.S. shipyard project that can be adequately powered and is fully supported by its surrounding community, will enable scalable production, set regulatory precedents, and lead U.S. energy dominance efforts in the civil nuclear maritime sector. Success hinges on cost control, regulatory navigation, and public acceptance.

Planning and developing such ambitious projects depend on having the right intellectual capital. Lessons from the Navy's Shipyard Infrastructure Optimization Program (SIOP) emphasize infrastructure modernization, workforce development, cost and risk management, and public-private partnerships. Research and educational content developed as part of a Cooperative Research and Development Agreement (CRADA) between NPS and Pareto Energy LTD highlight an innovative simultaneous engineering and institutional design methodology for Integrated Community Energy Systems (ICES) that can power critical infrastructure like shipyards, as well as benefit their surrounding communities. Key technical innovations like multi-agent simulation based digital twin applications are critical for ICES optimization, operations, and education, as well as community engagement and benefits. Learn more about ICES planning and project development for critical infrastructure by contacting the Energy Academic Group.

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USS Gerald R. Ford receives fuel lines from USNS Laramie (T-AO-203) to conduct a fueling-at-sea in the Eastern Mediterranean Sea, Oct. 11, 2023 (US Navy photo).

ENERGY RESEARCH

Fully Burdened Cost of Fuel: An Assessment of the Cost Competitive Nature of Alternative Fuel

By Rebecca Grippo, Faculty Associate-Research, Energy Academic Group

The Energy Academic Group has analyzed the fully burdened cost of fuel with a report due for release in April 2025. The Fully Burdened Cost of Fuel (FCBF) is defined in Title 10 Section 2911 of the U.S. Code (U.S.C.) as, "the commodity price of the fuel plus the total cost of all personnel and assets required to move and, when necessary, protect the fuel from the point at which the fuel is received from the commercial supplier to the point of use." Title 10 requires defense acquisition systems to include FBCF in life-cycle cost analyses but limits non-competitive drop-in fuels.

The NPS research team sought to fill a need in the FBCF analysis based on a prioritized strategic competition in the Western Pacific. The research team assessed FBCF for Navy platforms operating in the U.S. Indo-Pacific Command (U.S. INDOPACOM) Area of Responsibility (AOR). The FBCF analyses included a comparison of traditional fuels and alternative fuels and the potential cost competitive nature of generating fuel at sea. The fuel alternatives were traditional F76 and JP5 (DLA standard cost of fuel), sustainable drop-in fuels (data procured on commercial costs, and DLA distribution costs were added), and sustainable drop-in fuel generated at the point-of-need (i.e. the Navy's Seawater-to-Fuel (SW2F) Ship that captures carbon from seawater and produces tactical fuels through Fischer-Tropsch synthesis).

The analysis identified the absence of an up-to-date, common database to support FBCF modeling requirements and highlighted the need for a DoD-wide capability to maintain requisite data and models to support FBCF analyses. Significantly, the study revealed that the fully burdened cost of traditional fuel delivered to ships at sea is approximately 2.5x the DLA Standard Fuel Price. Meanwhile, the fully burdened cost of alternative drop-in fuel was approximately 1.35x the cost for traditional fuel. For in-theater fuel generation at sea to be cost competitive, a ship with 1 GW of installed power generating 400,000 gallons of fuel per day would need a similar procurement cost to T-AO class ships.

The study concluded by recommending the following next steps: align FBCF analysis process with other Navy energy data and analysis initiatives, such as Energy Supportability Analysis and Enterprise-Wide Energy Visibility projects; assess FBCF delivered into the contested environment (i.e. marine expeditionary); and analyze FBCF at specific locations globally to include analysis of non-product cost by location, and assessment of impacts from small SW2F ships (having with production rate at 60,000 gal/day).

The research project was funded through the NPS Naval Research Program with sponsorship from OPNAV. A previous EAG Faculty Associate, Cayle Bradley, spearheaded the effort with additional research by Rabia Kahn, along with Rebecca Grippo and Bill Muras as contributing editors. The report will be released in April 2025.

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ENERGY SECURITY

Subnational Energy Security: Agreements Between U.S. States and International Adversaries

By: Rebecca Grippo, Faculty Associate-Research, Energy Academic Group
and
Ella Nightengale-Luhan, ORISE Intern, Energy Academic Group

In furtherance of the Energy Academic Group's energy security initiatives, an ORISE intern has researched agreements between U.S. states and foreign countries on energy technology and advancement in a report due for release in June 2025. The project examines what agreements exist between U.S. states and foreign entities and the goals of these agreements in relation to energy security. It informs the Department of Defense (DoD) and energy security professionals about agreements that exist or have previously been in place between many U.S. states and foreign countries, particularly China, on energy technology and trade.

