



SURGE



ENERGY ACADEMIC GROUP QUARTERLY NEWSLETTER FALL 2022

Highlights

Climate Change and Operations Research
Curricula Development Team
Russian Ransomware
Evaluation of a Standalone and Mobile Microgrid
Critical Energy Infrastructure



Europe's Tiny Steps Won't Solve Its Energy Emergency

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

The European Union and its 27 member states have invested more money, effort, and political capital in energy policy than any other region in the world. Until this year, Europe was admired globally as the gold standard for energy and climate policy. Germany's Energiewende—or energy transition—was especially touted as a shining example of how to green the energy supply.

No one aspires to emulate the Europeans today. Germany and the EU have spiraled headfirst into the globe's worst energy crisis since the Arab oil embargoes of the 1970s

and 1980s. All across the continent, Europe's energy policies have led to astronomical price increases, industry shutdowns, potential energy shortages, and geopolitical vulnerability. Germany, in particular, is in crisis mode and will likely see much worse, as its entire economic model—based on energy-hungry manufacturing, cheap Russian gas, and a self-mutilating shutdown of nuclear energy that Berlin still won't reverse—is on the verge of collapsing without a plan B. In short, Europe is in a mess of its own creation.

READ THE FULL ARTICLE

Available at <https://foreignpolicy.com/2022/07/13/europe-eu-energy-crisis-war-russia-ukraine-gas-oil-coal-nuclear-germany/>



FROM THE CHAIR

Dan Nussbaum, Chair of the Energy Academic Group

Some wisdom is timeless, and we ignore it at our peril. For example, Hesiod said, around 700 BCE, "Moderation in all things"; Miguel de Cervantes (1615) has Don Quixote say "Don't put all your eggs in one basket"; and ANY financial advisor will tell you that "Diversification of investments is a necessary condition for financial security".

So, it should be an easy step to conclude that "*Diversification of energy sources is a necessary condition for energy security*".

Well, world events have certainly conspired to put energy in the center ring of conversations, so we have a nice test of whether the last maxim is true. We know

professional levels, in ways that are relevant to their naval careers. Training is provided to reinforce policies, procedures, behavioral expectations, and professional attitudes throughout the Navy. The new GMT—titled *Energy: Enabling Combat Operations*—incorporates new doctrine, terminology, and media, and it aims to bring energy awareness to its target learner audience of both sailors and Marines of all ranks and jobs. The module will be available on the Navy eLearning and MarineNet training domains as well as the EAG website beginning in FY23. The NPS POC is Marina Lesse, marina.lesse@nps.edu.

Second is the development of three all distance-learning certificates in the areas of Refuel Logistics, Directed

Dupuy, arnold.dupuy@nps.edu. The purpose of all these offerings is to provide foundational knowledge and experience for warfighters, and a thorough comprehension of the basis of OE (fuel; power generation and distribution; power storage; energy management and measurement; command and control).

Just a reminder about NPS' Defense Energy Seminar series, which presents to students and faculty a broad palette of topics, addressing both technology issues and policy perspectives. We feature speakers from the NPS faculty as well as from outside NPS - from the government, from

Diversification of energy sources is a necessary condition for energy security.

that without energy, nothing that supports civilization happens, so a sine qua non for national security is diversification of energy sources, or, as Professor Brenda Shaffer says, "*energy security is national security*". Unfortunately, there were those who did not take this to heart; there were those who said that, for example, Nordstream 2 was "just a business deal, and it would certainly never be used as a policy tool". They now know differently.

Developing and delivering energy educational offerings is a central pillar to EAG's mission, and on that front, there are several new and important developments.

First is the creation of an updated Energy General Military Training (GMT) module. For those who don't know, *GMT is a module that has been developed to inform and motivate individuals, on both personal and*

Energy, and Persistent Autonomous Systems. Each certificate is made up of four classes. The first offering will be in January 2023. Its website and registration information will be available shortly. It's our intention to structure these certificates so that they are "stackable", meaning that the completion of some subset of the three can be the basis for granting a master's degree. More on this aspect will follow. The NPS POC is Dr. Colleen McHenry, colleen.mchenry@nps.edu.

