Norwich University Applied Research Institutes

CONTRACT TITLE: NORWICH ENERGY TRACK IMPLEMENTATION PHASE 3

Final Technical Report

Development Report for Contract No. W9132T21C0015

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14. ABSTRACT

This is the final report documenting the findings of the entire contract and all appropriate final products developed. NUARI led the effort to develop the Energy Track within the Norwich University (NU) Center for Global Resilience & Security (CGRS) in three phases. The three-year BAA program culminated in the 2021-22 timeframe in the Third Phase – Implementation. The products developed include targeted education and training programs, the conduct of training activities using new models, pilot Internships, and the promotion of research to help military and surrounding communities lead energy resilience efforts in a manner compatible with DoD approaches.

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Program Executive Summary

Scope

NUARI led the effort to develop the Energy Track within the Norwich University (NU) Center for Global Resilience & Security (CGRS) in three phases. The three-year BAA program culminated in the 2021-22 timeframe in the Third Phase – *Implementation*. The products developed include targeted education and training programs, the conduct of training activities using new models, pilot Internships, and the promotion of research to help military and surrounding communities lead energy resilience efforts in a manner compatible with DoD approaches.

Education Programs

Undergraduate course modules – The modules listed below were implemented in three engineering courses (Introduction to Engineering, Engineering Economics, and Environmental Engineering) and two non-engineering courses (Energy and the Environment and Human Issues in Design).

- Resilience for Sustainability (sub-module of Energy Fundamentals)
- Energy and You Module
- Energy and Society Module
- Energy and Resilience Module
- Energy Nexus Module

Mid-career courses and modules were administered per Government requirements during the period of July 2021 and July 2022:

- Microgrid Architecture Course
- Industrial Control Systems Course
- Critical Infrastructure/Energy Resilience Overview Module
- Identifying Mission Critical Infrastructure/Energy Systems Module
- Critical Infrastructure Threat Analysis/Risk Management Module
- Energy/Critical Infrastructure Resilience Policy and Partnerships Module
- Exercise Development Process - Capstone Exercise with DECIDE® Module

- Energy Resilience Leadership Graduate Certificate – Public Leadership, Crisis Management and Organizational Change (AD586) and Critical Infrastructure Protection (GI566)
- National Cybersecurity Preparedness Consortium courses: https://nationalcpc.org/

Senior Leader Seminar – held in DC, integrated modules above in a requirements-based seminar in partnership with AUSA.

Internship program – Four Norwich University Students in the Fall and Spring semesters interned virtually with ERDC-CERL.

Major Findings

The team worked on **implementing** energy resilience and security curriculum across three levels of effort (LOE 1 – undergraduate, LOE 2, mid-career professionals, LOE 3 senior leaders). In addition, a fourth level of effort involved a pilot internship opportunity in which undergraduate students worked with ERDC-CERL. The implemented curriculum was designed in Phase 2 of the contract, following the findings of requirements and gaps identified in Phase 1 on planning.

The major activities/findings and future pathways are:

1. Sustained Implementation. This three-year effort has created a pathway for sustained implementation of the energy modules at all levels of study. For example, at the undergraduate level, year 3 instructors will further modify future offerings of courses where energy modules were integrated, and additional instructors will be invited to embed the energy modules within their courses. A memorandum of understanding with ERDC -CERL will seed future internships. This sustainment is critical given the need and urgency to train future DoD Army personnel in energy resilience areas as a way to fulfill components of the Army Installation Strategy and Army Climate Strategy.

2. Module Development. The modular structure of all curricula developed in this effort at the undergraduate, mid-career, and senior leader levels offers extreme flexibility to DoD Army, educational partners, and all entities involved in training for energy resilience. The energy track will experiment with badges, certifications, and degrees in ways that help address specific DoD personnel knowledge gaps in energy resilience from summer 2023.

3. Human Dimension. The integration of social, economic, political, and risk-based considerations in the energy resilience curriculum at all levels emphasized the human dimension in the evolving technological advancements, the uncertainties inherent in human decision making, and underscored the need for collaborative frameworks and partnerships that consider within and outside the fence vulnerabilities and capabilities. The need for more policy informed technical training was acknowledged by undergraduates through senior leaders. Along with experiential and hands on training

components, this type of thoughtful curriculum will be a hallmark of the Norwich University Energy Track moving forward.

4. Modern Platforms. Use of modern platforms for dissemination in multimedia formats and curricular tools such as tabletop exercises, NUARI's DECIDE® platform elevated student understanding, interactions, and engagement across all levels of effort. As the NU Energy Track moves forward, capstones at the undergraduate level to seminars at mid-officer and senior leader levels will continue to benefit from the juxtaposition of energy resilience with Norwich University's growing leadership in cybersecurity, information warfare, artificial intelligence, and machine learning to recruit, build, and train and bring about a generational change in the DoD.

Introduction

Background

The ERDC BAA #W912HZ-18-BAA-01—Energy Track within Norwich University (NU) Center for Global Resilience & Security (CGRS) for Topic Area CERL-6, Contingency Basecamp Operational Energy, noted in Phase 1 several emerging installation and operational energy resilience requirements tied to national security objectives outlined in the National Security Strategy (NSS) and the National Defense Strategy (NDS). In Phase 1 ("Analysis and Plan") a mixed-methods approach of literature reviews, gathering experts in round tables, interviews, small group discussions, surveys, live polling and feedback, debriefs, case-studies and interactive, engaging activities, was used followed by extensive analysis of the notes gathered in these exercises.

Next, a roadmap was built, including a research agenda, and an education and training plan with primary input from senior military leaders and subject matter experts with a focus on installations and operational energy.

Major takeaways from Phase 1 included: targeted educational modules at entry, mid, and senior levels using a diverse set of delivery tools; expanding experimental and experiential research opportunities by collaboration between academic units, military labs, and communities (municipal, business, and nonprofit sectors) to fill in educational gaps for future leaders, as well as career professionals; and piloting lesson plans and hands-on activities at the tactical, operational and strategic levels.

Phase 2, Design and Development, of an Energy Track within NU's CGRS involved producing scalable, modular, and adaptive education and training programs to benefit four critical lines of effort (LOE) covering tactical, operational, and strategic roles within and in support of the DoD. At the undergraduate level (LOE 1), the goal of the curricular enhancements is to provide foundational energy resilience knowledge to future military officers and civilians to initiate generational change. For the mid-level officers (LOE 2), the programming is intended to bridge any knowledge gaps by providing them with tactical and operational energy resilience knowledge tools to use their authority to positively influence the energy resilience in a military organization. In the case of senior leaders (LOE 3), the premise is to rapidly and efficiently gather and leverage experts to

provide strategic guidance in addressing energy resourcing, risk assessments, and engage in dynamic master planning with a goal to solve some of the most challenging national security risks in energy resilience facing our Nation. LOE 4 allows all curriculum development to be tied with current research and a precursor to hands-on internship opportunities to promote experiential and immersive energy resilience education.

Objectives

In Phase 3 (“Implementation”), the education and training products created in Phase 2, Design and Development, are being implemented to develop targeted education and training programs, conduct some of the training activities using new models, and promote research to help military and surrounding communities lead energy resilience efforts in a manner compatible with DoD approaches. The program will leverage established public-private partnerships and create new ones to assist in documenting, educating, and implementing resilient community models and strategies for government and military operational resilience. The goal is *to rapidly and efficiently gather and leverage experts to solve some of the most challenging national security risks in energy resilience facing our Nation.* This collaborative approach to program design is one focused on protection of the homeland against mounting strategic foreign threats of attacks, fortifying critical infrastructure and hardening the operations which are required for community resilience, as well as power projection. Phase 2 efforts resulted in tactical entry-level modules in energy resilience fundamentals, risk assessment, policy and master planning, and pilot programs to evaluate the effectiveness of the course implementation – these educational assets are being delivered in Phase 3, Implementation.

General Approach

Implementation Concept: The purpose of the Implementation phase is to launch the various energy resilience modules, courses, experiential learning activities, and other programming developed in the Development phase. Throughout the Implementation, summative evaluation is being utilized to assess how well the Implementation is delivering on the stated objectives and desired learning outcomes. This evaluation informs iterative curricular refinement and planning for the sustained, future delivery of the Energy Track educational platform to improve the energy resilience capability of installations and operational units.

The Implementation phase will provide energy resilience resources to NU students, other academic institutions, Department of the Army, other DoD entities, and local communities. The method to accomplish this “Generational Change” is a combination of academic and continuing professional education programs, consulting services, distributed exercise programs when fitting, security operations center training as needed, and internships in support of ERDC-CERL. The end state of the Implementation phase is a sustainable, engaging educational program that delivers relevant energy resilience educational resources in support of the objectives of the DoD and other customers.

Undergraduate Curricular Enhancements
The goal of the curricular enhancements is to provide foundational energy resilience knowledge to future military officers and civilians. This foundational knowledge will be delivered in the form of interdisciplinary curriculum, internships, research, and capstone projects that expose students to energy resilience.

Mid-level Professional Education/Training Programs
Mid-level professional education/training programs will provide energy resilience courses and certificates from a menu of relevant courses and resources to supplement knowledge gaps experienced by mid-level military and DoD civilian professionals who have the authority to positively influence the energy resilience in a military organization.

Senior Leader Professional Seminars
A professional seminar for senior leaders will address strategic energy guidance in order to understand strategic energy resourcing, strategic energy risk assessments, and appropriate mitigation in coordination with a dynamic strategic energy master plan.
Internships. The purpose of the Internships is to establish the Knowledge, Skills, and Abilities (KSA) required to successfully contribute to an energy research related internship for ERDC-CERL programs.

The ADDIE Model of Instructional Design

To build and offer the stated education and training goals, Phase 3 will continue to employ the ADDIE model of instructional design. This model gives a focused approach in the development of course content and allows for continuous evaluation and improvement. The ADDIE model includes the following phases: analysis, design, development, implementation and evaluation.

Analysis: Identify the Requirements
The analysis phase involves identifying the instructional problem or, from a training standpoint, identifying the performance gap and desired outcome subject areas. This phase includes identifying participant characteristics, learning resources, training methodologies, defining the learning environment, establishing instructional goals and objectives, and determining budget/time constraints.

Design: Identify the Learning Objectives
The design phase involves subject matter design broadly through storyboards or a prototype, including defining specific learning objectives and instructional strategies, structuring content, and assessments. Assessments will provide feedback on the learner's progress in achieving the learning objectives.

Development: Develop a Performance Solution
The development phase involves creating, curating, and assembling the content specified in the design phase. This phase includes stakeholder review and validation, as well as any required revisions. This phase will involve the integration of technology and related testing. Pilot programs will be conducted in this phase to test the validity of the material and delivery methods.

Implementation: Deliver the Performance Solution
Implementation is the construction and application of the course curriculum, learning outcomes, and the learning space. The process should also include confirming the availability of required materials and associated applications, preparing learners to use any required tools or technology.

Evaluation: Evaluate the Results Relative to the Performance Objectives
In practice, the evaluation phase is included in every aspect of the ADDIE process. The overall design process is iterative with elements fine-tuned along the way. Quality assurance evaluations are conducted prior to implementation to confirm the course material meets the specifications established in the design phase. A summative evaluation will be conducted after Implementation to determine training effectiveness on three bases: participant satisfaction, participant learning, and participant performance.

Program Objectives

Task 1. Deploy and evaluate the effectiveness of new courses of instruction in energy resilience for undergraduate and mid-career professional certificate programs.

The contractor shall conduct the five undergraduate energy resilience courses in congruence with Norwich University's various learning platforms appropriate to each academic program. The mid-career professional energy resilience certificate courses shall be conducted through a combination of on-site, virtual, and off-site courses. Target population size for both courses is 15 individuals. Each course shall include learning objectives and a course syllabus.

The topics for each course shall follow those previously developed by NUARI. The contractor shall provide ERDC-CERL a written report detailing the course materials, preparation and execution of each course, a participant and faculty assessment of each course, and a summary of lessons learned for each course.

Task 2. Conduct an energy resilience seminar focused on senior-level military energy managers and policy makers.