The research finds that most of these agreements are in the form of non-legally binding documents called Memorandums of Understanding (MOUs), which foster partnerships between parties to advance initiatives towards a common goal or interest; most of these initiatives are state led. The report will highlight California which is at the forefront of this subnational movement as it has over seventeen MOUs with China focused on energy technology and trade. Many of these agreements are still in effect through 2027. Some agreements focus on different sources of energy and incorporation into the grid. This raises concerns of grid security and energy security depending on what information is shared with China in accordance with these agreements. Supporters of these MOUs note that they foster trade, advancements, and mutual benefits for California and China, which in turn could benefit the U.S.-China relationship.

The report includes other state agreements and initiatives with China where states may gain technological advancements, including Iowa and Michigan. Iowa signed an MOU of Joint Working Group on Trade and Investment Cooperation with China in 2014 with key points of cooperation, including clean energy and biotechnology. In 2013, Michigan fostered state-province agreements, creating MOUs with Chinese provinces, such as Chongqing. Because Michigan leads the American automotive industry, its partnership with Chongqing focuses on benefiting trade and technology of the component part manufacturing industry. The MOU includes the U.S. in its statement of cooperation that "both sides will further explore the automotive markets in Chongqing and China as well as Michigan and the U.S." This shows how these MOUs foster a subnational push towards a partnership with China that implicates the relationship between the U.S. and China.

This report identifies the subnational agreements that impact energy security so that energy professionals have awareness of these subnational initiatives that implicate the U.S. and its relationship with China. The report will also suggest next steps in research and analysis to further inform potential security impacts from these agreements. The report is set to be released in June 2025.

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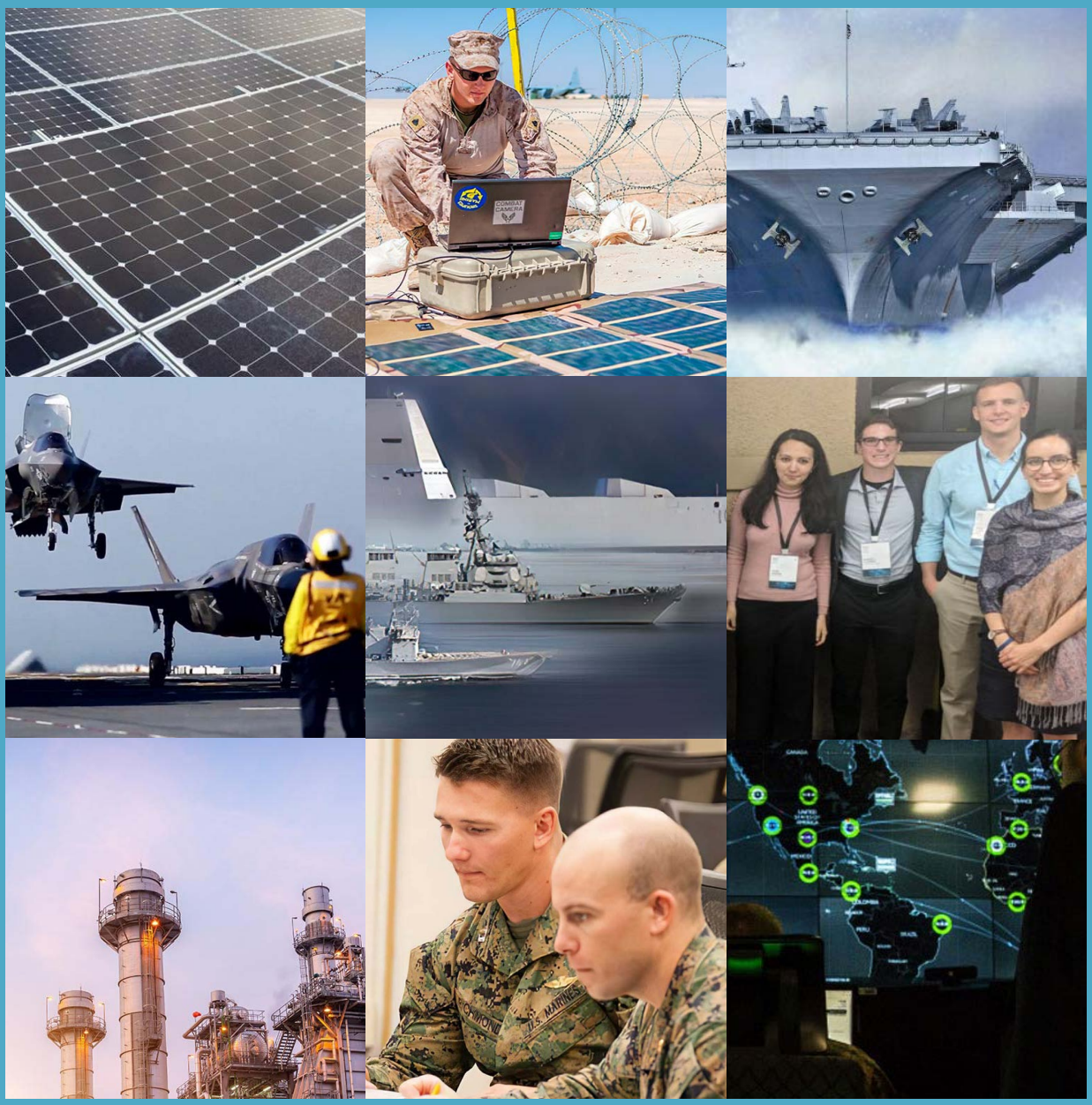

