



# SURGE



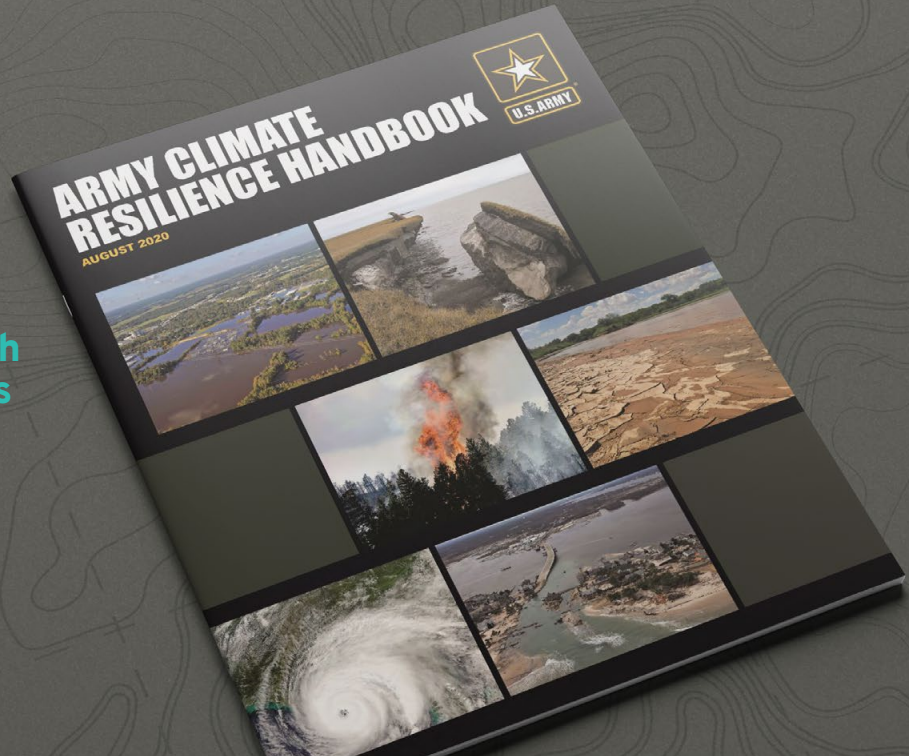
ENERGY ACADEMIC GROUP QUARTERLY NEWSLETTER WINTER 2021

## Highlights

- Infrastructure Resilience
- China's Role in Arctic Affairs
- Energy Security & Climate
- Woods' Resilience Concepts
- STAR-TIDES Technology Demo
- Air Force Research

## U.S. Army Installation Climate Resilience Initiatives

By Mr. J.E. "Jack" Surash and Dr. Stephen Dornbos



*Army Climate Resilience Handbook published in August 2020.*

### The Army considers changing climate and extreme weather events to be threats to its installation infrastructure.

Installation climate resilience measures must be employed to protect facility assets that support critical missions and help generate readiness. Recent Army efforts to enhance installation climate resilience include development of the web-based Army Climate Assessment Tool (ACAT), publication of the Army Climate Resilience Handbook (ACRH), and issuance of Army Directive 2020-08 addressing climate and extreme weather threats

Installation climate resilience measures must be employed to protect facility assets that support critical missions and help generate readiness

to installations. The web-based ACAT helps installation leaders understand and prepare for the projected impacts of coastal and riverine flooding, drought, desertification, wildfire, thawing permafrost, and extreme heat, among other factors. The ACAT was launched in July 2020 with data on all major Army installations in the United States. Data on overseas Army

installations will be added as well. The Army published the ACRH in August 2020 as a companion to the ACAT. This handbook supports field staff in their evaluation of the impacts of changing climate and extreme weather on installations, in order to plan and implement effective and efficient

**Continued on page 2**

resilience measures. Army Directive 2020-08 provides policy guidance to installation commanders to plan for and adapt to the projected impacts of climate and extreme weather threats by adding the results of projection analysis tools, such as the ACAT, into all facility and infrastructure-related plans, policies, and procedures. The Secretary of the Army signed this directive in September 2020.