The purpose of the seminar is to discuss current challenges of energy resilience and potential solutions. The contractor shall conduct the senior-level seminar in-person in Washington D.C. Seminar size should be at least ten individuals to facilitate robust discussion among participants. The seminar should be eight hours in length over two days. The contractor is responsible for coordinating and securing facilities and attendees. Draft seminar materials shall be provided to ERDC-CERL no later two weeks prior to the seminar for approval. Following the seminar, the contractor shall provide ERDC-CERL a written report detailing the preparation and execution of the seminar, a participant assessment, and a summary of lessons learned.

Task 3. Create a pilot internship program with ERDC-CERL for NU undergraduate students.

In conjunction with Task 1, the Contractor shall establish the Knowledge, Skills, and Abilities (KSA) required to successfully contribute to energy-related research. The internship program will use the KSA to provide two student candidates for Fall 2021 and Spring 2022 to participate in ERDC-CERL research projects. The internship shall be executed virtually. The contractor shall provide ERDC-CERL a written report detailing the preparation and execution of the internship program, participant assessment, a summary of lessons learned and recommendations for continuing the Internship Program.

Results

Task 1

With regards to Task 1 involving the integration of the Phase 2 modules in five different undergraduate courses, it was great to see that integration worked. The number of modules and range of topics they covered seemed daunting at first. However, all instructors found ways to adapt the modules that covered their learning objectives into their courses. One instructor noted “The key for me was finding something that I did not already do that also complimented/enhanced the curriculum.” An after-action review (AAR) discussion revealed that a “read me first” type of document to help orient a new instructor to all the modules, as well as a brief overview session with one of the core module development team members will be helpful to future adopters of the energy resilience modules.

In terms of specific pedagogical approaches, one instructor who developed a role-play approach noted that the case study of the Gulfport, MS Naval installation would benefit any course that has an introduction to energy concepts. He developed a case study deck where each student played a role and stated that the “hands-on” activity appeared to be enjoyed by the students and supplemented classroom discussions on energy systems (power plants, solar farms, etc.) as well as their discussion on energy resiliency. The instructor did plan to clarify the problem statement in the next offering to specify upfront which energy systems are viable. The role play activity was also one that other instructors saw themselves trying in their courses.

One spring 2022 course instructor noted that she was initially hesitant about discussing the module example that uses an atomic bomb as a way to think about the scale of energy given the Russian invasion of Ukraine. However, this did not end up being a deterrent or distraction from the discussions at hand. She did remark that the overall discussions on resilience, including on energy resilience energized the students into action and even activism, as they made a case to install a climate clock on campus to some members of the faculty and administration.

The one big takeaway from all instructors - Try new things! All instructors benefited from branching out and trying a new approach to presenting material. One instructor noted “It helped me break out of the standard lecture format and encouraged me to explore other

resources. These modules made it easier to do this because you had some faith that these resources had already been explored and vetted and were worthwhile. It can be hard to take on new approaches like this when you are also tackling the organization of material itself."

Another takeaway was that, in all courses, students were challenged by the uncertainty and complexity of the energy resilience considerations presented, and they were often uncomfortable with their lack of experience and reduced "sophistication" when analyzing and problem-solving in real-world contexts—in service to communities. Energy resilience provided a rich context for the students to mature as future engineers and professionals.

There were a lot of ideas on other courses that could benefit from the energy modules. For example, the instructor who covered the ES 200 course on energy and environment noted "A module could be included in Earth Materials (GL 267) on the impacts and importance of mining resources like lithium and rare earth elements which are critical to developing renewable energy resources. Oceanography (GL 111) could include a module on marine energy resources and Introduction to Geology (GL 110) might be able to use some of the Energy and Society info on the distribution of energy sources and the use by country."

In terms of moving this work further and building on the momentum from the year 3 courses, we talked about developing a module on energy economics and one on the impacts of energy to natural environments and other resources like air and water. One instructor asserted that she was willing to work on the latter of these this summer. As the Energy Resilience curriculum is enhanced and implemented in future courses, the possibility of creating a new field of study including a degree, a minor or a concentration will become increasingly feasible from the student interest, relevance, and accreditation perspectives.

The student-driven, discussion-focused course on Microgrid Architectures offered good opportunities for the participants to develop with respect to the 11 stated learning outcomes, with an investment of 2-4 hours per week.

Task 2

Regarding the Senior Leader Seminar, from the qualitative responses to areas for improvement and negative aspects, a common thread in the feedback was that there was not sufficient time to cover the material, to hear from all the panelists and to network with other attendees. That said, 71% of respondents said that the one-day format was preferred, with 10% preferring a half day and 19% preferring more than a day. This would support reducing the number of panels and extending the time of the panel discussions and breaks in the one-day session and creating a seminar series that offers the possibility of going into more depth, in both content and networking. Attendees also liked the topic and thought it was relevant including the focus on cyber security and the importance of bringing together diverse skill sets and experience to solve current problems.

Task 3

Rounding out the undergraduate activities was the engagement of four interns who conducted research projects under the guidance of ERDC-CERL. The student interns also had the title of Student Fellows in the CGRS Student Fellowship programs that identifies Norwich undergraduates with interests in a broad range of interdisciplinary research topics related to Resilience and Security. Because this was the pilot internship with an external partner, this dual appointment would ensure that students had adequate guidance for their independent research in the event that the external internship supervisor did not have time to support the students, which was fortunately not the case for this cohort of students. The recruitment of the interns was a challenge due to the timing of the contract, that is, recruitment was conducted mid-semester and few potential student candidates had capacity in their schedules. However, once the students were identified and agreed to begin the internship program, they were able to successfully complete their research projects over the course of the year. This was primarily due to the well-established internship framework that ERDC-CERL has developed over the years.

Conclusion

In this Phase 3 – Implementation, Task 1 involved integration of curriculum developed in Phase 2 into the undergraduate and mid-level officer courses. At the undergraduate level, five courses, three in engineering in fall 2021, and two non-engineering courses in spring 2022 were selected for integration across the academic year. Almost 200 students enrolled across the five courses were introduced to energy fundamentals, studied the relationships between energy generation, transmission, use, and consumption in the non-renewable and renewable sectors, explored the social, economic and environmental intersections of energy policy, technology, and partnerships and discussed risk and resilience. Each course instructor adapted the modules from Phase 2 to blend in with the broader course goals and learning objectives. A variety of supporting materials and assessment tools were used to support student understanding of these core areas. In addition, the instructors themselves reflected on the integration experience, the limitations and highlights of using these modules and on ideas for future improvements and expansion within these courses as well as others that they taught or would recommend to colleagues teaching courses that could benefit from these modules. An independent consultant hired by NUARI developed and provided an exhaustive evaluation of the course materials and their relationship to learning objectives, instructors' use of pedagogical tools and resources to cover the materials, and students' assessment of their learning and applicability to other courses and their professional tracks. A major conclusion of this effort was that the repository of modules that were developed in Phase 2 was expansive and effective at supporting the instructors as they worked to adopt new content into their courses that was outside of their primary discipline and that was outside the scope of what was previously presented in the courses. A sense of overwhelm expressed by new instructors at the volume of materials that were available could easily be averted in the future by a simple "read-me" style document or an initial orientation meeting with one of the faculty from Phase 3. Another major conclusion noted that exploring resilience as a concept with students is important and has the potential for great impact. Students demonstrated awareness and expansive thinking with respect to energy

and its many contexts through their reflective writing in response to open-ended survey questions.

Interdisciplinary teams were effective units of collaboration for preparing and delivering content related to energy resilience. Because the undergraduate classroom environment is inherently flexible and at the entry level, instructors could easily accommodate the interdisciplinary material into their courses even when it was out of their area of subject matter expertise. It would be more difficult to deliver interdisciplinary topics when as the level of the courses increases because of the need for specialized information that lies outside of the instructor's field. This could be mitigated by team teaching. Publication, on the other hand, presents more of a challenge with regards to interdisciplinary collaboration in Energy Resilience because of greater field-specific methodologies, skills and topics required for successful peer-reviewed research. Identifying existing journals and other platforms that would be appropriate for the dissemination of the various outputs of the Energy Track could motivate the initiation of interdisciplinary collaboration that is focused on research.

Task 1 also included implementation of the Microgrid Architecture course aimed at mid-level officers. The student-driven, discussion-focused course offered good opportunities for the participants to develop with respect to the 11 stated learning outcomes, with an investment of 2-4 hours per week. Expectations with respect to course structure, student responsibilities, and time commitment will be key for future offerings and may aid with the enrollment fluctuation issues. Student engagement among the persistent participants was high and the diverse backgrounds of the cohort led to great opportunities for student-to-student learning, lively class discussions, and an experience that stretched people out of their comfort zones. Technology issues for users of government-issued computers related to the LMS and media content delivery platforms need to be explored in future offerings.

Task 2 required the conduct of a senior-level seminar in-person in Washington D.C. with at least ten individuals to facilitate a military installation or operational energy resilience-related discussion among participants. The NUARI Team considered several options for the topics, location and conduct of the seminar to include the US Army G-9, IMCOM, Association of Defense Communities, and the International City Managers Association, and eventually decided on the AUSA venue in consultation with the government. Following the selection of the topic, "Executing the Army Installations Strategy" development of a divers lineup of experienced speakers across multiple panels, and promotion of the seminar in multiple venues, the Senior Leader Seminar was held on 13 April, 2022 at the AUSA Headquarters. AUSA reported over 130 registrations from the US Army, US Navy, USMC, industry, and academia. A survey of the participants in the AUSA Hot Topic/Energy Track Seminar was conducted the week after the event was held and it was sent to all participants, including panelists, moderators and event organizers. There were 28 responses of which 1 was also a panelist, 1 was a moderator and 2 were event coordinators. 87% of the respondents had a favorable view of the event, of which 65% were highly favorable. The greatest conclusion from this event was that partnering with an organization (AUSA for this Seminar) to host a senior seminar during an existing conference, or dedicated session, such as the AUSA Hot Topic program provided an opportunity to promote key topics such as Energy Resilience. Based on the high

participation numbers and satisfaction with the content, we recommend that this seminar continue yearly in coordination with the US Army.

Task 3 involved a virtual internship program with students trained by NUARI with the required Knowledge, Skills, and Abilities (KSA) to successfully contribute to energy-related research. Four student internships were offered to Norwich undergraduate engineering majors. The internships were paid, not for academic credit and primarily led and supervised by ERDC-CERL. The student interns also had the title of Student Fellows in the CGRS Student Fellowship programs that identifies Norwich undergraduates with interests in a broad range of interdisciplinary research topics related to Resilience and Security. The CGRS Student Fellow program offered the students resources and guidance related to the conducting of academic research and a network of over 12 other student fellows. The four student interns researched electric vehicles, national and grid security, preventing grid failure, renewable energy hybrid systems and microgrids. Students gained critical knowledge and thinking skills, trained under premier experts in the energy resilience and security domain and improved their research, management, and communication skills. They also learned to operate effectively as a team in an unstructured environment under conditions of uncertainty and incomplete information. A Memorandum of Understanding to continue the internships beyond the contract year will create pathway to sustain future internships.

In conclusion, the requirement to address energy resilience topics at the undergraduate, mid-career, and senior levels was validated by this three phase/year BAA program conducted with USACE ERDC-CERL. The curriculum developed in Phase 2 of the program provided a solid foundation to plan and conduct future energy related education programs. The end result of this program is a solid foundation to advance energy resilience and climate change efforts at all levels at Norwich University and other Institutions of higher education.

Enclosures

1) Task 1 – Deploy and evaluate the effectiveness of new courses of instruction in energy resilience for undergraduate and mid-career professional certificate programs
2) Task 2 – Conduct an energy resilience seminar focused on senior-level military energy managers and policy makers
3) Task 3 – Create a pilot internship program with ERDC-CERL for Norwich University Undergraduate students
4) Consolidated Lessons Learned

Enclosure 1: NU Energy Track DRAFT FTR – Task 1 - Deploy and evaluate the effectiveness of new courses of instruction in energy resilience for undergraduate and mid-career professional certificate programs

Contract requirement:

NUARI shall conduct the five undergraduate energy resilience courses in congruence with Norwich University's various learning platforms appropriate to each academic program. The mid-career professional energy resilience certificate courses shall be conducted through a combination of on-site, virtual, and off-site courses. Target population size for both courses is 15 individuals. Each course shall include learning objectives and a course syllabus. The topics for each course shall follow those previously developed by NUARI. The contractor shall provide ERDC-CERL a written report detailing the course materials, preparation and execution of each course, a participant and faculty assessment of each course, and a summary of lessons learned for each course.