Interested in Energy-related Thesis Research?

Since 2013, NPS and the EAG have supported a plethora of student thesis research in the area of energy. Publicly viewable student theses can be searched from the Resources page of the EAG website at **nps.edu/web/eag/resources**. The EAG's extensive resources, intellectual capital, and connections with multi-disciplinary faculty and energy professionals provide students enhanced support for energy-related research. If interested in energy research, please reach out to the EAG team!

nps.edu/energy

STUDENT ENERGY RESEARCH SPOTLIGHT

Review of Cybersecurity Regulations among Arctic States and Governance of UAS Ship-based Deployments

By LCDR Douglas Pinheiro Mazzuco, Brazilian Navy
Co-authors: Ms. Marina Lesse, Faculty Associate-Research, Energy Academic Group
Dr. Britta Hale, Assistant Professor, Computer Science

Intelligence operations are essential in the military as they support informed decision-making and help maintain national security. In this context, unmanned aerial systems (UAS) have gained importance, particularly in missions conducted in extreme environments where human access is challenging. Secure communication links for command and control as well as intelligence relay are fundamental to the effectiveness of such UAS operations, especially under adverse circumstances. The study looks at the technical and legal aspects surrounding UAS operations in the Artic region.

A theoretical model is developed to evaluate the resilience of UAS communication channels against threats such as jamming and hijacking. Different protocols (Internet Protocol Security, Transport Layer Security, Pre-Shared Keys, and Messaging Layer Security) and frequency bands are analyzed, accounting for attenuation rates and hostile scenarios. The findings underscore the significance of anti-jamming techniques including robust protocol and appropriate radio frequency band selection, with Messaging Layer Security emerging as a particularly promising response in the examined scenarios.

> **A key challenge for secure UAS use is the difficulty of regulations keeping pace with rapid technological advances, which risks impeding effective policy formation.**

Additionally, an analysis of the legal

An unmanned aerial system is deployed

frameworks governing UAS in the Arctic is conducted, with a focus on the cybersecurity regulations of the eight Arctic Council nations. This review covers security policies and legislation, identifying gaps in governance. A key challenge for secure UAS use is the difficulty of regulations keeping pace with rapid technological advances, which risks impeding effective policy formation. The study highlights the need for regulatory harmonization and collaboration among stakeholders to ensure robust legal support for UAS deployment in critical environments, especially in multinational missions.

To enhance UAS security, our study recommends the development of agile policies that strengthen overall security measures through clear guidelines. Adapting technical solutions to ensure integration through all network layer choices and security establishment protocols enables UAS use in more austere environments. In addition, regulatory updates must keep pace with evolving threats, enabling secure communications in hostile environments. In this context, international cooperation is crucial for standardization and establishment of minimum security criteria, which includes robust data authentication and the careful selection of frequencies and protocols, contributing to the effectiveness of operations.