#### About the Authors

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#### LEARN MORE

For more information on these initiatives, contact Dr. Dornbos at [stephen.q.dornbos.ctr@mail.mil](mailto:stephen.q.dornbos.ctr@mail.mil)

The ACRH can be downloaded at [https://www.asaie.army.mil/Public/ES/doc/Army\\_Climate\\_Resilience\\_Handbook\\_Change\\_1.pdf](https://www.asaie.army.mil/Public/ES/doc/Army_Climate_Resilience_Handbook_Change_1.pdf)

## Enrollment Open for Defense Energy Certificate Program

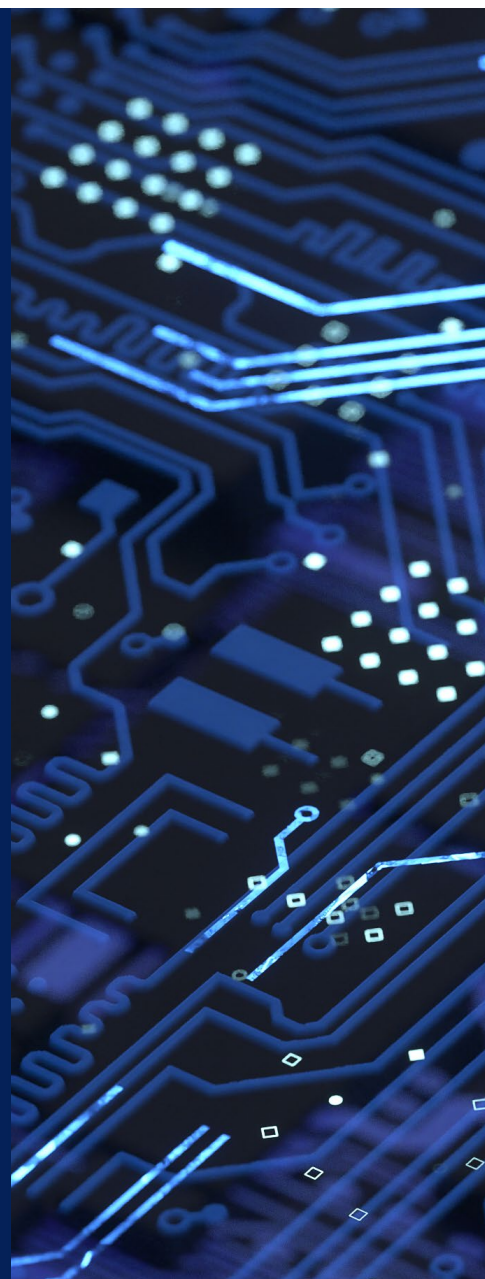
The Naval Postgraduate School's (NPS) Energy Academic Group is pleased to announce the fourth offering of its Defense Energy Certificate program. This offering (cohort) will begin Monday, 29 March 2021. The certificate program is free to all students, but applications must be submitted, transcripts received, and a Participation Agreement signed before NPS can process the application.

### Applications due no later than January 4, 2021.

The DL Defense Energy Certificate program is a graduate-level and accredited certificate program. It consists of four courses, offered one course (on-line) per quarter for four consecutive quarters. The program is open to all federal civilian employees who are U.S. citizens and qualified uniformed enlisted and officers. The Energy Certificate is designed to support the Office of the Secretary of Defense and the Secretary of the Navy's energy goals. The DL Energy Certificate provides those working military and civilian employees of the Department of Defense 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. This certificate program is designed to expose students to the technical, operational, and security aspects of DoD's energy needs. Students who successfully complete the program will earn an accredited Certificate in Defense Energy. The Western Association of Schools and Colleges (WASC) confers accreditation.

