SURGE
ENERGY ACADEMIC GROUP QUARTERLY NEWSLETTER WINTER 2025

Highlights

DEFENSE ENERGY

Protecting Defense Community Critical Energy Infrastructure from Emerging Threats

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

The Naval Postgraduate School's (NPS) Energy Academic Group (EAG) and Center on Combating Hybrid Threats (CCHT) have a close partnership with NATO's Energy Security Center of Excellence (ENSEC COE.) CCHT also closely collaborates with and is supported by NPS's Global Education Community Collaboration Online (ECCO.) As a result, CCHT is a lead participant in NATO Coherent Resilience (CORE) Tabletop Exercises (TTX) which are a series of national and regional level TTX developed by ENSEC COE and executed in partner countries. Global ECCO facilitates inclusion of strategic game sessions at these TTX to familiarize participants with valuable resources and tools to help enhance partner collaborative activities.

CORE TTX bring together a diverse group of organizations across the government, academic, military, and industry spectrum to examine hybrid risks to critical energy infrastructure and energy supply. During these exercises, participants are organized into syndicate groups, each representing an area of subject matter expertise (e.g. critical energy infrastructure protection, crisis response, and strategic communications). Each syndicate works through a TTX scenario and corresponding problems. At the end of the exercise, the individual syndicates brief their outcomes to key leaders and other stakeholders. Key takeaways, lessons learned, and recommendations that come out of the exercises are included in report products which can serve as guides for improving infrastructure, cooperation, capabilities, and capacities in the context of emerging threats. Practical opportunities such as the CORE TTX are critical in strengthening collaboration with our alliance and partners.

As we continue to face evolving threats and challenges at home and abroad, exercises like CORE TTX are essential for fostering preparedness and resilience at many levels. An event like CORE TTX could also be very valuable for strengthening collaboration among our domestic partners, like state level departments, for overall mission success as well. For example, Texas is home

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From the Chair

Dan Nussbaum, Chair of the Energy Academic Group

As we enter a new year, I thought it would be useful to lay out some of the uncertainties that we face in the Energy arena, so that we can keep an eye on them, and then to see how they resolve.

These uncertainties will certainly be shaped by fluctuating geopolitics, evolving climate policies, and the usual fluctuation of markets. For example, renewable energy growth faces challenges from supply chain disruptions, as well as for the need for advanced storage technologies, and—importantly—large capital investments. On the other hand, traditional energy sectors grapple with geopolitical considerations and decarbonization pressures. The transition from traditional fossil fuels to renewable energy has been uneven, influenced by regional disparities, regulatory changes, and the need for infusions of capital investment. Additionally, rising total energy demand driven by global population growth, globally rising standards of living, and new demands like AI and data centers complicate the overall picture. This also makes it harder to forecast with any confidence where the overall energy system is moving.

Meanwhile, innovations in hydrogen, nuclear, and carbon capture offer promises, but they also require significant investments, policy alignments, and technological progress.

The distinction between energy used for defense installations ("installation energy") and energy used for operations ("operational energy") was once fairly clear. Historically, installation energy accounted for about 20% of total Department of Defense (DoD) energy use, while operational energy comprised the remaining 80%. However, this distinction is becoming increasingly blurred as energy systems and military operations evolve. Advancements in technology and the integration of renewable energy sources have led to more interconnected and interdependent energy infrastructures. For instance, the deployment of mobile energy solutions, such as portable solar panels and microgrids, supports both installation and operational needs. Additionally, DoD's emphasis on energy resilience and efficiency has prompted a more holistic approach to energy management. Efforts to enhance supply security are considered across the entire spectrum of military activities, further blurring the lines between installation and operational energy. This shift reflects a broader understanding that energy is a critical enabler of military capability, necessitating integrated strategies that address the complexities of modern defense energy requirements.

My estimate of where we're going—not to be confused with the pronouncement of somebody who has a working crystal ball—is that we will adopt an "all of the above" policy, and then make decisions as the data become available. Anyone hoping for clarity is going to be disappointed.

My best wishes for a happy, healthy and safe New Year.

