SURGE
ENERGY ACADEMIC GROUP QUARTERLY NEWSLETTER WINTER 2023

Highlights

COP27
ANALYSIS OF MOVEABLE, DEPLOYABLE MICROGRIDS
ENERGY INFRASTRUCTURE
RUSSO-UKRAINE WAR
NAVY E-LEARNING
NET ZERO RESEARCH

OPERATIONAL ENERGY

EAG Announces Establishment of Operational Energy Certificates

By Colleen McHenry, DBA, Faculty Associate-Research, Energy Academic Group

The Energy Academic Group (EAG) is proud to announce the establishment of NPS' Operational Energy (OE) Certificate Program. Three stackable certificates have been developed for this program, which aims to provide working military and civilian employees of the Department of Defense (DoD) the opportunity to understand the complex issues facing the operational and installation energy segments of DoD and how they impact operational capability issues as well as military requirements. The certificate program is design to expose students to the technical, operational, and security aspects of DoD's energy needs.

The OE Certificate Program is open to all U.S. uniformed military personnel, federal civilian employees, and a limited number of defense industrial contractors. All applicants must have earned a bachelor's degree.

All certificates are a "tuition-free" curriculum sponsored by the OPNAV.

Each course is delivered asynchronously via a web-based system known as Sakai, the repository of all course materials. Instructors will create weekly modules for students to access and complete. These modules include syllabus, reading materials, power point slides, recorded lectures, homework assignments with solutions, quizzes, and exams.

Applicants are required to include a Participation Agreement with their application. The Participation Agreement must be signed by the applicant's supervisor, HR, or training officer representative. Detailed information about the application process and requirements can be viewed here: https://nps.edu/Admissions/AMS

The Unmanned Certificate was EAG's first offering and has reached capacity for this winter quarter. The course will be offered again next year. Refuel (Contested) Logistics, Certificate 121, which will be offered in Spring Quarter 2023, is currently open for enrollment.

To enroll, please visit the EAG website: https://nps.edu/web/eag/operational-energy-certificate-program-121.

Directed Energy, Certificate 119, will be open for enrollment on October 15, 2023 for the Winter Quarter. To enroll, please visit the EAG website: https://nps.edu/web/eag/operational-energy-certificate-program-119.

For all program information and course requirements, please visit https://nps.edu/web/eag/operational-energy-certificate.

EAG looks forward to reporting further developments in the OE Program in future editions of *Surge*.

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To learn more about EAG Curricula Development, email Dr. Colleen McHenry, Curricula Development Team, at colleen.mchenry@nps.edu

FROM THE CHAIR

Dan Nussbaum, Chair of the Energy Academic Group

A year ago, many would ask "Why should the military care about energy security?" No one asks that anymore, as the world is still contriving, and succeeding, in placing energy and energy security at the very center of national and world affairs. Everyone is aware of—and concerned about—these issues, whether in local or global venues.

Meanwhile, NPS EAG continues to be in the middle of many of these conversations and continues to contribute to the knowledge about, and the practices associated with, global energy resilience and energy security. This is accomplished through tabletop exercises, educational offerings, articles, and course offerings. This article identifies some of the ways in which these contributions are being made.

Educational Energy course offerings at NPS continue to expand in scope and diversity. NPS now offers four Energy related Certificate programs. The first is the Defense Energy Certificate which begins its sixth cohort in March 2023. The certificate is sponsored by OSD and designed to provide working military and civilian employees of the DoD the opportunity to understand the complex issues facing the Operational Energy and Installation energy segments of DoD. The other three certificates are sponsored by OPNAV and comprise the overall Operational Energy (OE) program. The three certificates are: Unmanned Autonomous Persistence (UAP), Refuel Logistics (RL), and Directed Energy (DE). The UAP certificate has formed its first cohort starting in January 2023. We are accepting applications for the RL certificate which will begin in March 2023, simultaneously with the Defense Energy Certificate. The DE certificate will be offered in January 2024 in parallel with the UAP certificate. Our plan is to structure these course offerings so that they are "stackable", meaning that individuals can earn a master's degree by successfully completing an appropriate subset of these certificates. Information about these offerings can be seen on our website at **www.nps.edu/web/eag/education**.

Additionally, NPS EAG has produced a General Military Training video for all members of the USN on Energy Policy. To view this training module, you need to have CAC access. Log in to Navy eLearning at https://learning.nel.navy.mil/ELIAASv2p/ and click on the 'Course Catalog' tab. Next, search 'Energy - Enabling Combat Operations'. You may then enroll, launch, and complete the course module.