#### FOR MORE INFORMATION OR TO APPLY

Email Kevin Maher at [kjmaher@nps.edu](mailto:kjmaher@nps.edu) or call 831-656-2691. Detailed instructions are also posted on the EAG website at <https://nps.edu/web/eag>







# FROM THE CHAIR

Dan Nussbaum, Chair of the Energy Academic Group

**This is a felicitous, retrospective note** about the wide spectrum of interests represented in the Naval Postgraduate School's (NPS) Energy Academic Group. This is evident by looking, for example, at the most recent edition of *Surge*, published in the fall of 2020. There you find articles written by NPS faculty and students, other DoD experts, and a former U.S. Ambassador. The subjects (and the associated article titles) cover a broad range, as the list below shows:

- **Energy Infrastructure** (COVID-19, Electrical Systems and National Security; Integration of Public-Public Partnerships for Enhancing Climate and Energy Resilience)
- **Education** (information on the NPS Defense Energy Certificate Program)
- **Geopolitics** (Operations and Communications in the Arctic; Operational Energy as an Essential Element for Winning Future Wars; Ocean Mapping, a U.S. Priority)

We are interested in your articles on topics that have a broad application across the intersection of the national security and energy domains.

- **Technology** (Shipboard Voltage Source Inverter Control System to Meet MIL-STD-1399-300 Limits for Pulsed Power Loads; Hybrid Photovoltaic Systems in Arctic Environments)

Yes, there are other topics that we can cover, and we are diligently trying to do exactly that. We are interested in your articles on topics that have a broad application across the intersection of the national security and energy domains. Do not hesitate to reach out to me if you have a topic to suggest. Articles written with students are especially welcome.

Additionally, our outreach to partners and our collaboration with them continues, including recent webinars with The Atlantic Council, the Payne Institute of the Colorado School of Mines, and with George Mason University, as well as upcoming events with NATO (Systems Analysis, SAS-163, "Energy Security in the Era of Hybrid Warfare"), and NAVFAC and Arizona State University (Microgrid Academy).

I also want to mention three theses (among many) coming to fruition this quarter. The first two are master's theses, while the third is a PhD thesis:

- **CDR David Barnhill** "F/A-18 Fuels Data Analysis" (a very nice Big Data analysis)
- **LT Joshua Hildebrandt** "Life Cycle Cost of Microgrid Resilience (what I like to call "how much does a pound of resilience cost?")"
- **Bill Anderson**; PE, CEM, LEED AP, "Resilience Assessment of Islanded Renewable Energy Microgrids" (think of this as also applying to isolated Forward Operating Bases)

The work in all aspects of the energy domain continues, and I am honored to work with outstanding colleagues at EAG and throughout NPS.



## CONTACT

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## ENERGY RESILIENCE

# NPS Researchers Advance Infrastructure Resilience Plans for the U.S. Virgin Islands

By Dan Eisenberg, PhD,  
Department of Operations  
Research, NPS



*A NOAA satellite image shows Hurricane Irma as a Category 5 hurricane on Sept. 5, 2017. (NOAA photo)*

### In September 2017, two Category 5 hurricanes—Irma and Maria—made indirect hits on the U.S. Virgin Islands

(USVI) destroying critical infrastructure systems that provide electricity, water, mobility, and communications, devastating local communities. Since this double disaster, the Federal Emergency Management Agency (FEMA) funded the Naval Postgraduate School (NPS) Center for Infrastructure Defense (CID) and the Energy Academic Group (EAG) to support recovery and mitigation efforts in the USVI. This three-year collaboration, led by Drs. David Alderson and Daniel Eisenberg of the NPS Operations Research Department, links stakeholders across the University of the Virgin Islands (UVI), territorial utilities, federal agencies, and national labs to produce practical modeling and analysis tools for the USVI.