Method of Surveillance: Review by COR Criteria for Acceptance
Submitted by the date agreed upon in the contractor's schedule.
Provide written report of course materials & course preparation for Fall semester for 3 courses
Provide written report of course execution, assessment, and lessons learned for Fall semester
Provide written report of course materials & course preparation for Spring semester for 2 courses
Provide written report of course execution, assessment, and lessons learned for Spring semester
Provide written report of course materials & course preparation for mid-career professional energy resilience certificate courses.
Provide written report of course execution, assessment, and lessons learned for mid-career professional energy resilience certificate courses.

General. The following is the Interim Course Evaluation for Contract No. W9132T21C0015 that covers undergraduate courses executed in 2021 (Fall term). The Energy Resilience Modules were included in the following courses at various stages of each 16-week semester course:

- Course: Introduction to Engineering - Energy block started the week of 13 September, 2021. Week 1 is fundamentals, Week 2 is source/use, Week 3 is resiliency (background + case studies/discussion).

- Course: Environmental Engineering – The majority of the Energy Resilience Modules were implemented in the latter part of the 15-week fall class schedule. Fundamentals were briefly covered in week 2 and students are assigned to work on research briefs that connect engineering in the energy-environment space. A portion of the remaining modules was covered in two class sessions in November. Students presented their research briefs in December and participated in two short focus groups to evaluate their experience in the course.

- Course: Engineering Economic Analysis incorporates energy resilience applications into the valuation, analysis and assessment methods used to assess engineering projects and investments. Students study the cost benefit analysis of grid resilience, are introduced to private and public funding mechanisms and learn how various natural and human threats can be accounted for in financial analysis and economic decision making.

Course(s) Assessment Summary and Lessons Learned - This report details results from the undergraduate course offerings at Norwich University in Fall 2021 that incorporated content developed during Phase 2 of the effort "Development of an Energy Track Within the Norwich University Center for Global Resilience and Security." For each course, the associated student learning outcomes, energy resilience learning modules incorporated, and the associated course assignments are described. A variety of assessment techniques were used with the course cohorts including Likert scale and free response student surveys, student focus groups, instructor reflection narratives, instructor interviews, and direct instructor assessment of student work products. Direct instructor assessment of student learning outcome attainment is still in process and could not be reported. A summary of key findings, separated by course offering, is provided below. The findings are labeled with the prefixes M, K, and T indicating findings from the observation of Mike Cross's Introduction to Engineering course, Kahwa Douoguih's Engineering Economic Analysis course, and Tara Kulkarni's Environmental Engineering course, respectively.

M1. Answering the question "why are we studying this?" and addressing student discomfort with uncertainty or problems with many possible solutions is always a challenge and is particularly a challenge with first-year students. The incorporation of energy resilience content in EG109 provided a great context for addressing student comfort with uncertainty and open-ended, real-world problem sets. As changes to this course are planned, modifying a few lab exercises to incorporate energy resilience concerns and the associated societal considerations into the engineering design or project planning focused lab exercises should help address some of the students' relevancy concerns and increase student buy-in.

M2. Despite some of the expressed student concerns, the open-ended student responses indicate that the experience in EG109 broadened their thinking with respect

to the way they approach engineering projects and challenges with our energy infrastructure.

M3. The use of the Gulf Port interactive case study and follow-up problem solving challenge was impactful. Following its first inclusion in EG109, students perceived the course impacting their understanding of the link between energy and issues of societal import at a rate that was higher than their perceived attainment of two technical energy outcomes typically covered in the course. The impact of the new content was reaffirmed by the student open-ended survey responses that demonstrated improved maturity of thought about issues in this domain.

K1. Addressing student discomfort with uncertainty or problems with many possible solutions is always a challenge, but it is something that one would expect the juniors and seniors in the EG350 cohort to have grown more comfortable with. The contrast between the complex, nuanced analysis of energy resilient systems and the rote, mechanical computation of engineering economics problems in the course suggests that the new content may be better placed in other courses, or that a more comprehensive redesign of engineering economics and the associated course objectives is needed.

K2. The instructor's use of case studies and writing assignments to engage the students in evaluation and analysis that was more realistic and complex than what was presented in the core course material and text was a great value addition to EG350 and should have a place in the overall curriculum for all students—it is essential for the attainment of the energy resilience focused student learning outcomes.

T1. Students matured in their understanding of the energy-environment-society-engineering connection with respect to infrastructure projects. The Environmental Engineering course helped students in their ability to consider non-technical factors and implications.

T2. Students should have been able to connect the technical and professional considerations explored to multiple other courses in their studies. More strategic and frequent inclusion of energy resilience content (technical and professional) throughout the undergraduate curriculum and more intentional connection of that content to future courses, career paths, and societal needs would benefit the students and is likely needed if the high-level student learning outcomes of this initiative are to be met.

T3. The difference in the students' "maturity of thought" with respect to the technical and professional considerations is not necessarily an issue for a course such as this; their belief that they are less capable of success on assignments involving those considerations could be an issue. It is important that students are developing holistically and maturing in many dimensions if the learning objectives of the energy resilience program are to be met.

T4. The fact that the students recognized the lack of coverage of policy and social considerations in their engineering classes and the need for this understanding to be

effective engineers supports the adoption of energy resilience content in the environmental engineering course and reinforces the need for engineering instructors to make concerted efforts to show students where and how their work matters in society – directly in service of communities—in all courses.

In summary, common instructional and pedagogical themes related to the importance of student motivation, connection-making, and understanding of broader contexts emerged. In all courses, students were challenged by the uncertainty and complexity of the energy resilience considerations presented, and they were uncomfortable with their lack of experience and reduced "sophistication" when analyzing and problem-solving in real-world contexts—in service to communities. Energy resilience provided a rich context for the students to mature as future engineers and professionals, and I am confident that the student participants in these courses will connect energy to environmental, technical, and societal concerns better in their future endeavors.

Evaluation Rubric – The rubric defines the outcome performance indicators for each energy resilience module developed in Phase 2 of the Norwich Energy Track along a continuum of poor, emerging, developing, and proficient levels of performance.

Fall Term Course Evaluations

A. Course: EG 109 – Introduction to Engineering I, Instructor: Mike Cross

Learning Outcomes Addressed:

02 discuss the scale and scope of energy consumption rates in the US and the world

04 quantify energy and power in its various forms (mechanical, thermal, electrical) and connect those forms to the physical world

05 differentiate between work / energy and power, connecting those quantities to time

010 demonstrate an understanding of the link between energy and issues of societal import by planning, synthesizing, and communicating an effort to answer a question or solve a problem

Modules Incorporated:

The Energy Resilience 03 – Gulfport, MS Case Study developed in Phase 2 was adopted and delivered as an interactive role-playing in-class exercise and subsequent assignment.

Lessons related to the content of Energy and You Modules 01 – 03 (Fundamental Dimensions, Measuring Energy, Personal Energy Footprint), and Energy and Society Module B1 (Global Energy Footprints Over Time) were delivered in the course. Rather than adopting the above modules as developed, the instructor opted to deliver related content sourced from the course textbook and previous offerings of the course.

Assessment of Student Learning Outcome Attainment:

For learning outcomes O2, O4, and O5, textbook derived homework exercises were assigned to reinforce the course lecture content. As a method of direct assessment of student learning related to those outcomes, 1 midterm exam question, 2 final exam

questions, and 1 final exam question, respectively, were mapped to the learning outcomes. Sub-scores detailing student performance on those items to provide a more granular measurement of student learning outcome attainment are currently being processed by the instructor.

For learning outcome 10, an interactive, role-playing case study exercise followed by a group problem- solving challenge was incorporated. A rubric-based assessment by the instructor of student learning outcome attainment is currently in process.

In addition to the in-process direct assessment methods, students were surveyed regarding their self- efficacy beliefs related to the four energy resilience learning outcomes. Students responded on a Likert scale from 1 to 5 (Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree) detailing their agreement with the course helping them develop their abilities related to each of the 4 learning outcomes. Table A1 details the survey responses and associated descriptive statistics. The % Affirmative column indicates the percentage of participants who agreed or strongly agreed that the course helped in their ability to attain the learning outcome. The % Non-Negative indicates the percentage of responses that were neutral or in agreement.

Table A1- Survey response statistics related to student self-efficacy beliefs in regards to learning outcomes O2, O4, O5, and O10 as a result of the EG109 offering in Fall 2021.

Outcome	No. Responses	% Affirmative	% Non-Negative	Mean	Std. Dev
O2	85	65.9	87.1	3.73	1.106
O4	85	62.4	88.2	3.68	1.014
O5	85	72.9	94.1	3.92	0.991
O10	85	72.9	92.9	3.82	0.953

Evaluator's Analysis:

As a result of interviewing Mike Cross following the course offering and reviewing student open-ended survey responses, I found several interesting themes to report and consider in the evolution of this program.

Mike reported that he felt the incorporation of energy resilience content (both technical and professional) was a perfect fit with the overall goals and concepts for the course, and that the adoption of the case study learning module was straightforward. Yet, he believes that the students did not appreciate the material much, as indicated by student complaints about lecture content that was not directly related to the upcoming course lab. He also shared that the Construction Management students in the course were the most vocal at questioning why they needed to be studying energy resilience.

Mike reported that the course format was recently changed and that future changes are being discussed as the student expectations for all lecture content to have immediate utility in the lab is a persistent challenge.

Mike shared that the students were too fixated on applying equations and that they showed frustration when they were asked to work on problems that did not have one

exact answer or solution. When completing the case study exercise, Mike reported good student engagement and student work products that went down non-obvious paths in both positive and negative ways.

Several recurring themes were evident in the open-ended student survey responses. The first prevailing response theme was that the concept of resilience as applied to infrastructure was new to many students as they had previously only thought about infrastructure through the lenses of redundancy or robustness; the second theme was that the great complexity (technical, operational, and societal) of our energy systems and the solutions needed was surprising and mind expanding to many respondents.

Other interesting themes related to the interdisciplinarity (both technical and professional) and the complex logistics required when developing solutions in this domain and the opportunity that exists for those willing to address the challenges.

In analyzing the student self-efficacy beliefs represented in Table A1, it is interesting to note that more than 60% of respondents reported a positive association between their experience in this course and their understanding of the four learning outcomes of interest. It is also evident that the students perceived stronger attainment of learning outcomes O5 (energy vs. power) and O10 (energy society link) than outcomes O4 (quantify forms energy) and O2 (scope of energy consumption). This is particularly interesting because the inclusion of content related to O10 was new for this course and related to the adoption of one of the modules developed in Phase 2.

The themes that resulted from my analysis and reconciliation of the instructor and student feedback described above are detailed below and labeled M1 – M3.

M1. Answering the question “why are we studying this?” and addressing student discomfort with uncertainty or problems with many possible solutions is always a challenge and is particularly a challenge with first-year students. The incorporation of energy resilience content in EG109 provided a great context for addressing student comfort with uncertainty and open-ended, real-world problem sets. As changes to this course are planned, modifying a few lab exercises to incorporate energy resilience concerns and the associated societal considerations into the engineering design or project planning focused lab exercises should help address some of the students’ relevancy concerns and increase student buy-in.

M2. Despite some of the expressed student concerns, the open-ended student responses indicate that the experience in EG109 broadened their thinking with respect to the way they approach engineering projects and challenges with our energy infrastructure.

M3. The use of the Gulf Port interactive case study and follow-up problem solving challenge was impactful. Following its first inclusion in EG109, students perceived the course impacting their understanding of the link between energy and issues of societal import at a rate that was higher than their perceived attainment of two technical energy outcomes typically covered in the course. The impact of the new content was

reaffirmed by the student open-ended survey responses that demonstrated improved maturity of thought about issues in this domain.