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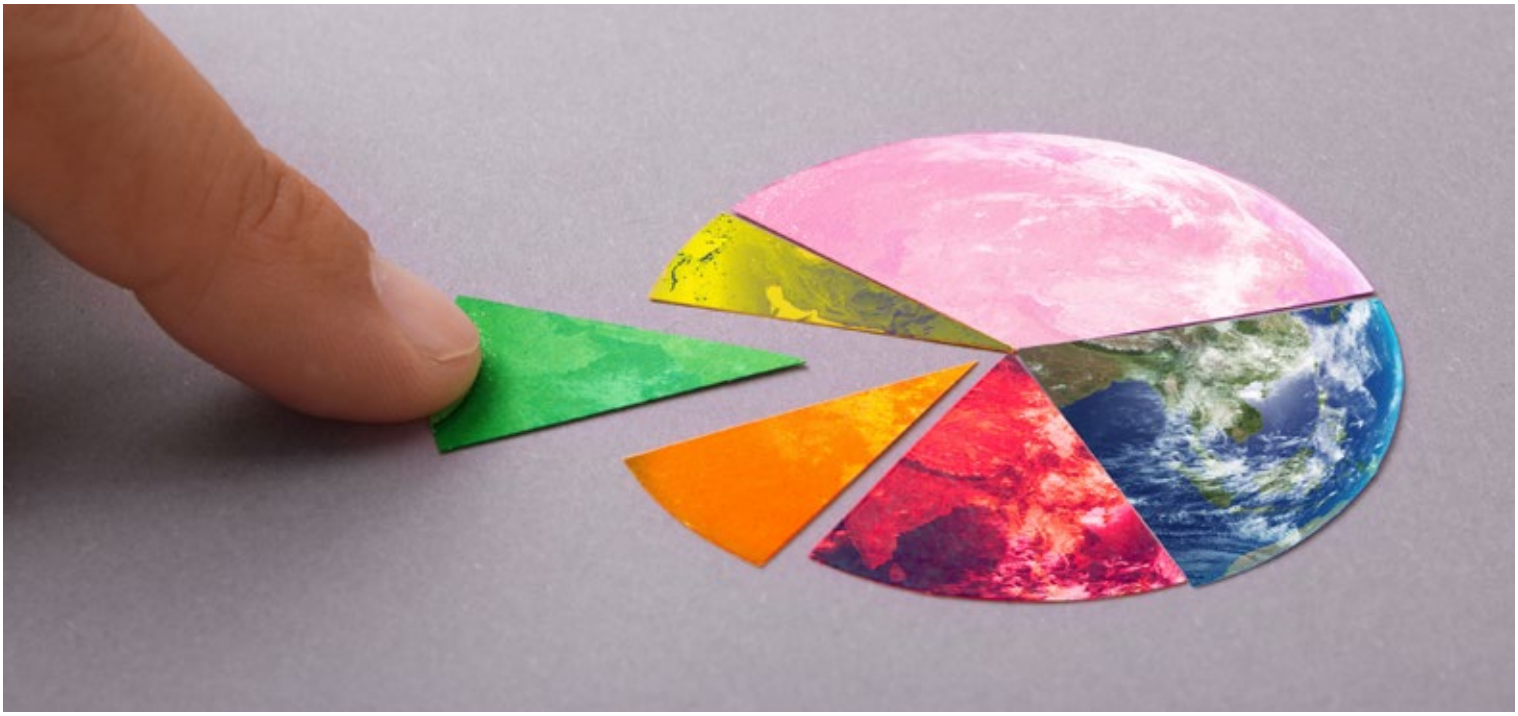
to a significant number of defense communities including over 30 defense installations that cover a wide range of defense functions including training, logistics, and operational support.

Texas' critical infrastructure is strategically important to these defense communities. In November of 2024 Texas Governor Greg Abbott issued an executive order to protect Texas' critical infrastructure from foreign threats, particularly from the People's Republic of China (PRC). The Center on Combating Hybrid Threats can potentially support US Northern Command and proactive states like Texas in protecting their critical energy infrastructure by leveraging its extensive experience and expertise from its work with CORE.