To date, NPS researchers alongside eight NPS military officer students produced vulnerability and

Together, NPS faculty and student-led research will directly influence future disaster mitigation and recovery activities in the U.S. Virgin Islands.

resilience analyses across electric power, water, transportation, and telecommunications systems. Each study addresses topics relevant to local stakeholders, such as measuring how blackouts impact potable water delivery, how floods impact local supply chains and disaster relief, and how loss of cell phone towers impact coverage and communications across each island. In total, this collaboration produced data sets, models, analysis tools, and visualizations helpful for guiding decisions and managing future hazards.

The recent 2020 Hazard Mitigation and Resilience Planning (HMRP) workshop held on November 5th and 6th online demonstrates the impact of

NPS work. This workshop led by Drs. Greg Guannel and Kim Waddel of UVI was the 3rd annual event to present the latest understanding of territorial hazards and to hold expert elicitation on territorial needs. The workshop series is meant to support the next USVI hazard mitigation and resilience plan, which is a federal requirement to receive FEMA funds for future disasters.

NPS assessments are at the heart of the HMRP workshop results, recommendations, and plan. Drs. Alderson and Eisenberg worked closely with Drs. Guannel, Waddel, and their team to shape the workshop and organize analyses to support territorial resilience to hazards as broad as hurricanes, earthquakes, tsunamis,





*Solar farm on St. Thomas destroyed by a hurricane. (FEMA photo by Jocelyn Augustino)*

and drought. Together, NPS faculty and student-led research will directly influence future disaster mitigation and recovery activities in the USVI. In turn, this work may influence billions of dollars when the territory experiences its next major disaster.

Success for the USVI is also success for the U.S. Navy and Department of Defense services. Models and

decision-tools developed for the USVI support analyses for systems at similar operational scales—specifically military installations. As a result, Drs. Alderson and Eisenberg are also leading projects to transition models developed for the USVI to military contexts, by linking infrastructure operations to missions and conducting case studies of DoD installations.

### LEARN MORE

For more information on USVI research efforts and military installation resilience, visit the USVI HMRP website at <https://resilientvi.org>

For more information about the Naval Postgraduate School's Center for Infrastructure Defense, visit the NPS CID website at

<https://www.nps.edu/cid>

Email Dan Eisenberg at

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## 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 see the Calendar of Events in this issue of *Surge* or visit [nps.edu/web/eag/seminars](https://nps.edu/web/eag/seminars) for upcoming and archived seminars.

## INTERN RESEARCH HIGHLIGHTS

# China's Role in Arctic Affairs



By Elizabeth Francis,  
Middlebury Institute  
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Studies, International  
Environmental  
Policy '21



*Icebreaker U.S. Coast Guard Cutter Healy (WAGB-20) is in the ice Wednesday, Oct. 3, 2018, about 715 miles north of Utqiagvik, Alaska, in the Arctic. (USCG / U.S. Coast Guard photo by Senior Chief Petty Officer NyxoLyno Cangemi)*

**The implications of a changing Arctic affect both Arctic and non-Arctic states.** Due to increased air temperatures and receding sea ice, the high seas are opening to allow for new transportation passages, the discovery of new mineral deposits, and harvesting of previously unavailable resources. As climate change progresses, many Arctic and non-Arctic nations are increasing their presence and activity in the region.

In 2018, China expressed its intentions and role in the Arctic, emphasizing its adherence to international norms, policy, and sovereignty of Arctic states but also claiming status as a “Near Arctic State” which previously did not appear in

international law or policy.

This claim of “Near Arctic State” raised considerable concern and opposition from Arctic nations over potential infringement on the sovereignty and policies of Arctic states. The unprecedented claim raises key considerations in current Arctic policy surrounding the role of non-Arctic nations’ involvement. A new report issued by the EAG presents analysis of China’s claim in light of international norms, governance under the Arctic Council, and China’s increasing activity and investment in the region.