In the past NPS and our partner, the NATO Energy Security Centre of Excellence, have developed and run a series of national and regional level tabletop exercises (TTXs) called *Coherent Resilience (CORE)*. Their purpose is to enhance the resilience of energy systems in an era of hybrid threats. CORE TTXs have been conducted in Ukraine and Georgia. Since 2014, national and regional level programs in the Baltic States have also been conducted. The most recent CORE TTX is *CORE 22 Central European Pipeline System (CEPS)*, which was planned to assess the pipeline's resilience against hybrid risks as well as its crisis response capabilities by enhancing inter-agency and civil-military coordination, planning and preparedness. The TTX final report will be published in February 2023.

The Defense Energy Seminar (DES) series continues to present timely topics across the energy spectrum. Two recent examples are: Dr. Amory Lovins of the Rocky Mountain Institute who spoke about *Radical Energy Efficiency Through Integrative Design*; and Mr. John Woods of the USN International Engagement Office who spoke about *Developing Power and Energy Solutions in the Polar Environment through International Cooperation*. We have curated all of the DES presentations—most of which were in person—which you can access by visiting our website at **www.nps.edu/web/eag/seminars**.

I am always happy to hear your ideas on developing and sustaining the Energy Community of Interest.

CONTACT
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or call 831-324-3228.

Enrollment Open for Defense Energy Certificate Program

The Naval Postgraduate School's (NPS) Energy Academic Group is pleased to announce the sixth offering of its Defense Energy Certificate program. This offering (cohort) will begin 27 March 2023. The certificate program is free to all students, but applications must be submitted, transcripts received, and a Participation Agreement signed before NPS can process the application.

FOR MORE INFORMATION OR TO APPLY

Email Kevin Maher at **kjmaher@nps.edu** or call 831-656-2691.
Detailed instructions are also posted on the EAG website at
nps.edu/web/eag/defense-energy-certificate-program

Wind turbine at San Nicolas Island. (Photo taken by Kristen Fletcher)

OPERATIONAL ENERGY

COP27: Energy Takes Center Stage at UN Climate Conference

By Kristen Fletcher, Faculty Associate-Research, Energy Academic Group

The 2022 UN Climate Change Conference, known as COP27, took place in November in Sharm El-Sheikh, Egypt, and marked 30 years since the United Nations Framework Convention on Climate Change (UNFCCC) was adopted. The 'Conference of the Parties', or 'COP', annually brings together the governments which have signed the UNFCCC, the Kyoto Protocol, or the Paris Agreement.

Under the Paris Agreement treaty, almost all countries in the world have committed to keep the rise in global average temperature to 'well below' 2°C, and ideally 1.5°C, above pre-industrial levels; strengthen the ability to adapt to climate change; and align finance flows to lower greenhouse gas emissions and encourage climate-resilient development.

The U.S. announced and joined many initiatives at COP27 including several energy-related programs.

- The U.S. launched the Net-Zero Government Initiative to accelerate the implementation and achievement of climate targets. Participating countries commit to achieving net-zero emissions from national government operations by 2050, developing a roadmap and interim targets by COP28, and publishing the roadmap. Countries joining the U.S. include Australia, Austria, Belgium, Canada, Cyprus, Finland, France, Germany, Ireland, Israel, Japan, Korea, Lithuania, Netherlands, New Zealand, Singapore, Switzerland, and the UK.

- The U.S. expanded the Global Methane Pledge (GMP) launched by the U.S. and EU at COP26. The GMP has now been endorsed by over 130 countries representing over half of global methane emissions. At COP27, the U.S. launched a joint declaration alongside the EU, Japan, Canada, Norway, and the UK uniting major energy importers and exporters to minimize flaring, methane, and CO2 emissions across the fossil energy value chain.

- The U.S. and Norway launched the Green Shipping Challenge at COP27. To advance zero-emission shipping, the U.S. announced three new bilateral workstreams focused on facilitating green shipping corridors with the Republic of Korea, Canada, and the UK; the development of a U.S. maritime decarbonization strategy; and the launch of a Green Shipping Corridors Initiation Project.

Leaders from the Department of Defense, along with other U.S. agencies, attended COP27. COP28 will convene from 30 November to 12 December 2023 in the United Arab Emirates.

LEARN MORE

View White House Fact Sheet on Climate Initiatives **here** and the Net Zero Game Changers Initiative **here**.