LEARN MORE

For more information email ccht_poc@nps.edu



CLIMATE POLICY

COP29: Finance, Water, Energy and Other Outcomes

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

The 2024 United Nations Climate Change Conference (also called the Conference of the Parties or COP29) was hosted in Baku, Azerbaijan on November 11-22, 2024, where tens of thousands of delegates came together to discuss decarbonization efforts. The purpose of the Conference is for the parties to negotiate the enforcement of terms agreed upon in the Paris Agreement and to make the necessary decisions on how to reach the 1.5C degree obligation as set forth in the Agreement. A major theme of COP29 was climate finance: the financial responsibility of developed countries and which developed countries should be held liable.

Continuing the work identified at COP28, COP29 continued to expand on climate funding efforts towards mitigation, adaptation, and "loss-and-damage" funds that cover the externalities certain countries' emissions have caused others, especially vulnerable developing countries. There was much debate during COP29 on the financial responsibilities of developed countries for which an exact list was determined in the 1992 UN Framework Convention on Climate Change, and whether this should include newly developed countries that were excluded in the original list. In a united front, developing countries asked developed countries for $1.3 trillion a year to support their efforts in climate change mitigation and adaptation. The previous figure for climate finance investment was an arbitrary figure of $100 billion. Now, developing countries self-estimate their needs and priorities with varying objectives and contexts as there is not an official quantifier for these calculations. In the end, the parties agreed to investments of $300 billion a year by 2035, an increase from $100 billion but below the developed countries' ask.

Another key achievement at COP29 was the Declaration on Water for Climate Action, signed by the United States, which is expected to see continued collaboration from COP-to-COP on the priority of explicitly including water-related climate solutions in the agenda.

Other major discussions were left unanswered as the parties failed to reach an agreement on how exactly to transition from fossil fuels moving forward. From the Global Stocktake coined at COP28, there was a gap in clarity and financial commitments to transition away from fossil fuels and meet the goals of the Paris Agreement. This was a major question left from COP28, and it will now be pushed to next year's COP30 in Brazil, COP30 will be held in November 2025 in the Amazonian city of Belém, Brazil, aligned with COP's theme of nature and addressing biodiversity.

LEARN MORE

More information may be found on the COP29 website:
https://unfccc.int/cop29

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ENERGY POLICY

EAG Leads NATO Exercise in Sweden and Finland

By Mike Davis, Faculty Associate–Research Energy Academic Group

In late September 2024, the Energy Academic Group (EAG) led a Joint U.S. Navy and U.S. Army evaluation team in support of the NATO Science and Technology Organization's NORDIC PINE exercise. NORDIC PINE 2024 (NP24) was the third iteration of this Tabletop Exercise (TTX) series, focused on government, military, and industrial policies and procedures relative to energy security in the renewable energy sector across Scandinavia. The event was hosted by the United States, as well as both Sweden and Finland, by the military research institute of Sweden, RISE, and their Finnish counterpart, VTT. The EAG team in support of NP24 consisted of professors and faculty from both NPS and the U.S. Military Academy, NPS students, and naval officers from the Office of Naval Research.

NP24, like the previous two years' TTX, focused specifically on these two new NATO allies, bringing together a diverse training audience of Swedish and Finnish government officials and civilian employees from across the renewable energy sector. As these training audience members were neither accustomed to NATO exercises nor familiar with one another, NPS faculty from the Defense Analysis Department conducted an icebreaker using the Global Education Community Collaboration Online (ECCO) platform. This initial scenario-based game pitted the various syndicate groups against one another, promoting rapid facilitation of teamwork and communication.

Following the Global ECCO warmup, the syndicate groups at sites in Sweden and Finland focused on responding to three days of injects and vignettes within an overarching scenario of hybrid warfare attacks on all manners of their renewable energy infrastructure. Over the course of the TTX, participants enhanced their understanding of and response capabilities to hybrid threats. The audience collectively noted that the three-day TTX helped each member understand and improve cyber resilience and supply chain resiliency. The TTX also led participants to propose and develop strategic countermeasures against malign influence within their businesses and government agencies. One of the most significant areas of collective amelioration was the comprehension of the risks associated with their understanding of Scandinavian offshore and subsea security - specifically their national and private infrastructure such as energy cables, pipelines, and communications cables.