B. Course: EG 350 – Engineering Economic Analysis, Instructor: Kahwa Douoguih

Learning Outcomes:

O8	connect the source and demand for energy to meet human needs to global societal, economic, and environmental contexts
O10	demonstrate an understanding of the link between energy and issues of societal import by planning, synthesizing, and communicating an effort to answer a question or solve a problem

Modules Incorporated:

Engineering Economics introduced concepts and tools such as the time value of money, prices and inflation, and scenario planning under risk and uncertainty. Assignments and class activities during the first ten weeks of the course were drawn from a combination of textbook problems and current events that related to infrastructure investments and other relevant economic concepts. Each of the problem sets had at least 10% of the questions that were designated as covering energy resilience aspects of engineering economics. In the last four weeks of class, students were given several case study assignments and they also had to propose a strategy for public investment in the modernization of US military installations considering both efficiency and resilience factors.

Entire undergraduate energy resilience modules were not incorporated in the course, but content from the modules was excerpted and incorporated as it fit with the content presented in the course textbook.

Evaluator's Analysis

The basis for my evaluation of this course offering is a series of nine phone calls with the course instructor throughout the offering in the fall and subsequent to its offering, as well as review of a post course reflection instrument completed by the instructor.

The instructor noted that the expected engineering economics content required of the course left room for additional content to be added, but that the nuanced, holistic, approach desired for the introduction of the energy resilience topics was at odds with the approach of the course textbook which focused on rote application of economic analysis tools and formulae. In addition to introducing energy resilience and infrastructure concerns, the instructor introduced case studies and writing assignments to provide more real-world context to the subject matter and to improve student motivation and engagement. The instructor noted that the use of case studies was effective at improving student engagement and buy-in, and that the inclusion of cases with military contexts was loved by the audience and spawned enthusiasm. However, the lack of certainty with the parameters of the cases explored and the openness of the solution domains for the challenges considered was frustrating to most of the students. The instructor reported multiple experiences where students complained about questions being invalid because "needed" information was not provided or the solution path to find an acceptable answer

was initially unclear. In addition, the instructor noted that when shifting from a case study / post analysis operating mode to a problem-solving approach, the students' lack of understanding of key concepts related to uncertainty, statistics, and rhetorical writing resulted in lower quality work products than what was expected. This underscored the lack of preparedness of the students to create real-world solutions and confirmed the decision to focus on analyzing realistic cases to develop skill and understanding.

The themes that resulted from my conversations with the instructor are detailed below and labeled K1 – K2.

K1. Addressing student discomfort with uncertainty or problems with many possible solutions is always a challenge, but it is something that one would expect the juniors and seniors in the EG350 cohort to have grown more comfortable with. The contrast between the complex, nuanced analysis of energy resilient systems and the rote, mechanical computation of engineering economics problems in the course suggests that the new content may be better placed in other courses, or that a more comprehensive redesign of engineering economics and the associated course objectives is needed.

**Note: Perhaps incorporation of concepts from statistics, probability, and public policy into the economics course would be a better fit, making room elsewhere for the desired energy resilience content.*

K2. The instructor's use of case studies and writing assignments to engage the students in evaluation and analysis that was more realistic and complex than what was presented in the core course material and text was a great value addition to the course and should have a place in the overall curriculum for all students—it is essential for the attainment of the energy resilience focused student learning outcomes.

C. Course: CE 421 – Environmental Engineering, Instructor: Tara Kulkarni

Learning Outcomes:

O3	describe how electricity is typically generated, transmitted, and distributed, as well as the impact of renewable or local energy sources on those processes
O4	quantify energy and power in its various forms (mechanical, thermal, electrical) and connect those forms to the physical world
O8	connect the source and demand for energy to meet human needs to global societal, economic, and environmental contexts
O10	demonstrate an understanding of the link between energy and issues of societal import by planning, synthesizing, and communicating an effort to answer a question or solve a problem

Modules Incorporated:

Students in CE 421 participated in course lessons that were modified adoptions of or excerptions from the following curricular modules:

1. Energy and You 01 – Fundamentals
2. Energy and You 02 – Measuring Energy
3. Energy and You 03 – Personal Energy Footprint
4. Energy and Society* – Energy Economics
5. Energy and Society B1 – Global Energy Footprints
6. Energy and Society B2 – Connections
7. Energy and Society C1 and C2 – Resilience for Sustainability
8. Energy Resilience 01 – Defining Resilience
9. Energy Resilience* – Energy Inequities in the USA

A homework problem was used to assess student understanding of concepts from modules 1-3. The content was extensively covered in a previous course (EG 303 Fluid Mechanics) and it was presented in this course as a review to provide a basis for the other lessons.

Understanding of lessons 5 and 6 was assessed with a question on the second course exam.

Understanding of lessons 4, and 7-9 was assessed with an exam question and a follow-up student video response.

Evaluator's Analysis

The basis for my evaluation of this course offering is two focus group meetings conducted with the students following the course, a debriefing phone call with the course instructor following the course, and a post course reflection instrument completed by the instructor.

The instructor felt that weaving the energy content into the environmental engineering course worked well because students did not perceive the energy modules as separate or different. This was confirmed in the focus group conversation. Group consensus was that the students would have thought it odd if the environmental course did not cover energy topics. The inclusion of the modules was strengthened by the requirement that each student individually select a topic that connected energy, the environment, and engineering. The students self-reported this assignment as being impactful and motivating.

The instructor also reported that adopting the modules or even adopting small excerpts of the modules was straightforward. The greatest challenges were in sequencing where to insert the modules and more seamlessly integrating the assignments and student assessments, both of which will be easier in future iterations and overall were not obstacles to starting the effort.

From the focus group analysis, themes related to the appropriateness or fitness of the content into the course, student motivation, and student self-efficacy beliefs emerged and are detailed below.

Appropriateness / Fitness

- Student consensus was that the energy resilience and resilience for sustainability concepts fit well within the overall learning objectives of the course—both the lecture and lab components of the course.
    - This is an important distinction as the lab instructor was not a part of the pilot adoption, and future instructors should ensure the students' sense of connection to both lecture and lab is preserved.
    - The students' perception of the fit and general suitability of the resilience content to the overall course learning objectives is important. The students agreed that lessons that feel detached from regular operations or tangential are typically presumed to be less important and taken less seriously.
- Owing to the incorporation of *energy fundamentals*, *resilient cities*, and *sustainability* modular content, students connected learning in this course to experiences in a Navy ROTC course and the Site Development course.
    - One cadet commented that connecting studies in an engineering course to a previous ROTC course was atypical, but desirable.
    - A minority, but notable number, of the students said they would have been surprised for a course in environmental engineering not to include content on energy fundamentals.
- The absence of connection-making to other engineering courses by the cohort suggests that more strategic and frequent inclusion of energy resilience content throughout the undergraduate curriculum could make a positive impact.

Motivation

- Having the freedom to explore and the autonomy to select a topic area for the research brief assignment was key to student motivation and engagement.
- Students reported leaving the course with a sense that what they are doing in school matters more and matters to people beyond themselves. The sense of relatedness or purpose that they expressed was also a key factor in their engagement.
- Most students entered the course with few to no personal expectations for their study of this material – they were procedurally checking the boxes on their way to the degree.

Only two students reported personal motivations for taking the course due to their personal career aspirations and plans.

Student Self-Efficacy Beliefs

- Group consensus was that previous engineering courses helped develop the students' ability to understand the technical complexities of the infrastructure systems explored in the course.

- The students self-identified a distinct reduction in their ability to explore and understand the economic, policy, and societal (professional) complexities of the infrastructure systems studied in the course, as compared to their technical competency.
    - The difference between the students' ability to analyze or reason through the technical versus the professional infrastructure considerations was jarring to them.
    - Some students discussed a desire to have more exposure to the professional infrastructure considerations earlier in their studies so that their skills on both fronts would be more aligned before approaching the content in this course.
    - Two students mentioned they now feel a need to further study the professional aspects of energy infrastructure before being comfortable applying for a job in this sector.

For future iterations of the course, the *students recommended*:

- Autonomy in selection of the research brief was motivating and greatly appreciated by the students and should be preserved.
- When planning iterations of the course, the most impactful assignment with respect to the students' "energy learning experience" was the research brief, and the most impactful presentations were the lessons on resilient cities.
- Introduce some of the professional resilience fundamentals from this course earlier on, so the student projects and analysis in this course could be more developed.
- The resilient city case studies were well-received and impactful. Contrasting case studies would add value—exploring cities that have not been as resilient or smart.
- An assignment to propose / design how a city with challenges could become more smart / sustainable would be interesting and desirable to the students.
- In response to a final question, group consensus was "keep doing this."

The themes that resulted from my analysis and reconciliation of the instructor and student feedback described above are detailed below and labeled T1 – T4.

T1. Students matured in their understanding of the energy-environment-society-engineering connection with respect to infrastructure projects. The Environmental Engineering course helped students in their ability to consider non-technical factors and implications.

T2. Students should have been able to connect the technical and professional considerations explored to multiple other courses in their studies. More strategic and frequent inclusion of energy resilience content (technical and professional) throughout the undergraduate curriculum and more intentional connection of that content to future courses, career paths, and societal needs would benefit the students and is likely needed if the high-level student learning outcomes of this initiative are to be met.

T3. The difference in the students' "maturity of thought" with respect to the technical and professional considerations is not necessarily an issue for a course such as this; their belief that they are less capable of success on assignments involving those considerations could be an issue. It is important that students are developing holistically and maturing in many dimensions if the learning objectives of the energy resilience program are to be met.

T4. The fact that the students recognized the lack of coverage of policy and social considerations in their engineering classes and the need for this understanding to be effective engineers supports the adoption of energy resilience content in the environmental engineering course and reinforces the need for engineering instructors to make concerted efforts to show students where and how their work matters in society – directly in service of communities—in all courses.

Assessment Report **-** Spring 2022 Energy Resilience Course Offerings at Norwich University

Executive Summary

Upon review of student survey feedback, student narrative reflections, student performance on exam questions, and reflective debriefing conversations with the instructors, the following lessons and recommendations were extracted. The list below is not exhaustive. The genesis of the lessons and additional lessons and recommendations can be found in the narrative analysis that follows for each of the two course offerings—*ES200 Energy and the Environment* (an environmental science lecture and lab course) and *AP222 Human Issues* (an architecture seminar).

- The repository of modules available was expansive and effective at supporting the instructors as they worked to adopt new content into their courses that was outside of their primary discipline and that was outside the scope of what was previously presented in the courses.
- Accessing the repository of modules felt overwhelming initially to both instructors. Creating instructor-focused narrative introductions to each module, making available support or coaching resources who are familiar with the modules, and allowing time for deliberative exploration of the resources so the instructors can search through the modules until they find the one that is the best fit for them should reduce this sentiment or barrier to getting started and assist with future module adoptions.
- Both instructors saw positive responses from their classes and expressed sentiments that the modules enriched their courses by spawning amazing dialogs, explorations, and discussions.
- Students in both courses demonstrated awareness and expansive thinking with respect to energy and its many contexts through their reflective writing in response to open-ended survey questions. Their awareness of the complexity of energy issues and connecting it to many societal contexts became apparent.
- Exploring resilience as a concept with students is important and has the potential for great impact. The students naturally gravitate towards a conception of resilience as grit or overcoming adversity. Introducing other elements or conceptions of resilience could support more inclusive thinking with respect to energy through multiple contexts.
- Both instructors valued the opportunity to incorporate the modules, felt comfortable augmenting the lessons to better connect them to their courses, and expressed desire to incorporate more in future offerings.
- Both instructors expressed curiosity about the opportunity for something bigger in the future—perhaps a degree focused on energy issues from all contexts.

- Student and instructor interest in additional support materials and course content on energy economics and energy policy remains strong and existed in both the fall and spring undergraduate offerings.