Contact Kristen Fletcher at **kristen.fletcher@nps.edu** for more information.

ENERGY EDUCATION

Operations in the Information Environment (OIE) Workshop

By Tahmina Karimova,
Faculty Associate-Research,
Energy Academic Group

The Naval Postgraduate School successfully executed the Strategic Communications and Operations in the Information Environment (OIE) workshop on 19-23 September 2022 in Bucharest, Romania. The event was facilitated by the Center on Combating Hybrid Threats through close cooperation and subject matter expertise provided by NPS' Department of Defense Analysis. The purpose of the event was to conduct a tailored interagency workshop for diverse participants from Romania's government, ministries, security agencies, as well as for other organizations responsible for strategic communications, defense, resilience, operations in the information environment, and national security.

The workshop's thematic focus encompassed a wide variety of topics and syndicate work pertaining to psychology of influence, psychological warfare, deception, conflict in cyberspace, disinformation, adversarial propaganda, and others. Partners from the Defense Threat Reduction Agency also supported the line of effort and shared their insights and experience on countering propaganda. In addition to presentations by leading OIE experts, the event provided an opportunity for participants to exchange information, lessons learned, and best practices regarding shared challenges, and address ways to develop potential solutions to those challenges.

The Carol I National Defence University played an instrumental part in planning and hosting the event. The Romanian counterparts ensured the right level of participation and presented high-level perspectives on the matters important to national and regional security. The workshop has been beneficial in enhancing collaborative activities and potential partnerships among the U.S. and Romanian stakeholders.

LEARN MORE

Email Tahmina Karimova at **ttkarimo@nps.edu** for more information.

Interested in Energy-related Thesis Research?

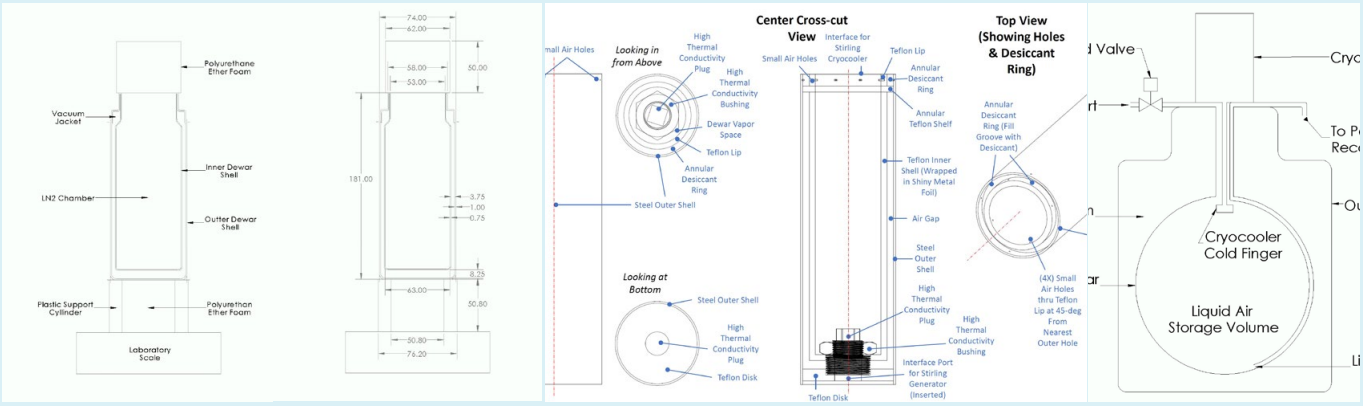
Since 2013, NPS and the EAG supported a plethora of student thesis research in the area of energy. Publicly viewable student theses can be searched from the Resources page of the EAG website at **nps.edu/web/eag/resources**. The EAG's extensive resources, intellectual capital, and connections with multi-disciplinary 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

Experimental Assessment of a Novel Liquid Air Storage to Support Remote, Islanded, Renewable Military

By LCDR Chris Fackrell, USN



Recent targeted attacks on the Ukrainian energy and transportation infrastructure highlight the vulnerabilities that exist for regional power grids and public transport. To reduce these risks the Department of Defense (DoD) has invested in researching innovative solutions for remote, standalone (islanded), renewable microgrids for forward operating bases (FOBs). These microgrids reduce, or eliminate, reliance on publicly supplied electrical power while reducing the logistical costs associated with fuel deliveries for diesel generators, the typical source of electrical power for FOBs.