The last phase of the exercise included two significant events for the EAG team: the After-Action Review (AAR) and the creation and submission of the NATO First Impressions Report (FIR). During the AAR, EAG faculty members, Michael Davis and Charles "Jay" Lynn, briefed the NATO Exercise Director and members of the Swedish parliament on the key takeaways and findings, providing proposals for enhancements to Swedish national response capabilities and legislation as well as suggestions for continued exercise advancements.

As the participants bade farewell, each noted their knowledge of the NATO alliance had been increased, but more importantly participants aimed to use their experience at NP24 to conduct internal TTX with their own businesses and government agencies.

LEARN MORE

For additional information on EAG TTX opportunities contact:

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Atendees at the NPS European International Alumni Symposium in Garmisch, Germany.

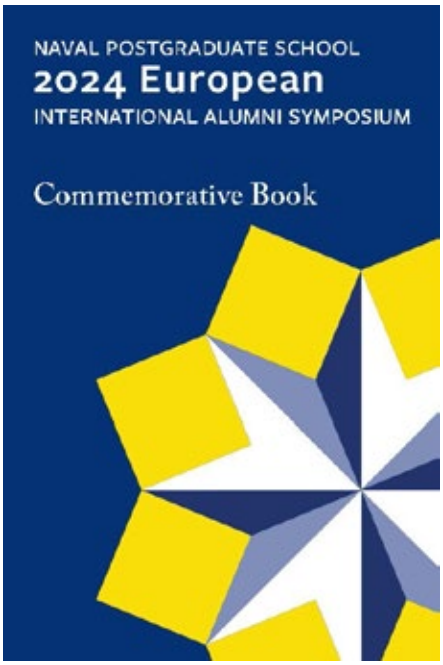
ENERGY SECURITY

EAG Presents Climate & Energy Security at International Symposium

By Kristen Fletcher and Mike Davis, Faculty Associates-Research, Energy Academic Group

In September 2024, the Energy Academic Group participated in the first NPS European International Alumni Symposium in Garmisch, Germany. The event included more than 100 NPS alumni representing 29 nations across Europe. The symposium, organized by the NPS International Graduate Programs Office and supported by the NPS Foundation, enabled a unique collaboration venue by offering opportunities to learn alongside allies and partners.

As part of three days of exchange, EAG Chair Dan Nussbaum led the Climate and Energy Security in Europe panel featuring EAG Faculty Associates Brenda Shaffer, Kristen Fletcher, and Mike Davis. The discussion included key issues such as the role of energy in the China-Russia-Iran-North Korea alliance,



international and DoD energy policies in the face of global climate change, and the role of energy in global instability. Speakers also highlighted several challenges and opportunities for both energy and climate security including maintenance of reliable Operational Energy (OE) to deployed forces and increased efficiencies, which reduce the climate impacts that can worsen global conflict. The panel highlighted the ongoing EAG OE and climate security courses/stackable certificates as well as research, alongside many European allies and partners, to increase understanding of these challenges.

Nussbaum and Fletcher were among the participants who visited the nearby Schneefernerhaus Environmental Research Station, Germany's highest environmental research facility located just below the summit of Germany's highest peak, the Zugspitze. There, they learned about the variety of ongoing climate research conducted by several global institutions including the tracking of greenhouse gas emissions, especially those occurring at high altitude, as part of a Global Atmosphere Watch program. These researchers also track physical observations of the nearly depleted Southern Schneeferner glacier, cloud dynamics, and impacts of climate change on high altitudes.