Analysis of China’s claim reveals its intentions of normalizing a presence to access resources and shipping passages. To solidify its role as an actor in the Arctic, China began considerable investments in deep-sea ports, railways, and research bases

with countries such as Russia. The EAG report presents implications of China’s “Near-Arctic State” claim under international law and policy that will become progressively more important as activity in the Arctic increases.

### LEARN MORE

Report available at  
<https://nps.edu/web/eag/intern-research>

Contact Elizabeth Francis at  
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EAG Contact: Kristen Fletcher at  
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## ABOUT EAG's INTERNSHIP PROGRAM

Each year the EAG offers internship opportunities for motivated young people who share an interest in energy-related research and a possible future career strengthening the intellectual capital within the U.S. Government. During the summer months, we run a structured 8-10 week internship program, but also have opportunities throughout the year to craft a valuable and challenging experience, both for the intern and for the EAG. Our intern programs are always fast-paced, rigorous, and focused on energy-related challenges facing our nation’s defense. If you are interested in learning more, please contact Alan Howard ([arhoward@nps.edu](mailto:arhoward@nps.edu)) to see if an internship experience with EAG could be right for you.





## ENERGY AND CLIMATE

# 2020 Proves Pivotal Year for Energy Security & Climate

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

*Damage from Hurricane Florence on Marine Corps Base Camp Lejeune, Sept. 15, 2018. Hurricane Florence impacted MCB Camp Lejeune and Marine Corps Air Station New River with periods of strong winds, heavy rains, flooding of urban and low lying areas, flash floods and coastal storm surges. (U.S. Marine Corps photo by Lance Cpl. Isaiah Gomez)*

**The year 2020 has been one for the record books in the U.S.:** in addition to the worst recorded wildfire season, the U.S. experienced a record-setting hurricane season, with the western and central Gulf coast (and its significant energy infrastructure) feeling the brunt. Worldwide records were set as well: 2020 is set to be the warmest year on record. The first nine months of 2020 saw record concentrations of major greenhouse gases like CO<sub>2</sub>, methane, and nitrous oxide (despite shelter in place orders), and Arctic sea ice extent was at record low levels for much of the summer. In addition, after formally notifying the United Nations in 2019 of its intention, on November 4, 2020, the U.S. officially departed the Paris Agreement, part of the United Nations Framework Convention on Climate

Leaders in the national security and homeland defense communities understand that climatic changes will impact how they do business.

Change, which was signed by President George H.W. Bush in 1992.

Leaders in the national security and homeland defense communities understand that climatic changes will impact how they do business, from the amount and type of energy used and the investment made in innovative technologies and other energy-reducing strategies. Climate change also will influence future laws and policies—both domestically and internationally—that will guide their strategies and affect abilities to meet mission requirements. There is acknowledgment that within the U.S. and overseas, water scarcity, ocean warming and acidification, sea level rise, extreme weather, risks to public health, and increased wildfires all contribute to and magnify national security risks and help to drive aspects

of energy use and policy.

The Energy Academic Group is developing capacity on the law and policy related to energy security and climate, including new technologies and emerging policies to address the current and future challenges facing the Navy and national security community. *Surge* will feature articles in 2021 on these increasingly important aspects of energy security and climate, and we invite you to visit the resource page at <https://nps.edu/web/eag/energy-climate>.

### LEARN MORE

Ms. Fletcher recently provided a lecture on Climate Change Law and Policy to the Executive Leaders Program of the Center for Homeland Defense and Security at NPS. For more information or to request a similar presentation, contact her at [kristen.fletcher@nps.edu](mailto:kristen.fletcher@nps.edu)



## RESILIENCE CORNER

# Practical Applications of Woods' Four Resilience Concepts

By Dan Eisenberg, PhD,  
Department of Operations  
Research, NPS

**Resilience is a “new” term creeping into military directives**, but what does it mean and how do we use it to guide decisions? In previous Resilience Corners, we described how applications of resilience emphasize a ‘resilience-as-a-verb’ perspective on the actions people take to sense, anticipate, respond to, and learn from stressful events. However, this perspective also relates to the ways our systems respond to threats and achieve resilient outcomes.