ABOUT THE AUTHOR

LCDR Douglas Pinheiro Mazzuco is an officer in the Brazilian Navy and a recent 2025 NPS graduate with a Master of Science in Computer Science. He received an Outstanding Thesis award for his research on this topic. Contact Dr. Britta Hale at **britta.hale@nps.edu** for more information about this research.

Defense Energy Seminar Series

NPS' academic programs in Defense Energy are supplemented by a seminar series which provides a forum for leading voices within the field, practitioners, and other Defense Energy influencers. These professionals give presentations, engage in brown bag discussions, and facilitate informal gatherings that encourage Defense Energy faculty and students to discourse over current issues in Defense Energy, supplementing classroom teaching with practical, professional experiences. The Defense Energy Seminars Series is a permanent part of NPS' Defense Energy program, and a key to its real-world relevance.

LEARN MORE
Please visit **nps.edu/web/eag/seminars** for upcoming and archived seminars.

STUDENT ENERGY RESEARCH SPOTLIGHT

Evaluating Hybrid Aircraft Adoption for DoD

By Andrew Jennings, Faculty Associate – Research, Energy Academic Group

All current and prospective DoD platforms require energy to operate. While current platforms have well established energy needs, prospective platforms require analysis to determine whether they are suitable for use within the fleet. In his thesis titled, "An Analysis of the Operational Integration of Emerging Technology with Hybrid Aircraft", Mr. Jennings evaluates the Hybrid Air Vehicles Airlander 10 in a variety of missions to determine if the platform would be suitable for the DoD. Intelligence, Surveillance, and Reconnaissance (ISR) and drone mothership concepts are explored for mission durations up to 72 hours of continuous flight. Mr. Jennings also analyzes the feasibility of employing a high energy laser onboard. Finally, hydrogen fuel conversion is considered, replacing all internal combustion systems with hydrogen fuel cells and determining the impact on range, endurance, and mission system power. The Airlander 10 analysis provides insight into the unique capabilities of hybrid aircraft for missions requiring extended time on station.

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ABOUT THE AUTHOR

Andrew Jennings is a Faculty Associate for Research with the Energy Academic Group. He graduated in December 2024 with a Professional MBA degree from NPS and the Defense Management Department. Contact Andrew Jennings at andrew.jennings@nps.edu for more information about his research, or go to Calhoun at **https://hdl.handle.net/10945/73471** to read the full thesis.

Airlander 10 (Photo by HAV)

Operational Energy Research Available on Calhoun

All NPS resident students write a thesis or capstone project report as part of their curricular requirements. Many theses are unclassified and accessible on Calhoun—the Naval Postgraduate School's digital repository for research materials and institutional publications created by the NPS community. To access theses which involve operational energy, please use the following link. New theses are added every quarter.

View operational energy theses available on Calhoun:
https://calhoun.nps.edu

Calendar of Events and Important Dates

MAY

1 May 2025
Operational Energy Certificates Program
Applications open for Unmanned Systems Persistence, Winter 2026 Start

19-23 May 2025
Energy Efficiency in Military Operations (EEOMC) course
NATO Energy Security Center of Excellence Vilnius, Lithuania

SEPTEMBER

15-19 September 2025
Critical Energy Infrastructure Protection & Resilience (CEIP) course for Ukraine
Bydgoszcz, Poland

23-26 September
NORDIC PINE Exercise
Sweden, Finland and Germany

NOVEMBER

3-7 November 2025
Coherent Resilience (CORE) 2025 - Arctic Tabletop Exercise (TTX)
Stockholm, Sweden

UPCOMING

2025 Defense Energy Seminar Series
Watch for upcoming dates and full event details as they become available on the EAG website at ***nps.edu/web/eag/seminars***

EVENT UPDATES

For updates to our calendar, please visit the EAG website and Events tab at ***nps.edu/web/eag/events***

ENERGY ACADEMIC GROUP
NAVAL POSTGRADUATE SCHOOL

Connect with the Energy Academic Group

The Energy Academic Group is located in Suite 537, Spanagel Hall on the NPS campus in Monterey, California. A wide range of NPS faculty are affiliated with the energy program, actively participate in energy graduate education, energy executive education, and energy research. For questions, please contact one of the principal EAG faculty members:

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Contribute to an issue of *Surge*

If you would like to contribute an article or have your research/work published in the *Surge* newsletter, please contact Lois Hazard via email at **lkhazard@nps.edu.**

Surge is published quarterly by the Energy Academic Group at the Naval Postgraduate School.

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