Third is an introductory Operational Energy (OE) course, the purposes of which are to: understand OE's impact on mobility, lethality and mission success; ensure the ability to operate effectively in a contested logistics environment (resilience); understand supply chain constraints and their potential mission impacts; emphasize jointness across all warfighting domains. The NPS POC is Dr. Arnold

commercial firms, and from not-for-profit organizations. All this is masterfully curated by Alan Howard. You can view both our past efforts (including videos which you can replay) and future plans at nps.edu/web/eag/seminars.

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



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Waves crash over the bow of the U.S. 7th Fleet command ship USS Blue Ridge (LCC 19) while the ship is underway in the Philippine Sea. (Photo by: Cmdr. Richard Keltner)

ENERGY & CLIMATE

EAG Initiates Climate Change and Operations Research

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

For many years, DoD has recognized the relevance of climate change to national security, and recent Executive Orders require DoD to take climate change into account in operations. The range of operations includes ships, planes, submarines, expeditionary forces and installations. A persistent challenge is identifying and understanding the true impact of climate change on Navy and Marine Corps operations.

Many climate change impacts will reduce naval capabilities, some impacts will be benign, while others may be beneficial. Understanding, projecting, and predicting impacts is especially important for strategic and

operational planning, but they are also important for tactical planning. In addition, the availability of data and analysis is increasing and can help the DoN better understand how to meet its operational mission in a changing climate and environment.

This summer, EAG initiated an interdisciplinary research project to catalogue existing studies that show climate change impacts on systems, platforms and their related operations and to develop a framework to assess the ways in which a changing climate may cause impacts. The project will help identify knowledge gaps and target research and analysis priorities. EAG will share its findings in the form of a report and briefings in 2023.

LEARN MORE

Resources are available at nps.edu/climate and nps.edu/web/eag/energy-climate

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



ENERGY EDUCATION

EAG Announces Establishment of Curricula Development Team

By Arnold C. Dupuy, PhD
Faculty Associate-Research,
Energy Academic Group

EAG is proud to announce the establishment of the Curricula Development Team. The team is led by subject matter experts within EAG, Dr. Arnie Dupuy and Dr. Colleen McHenry, and draws from support across the NPS community. Its purpose is to educate warfighters on the critical importance of operational energy to the Navy-Marine Corps mission. Special thanks to Andrew Jennings, Elle Hancock, Marina Lesse, Jay Lynn, Kevin Maher, Eric Hahn, Rabia Khan, Doug MacKinnon and Sheila Sklerov for their contribution to this effort.

The Curricula Development Team is making progress under the Naval Enterprise Energy Education and Training (NE3T) program, an effort sponsored by DASN(RDT&E) and N94. Three stackable certificates have been created; Directed Energy and Refuel, (Contested) Logistics, and Unmanned Systems Persistence. The Unmanned

Systems Persistence certificate will be EAG's first offering and will commence in Q2 2023 via asynchronous distance learning. Please visit the EAG website and the Education section for full details as they become available.

The General Military Training (GMT) module for operational energy has been completed and will soon become available online throughout the Navy enterprise.

The Curricula Development Team is also in the process of developing introductory courses in operational energy. The preliminary course, Operational Energy I, will be in-residence and is designed for the forward deployed Navy and Marine warfighter. This course will address the four primary operational

energy competencies of fuel, power development and distribution, energy storage, and energy management.

EAG looks forward to reporting more good news in the next issues of *Surge*.

LEARN MORE

Contact Dr. Arnold C. Dupuy, Curricula Development Team Lead, at arnold.dupuy@nps.edu to learn more about EAG Curricula Development.

⚡ STUDENT ENERGY RESEARCH SPOTLIGHT

Reliability and Resilience Evaluation of a Standalone and Mobile Microgrid

By Maj David Jones, USMC



Maj David Jones (pictured above) next to solar panels as energy sources for the standalone microgrid.

As the Department of Defense (DoD) deploys renewable distributed energy resources (DERs) to reduce fossil fuel consumption, microgrids are being evaluated as one way to generate and deliver reliable electric power to stationary and mobile military units. Commercial-off-the-shelf (COTS) microgrid components are a viable cost-effective option to setup stand-alone microgrid systems to support mobile military units and help drive the transition to a more sustainable yet energy-resilient military. Reliability and resilience are key parameters in determining the effectiveness of microgrids in supporting military missions. Although in the past few years many researchers have presented reliability and resilience models of various complexity, experimental measurements and model validation are not available in the literature for mobile COTS microgrids.