David Woods, an Emeritus Professor at the Ohio State University, outlines four concepts that describe the resilience outcomes we want for military systems<sup>1</sup>:

- **Robustness:** systems continue to function as intended;
- **Extensibility:** systems stretch function to support new needs;
- **Rebound:** systems return to previous function;

- **Adaptability:** systems change to support new functions.

Each of these concepts achieves resilience in a different way. Robustness and extensibility enable systems to continue to function in lieu of stress, where robustness highlights mitigation to anticipated hazards and extensibility stresses a need to extend system function to unforeseeable threats. In contrast, rebound and adaptability concepts enable response after failures, where rebound emphasizes quick recovery of previous function and adaptability harnesses failures to meet new needs.

Woods’ concepts offer a framework for improving the resilience of critical systems like power grids. Robustness relates to hardening power equipment, such as installing composite poles so power lines can survive disasters. Extensibility relates to backup generators—they are useful during a blackout, but non-ideal for long-term operations. Rebound relates to deployable crews to quickly fix failed equipment. Adaptability relates to deploying technologies like microgrids that support new system functions.

Overall, Woods’ four concepts provide a helpful framework for protecting military systems and infrastructure. However, there are tradeoffs to consider when prioritizing resilience efforts. Some technologies that enhance one type of resilience may preclude another—such as composite power poles being more robust than wooden poles, but more costly and difficult to rebound. Future resilience efforts should identify how efforts across the DoD relate to Woods’ four concepts and determine the resilience tradeoffs we are making and want to make in the future.



### LEARN MORE

Email Dan Eisenberg at [daniel.eisenberg@nps.edu](mailto:daniel.eisenberg@nps.edu) or call 831-656-2358

### REFERENCES

[1] Woods, David D. "Four concepts for resilience and the implications for the future of resilience engineering." *Reliability Engineering & System Safety* 141 (2015): 5–9.



## ENERGY OUTREACH

# Energy Highlighted at STAR-TIDES Technology Demo

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



### The EAG headlined a panel for the STAR-TIDES Technology Demo

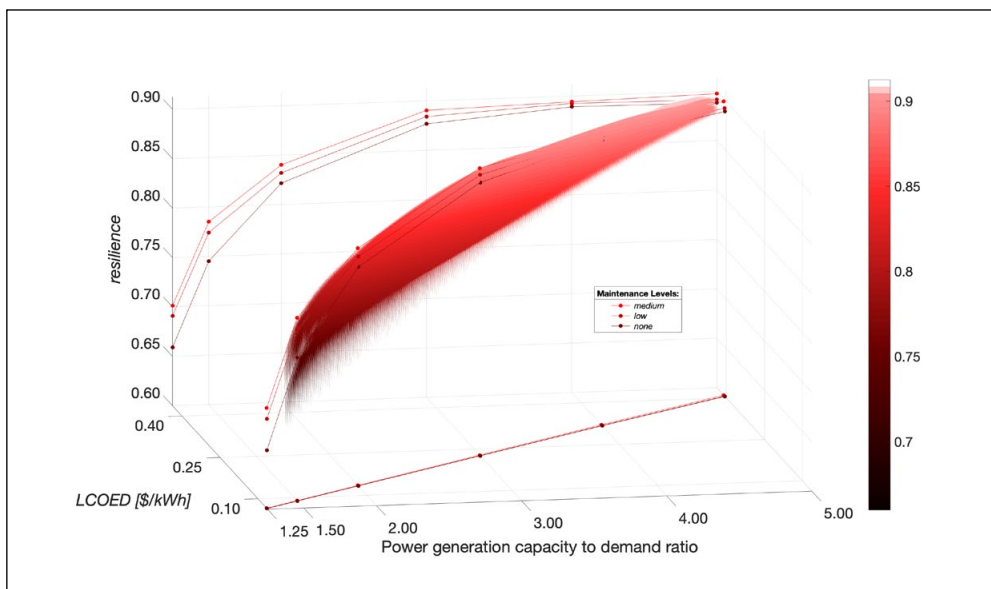
held virtually on 20–21 October 2020. This year's theme was Converging Approaches to Sustainable Resilience: STAR-TIDES' 14th Annual Capability Demonstration. STAR-TIDES (Sharing To Accelerate Research – Transformative Innovation for Development and Emergency Support) is a global knowledge-sharing network which is part of George Mason University's Center for Resilient and Sustainable Communities. The STAR-TIDES network focuses on building sustainable resilience, promoting human security,