Spring Term Course Evaluations

D. Course: ES 200 – Energy and the Environment, Instructor: Laurie Grigg

Learning Outcomes Addressed: 3, 7, 10

Modules Incorporated: Energy and Society – Key Systems and Infrastructure (B2)

Assessment Results:

The ES200 offering was assessed in three dimensions: student self-assessment of learning outcome attainment, instructor assessment of student outcome attainment, and instructor reflection on the course experience. Student perceptions were assessed using a survey that included Likert scale items and free-response questions. The survey was administered on paper at the end of the semester with 12 out of 15 students in the course completing the survey. Table D1 below lists the student learning outcomes mapped to the course offering. Table D2 shows the results of the survey with respect to the students' assessment of the effectiveness of the course at helping them attain the stated learning outcomes. Table D3 provides insight into student development based on themes evident in their responses to the following question:

> *Imagine that you are an environmental scientist or geologist tasked with providing advice related to energy infrastructure investments, such as new power plant or pipeline, being made in your community for the future. A) What would you research or investigate further to inform your recommendations? B) What other experts and stakeholders would you expect to be involved in and advising for the project?*

Table D1 - Student learning outcomes mapped to the ES200 course offering in Spring 2022.

Outcome	**Outcome Description – As a result of taking this course, I am better able to…**
O3	describe how electricity is typically generated, transmitted, and distributed, as well as the impact of renewable or local energy sources on those processes.
O7	apply key sustainability concepts, assessments, and tools to analyze existing systems and explore the impacts of the systems in environmental and societal contexts.
O10	connect the source and demand for energy to meet human needs to global societal, economic, and environmental contexts.

Table D2 - Summary of student responses regarding the effectiveness of the course at helping them attain the stated learning outcomes. (Likert response scale: 1 = Strongly disagree, 2 = Disagree, 3 = Neither agree nor disagree, 4 = Agree, 5 = Strongly Agree)

Outcome	Mean Response	% Affirmative Responses	% Negative Responses
O3	4.33	83%	0%
O7	4.25	92%	0%
O10	4.25	83%	0%

Table D3 - Summary of student open response answers to a question about research and stakeholder involvement for a new energy infrastructure project.

Theme	# Responses
A) Expressed a concern for both local community assets and needs.	8 / 12
B) Included community stakeholders and a broad list of professionals	2 / 12
B) Included community stakeholders and a limited / obvious list of professionals	4 / 12

Two questions on the final exam for the course were directly related to learning outcomes 3 and 7. The performance of the students on these two questions is shown in Table D4. A total of 15 students participated in the course and completed the final exam.

Table D4 - Performance of students on two final exam questions related to the stated learning outcomes.

Question	Related Outcome	# Full Credit	# 75% Credit
Final Exam 2 pts	O3	7 / 15	1 / 15
Final Exam 4 pts	O3, O7	7 / 15	2 / 15

Lastly, the course was assessed from the instructor perspective. The findings that result are the result of multiple phone and email conversations throughout the offering of the course, two debriefing discussions following the completion of the course, and analysis of a guided reflection from the instructor. A few quotes from the instructor reflection are listed below.

- “I think we all had a vague sense of the grid beforehand but after this module, I know we all understood both its components and the importance of the on-demand structure of the grid. We could then apply this perspective to learning

about how renewables currently can meet our needs and the challenges they pose."

- "Some feedback I have received from students is to include more of the socioeconomic aspects of energy."
- "I found the organization of the material in the shared folder confusing. I suggest putting each module into its own folder with a read me file that outlines the module."

Evaluator's Findings:

Overall, Dr. Laurie Grigg was successful at incorporating the selected lesson into the ES 200 Energy and Environment course. Strong engagement by the students was reported and both Dr. Grigg and the students felt the lesson fit within the overall scope of the course—there were no comments or complaints about the added material feeling ancillary or forced. As some of the content related to the power grid was new to Dr. Grigg, she took the approach that "they [the class and instructor] were participating in the activities and learning together." This approach engendered a sense of curiosity and inquiry, sparking thoughtful discussions and explorations throughout the course. It also led to the students using sections and content from their primary textbook that was not used in previous offerings of the course.

In terms of meeting the three learning objectives associated with the lesson on the power grid and other key elements of our energy infrastructure, the student perception of the effectiveness of the course was strong. As shown in Table D2, 83 – 92% of the respondents felt the course lessons helped them in their ability to achieve the learning outcomes. Of 12 respondents, 2 responses were neutral regarding outcomes 3 and 10, and 1 response was neutral regarding outcome 7; for all three outcomes there were no negative responses. Although the student perceptions related to all 3 of the outcomes was strong, the response related to outcome 10 was the weakest of the 3—it is also the most complex and requires the highest order of thinking among the three outcomes.

Through the debriefing interviews and course reflection, Dr. Grigg expressed the sentiment that the students "got it" with respect to the added content on infrastructure. For the two questions on the final exam directly linked to the learning outcomes, as shown in Table D4, the percentage of students performing at the 75% level (C-level) or higher for the two questions were 53% and 60%, respectively. Additionally, it is worth noting that 47% of the students received full credit on both questions. As shown in Table D3, when asked to consider a typical infrastructure project planning concern from the environmental science perspective, 67% of students communicated the need to better understand community needs and assets before adopting a known design or solution and 50% of students recognized community stakeholders in the project—stakeholders beyond the typical technical professionals. In general, it seems that these results reflect more expansive and holistic thinking by the students in terms of energy and its intersection with the environmental science discipline.

In multiple conversations with Dr. Grigg, it became apparent that the presentation of the modules and the task of incorporating one into her course was initially overwhelming. So many of the modules were relevant to the course, and some of the modules overlapped with content and resources already in the course outline and text. The Course Development Document was helpful at communicating the objectives for each lesson and an outline of the content covered, but going through the slide deck was required to convey how the module could be integrated and executed. More effort is needed to develop a “readme” file or elevator pitch for each module to assist instructors in their efforts to understand and select lessons for use in their courses. The CDD could be parsed into “readme” files as a starting point. Contributing to the challenge was the instructor’s desire to incorporate many, or as many as possible, of the lessons into the course. While this is a great vote of confidence for the content, it most certainly contributes to one’s feeling of being overwhelmed. When working with future instructors, it will be important to give time for exploration of the modules and to coach instructors to help them find content that resonates or fits with their courses. Adoption of new content will always be a deliberative process and rather than focusing on increasing the speed of selection, the support structure (summary files and coaching) should focus on improving understanding and conveying the fitness of the resources selected.

Other interesting threads or observations that resulted from the debrief sessions included the student sentiment that more info on the economic and policy aspects of energy was desired. This is in line with the sentiments of students from Dr. Tara Kulkarni’s course in the fall. It remains and open challenge to create lessons on the complex economics of energy that is approachable to a general audience and that can be adequately covered in a minimal set of lessons. It was also noted that the modules on sustainability were very thorough and focused on the engineered or built environment. There is an opportunity to enlist Dr. Grigg to complement the existing module bank by developing lessons on sustainability from the environmental science and natural resource perspective, as opposed to the built environment perspective. Dr. Grigg already includes content from this perspective in her course and the students were naturally connecting this content to their learning in the energy infrastructure module.

Lastly, there is nothing more telling to the success of the effort than the instructor’s closing sentiment that in the future, she would adopt more modules, adopt the module she used earlier in the semester, and add additional media and reading content to better scaffold the lesson and connect it to more aspects of the existing course—for Dr. Grigg, adopting the content was constructive and generative.

E. Course: AP 222 – Human Issues, Instructor: Wendy Cox

Learning Outcomes Addressed:

Table E1 - Learning outcomes mapped to the Spring 2022 offering of AP 222.

Outcome	Outcome Description – As a result of taking this course, I am better able to…

O1	estimate the energy requirements of addressing basic human needs such as food, shelter, water, transportation, or waste management
O8	connect the source and demand for energy to meet human needs to global societal, economic, and environmental contexts.

Modules Incorporated:

Energy and Resilience – Defining Resilience
Energy and You – Personal Energy Footprint

Assessment Results:

The AP222 offering was assessed in two dimensions: analysis of student reflections on the meaning of resilience, habits to promote resilience, and lessons learned from the energy lessons; and instructor reflection on the course experience. Student development with respect to the learning outcomes was assessed by analyzing the students' responses to seven free response questions administered through two separate paper surveys. Thirteen students completed the survey on resilience and fourteen students completed the survey on lessons learned about energy consumption. In terms of instructor evaluation, the findings presented are the result of a phone conversation midway through the offering of the course and two debriefing discussions following the completion of the course. As neither collection of materials lends itself to numerical analysis, the findings will be discussed in narrative form in the next section.

Evaluator's Analysis:

Prof. Wendy Cox blended the two modules into the course over two-to-three weeks. The *Defining Resilience* slide deck was used to introduce the concept of resilience and was then augmented with additional reading and video content to provide more depth on a few of the concepts introduced. It is very clear that the introduction of the concept of resilience was impactful with the students. Upon reflection, all 13 student respondents connected to the concept of resilience as one involving grit and powering over hurdles or fighting through adversity. While it was important to see this element of resilience resonate with the students and to see them connect and extend it to the built environment, it is also important to note that all 13 respondents missed other, softer aspects of resilience—there was no discussion of acceptance and malleability or the ability to adapt and "roll" with changing circumstances instead of fighting against them. This result underscores the importance of the continued presentation and exploration of resilience with students. From the instructor standpoint, the lesson and additional thought pieces led to what was joyously described as "amazing dialogs."

Evidence of student progress with respect to Outcome 1 was seen in many student responses related to increased awareness of their personal energy footprints and the impact of our use of energy to meet basic human needs. Upon reflection, students connected increased use of energy to wealth, digital devices pervading society, and building design choices that have lasting impacts on long term energy requirements. It

was also eye-opening for some students to connect energy to food, using the calorie as a measure. Most important related to this outcome was the student realization of the complexity of the energy system and how the total energy impact of our needs / actions is much larger than the energy that we can directly measure or that we are directly billed for due to inefficiencies, transportation, and other factors. Students began thinking about “what am I using right now vs. the [total] energy I am using.”

Using examples was helpful for the students to understand the scale and scope of their energy footprint and related societal energy challenges. The lesson was written with built in comparisons to the energy footprint of an atomic bomb. This comparison was troubling for the instructor but did not appear to be troubling for the students. Additionally, the instructor supplemented the lessons by including comparisons to the energy required to make a cup of tea. Moving forward, enriching the lessons by including scale references from multiple fields or contexts would be helpful as the modules are adopted for use by broader audiences.

Regarding Outcome 8, the student reflections connecting energy usage to wealth and privilege, our built environment, our reliance on technology, and design choices shows that they are thinking about big picture societal contexts—they were connecting personal behavior choices to more global challenges and issues. One student summarized this by stating that we (society) will always be, “on the edge of no return due to human nature – the need to ‘level-up’ and what we are willing to put at risk for that.”

In multiple conversations with Prof. Cox, it became apparent that the repository of the modules was overwhelming and that many of the slide decks were “dense,” making it difficult to envision how the material could blend into her course. To fit with the presentation style of the class, the decks were expanded, and more visuals were included.

One of the most telling metrics and measures of success is that students in this course took the lesson on their personal energy footprint and converted it to action through on-campus student activism on the Norwich campus. The students developed a proposal and pitched the creation of a public climate clock to promote community engagement and increase awareness of energy consumption.

For Prof. Cox, inclusion of the lessons was constructive and generative. Through discussions with Prof. Cox, she expressed excitement for including the modules in the future, interest in exploring the addition of more modules, and desire for the creation of a degree focused on energy issues from all perspectives, a “Degree in CGRS.”

Assessment Report - Norwich Pro Microgrid Architectures Course Offering and Industrial Control Systems Offering (used the same format and delivery system)

Executive Summary

Upon review of student survey feedback, student narrative reflections, student performance on pre- and post-test instruments, and a reflective debriefing conversation with the instructor, the following lessons and recommendations were extracted. The list below is not exhaustive. The genesis of the lessons and additional lessons and recommendations can be found in the narrative analysis that follows for the Norwich Pro *Microgrid Architectures Spring 2022* offering.