The goal of this thesis research is to experimentally assess the resilience of stand-alone, mobile microgrids

that can be carried by one or two individuals and can be easily assembled in the field in support of operations in locations where utility power is not available. Additionally, in enemy contested environments, fossil fuel through existing supply lines may not be available, hence the need for mobile renewable DERs capabilities and microgrid technology. Utilizing COTS DERs including batteries, PV arrays and power converters, three different standalone microgrid architectures were designed, analyzed, and tested in the laboratory.

First, the reliability block diagrams and system fault trees were created per MIL-HDBK-338B to compare the reliability of the three microgrid configurations. Redundancy was built into the design of the three microgrid configurations to evaluate its impact on the overall system reliability. Then, several experiments were conducted in the laboratory to observe the performance of the three microgrid configurations when various faults were

simulated, such as failure of a solar panel or other key component. These experiments were designed with the goal to evaluate the time to failure of each microgrid configuration and how the different configurations performed with respect to each other.

The measured results presented in the thesis can help decision makers select the most resilient mobile configuration for a specified critical load in a set environment.

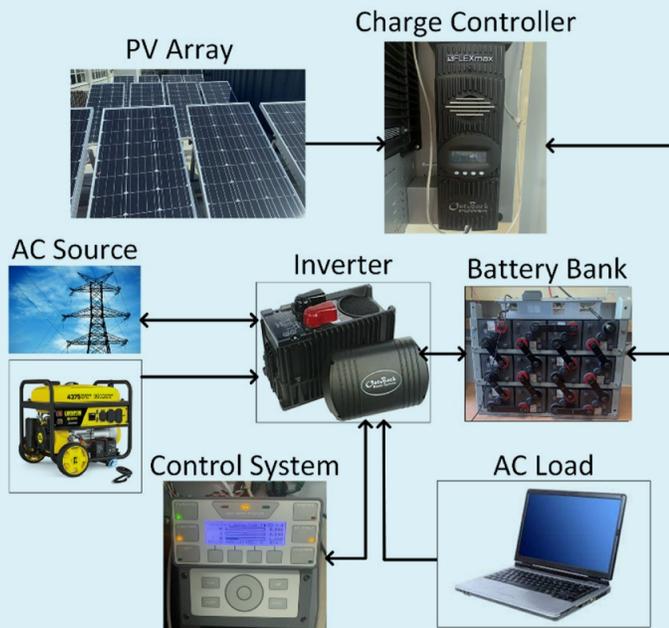
ABOUT THE AUTHOR

Maj David Jones is a USMC Officer and is a MSEE candidate at the Naval Postgraduate School. Contact Prof. Giovanna Oriti at goriti@nps.edu for more information about this research.

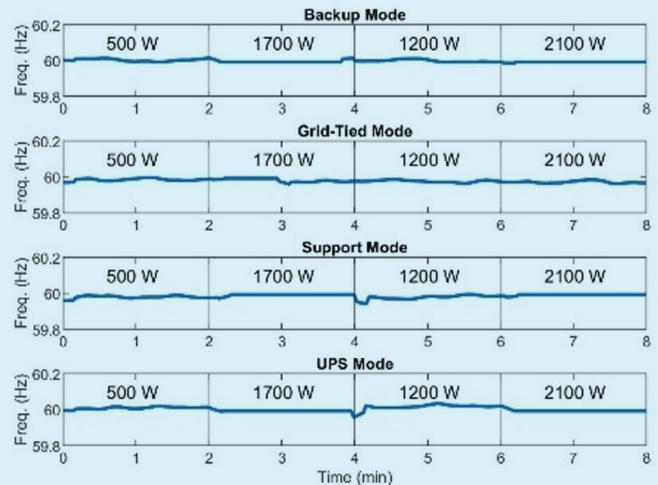
STUDENT ENERGY RESEARCH SPOTLIGHT

Performance Characterization of a COTS Moveable Microgrid

By Capt Robert Lindstrom, USMC



AC Source Switching Frequency Profiles



The goal of the U.S. Navy and USMC to reduce fuel consumption while providing reliable power to military operations has led to the deployment of distributed energy resources (DERs) as part of microgrids. Commercial-off-the-shelf (COTS) microgrids are available, but an objective characterization of their performance is not usually available from the manufacturers. In this thesis, a microgrid assembled with COTS DERs is tested to assess its functionality and performance with respect to the IEEE Standard 1547-2018, which specifies the technical requirements for the interconnection and interoperability between an area or local Electric Power System (EPS) and a DER. This standard establishes limits for normal and abnormal operation and expectations for interrupting events.