LEARN MORE

EAG Climate Security research is available at: **https://nps.edu/web/eag/energy-climate/**

Information on EAG OE Stackable Certificates is available at: **https://nps.edu/web/eag/education/**

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ENERGY RESEARCH

Wind Power Added to NPS Microgrids

By Karen Flack and Brandon Naylor, Faculty Associates-Research, Energy Academic Group

Two electrical engineering master's students, Captain Dillion Hartmann, USMC, and Captain Sean Sullivan, USMC, helped install wind turbines on the roof of Spanagel Hall at the Naval Postgraduate School. The wind turbines are part of a demonstration microgrid with other generation sources, including solar panels. The turbines have rotor diameters of approximately 1.2 m and a rated power of 2 kW. While small compared to grid-scale turbines, the demonstration turbines serve as a test instrument to understand the potential of larger turbines as a generation source in microgrids at naval installations. An anemometer was also installed to measure the wind speed and direction simultaneously to the wind turbine power. The location on the roof allows the turbines to take advantage of higher wind speeds that occur further from the ground in the atmospheric boundary layer. The independent research project provided analysis and test data to improve the capabilities of the microgrid modeling tool developed at NPS. This research is part of an overall effort in the Department of Defense to enhance mission resilience with microgrids that provide electricity for critical infrastructure during local grid outages. The students were given technical assistance from Research Associates Richard Alvez and Brandon Naylor and were advised by Professors Giovanna Oriti and Karen Flack.

LEARN MORE

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Interested in Energy-related Thesis Research?

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

nps.edu/energy

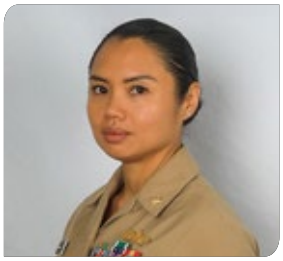
ENERGY RESEARCH

Naval Postgraduate School Operations Research Graduate Advances Military Base Resilience with Comprehensive Power System Model

By Dr. Emily A. Pesicka
Postdoctoral Researcher
Energy Academic Group and
Climate & Security Network

The 2022 Chief of Naval Operations Navigation Plan (CNO NAVPLAN) emphasizes critical readiness infrastructure as a strategic priority, advocating for data analytics to enhance fleet operations by better understanding infrastructure costs and impacts. This mandates that the Commander, Naval Installations Command (CNIC), improve infrastructure resilience against mission disruptions and meet environmental goals. Moreover, the Energy Security Framework requires the Navy to develop benchmarks, assess performance, and prioritize energy security investments focused on reliability, resilience, and efficiency.

The reliable operation of power grids at naval bases is essential for mission success and integrating renewable energy projects to meet long-term climate goals. In response, the CNIC and Naval Facilities Command (NAVFAC) have identified the need for sophisticated power system models to prioritize energy security Navy benchmarks. However, existing models are insufficient, as they do not address the unique requirements of military installations, which include mission-critical assets, multiple services, and complex interconnections with public and private systems.



LCDR Olive Oliveros' thesis titled "Test Model for Power Distribution on U.S. Naval Installations" introduces an innovative test system encompassing various naval installations developed in collaboration with NAVFAC and the NAVFAC Expeditionary Warfare Center (EXWC).

LCDR Olive Oliveros' thesis titled "Test Model for Power Distribution on U.S. Naval Installations" introduces an innovative test system encompassing various naval installations developed in collaboration with NAVFAC and the NAVFAC Expeditionary Warfare Center (EXWC). The model integrates ten feeder powerline configurations, each reflecting distinct mission sets and power demands, providing a holistic representation of a military installation's power grid. This thesis directly supports the CNO's NAVPLAN of 2022, emphasizing resilience during mission disruptions and achieving environmental objectives.

Baseline vulnerability analyses are a cornerstone of this research, evaluating the impact of N-1 and N-2 component failures on mission-critical loads. The model reveals significant variations in resilience across different feeders, highlighting the importance of tailored strategies to mitigate power outage risks. This model addresses critical gaps in existing infrastructure management approaches by incorporating mission-specific characteristics and comprehensive data.

The test system facilitates further rigorous analyses and is a vital tool for training and education. It supports strategic decision-making aligned with the U.S. Navy's goals to enhance mission readiness and operational effectiveness. Future research from the warfighters in the departments of System Engineering or Operations Research might expand this model by integrating daily and seasonal load variations, updating generator cost profiles, refining visualization capabilities, and exploring alternative power flow optimization methodologies.