- The student-driven, discussion-focused course on Microgrid Architectures offered good opportunities for the participants to develop with respect to the 11 stated learning outcomes, with an investment of 2-4 hours per week.
- The student-led aspect was key to the student self-efficacy belief with respect to outcome 11, “present[ing] independent research on a microgrid-related topic.”
- Expectations with respect to course structure, student responsibilities, and time commitment will be key for future offerings and may aid with the enrollment fluctuation issues.
- Capturing and posting digests from online discussion forums or live discussion sessions will help professional students stay engaged if “life gets in the way” for some of the key synchronous elements of the course.
- Student engagement among the persistent participants was high and the diverse backgrounds of the cohort led to great opportunities for student-to-student learning, lively class discussions, and an experience that stretched people out of their comfort zones.
- Technology issues for users of government-issued computers related to the LMS and media content delivery platforms need to be explored. A replacement for Big Blue Button should be sought because it was a poor performer for users of many platforms.
- Development in advance of support resources to supplement topics where the student-led discussion is lacking or absent (due to enrollment and participation fluctuations) would be helpful for future instructors and students.

F. Course: Microgrid Architecture Spring 2022, Instructor: Bill Lyons

Learning Outcomes Addressed:

As a result of this course, students will be able to…

1. describe the objectives of a tactical microgrid.
2. identify the components of a tactical microgrid.
3. describe multiple configurations in the deployment of tactical power generation.
4. describe advanced capabilities required for future microgrids.
5. describe advanced power architecture requirements for a modern microgrid deployment.
6. describe types of power generation platforms that could be used in deploying microgrids.

7. describe civilian applications of microgrids.
8. describe the role of communications and automation in the deployment of microgrids.
9. describe risks posed by cyber threats to the deployment of microgrids.
10. describe countermeasures to reduce the risk of cyber attacks on microgrids.
11. present independent research on a microgrid-related topic.

Assessment Results:

The Microgrid Architecture course offering was assessed in three dimensions: student self-assessment of learning outcome attainment, assessment of student outcome attainment through analysis of student pre- and post-tests, and instructor reflection on the course experience. Student perceptions were assessed using a survey that included Likert scale items and free-response questions. The anonymous survey was administered through the Norwich Pro (Moodle) LMS. The completion rate for the survey was 6 out of 9 students. 8 of the 9 students completed both the pre- and post-surveys used for direct assessment of outcome attainment.

In terms of the course, 19 students were enrolled in the course. 17 of those 19 students engaged in the course for more than one day or session. 9 of the 17 students completed the course and the other 8 elected not to complete the course at various points in the term. The 10 students who did not complete the course were offered a survey opportunity administered through the SurveyMonkey platform. Only 1 of the 10 students responded to complete that survey.

Table F1 details the pre- and post-test results for 8 students who completed the course and both tests. Table F2 details student survey responses regarding their perception on attainment of the learning outcomes from 6 survey respondents. Table F3 details student reported time spent on the course from 6 survey respondents. Table F4 details student perceptions of the course experience from 6 respondents.

Lastly, the information from one student who elected not to complete the course is detailed in the narrative and quoted response below.

The student reported that they had trouble accessing the course site while using a government-issued laptop computer. The student reported that expectations for the course were not clearly communicated prior to enrolling in the course, but that the expectations were clearly communicated during the first session with the instructor. The reason the student withdrew from the course was because an unexpected life event drew them away and made it difficult to continue at the time. In an open-ended prompt about the course, the student offered:

> “Not much course content provided. Majority was self-discovery /research on directed topics. Assignments given out less than 48 hours prior to meetings.”

Table F5 – Comparison of student performance on a pre- and post-test administered in the course. Table maps 23 questions to 10 of the 11 course learning outcomes. Learning outcomes where student performance indicated strong progress or development are emphasized in green. Outcomes where student performance results are such that a definitive conclusion about progress cannot be made due to various factors discussed in the evaluation section are emphasized in blue. Questions where the student performance was at the 100% level in both the pre- and post-tests are italicized.

Outcome	**Associated Question [Q #]**	**Pre-Test Result [%]**	**Post-Test Result [%]**	**Students Improved [#]** *out of 9*	**Students w/ Error on Post-Survey [#]** *out of 9*
1	14 22	37.5 89.3	87.5 100	4 4	1 0
2	5 7 16	82.5 87.5 87.5	95.0 100 100	4 1 1	2 0 0
3	15 17 18	62.5 87.5 100	87.5 87.5 87.5	3 1 0	1 1 1
4	4	87.5	87.5	1	1
5	3 8 9 *10* 12	70.0 75.0 87.5 *100* 75.0	90.0 100 100 *100* 100	6 2 1 *0* 2	3 0 0 *0* 0
6	1	100	96.9	0	1
7	*2*	*100*	*100*	*0*	*0*
8	*21* 23	*100* 87.5	*100* 100	*0* 1	*0* 0
9	6 11 13 *20*	95.8 87.5 100 *100*	100 100 87.5 *100*	1 1 0 *0*	0 0 2 *0*
10	19	12.5%	87.5%	6	1

Table F6 - Summary of student responses regarding the effectiveness of the course at helping them attain the stated learning outcomes. (Likert response scale: 1 = Strongly disagree, 2 = Disagree, 3 = Neither agree nor disagree, 4 = Agree, 5 = Strongly Agree). The strongest responses are emphasized in green and the weakest response is emphasized in orange.

Outcome	**Mean Response**	**Affirmative Responses [%]**	**Negative Responses [%]**
1	4.0	83	0
2	3.7	67	17

3	3.7	67	17
4	**3.5**	**50**	**17**
5	3.7	67	17
6	3.7	67	17
7	3.7	67	17
8	3.7	67	17
9	3.7	67	17
10	3.7	67	17
11	**4.0**	**83**	**0**

Table F7 – Student feedback regarding time spent on the course each week. The most frequent response was 2-4 hours per week.

Time Per Week in Course	**# Responses**
4-6 Hours	1
2-4 Hours	4
1-2 Hours	1

Table F8 – Results from a survey on student perspective of the overall course, the learning experience and materials, and other items related to student satisfaction. There were 6 / 9 students who responded to the survey. The same Likert scale defined in Table F2 was used for these items.

Outcome	**Mean Response**	**Affirmative Responses [%]**	**Negative Responses [%]**
Course materials aided in achieving outcomes	3.7	67	17
Instructor guidance in achieving learning outcomes	3.2	33	17
Class discussions aided in achieving the outcomes	4.0	83	0
Instructor expert in the field	3.5	33	0
Take another course with instructor	3.7	50	0
Got what were hoping for in course	3.7	67	17
Materials easy to access	3.8	67	17
Online meetings easy to access	3.2	33	33
Support was easy to seek	3.7	50	0
Content suitable to my learning style	3.5	50	17
Had difficulty mastering the content	2.3	67	17

In an open-ended prompt about suggestions or feedback for the course, the following student responses were collected and have been categorized into compliments,

operations feedback or suggestions, and questions. The comments were excerpted for conciseness, but they capture the key elements of every response.

- Compliments
    - “Great Course, very lively group of colleagues.”
    - “Predictability was really helpful for this course…”
- Operations Feedback
    - “The only question I have is with big blue button could we dial in to the same number every time and have the same link for every time? All of our previous notes and information would show up for reference, which would be helpful and easy to dial in quickly.”
    - “Not everyone posted, I like the posting, but if it is not part of their grade then they will not do the post…”
    - “If you want quality posts, they need to be graded [only] me and 3 other students really posted at the end.”
    - “Keep the sections open at all times and not restricted. Keep the forums open for the entire class for reference.”
    - “Work out the issues with grades posting”
    - “Can you make sure the quiz and the weeks information are the same.”
    - “the pre/post test was quite weak, it would be what i would expect from a 1 hour training on a subject that was taught.”
    - “Need more instructor involvement upfront, during and at the end of the course.”
    - “A short 15-20 minute weekly video offered by the instructor would be very helpful to clarify and reinforce covered material.”
    - “Many people did not have a background to allow for full understanding - student presentations were helpful but not a replacement for some course instruction.”
    - “Suggest providing links to sources of information.”
    - “…if the Army is paying for it, it should be elevated.”
- Questions
    - “I would like to know if there is a masters degree that we could apply these certificates too.”

Lastly, the course was assessed from the instructor perspective. The findings are the result of phone and email conversations throughout the offering of the course, and a debriefing discussion following the completion of the course. A few sentiments expressed by the instructor are paraphrased below.

- Participants from a cyber background expressed that they got a lot out of the energy-related modules. Participants from an installation or energy background expressed that they got a lot out of the cyber security content. Everyone said they got something out of the course.
- The course discussions were high quality, showed high student engagement, and forced some of the students out of their comfort zones. The interplay of students from a variety of backgrounds added value to the course.
- Having individual Big Blue Button sessions with unique IDs for each meeting was confusing and caused problems. In the future, one virtual meeting link / ID should be created that students use to access every course meeting.
- The fluidity of the enrollment combined with the structure of the course built around student inquiry and student-led discussions presented challenges.
- Many students were spending too much time and preparing too much content for the student-led discussions. Their natural tendency was overkill with respect to the spirit and intent of the exercises, and counter to explicit instruction. The assignment distribution was modified on the fly to announce the exercises on short suspense to combat this. In the future, other solutions to managing this issue should be explored.

Evaluator's Findings:

Overall, Bill Lyons was successful at delivering a course that helped students meet the stated 11 learning outcomes related to Microgrid Architectures. As shown in Table F2, student perception on attainment of the learning outcomes was greatest for outcomes 1 and 11. For outcomes 2,3, and 5-10, 4 out of 6 students reported the courses aiding in their development, and 1 out of 6 respondents indicated that the course did not contribute in their development towards that outcome—an overall indicator of positive development and progress. Student perception of progress towards outcome 4 was the lowest, indicating an opportunity area for improvement. It should be noted that this outcome involved understanding of one of the more advanced and open-ended concepts in the course. The students' perceptions are supported by direct measure of their performance on pre- and post-tests summarized in Table F1. Student performance indicated strong development with respect to outcomes 1, 2, 3, 5, and 10. The pre- and post-test instrument was not a good tool for measuring progress on outcomes 4, and 6-9. The results did not indicate a lack of progress or attainment for any item or outcome. Various factors contributed to the inconclusiveness of those items. For example, for

outcomes 7, 8, and 9, there were questions associated with those items where the student performance was at the 100% level on both the pre-and post-tests. This could simply be because of the baseline knowledge of the participants, or it could be an issue with a lack of question discrimination. For outcome 4, the number of students who improved was equal to the number whose performance decreased. Regardless, modification, replacement, or the addition of more questions related to those outcomes could be explored to provide a better measure of attainment in the future.

In their open-ended feedback provided through the surveys, some students expressed frustration that more “content” was not provided by the instructor while students throughout the offering expressed concern that the course was demanding too much time. As shown in Table F3, the most common reported time commitment experienced by students in the course was two-four hours per week. This information could be helpful in communicating and managing expectations for future offerings.

When asked about their reasons for completing the course, the most common student responses could be summarized as increased understanding of microgrids, or to assist the students in their pursuit of professional development or to assist them with future career challenges and opportunities.

As shown in Table F4, five out of six respondents attributed the course discussions as contributing to their learning—this was the item with the most affirmative response. Four out of six students responded in the affirmative with respect to the value of the course materials, being able to easily access (tech) the materials, the content being approachable (learning), and overall satisfaction with the course. The items of most concern for future investigation involve the online sessions being east to access and the course meeting the learning style of the students. Upon analyzing individual responses, it becomes apparent that the pedagogical style of the course contributed to a polarization in the sentiment of some of the students. While the students who completed the course felt that the student-led discussions and synchronous class discussions were the strongest contributors to their development, some students clearly had a problem with this active, inquiry-focused learning approach. Those students expressed frustration and disappointment in not having information “provided” by the instructor or subject matter expert (SME). Their comments also hint at a desire to have more resources to keep after the course.

The disappointment of a few students with this fundamental structural / organizational element directly corresponded to negative ratings on some of the key measures discussed above. Managing this student expectation is a challenge in all classrooms and will be key for future offerings. Diverse populations of students will expect a course or training experience that is like what they have experienced and felt successful with previously. One student response indicated “It's a good course to sign-up for and learn something new. I enjoyed this type of knowledge acquiring.” Students expecting a typical “continuing ed” style training will have different expectations with respect to

course operations and materials than someone who has had recent educational experiences built around active, guide inquiry, or problem-based pedagogies. All approaches are valuable and it is clear that the approach designed by Bill for this course was successful at meeting student expectations and leading to student development and progress with respect to 11 learning outcomes for the majority of survey respondents.