and creating life-changing social and economic activities. It includes four defense-related mission areas: Building Partner Capacity, Humanitarian Assistance and Foreign Disaster Relief, Defense Support of Civil Authorities, and Stability and Peace Keeping Operations.

Due to health and safety protocols, this year's Technology demonstration was virtual. The EAG panel focused on Energy Security and the Navy, featuring energy capabilities at the Naval Postgraduate School (NPS) and within the Navy. Panelists and topics included the following:

- **Dan Nussbaum, Chair, NPS/EAG**  
NPS Capabilities in Energy Research and Outreach
- **Bill Anderson, NAVFAC EXWC**  
Microgrids in Isolated Places
- **Brandon Naylor, NPS/EAG**  
COTS Containerized Microgrids
- **Dan Eisenberg, NPS/OR Department**  
Vulnerability and Resilience of Energy Infrastructure on Islands and Installations
- **Brenda Shaffer, NPS/EAG**  
International Energy Security in the Age of COVID
- **Kevin Maher, NPS/EAG**  
Energy Certificate Program at NPS

The panel presentations are available on video at <https://nps.edu/web/nps-video-portal/-/energy-and-the-navy>.



*We observe how resilience exponentially increases as the microgrid's power generation capacity to demand ratio increases, until generation is four times the demand. Costs linearly increase as this power capacity ratio increases, and increasing maintenance investments improves resilience more when this ratio is smaller. (Graphic by Bill Anderson, NAVFAC EXWC PW6)*

### LEARN MORE

Read about STAR-TIDES and George Mason's Center for Resilient and Sustainable Communities at <https://star-tides.net>

Email Kristen Fletcher at [kristen.fletcher@nps.edu](mailto:kristen.fletcher@nps.edu)



## ENERGY SECURITY

# EAG Successfully Completed (Virtual) Regional Energy Security & Resilience Workshop – Caucasus

The NPS EAG successfully completed a Regional Energy Security & Resilience Workshop August 11–14, 2020 in partnership with the NATO Energy Security Center of Excellence (Vilnius, Lithuania) and ADA University (Baku, Azerbaijan). While this event has taken place annually over the last few years alternating between Tbilisi, Georgia and Baku, Azerbaijan, this year's event was executed virtually

security stakeholder participants from Turkey, Georgia, and Azerbaijan. Lecturers included academia and government officials, as well as oil executives from BP and the State Oil Company of the Azerbaijan Republic (SOCAR).

The objective of the workshop was to further energy security and resiliency through increased awareness, information sharing, interagency collaboration, and regional cooperation. Several topics were included such as geopolitics of energy, regional geopolitics and energy, threats to energy infrastructure, public-private partnerships in energy security, cybersecurity, and critical infrastructure protection/resilience. The workshop concluded with a senior-official panel, where the U.S. Ambassador to Azerbaijan, Lee Litzenberger; Ambassadors from Turkey and Georgia;

The program was effective at sharing best practices and discussing areas of concern common to the growing community of interest that promotes energy security and resilience in the region.

The NPS EAG led the execution of the August 2020 workshop. Faculty from both EAG and NPS' Center for Infrastructure Defense (CID) provided briefings on energy security, geopolitics and energy, and critical energy infrastructure protection/resilience.