Generally, renewable energy sources are either wind or solar based, but these sources of energy are intermittent. Thus, energy storage is required. Lithium-ion batteries can be both expensive and heavy to move, so the medium of liquid air (LA) is being investigated for use on small-scale microgrids due to its high energy density and lack of geographical constraint (i.e., it can be produced anywhere in the atmosphere); however, storing energy as LA, and its subsequent energy extraction, has multiple problems that must be overcome at non-industrial scales.

This work investigated the development of a novel Dewar (i.e., cryogenic liquid storage vessel) that receives LA from a LA production cycle and directly pairs it with an electrical power recovery cycle in the form of a Stirling generator or thermoelectric generator. Low-cost commercial-off-the-shelf (COTS) components were used to rapidly prototype and perform performance-based tradeoff analysis between Dewar designs, which showed that a vacuum-jacketed and Teflon-based Dewar would prove optimal for the intended application, resulting in U.S. Patent Application 63/343,020, 2022. Additionally, an alternative LA storage design was formulated for future work that leverages insights gained by this experiment.

The results of this work were published in the Multidisciplinary Digital Publishing Institute's (MDPI's) *Inventions* journal authored by LCDR Chris Fackrell, Dr. Anthony Pollman, Dr. Douglas Van Bossuyt, and Dr. Anthony Gannon. Link: https://www.mdpi.com/2411-5134/7/4/101

ABOUT THE AUTHOR

About the Author: LCDR Chris Fackrell, USN, graduated in December 2022 with a master's degree in Systems Engineering. Contact Dr. Douglas Van Bossuyt at **douglas.vanbossuyt@nps.edu** for more information about this research.

STUDENT ENERGY RESEARCH SPOTLIGHT

Impacts of Climate Risks on Microgrid Models

By Christian Bowers

The 2022 National Defense Strategy identifies climate change as a part of the security environment, highlighting the effects of climate change on readiness, installations, and capabilities. Energy security at installations is an essential component to ensure operations can continue through adverse events. Microgrids have been employed by the Department of the Navy to ensure energy security at naval installations to support the readiness of the naval force; however, the impacts due to climate change on microgrids have not been thoroughly addressed. Addressing the impacts of climate change on microgrids requires an analysis on microgrid design tools, such as microgrid models.

The highlighting of climate risks in the National Defense Strategy instigated a capstone project to determine the climate risks at naval installations, evaluate the impacts of these climate risks on microgrids, and analyze microgrid models to determine if these models consider the climate risks. A capstone team consisting of Jacob Bell, John Berry, Christian Bowers, and Chase Slagle with advisors Drs. Douglas Van Bossuyt and Ron Giachetti conducted this analysis.

The capstone team used the Defense Climate Assessment Tool (DCAT) to determine six climate risks at naval installations. These climate risks included drought, flooding, cold temperatures, hot temperatures, wildfires, and weather extremes. Each climate risk was evaluated for the various ordered effects and the impacts to microgrid components. These impacts were used to analyze the microgrid models to determine the degree to which the climate risks were incorporated into the models.

The three models analyzed in this capstone project were the resilience and cost model for renewable energy microgrids, the mission impact microgrid model, and the lifecycle cost of a resilience microgrid model. The inability or limitations of the models to incorporate the six climate risks, their ordered effects, or their impacts to microgrids were classified as gaps. These gaps were identified in each model's assumptions, the approach for the incorporation of climate data, and the limitations of input data when considering impacts due to the climate risks.

After further analysis into the gaps, the capstone team determined that further evaluation is required into the failure scenarios due to climate events, the increase in critical energy demand on the microgrid due to changes in climate and weather events, and the impacts of climate exposure on the failure rates of microgrid components. Additionally, the quantification of the climate risks and impacts of the climate risks on microgrids is necessary to determine the approach for incorporating the climate risks into microgrid models.

The analysis conducted in this capstone project will inform future efforts required to address climate risks in microgrid models. Addressing the climate risks in microgrid models will enhance the design tools used to harden microgrids against the climate risks, ensuring energy security and readiness at naval installations.

Microgrids have been employed by the Department of the Navy to ensure energy security at naval installations to support the readiness of the naval force; however, the impacts due to climate change on microgrids have not been thoroughly addressed.

ABOUT THE AUTHOR

Mr. Christian Bowers graduated from the Naval Postgraduate School in December 2022 with a Master of Science in Systems Engineering Management. Contact Dr. Douglas Van Bossuyt at **douglas.vanbossuyt@nps.edu** for more information about this research.