The student operational suggestions related to Big Blue Button, access to discussion forums or discussion digests, and grades passing to the gradebook from the multimedia modules are all technology platform issues that could be explored and addressed. Many issues expressed frustration with Big Blue Button access and the complaints came from users of both personal and government-issued devices. The gradebook issues appear to be an issue for students using government-issued devices and may relate to a cookie or other web-based token mechanism used to pass grades in the background between the two platforms used.

In summary, the student-driven, discussion-focused course on Microgrid Architectures offered good opportunities for the participants to develop with respect to the 11 stated learning outcomes, with an investment of 2-4 hours per week. The student-led aspect was key to the student self-efficacy belief with respect to outcome 11, “present[ing] independent research on a microgrid-related topic.” Expectations with respect to course structure, student responsibilities, and time commitment will be key for future offerings and may aid with the enrollment fluctuation issues. Capturing and posting digests from online discussion forums or live discussion sessions will help professional students stay engaged if “life gets in the way” for some of the key synchronous elements of the course. Student engagement among the persistent participants was high and the diverse backgrounds of the cohort led to great opportunities for student-to-student learning, lively class discussions, and an experience that stretched people out of their comfort zones. Technology issues for users of government-issued computers related to the LMS and media content delivery platforms need to be explored. A replacement for Big Blue Button should be sought because it was a poor performer for users of many platforms. Development in advance of support resources to supplement topics where the student-led discussion is lacking or absent (due to enrollment and participation fluctuations) would be helpful for future instructors and students.

To close the discussion of student experience and outcome attainment, the following survey responses from students regarding what they got out of or would like to remember from the experience reflect an experience that was formative, informative, and generative.

- “I learned about how the Army implements microgrids and how they plan on implementing more environmentally friendly options. Even though the Army wears green, I never really saw the Army as an organization that wants to be

"greener" so it surprised me how many programs and new renewable resources they are using."

- "The most surprising thing is that I actually understood the program. I thought the material would be above my head in understanding, but I was able to not only understand but contribute my experiences and expertise."
- "With the microgrid knowledge/foundation that I learned from the course has prepared me to speak more intelligent about microgrids."
- "I [now] understand use-case scenarios for microgrids and their employment in mitigation of disasters.
- "I feel like I will be better equipped than I had before and have a better understanding of the Army application of microgrids so when asked about them I can offer insight from a cyber security standpoint."

G. Course: Norwich Pro Industrial Control Systems Course Offering. Revised July 18, 2022

Executive Summary

Upon review of student survey feedback, student narrative reflections, and a reflective debriefing conversation with the instructor, the following lessons and recommendations were extracted. The list below is not exhaustive. The genesis of the lessons and recommendations can be found in the narrative analysis that follows for the Norwich Pro *Industrial Control Systems 2022* offering.

- The student-driven, discussion-focused course on Industrial Control Systems offered good opportunities for the participants to develop with respect to the seven stated learning outcomes, with an investment of two-four hours per week.
- The student-led discovery combined with the engagement of a class cohort from diverse professional backgrounds was key to the development of student self-efficacy beliefs with respect to the outcomes.
- Communicating expectations with respect to course structure, student responsibilities, and time commitment will be key for future offerings.
- The course persistency rate (60%) should be explored. Owing to the students' previous participation in the Microgrid Architectures Course, tech issues and expectation mismatches should have minimized those factors' influence on persistency. The "no skin in the game" phenomena (free offering) may have been a dominant factor.
- Student engagement among the persistent participants was high and led to great opportunities for student-to-student learning and rich class discussions.
- Technology issues were minimal during this offering. Use of a persistent Big Blue Button link was a notable improvement. The reduction in issues is likely attributed to prior student experience indicating that the creation of a test course with a trial assignment to be completed before the start of the formal course may be useful for future offerings.

- Exploring the student sentiment regarding the course materials matching their learning style and the possible creation of resources to engage students in a broader variety of ways or modes of learning may add value to future offerings.

The pre-, periodic-, and post-test assignments in the course should be built in a manner that allows the instructor access to the students' individual responses and performance as a means of assessing student understanding, to support formative feedback, and to inform learning interventions as needed.

Learning Outcomes Addressed:

As a result of this course, students will be able to…

1. *understand the definition of industrial control systems (ICS)*
2. *understand the DoD definition of ICS*
3. *analyze the components of DoD ICS*
4. *explain the importance of standardization in industrial control system design*
5. *explain the process of conducting an inventory of DoD ICS*
6. *explain the critical documentation of DoD ICS*
7. *explain the process of lifecycle management for ICS*

Assessment Results:

The Industrial Control Systems (ICS) course offering was assessed in two dimensions: student self- assessment of learning outcome attainment and instructor reflection on the course experience. Direct assessment of student outcome attainment through analysis of student pre- and post-tests was not possible due to the implementation choices for the pre-test.

Student perceptions were assessed using a survey that included Likert scale items and free-response questions. The anonymous survey was administered through the Norwich Pro (Moodle) LMS. The completion rate for the survey was 4 out of 6 students.

In terms of the offering, 10 students were enrolled in the course. 6 of those 10 students engaged in the course for more than one day or session. Those 6 students completed the course and 4 of those 6 completed the end of course survey. Table G1 details student survey responses regarding their perception on attainment of the learning outcomes from the survey respondents. Table 2 details student reported time spent on the course from the survey respondents. Table 3 details student perceptions of the course experience from the respondents.

Table G1 - Summary of student responses regarding the effectiveness of the course at helping them attain the stated learning outcomes. (Likert response scale: 1 = Strongly disagree, 2 = Disagree, 3 = Neither agree nor disagree, 4 = Agree, 5 = Strongly Agree). The strongest response is emphasized in green and the weakest response is emphasized in orange.

Outcome	Mean Response	Affirmative Responses [%]	Negative Responses [%]
1	4.25	100	0
2	4.25	100	0
3	4.25	100	0
4	4.50	100	0
5	4.25	100	0
6	4.00	75	0
7	4.25	100	0

Table G2 – Student feedback regarding time spent on the course each week. The only selected response was two-four hours per week.

Time Per Week in Course	# Responses
4-6 Hours	0
2-4 Hours	4
1-2 Hours	0

Table G3 – Results from a survey on student perspective of the overall course, the learning experience and materials, and other items related to student satisfaction. There were 4 / 6 students who responded to the survey. The same Likert scale defined in Table 1 was used for these items.

Outcome	Mean Response	Affirmative Responses [%]	Negative Responses [%]
Course materials aided in achieving outcomes	4.25	100	0
Instructor guidance in achieving learning outcomes	4.00	75	0
Class discussions aided in achieving the outcomes	4.50	100	0
Instructor expert in the field	4.25	75	0
Take another course with instructor	4.25	75	0
Got what were hoping for in course	4.25	100	0
Materials easy to access	4.00	75	25
Online meetings easy to access	4.25	100	0
Support was easy to seek	4.00	75	0
Content suitable to my learning style	4.00	75	25
Had difficulty mastering the content	3.00	50	50

In a series of open-ended prompts regarding feedback for the course, the following student responses were collected and have been categorized into pleasant surprises, compliments, concerns, and future coursework. The comments were excerpted for conciseness, but they capture the key elements of the responses.

- Pleasant Surprises
  - "I researched many different implementations of ICS projects worldwide that are very eye-opening."

  - "Honestly the conversations with the classmates with our weekly sessions was the most beneficial. I learned so much during those. That surprised me."

- Compliments
  - "This was a great introductory course to enable me to speak intelligently about ICS."
  - "Great course, would definitely recommend to anyone seeking understanding."
  - "Sustain, keep the dial in number the same and the code, that was sooo helpful"

- Concerns
  - "The fundamentals of Industrial Control Systems presented here was a little to basic for my liking as an experienced engineer but for a lay person this course is a great introduction."
  - "I would like that the instructors of future courses provide a bit of a lecture or presentation at the beginning or end of the weekly class to augment the reading materials."
  - "Can the presentation topics w/ names be posted w/ the dates so we can get these started way ahead of time, or at least a week earlier."

- Further Coursework Interests
  - "Incident response and disaster recovery."
  - "Space and Cyber Security or Satellite Systems"
  - "Army funding and appropriations timelines, deadlines, application requirements, etc. to fund base-ops."

Lastly, the course was assessed from the instructor perspective. The findings are the result of conversations throughout the offering of the course, and a debriefing discussion following the completion of the course. A few sentiments expressed by the instructor are paraphrased below.

- The tech issues with platform access, use of Big Blue Button (BBB), and BBB session access were significantly reduced / non-issues during this offering. This can likely be attributed to the cohort and their enrollment in the previous course.
- The course discussions were high quality, showed high student engagement, and forced some of the students out of their comfort zones. The interplay of students from a variety of backgrounds added value to the course.
- Having course content that was "new" for everyone, but also having content that overlapped with the domain expertise of each individual was helpful in terms of engagement, motivation, and classroom dynamics.
- This high level of student motivation and overall student engagement was an asset and seemed improved from the Microgrid Architecture offering—it was refreshing.

Evaluator's Findings:

Overall, Bill Lyons was successful at delivering a course that resulted in the students perceiving a high level of progress or attainment with respect to seven learning

outcomes in the area of Industrial Control Systems. As shown in Table G1, student perception on attainment of the learning outcomes was greatest for outcome 4, and lowest for outcome 6. It is noteworthy that there were no negative responses from any respondent regarding the course contributing to their progress or attainment with respect to any of the seven learning outcomes. The response was universally positive, and even for the lowest ranked outcome (outcome 6), student narrative responses showed an understanding of the importance of DoD documentation standards and their applicability to future work. One student mentioned that learning outcome as the thing they most wanted to remember after taking the course.

No direct measures of student attainment with respect to the learning outcomes were possible due to the implementation of the pre-test. Student responses to the pre-test survey questions were not available to the instructor or to the outside assessor. The course instructor's perception of student progress or attainment was that all students performed well with respect to all learning outcomes. The basis for this belief was student performance on assigned class briefings, and student contributions to class forums and discussions.

As shown in Table G2, students in the course uniformly reported a two-four hour per week time commitment for the course. This information could be helpful in communicating and managing expectations for future offerings.

When asked about their reasons for completing the course, the responses can be summarized as pursuit of professional development or to assist them with training in support of their job or career.

As shown in Table G3, among course materials, instructor guidance, and class discussions, class discussions were rated the highest with regards to student learning outcome attainment. This was reinforced by student free responses. The lowest performing items of interest for future exploration involve the online sessions being easy to access and the course meeting the learning style of the students. The strengths and opportunities uncovered were the same items identified in the Microgrid Architectures course survey, but it should be noted that both courses included many of the same students.

Student engagement among the six participants who completed the course was high and the diverse backgrounds of the cohort led to great opportunities for student-to-student learning, lively class discussions, and an experience that stretched people out of their comfort zones. The completion or persistence rate of 60% (6 out of 10) students is something that should be explored further. The lack of "skin-in-the-game" due to the offering being free may have been a contributing factor. In a future, fee- for-service offering of the course, persistence may be higher, but maintaining a cohort with diverse and complementary backgrounds will be a marketing and recruitment concern as both the students and instructor recognize this aspect of the course offering as key to the learning experience.

Technology issues for users of government-issued computers related to the LMS and media content delivery platforms need to be explored. No issues related to government account and devices surfaced with this offering, but students inherited the behavior of using personal accounts and devices based on the previous offering. Given the audience, a different solution should be explored. The change to the type of Big Blue Button meeting used for the course (session with a persistent access link) was an improvement and it was acknowledged in the feedback survey. It was noted that the number of tech issues this offering was significantly reduced, and if they existed, they were not a hindrance / topic of discussion. Aside from the type of Big Blue Button access link used, the tech platform changes were minimal, indicating that user experience issues may have been the predominant factor for the tech issues in the previous offering. Perhaps the creation of a “test / trial course” and assigning students to complete an activity in the test / trial platform would be helpful for future offerings.