The microgrid can operate in

islanding mode, disconnected from the AC utility grid, as well as in grid-connected mode if the AC utility grid is available. The microgrid testbed includes the individual COTS components, controlled by a centralized control system and several measurement instruments set up to read voltages and currents continuously throughout the duration of the experiments.

Several experiments were conducted to test the microgrid standalone capability and battery recharge functionality. Additionally, voltage and frequency ride-through tests assessed the ability of the COTS microgrid to meet the requirements in IEEE-Std-1547-2018 with different settings of the central control system. The experimental results demonstrate that the COTS microgrid is able to service loads that are critical for military

operations, as long as the control system is set up in uninterruptible power supply (UPS) mode of operation.



ABOUT THE AUTHOR

Capt Robert Lindstrom is a USMC Officer and is a MSEE candidate at the Naval Postgraduate School. Contact Prof. Giovanna Oriti at goriti@nps.edu for more information about this research.

⚡ STUDENT ENERGY RESEARCH SPOTLIGHT

Increasing DOD's Building Envelope Efficiency

By LT Shawn Reed, USN

A recent NPS thesis examines the building envelopes of three buildings at NPS and downstream benefits of retrofitting current building stock on Department of Defense (DoD) installations. A building envelope refers to the outer shell of a building that maintains a dry, heated or cooled indoor environment and facilitates its climate control. A holistic approach to retrofitting existing buildings can help reach the net-zero emissions building portfolio by 2045. Focusing efforts on DoD installations will produce not only cost savings from reduced energy demand, but also other significant downstream benefits.

Within the country's energy use portfolio, the federal government is the largest consumer across all industries, and the DoD makes up 77% of the government's energy use. As the top consumer in the U.S., this translates to an opportunity and responsibility to lead the nation by example toward improving energy efficiency. The DoD's energy use is split into installation energy and operational energy; the former makes up 30% of the portfolio with the latter making up the remaining 70%. The DoD has chronically underfunded

facilities sustainment which is leading to deteriorating facilities within its aged building stock, coupled with a flawed funding model.

Current procurement standards address energy efficiency with new construction; however, most buildings within the DoD stock were built ahead of these initiatives and 29% have exceeded their life-expectancies. Because this represents a significant portion of the DoD building stock, retrofitting aged buildings compared to their destruction and reconstruction should be considered with variables such as carbon emissions and lengthy reconstruction processes. Retrofit projects should prioritize envelope conditions and elements to reduce the thermal demand in a logically sequenced approach toward net-zero goals. These initial steps are necessary to improve efficiencies which will lead to reduced demand and facilitate downstream investments in alternative and reduced emissions systems.

This report utilizes a case study completed at NPS that highlights the savings achieved from buildings with tight envelopes and investigates funding streams to achieve these goals. It also

identifies potential solutions to reduce the energy consumption of installation energy across the DoD, focusing on dissecting the current government policy, actions, and funding. Future policy and retrofitting efforts within the aged building stock on DoD installations are suggested, with a focus on building envelopes to reduce the unnecessary waste of energy and advance energy efficiency.



ABOUT THE AUTHOR

LT Shawn Reed, USN, graduated in June 2022 with a Master of Business Administration, Financial Management from the Defense Management Department at the Naval Postgraduate School. Contact Kristen Fletcher at kristen.fletcher@nps.edu for more information about this research.

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



OUTREACH

Critical Energy Infrastructure Protection and Resilience Workshop

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



Group photograph of participants at the CEIP&R Workshop in Baku, Azerbaijan, 27 June - 1 July 2022.

The Naval Postgraduate School's (NPS) Energy Academic Group (EAG) successfully executed the Critical Energy Infrastructure and Protection and Resilience (CEIP&R) Workshop in Baku, Azerbaijan, 27 June-1 July 2022.

The purpose of the CEIP&R effort was to conduct a tailored inter-agency workshop for diverse participants from Azerbaijan's ministries, government and security agencies, and other applicable organizations with responsibilities related to energy security, cyber security, resilience, and national critical (energy) systems protection.

NPS' multidisciplinary team from the Systems Engineering Department and Energy Academic Group led the workshop, in partnership with the Department of Homeland Security's Cybersecurity & Infrastructure Security Agency (CISA).