Learn More: The full report titled "Microgrid Modeling Assessment for Climate Trends and Weather Events" can be found in the NPS library at **library.nps.edu/nps-archive**

STUDENT ENERGY RESEARCH SPOTLIGHT

Analysis of MOveable, DEployable Microgrids (MODEMs) for Increased Energy Infrastructure Resiliency

By Jordan Drake, Graham D. Hardman, William C. Kimble, Andrea Rodriguez, and Bradley I. Smith

As concern heightens over energy resiliency at critical and strategic infrastructure loads due to an increased reliance on technology, the Department of Defense (DoD) looks to identify potential solutions to reinforce the ability of these critical loads to recover from periods of interruption. The proposed Moveable, Deployable Microgrid (MODEM) system would provide a mobile "nanogrid" to power critical loads during periods of power interruption by utilizing a combination of solar energy and diesel generators. The system is designed so that all components can fit into a single triple container (TriCon) storage unit and can be easily transported to the site of the critical load.

This thesis research aimed to provide feasibility analyses of the system through the development of a Systems Modeling Language (SysML) model and conducted analyses to determine the acquisition, Life-Cycle Costs (LCC), potential life-cycle energy savings for MODEM units, and safety protection for installation and implementation analysis. Additionally, support costs were evaluated through a Reliability, Maintainability, and Availability (RM&A) analysis. The MODEM system model provides a baseline for future projects to start from that defines the MODEM Measures of Effectiveness (MOEs); Measures of Performance (MOPs); stakeholder needs; system, subsystem, and component requirements; and system logical, functional, and physical architectures. The model was developed utilizing the MODEM team's current understanding of the system and is designed so that it may be iteratively refined as new information is learned through further research and development.

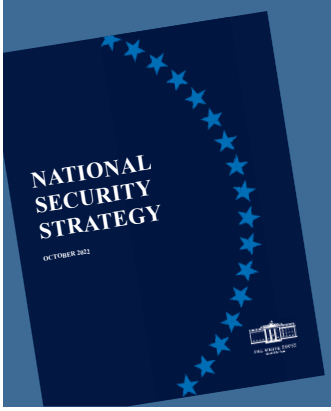
Through the reliability analysis the team was able to verify the system requirements for reliability (90%) and sustainment. The results of the reliability analysis ultimately found that the MODEM system had an overall system reliability of 92% for a mission duration of 14 days and 1% for the continuous use over a year.

Through the LCC analysis, the team identified that the MODEM system had a Savings-to-Investment Ratio (SIR) of –6.19 when providing supplemental power to a permanent installation and an SIR of 0.22 when used to provide direct power to a source. These SIR values led the team to conclude that the current system design is not economically viable to provide a satisfactory return on investment for the identified use cases.

Overall, the MODEM system shows considerable promise as a potential solution to improving and maintaining resilience of DoD energy infrastructure across multiple CONOPs. However, further analysis and refinement of the system is imperative to more accurately make a determination.

ABOUT THE AUTHOR

About the Authors: The team consists of five Master of Science in Systems Engineering candidates at the Naval Postgraduate School from NSWC Crane in Indiana. Contact Dr. Douglas Van Bossuyt at **douglas.vanbossuyt@nps.edu** for more information about this research.



National Security Strategy Addresses Climate and Energy

The White House issued the 2022 National Security Strategy in October. Its core themes include strategic competition with China and Russia, investment at home, and climate change as a central challenge to the U.S.. While energy and climate are woven through the Strategy, it specifically includes a section on Climate and Energy Security, expressing that the "climate crisis is the existential challenge of our time" and "long-term energy security depends on clean energy." The Strategy further calls for working with allies and partners to secure energy security and affordability, access to critical mineral supply chains, and just transitions for affected workers.

LEARN MORE

The National Security Strategy is available at: https://www.whitehouse.gov/wp-content/uploads/2022/10/Biden-Harris-Administrations-National-Security-Strategy-10.2022.pdf

ENERGY INFRASTRUCTURE

Resilience Training for Critical Infrastructure

By Elle Hancock, Faculty Associate – Research Operations Research, Center for Infrastructure Defense

Dr. David Alderson and Dr. Daniel Eisenberg introduce Dysruption at the Naval Civil Engineer Corps Officers School intermediate public works class. Naval Base Port Hueneme, June 2022

In 2022 the NPS Center for Infrastructure Defense (CID) introduced a new take on resilience training for critical infrastructure as Naval Civil Engineer Corps Officers, operations research experts, emergency response managers, and Department for Homeland Security employees experienced *Dysruption,* an online TTX for infrastructure vulnerability.