LCDR Oliveros' research represents a significant advancement in military power system modeling, providing a robust framework for enhancing the resilience and sustainability of military installations. The resulting insights and tools will ensure that naval facilities are better equipped to maintain operational continuity and meet evolving challenges.

READ THE FULL ARTICLE

Visit Calhoun to read the entire thesis here: **https://hdl.handle.net/10945/73198**

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STUDENT ENERGY RESEARCH SPOTLIGHT

Fuel Efficient Flight Paths for High Endurance UAV Missions

By LT Zachary Michael, USN

Given the ever-growing political tension between the U.S. and Russia, it is not hard to fathom that a direct conflict between the two superpowers can soon be taking place. Russia is widely recognized for maintaining one of the most extensive operational satellite infrastructures and has successfully conducted anti-satellite (ASAT) weapon tests by intentionally destroying orbiting satellites. These actions present significant challenges to global space security. To safeguard its interests, the United States must take proactive measures to protect and advance its strategic objectives in the Arctic region, a critical area for Russia's military strength. While Russia is almost certainly predicted to disable or significantly degrade space operations, Long Endurance Unmanned Aerial Vehicles (UAVs) have the potential to augment the space segment by providing pseudo-satellite capabilities. In fact, Unmanned Aerial Vehicle (UAV) applications have already been used for many of the same missions that satellites are normally tasked such as infrared (IR) imagery, providing communication relay, and alternative Position, Navigation and Timing (PNT) in support of U.S. Navy and joint force operations. In the Arctic region, energy logistics is a challenge, and so using energy more effectively can pay large dividends. In particular for UAV missions, improving energy efficiency means extended reach and/or greater on station time without refueling.

In the fall of 2023, the Naval Postgraduate School, the Naval Research Laboratory, and Platform Aerospace together achieved a groundbreaking milestone by flying the high-endurance UAV, Vanilla, for several consecutive days above the Arctic Circle on Alaska's North Slope. This mission showcased cutting-edge advancements in fuel efficiency and full autonomy, setting new benchmarks for multi-day, high-endurance UAV operations. This project was the culmination of years of dedicated effort and was funded by the Operational Energy Capability Improvement Fund (OECIF), the principal joint operational energy investment program within the Department of Defense (DoD). Demonstrating Vanilla's multi-day endurance, fuel efficiency, and autonomous capabilities in one of the world's most challenging environments has set a new standard for UAV operations, advancing the DoD's strategic energy and operational goals. The initiative evolved into the energy-aware project called POTION, which is a mission planning software infrastructure designed to find the most energy advantageous route through time-varying three-dimensional winds. As part of POTION, the team designed a propulsion efficiency model for Vanilla's fuel consumption and integrated it with machine learning algorithms to optimize aircraft routing. This innovative approach demonstrated the transformative capabilities of POTION by showcasing UAVs' ability to perform optimally and efficiently in the extreme Arctic environment. By leveraging these advancements, Vanilla can achieve an extended flight endurance, enabling it to follow an optimized, fuel-efficient path or perform extended loiter in an operational area for an extended duration before returning to base.

The motivation behind the next phase of this research is to employ high endurance UAVs operating as pseudo-satellites in high latitude regions by enabling the platforms to remain on station and provide persistent coverage for days at a time, all without the need to refuel. By optimizing the transit to the mission area, fuel will be conserved to further increase on station time. The work will focus on efficiently navigating in the presence of various "keep out" zones which are needed to address a variety of different issues such as hostile airspace, FAA regulated no-fly zones, or other obstructions that need to be maneuvered around. This thesis will explore the optimal trajectory design for fuel efficient transit paths of a high endurance UAV to avoid weather and other identified no-fly regions. The goal will be to create a practical process that can be tested as part of an upcoming flight experiment to be conducted in the Arctic region.

ABOUT THE AUTHOR

LT Zachary Michael is pursuing a Master of Science in Space Systems Engineering. He will graduate in June 2025. Contact Prof. Mark Karpenko at **mkarpenk@nps.edu** for more information about this research.