The recently executed workshop centered on a systematic approach for

developing an Energy Infrastructure Resiliency Plan for Azerbaijan to enhance the security and resilience of its critical energy infrastructure systems. The event included lectures, information sharing sessions, and syndicate work focused on critical (energy) infrastructure protection, resilience methods and best practices, development and analysis of conceptual designs, requirements, and alternatives in order to enhance partner nations' energy security and resilience efforts.

EAG has been executing successful energy security and CEIP programs with multiple iterations held in Georgia and Azerbaijan since 2017. These series of events included interdisciplinary lectures, information exchanges, discussions, and exercises on best practices, shared challenges, and capabilities assessments with energy security stakeholders from Azerbaijan,

Georgia, Turkey, and Central Asia. The effort has been instrumental in enhancing collaborative activities and potential partnerships aimed at supporting national and regional security goals related to the protection and resilience of energy infrastructure and systems.

LEARN MORE

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

EAG INTERN RESEARCH HIGHLIGHTS

Environmental Law Applied to Expendable Unmanned Systems



By Philip DeCocco,
EAG Intern, Marquette
University



The use of expendable unmanned systems (UxS) is expected to grow rapidly in the coming years.

Expendable systems are not legally defined but are generally referred to as unmanned systems for which little or no attempt is made to retrieve after use. This summer EAG undertook research funded by the NPS Consortium for Robotics and Unmanned Systems Education and Research (CRUSER) to study how federal, state, and regional environmental statutes apply to the operation of expendable systems in water, land, and air environments.

Two hypothetical scenarios—one water-based and one air/land-based—were reviewed to understand how laws apply to expendable systems. Analysis

of the water-based scenario shows that the deployment of Navy expendable systems is legal in the maritime environment once material, activity, and geographic limitations are considered and, in some cases, permitted. In the air/land-based scenario, analysis of the statutes suggests that abandonment of expendable systems would be considered littering or unlawful dumping. There is little research on the impact these systems have on the environment; impact depends upon material composition, activities executed, and the location of abandonment.

Several statutes that apply to expendable UxS include exemptions for U.S. Navy deployed systems. Despite these exemptions, it is advisable for the Navy to adhere to them during peace-time operations. In this way, the Navy can limit pollution created by abandoning UxS and can consider

alternative methods or materials that will limit these systems' impact on the environment.

The lack of literature and legal statutes that directly apply to UxS and expendable systems remains an obstacle to a full understanding of the legal landscape. EAG will offer its complete report in December 2022.

LEARN MORE

Report available at
nps.edu/web/eag/intern-research

More information on CRUSER is available at: nps.edu/web/cruser

Contact Marina Lesse at
marina.lesse@nps.edu for
more information.

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) to see if an internship experience with EAG could be right for you.



EAG INTERN RESEARCH HIGHLIGHTS

Arctic Governance over Unmanned Systems in the Arctic



By Rebecca Grippo, EAG Intern,
Roger Williams University
School of Law

Unmanned Systems (UxS) are proving to be useful in the Arctic region as they can withstand the extreme climate and adapt to sea ice and rough currents. This summer, funded by the NPS Consortium for Robotics and Unmanned Systems Education and Research (CRUSER), EAG undertook research focused on how Arctic governance applies to these systems.

The report focuses on the Polar Code, the United Nations Convention on the Law of the Sea (UNCLOS), and national and international laws applicable in the region's airspace. Although most of these laws do not explicitly include UxS, they offer guidance for the development of new policies to address the use of UxS in the region. For systems in the air, the Federal Aviation Administration (FAA) has authority in U.S. airspace out to 12 nautical miles while the International Civil Aviation Organization (ICAO) and the Specific Operations Risk Assessment

(SORA) offer guidance in international airspace. The report also highlights the role of the Arctic Council, a non-rulemaking and non-regulatory forum aimed at cooperation and coordination among the Arctic States.

To show how these laws and policies may apply, the report includes two scenarios involving an UxS - one in the air and one in the maritime environment. The analysis shows how the laws, conventions and agreements apply to specific situations and how that may change through the region, particularly in contested areas such as the Bering Strait and Northwest Passage.

Given that UxS are in use in the region, the absence of UxS in Arctic laws, conventions, and agreements reveals a gap in governance. The report recommends the following steps to address this gap: (1) create an interagency group within the U.S. to assess the national use of UxS and organize research and development of

policies; (2) task a working group within the Arctic Council to study the use of UxS in the region; and (3) fill the gap in policy regarding UxS by revisiting conventions and bilateral agreements. EAG will offer the full report in December 2022.