Shore infrastructure is critical to supporting fleet readiness and sustainment. The recent CNO Navigation Plan specifically calls out initiatives for *critical readiness infrastructure* to better support fleet operations. While best practices for military infrastructure currently follow principles of reliability and risk, these are—by necessity—based on knowledge of *past events.* They are not suited to adapt infrastructure to dramatic change and/or future surprising events, such as extreme weather driven by climate change. The DoN Climate Action Plan 2030 recognizes this need to incorporate climate-informed decision making and develop training "to operate effectively and efficiently in evolving and intensifying climate conditions."

The NPS Center for Infrastructure Defense has been working to develop theory, training techniques, and exercises that accelerate development of expertise for adaptive response of infrastructure systems and personnel to surprise events. Developed in collaboration with Arizona State University and the NPS MOVES Institute, *Dysruption* is an online game that introduces players to some of the tensions and tradeoffs related to critical infrastructure vulnerability and operation. The three challenges within the game, 'Break It Bad', 'Fix It Fast', and 'Save Our System', require players to break, fix, and operate a pipeline system that moves fuel from supply sources to demand locations. By playing the role of both attacker and operator for a critical infrastructure system, players learn how to prioritize infrastructure investment in the presence of time pressure, limited investment budgets, and (climate-driven) surprise events.

To date, *Dysruption* has been introduced at the 2022 Military Operations Research Society Symposium, the Naval Civil Engineer Corps Officers School public works classes, and the NPS Center for Homeland Defense and Security (CHDS) master's program. CID is working to further expand *Dysruption* into DoD and military operational settings, so that agencies and commands can examine how their infrastructure systems, including the operators, handle challenges that fall outside of their design envelope.

The overarching research project, Advancing Resilience Theory and Tools to Combat Environmental Surprise, is funded by the Strategic Environmental Research and Development Program (SERDP), and is focused on improving assessment, planning, and investment of DoD infrastructure resources. The overall aim is to enhance resilience, sustainment, and mission assurance in the presence of climate extremes and surprises that challenge system function. This project, and the development of the game *Dysruption*, complements existing approaches by predicating investigative techniques on a theory of resilience that emphasizes adaptive response to surprise.

LEARN MORE

For further information regarding *Dysruption* and/or the research study, please contact the CID team at: Dr. David Alderson (Lead PI, **dlalders@nps.edu**) or Elle Hancock (Project Manager, **michelle.hancock@nps.edu**).

HYBRID THREATS

Lessons Learned: Russo-Ukraine War

By Tahmina Karimova, Faculty Associate-Research, Energy Academic Group

It has been almost a year since Russia's full-scale invasion of Ukraine. Emboldened by its presumptive success after the 2014 Crimea annexation, Putin launched the so-called Special Military Operation on 24 February 2022 in the hopes of swift victory.

However, the operation has largely failed and has turned into a devastating war resulting in thousands of innocent lives lost, heavy military casualties on both sides, damaged infrastructure, and cascading global shockwaves on the economic front which jeopardize supply chains, food and energy security, defense, and national security. This failed operation has also contributed to increased global refugee challenges.

Presently Russia's war in Ukraine continues despite NATO unity and resolve and, more importantly, the remarkable resistance of Ukrainian armed forces and society. In recent months, Russia has been actively targeting national critical infrastructure and energy assets and facilities, causing reoccurring blackouts, increased casualties, and deaths among military and civilian populations. In view of renewed winter offensives, Ukraine is bracing for potential escalation of war, and currently, there is no solid indication for the war to cease.

As Putin continues to unleash his rage, it remains to be seen how Russia will seek to morph the palpable failures at strategic, operational, and tactical levels and ultimately claim some pseudo-victory to dislodge itself from its misguided and increasingly hopeless war.

With every war and conflict, it is imperative to study, analyze, and develop lessons learned. NPS' Center on Combating Hybrid Threats is currently collaborating on an interdisciplinary study pertaining to the Ukrainian war, funded by NPS' Naval Research program:

The Study on the Changing Dynamics of Hybrid Threats in a (Post) Russia-Ukraine War Era. The interdisciplinary study is being carried out in close collaboration with two of NPS' academic departments: Defense Analysis and National Security Affairs. The team will conduct research on Russia's use of hybrid threats ahead of and during its war in Ukraine, as well as analyze and identify best practices, lessons learned, and recommendations relevant to U.S. naval forces and the Department of Defense.