STUDENT ENERGY RESEARCH SPOTLIGHT

FPGA-Based Digital Twin for Zonal Nanogrids

By LT Yongsung (Andrew) Cho, USN

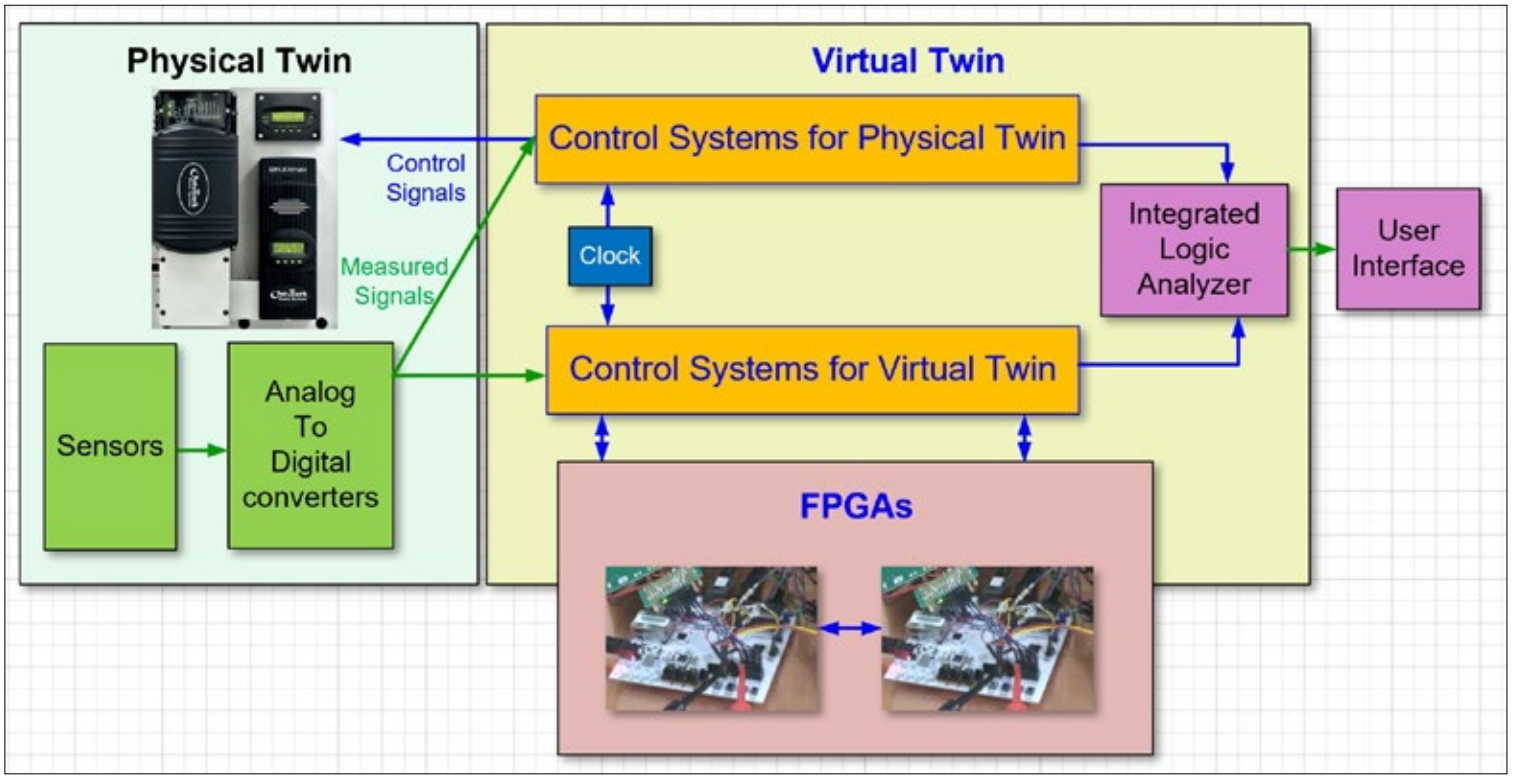
Microgrids have become increasingly more prevalent in industrial and military settings to provide power outside the grid; however, there have been difficulties prioritizing power during electrical faults or communications failures. This research argues for and builds off the premise that the solution is to use zonal nanogrids to power specific critical loads. This concept is based off the zonal ship power systems that have been time-tested on naval warships like the DDG-51 Arleigh Burke-class Destroyers. The huge benefit of zonal power systems is that they provide multiple redundancies, and thus increase reliability. Noting that there is currently little to no reliable digital real-time simulation of the zonal nanogrid model, this thesis seeks to ultimately develop a Field Programmable-Gate Array (FPGA) based digital twin for zonal nanogrids.