A Critical Energy Infrastructure Protection and Resilience workshop will soon follow, to be coordinated by EAG in partnership with CID experts, with the goal of helping our Azerbaijan partners to identify vulnerabilities and implement best practices to further the security and resilience of Azerbaijan energy systems.

The objective of the workshop was to further energy security and resiliency through increased awareness, information sharing, interagency collaboration, and regional cooperation.



### LEARN MORE

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due to COVID-19 restrictions. The regional aspect of the program is a unique attribute, as the event gathered 36 government and industry energy

and the Deputy Minister of Energy for Azerbaijan each presented formal remarks and participated in a panel discussion question and answer period.



## OPERATIONAL ENERGY

# Air Force Technology Research Increases Efficiency, Performance, and Readiness

As the Department of Defense's largest energy consumer, the Air Force depends on aviation fuel to remain successful. Air Force Operational Energy aims to mitigate operational risk to the warfighter and optimize how the Air Force uses fuel by developing and championing energy-informed solutions. Two examples, Engine Sustainment and Modernizing Legacy Aircraft, are highlighted below.

*Content originally published April 20, 2020. Provided by the U.S. Air Force Air Combat Command and reprinted with permission.*

## Engine Sustainment

Clean engines **perform better**, run cooler and more efficiently, and avoid **maintenance issues**. Our office is evaluating the benefits of regularly scheduled aircraft engine washing and have initiated a pilot project with the AF Special Operations Command and AF Research Laboratory to determine how **engine foam washing** increases performance and promotes **aircraft readiness**. Additionally, we're refining compressor **blade shape** and advocating for the certification of **erosion resistant** blade coatings.

According to commercial studies, engine sustainment initiatives like scanning coatings, and washings result in **greater time on wing, enhanced performance**, lower carbon emissions and engines temperatures, and potential **fuel savings** up to **3 percent**.



*Air Force Operational Energy photo*

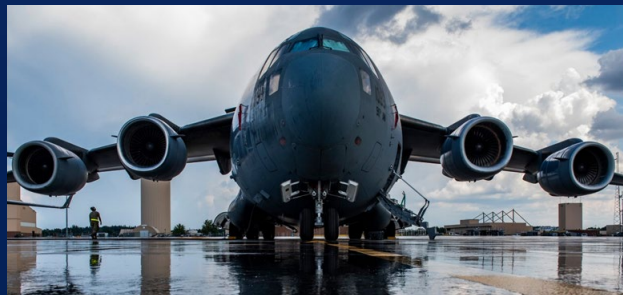
## Modernizing Legacy Aircraft

By modernizing new and legacy weapon systems and investing in proven technologies, we will optimize aviation fuel use and streamline operations.

'Bolt-on' parts like aft-body **drag reduction** devices (Microvanes, Finlets) and blended wingtip devices (winglets, raked wingtips) can seamlessly integrate into operations and begin **reducing fuel demand** immediately, some paying for themselves in a matter of months.

Light-weight, corrosion resistant aero-structures can replace heavier parts on an attrition basis. Engines can be retrofitted with state-of-the-art technologies to **improve performance** and increase time-on-wing.

21st-century tools and processes like these will increase our **readiness** and **lethality**, while reducing fuel use and maintenance costs.



*Air Force Operational Energy photo*



**AIR  
FORCE  
OPERATIONAL  
ENERGY**



# Calendar of Events

## Winter Defense Energy Seminar Series

Due to rapidly changing circumstances surrounding the COVID-19 virus, the Defense Energy Seminar Series will be offered exclusively online for the Winter Quarter. Please visit our website at <https://nps.edu/web/eag/seminars> for upcoming seminar dates and all EAG event details.



## 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](https://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!



**ENERGY ACADEMIC GROUP**  
NAVAL POSTGRADUATE SCHOOL



## Connect with the Energy Academic Group

The Energy Academic Group is located in Quarters D, Bldg 281 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](mailto:lkhazard@nps.edu).

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