As this collaborative effort comes to a conclusion, its results and key takeaways will be highlighted in future editions of *Surge*.

LEARN MORE

Email Tahmina Karimova at **ttkarimo@nps.edu** and Lawrence Walzer at **lwalzer1@nps.edu** for more information.

Energy Training Module Hosted on Navy e-Learning

By Marina Lesse, Faculty Associate-Research, Energy Academic Group

After multiple stakeholder meetings, workshops, and countless hours of researching and collecting feedback, the EAG has successfully completed its effort in updating the energy training module titled *Energy – Enabling Combat Operations* (product number NPS-E-ECO-1.0). The General Military Training module is designed for both civilians and active-duty enlisted and officer members of the Department of the Navy (DoN), both sailors and Marines, and enables learners to harness a greater understanding of the DoN's operational energy focus. The learning objectives include how energy is critical to combat operations; DoN strategic energy objectives; energy challenges and best practices for different Naval Communities; and actions to take to become a more effective warrior. The GMT is a product of EAG's multi-year initiative: Naval Enterprise Energy Education and Training (NE3T).

To enroll and complete the updated GMT:

1. Log into your Navy e-Learning account at **https://learning.nel.navy.mil/ELIAASv2p/**
2. Click the 'Course Catalog' tab
3. Search 'Energy - Enabling Combat Operations'
4. Enroll, launch, and complete the course module

LEARN MORE Contact: Marina Lesse **marina.lesse@nps.edu** for more information.

ENERGY RESEARCH

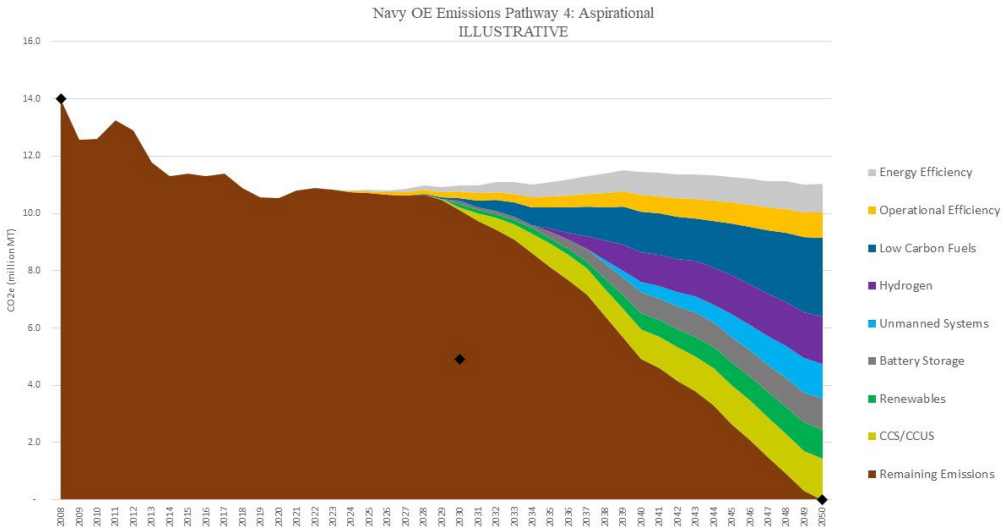
Interdisciplinary Team Completes Year One of Net-Zero Research

By Marina Lesse, Faculty Associate-Research, Energy Academic Group

An interdisciplinary team of researchers at the Naval Postgraduate School recently concluded the first year of research on *Pathways to Net Zero Emissions for the Operational Navy.*

Researchers utilized an analytical approach to focus on current Department of Navy (DoN) emissions, mostly from ships and aircraft, to understand the energy demand of supporting mission readiness and prioritizing national security. The team worked with DoN stakeholders and subject matter experts from other agencies, as well as the private sector to consider pathways to net-zero emissions in other sectors and their relevance in the military sector.

Four pathway models were created using sand charts, showing what strategies would most contribute to reaching net-zero emissions. The models included a baseline or status quo, emphasis on technology and operations, aggressive advances, and aspirational advances. Key findings highlight the difficulties in decarbonizing military ships and aircraft, and those strategies such as hydrogen, UxS, and efficiencies are seeing growth and future potential. Further research in improved underlying data include additional operational efficiencies in ships and planes, advances in low-carbon fuels, ability of hydrogen-based systems to scale up, potential emissions savings from the use of UxS, battery storage capabilities, operational use of renewable energy, and carbon capture and sequestration, especially in submerged lands of naval installations.