This research will be conducted in three phases. The first phase is to implement a fully operational physics-based microgrid model into a FPGA. This will provide the bedrock of the virtual twin. The second phase is to integrate multiple microgrid FPGAs into a zonal nanogrid power system. The second phase will provide deliverables on the communications and power sharing of the virtual twin model. The third phase will be to incorporate this zonal nanogrid virtual twin with the physical twin. The physical twin will be the microgrid hardware that is currently being connected in the NPS Power Lab. Once all phases are complete, a functional digital twin of the zonal nanogrid will be accomplished.

Further research will be to integrate machine learning and artificial intelligence to get a more robust and accurate operation of the digital twin.

ABOUT THE AUTHOR

LT Yongsung (Andrew) Cho is pursuing a Master of Science in Electrical Engineering at the Naval Postgraduate School. Contact Dr. Giovanna Oriti at goriti@nps.edu for more information about this research.



ENERGY RESEARCH

NPS Faculty Working to Establish Microgrid Center of Excellence

Faculty and student teams are building microgrid "sandbox" labs that can be used as testbeds to teach NPS students advanced power electronics principles and experiment with state of the art equipment from a variety of vendors.

By Brandon Naylor
Faculty Associate-Research
Energy Academic Group

The Electrical and Computer Engineering department at the Naval Postgraduate School (NPS) with support from the Energy Academic Group is in the process of establishing a microgrid center of excellence on campus. In response to growing challenges and demands for electrification in the maritime domain, the team is working to advance research in topics related to electrical energy storage, power quality, networked energy systems, and expeditionary energy harvesting. Faculty and student teams are building microgrid "sandbox" labs that can be used as testbeds to teach NPS students advanced power electronics principles and experiment with state of the art equipment from a variety of vendors. This effort will build on past microgrid work at NPS by incorporating new types of battery chemistry, informing wind energy generation models, and serving as a test bed for "digital twin" and networked microgrid experiments that will inform future distributed energy projects at forward deployed locations and installations. These microgrid labs are an excellent tool for teaching students not only the engineering principles of their design and operation, but also the process of navigating the standards and policies for safe high power electronics handling and facilities criteria for handling hazardous materials such as fuel storage for backup generation. The effort provides a holistic experience of energy system design and integration for the students, encompassing documentation, regulatory compliance, component sourcing, and stakeholder needs assessment among other criteria that are all required for the successful implementation of large engineering projects.

LEARN MORE

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

Operational Energy Research Available on Calhoun

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

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

Calendar of Events and Important Dates

JAN

27–31 January
Naval OE Forum
Washington, D.C.

FEB

17–21 February
Energy Security Strategic Awareness Course - NATO School
Oberammergau, Germany

MAR

17–21 March
Energy Security Course – Baltic Defense College
Tartu, Estonia

24–28 March
Cyber Incident Handling Course Week 1
Vilnius, Lithuania

APR

31 March – 4 April
NATO Cyber Security Annual Discipline Conference – Naval Postgraduate School
Monterey, CA

7–11 April
Energy Security Strategic Awareness Course
Belgrade, Serbia

UPCOMING

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

EVENT UPDATES

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

ENERGY ACADEMIC GROUP
NAVAL POSTGRADUATE SCHOOL

Connect with the Energy Academic Group

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

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Contribute to an issue of *Surge*

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

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