LEARN MORE

Report available at
nps.edu/web/eag/intern-research

More information on CRUSER is available at: nps.edu/web/cruser

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



FOREIGN POLICY

Restraining Russian Ransomware

By Scott Jasper, PhD

Senior Lecturer, Department of National Security Affairs

Last May, Americans up and down the East Coast waited in long lines for gas.

The panic wasn't caused by a foreign war or sanctions—it was triggered by a Russian ransomware attack. The Russia-based criminal group DarkSide had infected Colonial Pipeline with ransomware and demanded millions of dollars to unlock Information Technology systems. Colonial shut down the flow of fuel from the Gulf Coast for a week, even after paying the hackers roughly \$5 million.

Soon after, DarkSide went dark when its blog site and payment server were taken down by its service provider. However, the group adapted. It rebranded as BlackMatter in an attempt to avoid law enforcement. That tactic worked until Russian authorities arrested a DarkSide hacker behind Colonial Pipeline in January after President Joe Biden asked President Vladimir Putin to crack down on Russian cyber criminals.

Another prolific ransomware operation named Conti, run by a Russian cybercrime syndicate, chose a different, more clever strategy to continue its operations in the face of efforts by law enforcement to stop them. Conti drew undue attention after the Russian invasion of Ukraine by officially announcing full support for the Russian government, and declaring that it would strike back at the critical infrastructure of any country that decided to organize war activities against Russia. In response, an

infuriated Ukrainian security researcher leaked thousands of internal Conti messages and the source code for the Conti ransomware encryptor and decryptor.

Within months, the Conti operation shut down its public facing internet sites used to leak data and negotiate with victims. Instead of a major rebrand, the Conti syndicate continues to operate with gang members splintered into smaller cells that infiltrate other ransomware operations, known as BlackCat, Hive, and HelloKitty. This prevented the whole network from being taken down at once by the authorities. The groups take advantage of the penetration testers (breaking into the device to probe for system weaknesses), developers, and programmers still loyal to the Conti syndicate, gaining access to seasoned expertise and vulnerability exploits. Other syndicate members have created their own data extortion operations that do not encrypt data, such as Karakurt.

Despite the public exposure, Russian ransomware groups have been able to adjust strategies in order to survive. Previous attempts to coerce the Russian government into cracking down on hacker groups on their own territory have produced only superficial results—Russia did make some arrests of lower-level hackers, primarily for political theater. Even if Moscow had done more, it would be impossible now given the dismal relations between the United States and Russia over the war in

Ukraine.

With this level of resilience to continue operations, how can the United States restrain Russian ransomware? America's strategy is to disrupt ransomware actors' activities, finances, and infrastructure. Washington can pursue criminal charges against Russian ransomware with assistance and insight from the intelligence community. The Justice Department has already stepped up efforts to impose costs through arrests of ransomware actors and seizure of their proceeds.

U.S. Cyber Command and the National Security Agency have enabled cross-government actions by sharing key insights on ransomware actors in near real-time. Their commander recognizes that Russian protected gangs carrying out ransomware attacks are a national security issue. Yet as criminals, they operate based on financial motivations. While the government is doing what it can to prosecute cyber criminals, American companies and organizations have no choice but to protect their networks to avoid becoming a victim.

READ THE FULL ARTICLE

Available at <https://www.fpri.org/article/2022/08/restraining-russian-ransomware/>



CALENDAR OF EVENTS

OCTOBER

October 24–28, 2022
CORE 22 CEPS TTX
Versailles, France

31 October–4 November, 2022
Nordic Region Wargaming for
Hybrid Threats and Resilience,
Oslo, Norway

NOVEMBER

28–29 November, 2022
Black Sea Security
Istanbul, Ankara

November 28–December 2, 2022
Energy Security Awareness Course
Ankara, Turkey

DECEMBER

December 12–16, 2022
Energy Security Course
Oberammergau, Germany

UPCOMING

Q1 FY23
The Nordic Region Wargaming for
Hybrid Threats and Resilience
TBD

February 13–24, 2023
Energy Security & Critical Energy
Infrastructure Protection
Monterey, CA

TBD March 2023
Operational Level Energy Security Course
Tartu, Estonia

2022 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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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.

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