Research is underway on *Advancing Pathways to Net Zero for the Operational Navy*, the second year of the project. In 2023, researchers will evaluate particular strategies toward net-zero emissions and the requirements needed. These findings will contribute to the interdisciplinary work underway within the DoN and the Department of Defense as the community makes strides to reach net-zero emissions by 2050.

The project was funded through the NPS Naval Research Program with sponsorship from OPNAV. Two EAG Faculty Associates of Research spearheaded the effort, Kristen Fletcher and Marina Lesse, along with fellow EAG colleague Brandon Naylor, and Jonathan Lussier and Dr. Bonnie Johnson of Systems Engineering. A team of capstone students conducted analysis on alternative fuels which will be included in the final version of the report in December.

LEARN MORE

Contact: Marina Lesse at marina.lesse@nps.edu

View the briefing video at: https://nps.edu/web/nps-video-portal/-/net-zero-briefing-pathways-to-net-zero-emissions

GLOBAL ENERGY

Geopolitics of Natural Gas

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

The world is experiencing the worst energy crisis since World War II. The energy crisis has contributed to the current global economic recession and world food crisis. While many Western policymakers are putting the blame for the energy crisis on geopolitics, many other factors contributed to its emergence. These include longterm underinvestment in oil and natural gas production, public finance policy of denial of investment in fossil fuels, market design, and energy policies of governments around the world. In illustration, Europe experienced two major energy crises in the two winters (winter 2020/2021 and winter 2021/2022) prior to the current Ukraine-centered crisis. Thus, in considering how to address the energy crisis, it is important to recall that it started before the current geopolitical challenge in Ukraine.

READ THE FULL ARTICLE

Remarks by Dr. Brenda Shaffer. Seventh Joint Energy Conference "Energy and the Economy: The new energy landscape," Federal Reserve Bank of Dallas and Federal Reserve Bank of Kansas City. Available at https://www.kansascityfed.org/Energy/documents/9254/22energy-shaffer.pdf

With Winter Coming, Europe Is Walking Off a Cliff

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

Facing the worst energy crisis since World War II as the cold-weather heating season starts, Europe continues to dither. European Commission President Ursula von der Leyen has presented a series of new European Union energy policies, including planned price caps, additional taxes on energy producers, establishment of a new European hydrogen bank, and new support for electric vehicles. European Union member states, meanwhile, are nationalizing utilities, setting electricity prices, and subsidizing consumers. These EU policies do not represent a significant departure from the policies that got the continent into the energy mess in the first place.

The fundamental problem is that Europe is still not facing the sources of its energy security crisis, preferring to blame outside forces for its current predicament. Von der Leyen and other European leaders point at Russia and its war on Ukraine for Europe's energy woes. Russian President Vladimir Putin's throttling of the gas taps has undoubtedly made things worse, but this will already be the third winter of Europe's energy crisis. In the winters 2020-2021 and 2021-2022, Europe already experienced significant spikes in the prices of electricity and natural gas, as well as gas shortages that led to increased use of coal and fuel oil. European policymakers either did not take notice or preferred not to change course.

As long as so many people in Europe and elsewhere believe that the continent's energy predicament is all about Putin, it helps to be very clear about the policies that led Europe to this crisis. Knowing what caused the problem is the first step to addressing it.

READ THE FULL ARTICLE

Read the full article at foreignpolicy.com/2022/09/29/europe-energy-crisis-russia-policies-gas-nuclear-renewable-electricity-prices/

CALENDAR OF EVENTS

FEBRUARY

7–8 February 2023
Energy Security in the Black Sea Symposium
Monterey, CA

9 February 2023
Combined Naval Address on Climate, Energy, and the Environment
Virtual
*See **https://nps.edu/web/climate-and-security/events***

MARCH

20–24 March 2023
Operational Level Energy Security Course
Tartu, Estonia

APRIL

17–18 April 2023
Cyber Security and Critical Infrastructure Protection Workshop
Astana, Kazakhstan

UPCOMING

2023 Defense Energy Seminar Series
*EAG is pleased to have resumed in-person presentations for its Defense Energy Seminar lecture series. Watch for upcoming dates and full event details as they become available on the EAG website at **nps.edu/web/eag/seminars**.*

ENERGY ACADEMIC GROUP
NAVAL POSTGRADUATE SCHOOL

Connect with the Energy Academic Group

The Energy Academic Group is located in Room 101A, 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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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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