In summary, the student-driven, discussion-focused course on Industrial Control Systems offered a learning environment where the students and instructor perceived development and attainment with respect to the seven stated learning outcomes, with an investment of two-four hours per week. The student-led aspect was key to the development of student self-efficacy beliefs.

Enclosure 2, NU Energy Track DRAFT FTR - Task 2 - Conduct an energy resilience seminar focused on senior-level military energy managers and policy makers.

Contract requirement:

The purpose of the seminar is to discuss current challenges of energy resilience and potential solutions. NUARI shall conduct the senior-level seminar in-person in Washington D.C. Seminar size should be at least ten individuals to facilitate robust discussion among participants. The seminar should be eight hours in length over two days. The contractor is responsible for coordinating and securing facilities and attendees. Draft seminar materials shall be provided to ERDC-CERL no later two weeks prior to the seminar for approval. Following the seminar, the contractor shall provide ERDC-CERL a written report detailing the preparation and execution of the seminar, a participant assessment, and a summary of lessons learned.

Method of Surveillance: Review by COR Criteria for Acceptance
Submitted by the date agreed upon in the contractor's schedule.
Select a Spring conference/meeting with a break-out session for the Senior Leader Seminar
Advertise for participants for the Senior Leader Seminar by November
Send seminar materials to CERL for input >two (2) weeks prior to seminar
Provide analysis of results and feedback from seminar

Task 2 – Conduct Senior Leader Seminar

The following milestone tasks are defined in relationship to accomplishment:

- Select a Spring conference/meeting with a break-out session for the Senior Leader Seminar – The NUARI Team considered several options for the location and conduct of the seminar to include the US Army G-9, IMCOM, Association of Defense Communities, and the International City Managers Association. The AUSA venue was chosen based on the following:
    - the timing of other conferences that would include the same attendees in the spring of 2022
    - No cost for facilities
    - AUSA Program coordination with NUARI

- Advertise for participants for the Senior Leader Seminar by November – The AUSA Team began advertising in late April to their network that included military and DoD leadership, industry experts, and academia.
- Send seminar materials to CERL for input >two (2) weeks prior to seminar – Seminar materials, the agenda, and speaker biographies were sent to the Government team three weeks prior to the event.
- Provide analysis of results and feedback from seminar – the contents of this document include the seminar program concept, the YouTube recordings of each panel and speaker, the survey results and lessons learned/recommendations.

Senior Leader Seminar Concept: The Senior Leader Seminar was held on 13 April, 2022 at the AUSA Headquarters, 2425 Wilson BLVD, Arlington VA 22201. AUSA reported over 130 registrations from the US Army, US Navy, USMC, industry, and academia. Leon Panetta spoke on the topic "Cyber Pearl Harbor" and the seminar evaluation began.

The Seminar proposal, the agenda, and biographies are located at Enclosure 1. The raw data feedback from the Seminar survey is located at Enclosure 2.

The following links are the YouTube documentation of the event:

- **AUSA article**: http://extra.ausa.org/04-14-2022/#page=1
- **Youtube videos links for each panel and speaker:**
  - https://www.youtube.com/watch?v=Y1vfgTYNbz0 Opening Remarks – Mr. Klippstein
  - https://www.youtube.com/watch?v=VY8SYFovAPg Keynote – Mr. Farnan
  - https://www.youtube.com/watch?v=cy-FEDnF5eo Panel 1 – Climate Change Resilience
  - https://www.youtube.com/watch?v=kbQjO4B9Hk8 Panel 2 – Threats to Critical Infrastructure
  - https://www.youtube.com/watch?v=p7pENcaxaCg HON Leon Panetta
  - https://www.youtube.com/watch?v=PEm3b9RNd7A Panel 3 – Risks: From Fort to Port and to the Fight
  - https://www.youtube.com/watch?v=zwV1uXEkz2k Panel 4 – Infrastructure Lessons Learned

- https://www.youtube.com/watch?v=N4XjxKXyrTM Panel 5 – When the Grid Goes Down
- https://www.youtube.com/watch?v=x-sQFGI6wDA Wrap Up – LTG Evans
- https://www.youtube.com/user/AUSANational AUSA YouTube Page

Results/Analysis – Senior Leader Seminar Survey Analysis

A survey of the participants in the AUSA Hot Topic/Energy Track Seminar was conducted the week after the event was held and it was sent to all participants, including panelists, moderators and event organizers. There were 28 responses of which 1 was also a panelist, 1 was a moderator and 2 were event coordinators. 87% of the respondents had a favorable view of the event, of which 65% were highly favorable. When asked to choose the single most interesting aspect of the seminar, the respondents chose:

- 36% Topics,
- 31% Networking,
- 9% Professional Development and
- 23% New Ideas.

From the qualitative responses to areas for improvement and negative aspects, a common thread in the feedback was that there was not sufficient time to cover the material, to hear from all the panelists and to network with other attendees. That said, 71% of respondents said that the one-day format was preferred, with 10% preferring a half day and 19% preferring more than a day. This would support reducing the number of panels and extending the time of the panel discussions and breaks in the one-day session and creating a seminar series that offers the possibility of going into more depth, in both content and networking. Attendees also liked the topic and thought it was relevant including the focus on cyber security and the importance of bringing together diverse skill sets and experience to solve current problems.

One of the open-ended questions was designed to extract new ideas from the most engaged participants: *"What would be the most valuable experience we could facilitate at the AUSA Hot Topic: Army Installation Partnerships for Mission Assurance next time?"*

The responses form a broad-based set of topics that can inform a future seminar series or curriculum development. They are grouped by the knowledge areas of the Energy Track: Energy Fundamentals, Risk Assessment, Policy/Funding and Master Planning:

Energy Fundamentals

“How the Army views maintenance of the installation. Some installations are maintained by civil service employees and some are by contractors. Which is more efficient? How can industry leaders assist the Army in maintaining these older facilities?”

“Extended discussion regarding resiliency definition and metrics; focused discussion on installation mission assurance related data”

Risk Assessment

Exercise programs and results
“You mentioned needing Industry to bring solutions to you and when you look at some of the top global employers like J&J, B of A and Walmart and how they are utilizing a continuous response model to understand, anticipate and respond to employee needs in near real time, and using AI/ML to predict employee needs to drive culture change - Is the Army looking at or researching how a continuous response model from Soldiers can be leveraged to give Garrison Commanders and leaders a real time view of Readiness and ultimately accomplish the cultural change the Army is driving?”

Policy/Funding

“I would have liked to see presentations on successful or in progress mission assurance initiatives. It appeared that a lot of objectives were shared but it was acknowledged that resources are austere. I wanted to see more solution-oriented presentations, acknowledging that initiatives can proceed but innovative approaches are necessary. I would have liked to have seen more examples of partnerships between Army/DOD and the public/private sector.”

"Add more examples of best management practices and bring more policy discussion to the forum."

“Deeper understanding of the link from policy to ability to execute. Do budgets support policy? Are plans achieving metrics? What does the future hold in aligning PPBE?”

"Update on Army initiatives and business opportunities that address the challenges presented (e.g. operational technology cyber security) Include IMCOM speakers to provide their point of view"

Master Planning

“The recently released President's Management Agenda has Employee Experience and Customer Experience as 2 of its priorities; how is USACE looking to incorporate this into Mission Success. For example, several Federal Government Agencies automatically score 100% of all customer and agent interactions. Incorporate unstructured feedback

signals to get the most complete view of your customer and agent experiences, and understand the end-to-end customer experience with unified, cross-channel reporting."

“I enjoyed the event. The topics discussed were relevant. However, you missed sending an email with presentations recording information. An email with links to the presentations would be appreciated.”

Major findings – Senior Leader Seminar:

1) Senior Leader Forum: Partnering with an organization (AUSA for this Seminar) to host a senior seminar during an existing conference, or dedicated session, such as the AUSA Hot Topic program provides opportunity to promote key topics such as Energy Resilience. Based on the high participation numbers and satisfaction with the content, recommend that this seminar continue yearly in coordination with the US Army.

2) Stakeholders: Networking and information sharing, particularly across military and civilian communities, will be essential to the protection of critical infrastructure and Military mission assurance.

3) Risk and Funding: There is a correlation between risk and funding of an energy resilience project/program. Consider multiple funding opportunities such as federal grants, state funding, industry partnerships, and programed budget opportunities to fund energy projects.

4) Policy Integration: Knowledge of policy documents at the Department level is relevant to the development of Installation level energy programs. For example, the Hot Topic seminar highlighted the new Army Installations Strategy (G-9) and the new Army Climate Strategy (AASA I&E) that require coordination to be effective in the realm of mission assurance.

5) Energy Resilience Exercises: Training energy professionals and those that support energy efforts on an Installation is a key component to achieving Energy resilience on an Installation. A distributed exercise is a viable tool assess the collective ability of the Installation Management staff and Partner organizations in order to maintain mission capabilities.

6) Future Seminars: The value of Senior Level Seminars in the field of energy resilience and mission assurance is needed based on the feedback from the 13 April, 2022 event. Recommend that USACE continue to fund future seminars.

Conclusion

The need to address energy resilience topics at the Senior Leader level in relationship to maintaining mission assurance was validated by this conference. The modules developed in Phase 2 (Identifying Mission Critical Infrastructure/Energy Systems

Module, Critical Infrastructure Threat Analysis/Risk Management Module, Energy/Critical Infrastructure Resilience Policy and Partnerships Module, Exercise Development Process module) of the program provide a solid foundation to plan and conduct future seminars. The forum and funding of Senior Level Seminars in the future should be programmed and funded in order to maintain awareness of energy resilience policy and programming as well as the value of partnership development for mission assurance.

Enclosures:

Appendix A - Task 2 Proposal to AUSA

Appendix B – Agenda for Conduct an energy resilience seminar focused on senior-level military energy managers and policy makers.

Appendix A, Enclosure 2, NU Energy Track Draft FTR - Task 2 Proposal to AUSA

Installation Hot Topic Proposal

"The Installation Fence line is now the Frontline"

"With adversaries' malware in the National Grid, the nation has little or no chance of withstanding a major cyberattack on the North American electrical system…This {electric power} industry is simply unrealistic in believing in the resiliency of this Grid…. When such an attack occurs, make no mistake, there will be major loss of life and serious crippling of National Security capabilities…"

Mr. George Cotter (NSA-Technology Division-2015 White Paper to National Security Council and Congressional Intelligence and Homeland Security Committees)

The Army published its new Installation Strategy in Dec of 2020. The strategy builds on the 2018 National Defense Strategy that highlighted that the Homeland is no longer a Sanctuary. The Army Installation Strategy builds on the premise that the Installations in the homeland could and probably will be targets. In Dec 2020, the Army also published the Installation Energy and Water Strategy to further identify and address steps necessary to develop and protect the critical infrastructure necessary to provide an installation's mission assurance.

A cursory analysis of the strategy and its underlying assumptions make it clear that many if not most of our installations are extremely vulnerable to peer, near-peer or even non-governmental adversaries. This vulnerability is due in part to a lack of sufficient investment in the critical physical and human infrastructure necessary to assure our installation's fundamental ability to project combat power they house. The communities, where 100 % of the civilian government and contract workforce and a very high percentage of the uniformed members and their families live are equally vulnerable. A clever adversary could severely disrupt the capability of an installation to perform its power projection mission, by a kinetic or non-kinetic attack on critical infrastructure not even on the installation.

This reality was evident in comments recently made by Secretary of Homeland Security Alejandro N. Mayorkas and Secretary of Commerce Gina Raimondo on 22 September 2021- "The safety and security of the American people relies on the resilience of the [organizations] that provide essential services such as power, water, and transportation." In addition, according to a March 2014 report in the Wall Street Journal, "The U.S. could suffer a coast-to-coast blackout if just nine of the country's 55,000 electrical transmission substations were to fail on a hot summer day". The scenario of losing power for months, not days, is closer than we think.

CERL/ERDC has contracted with Norwich University to develop several projects and curricula to help address this National Security imperative. A component of this effort is an 8 hour in person seminar to be held in Washington DC in the Spring. The seminar is to be titled Critical Infrastructure Resilience for Senior Army Leaders. A pilot seminar that was done in collaboration with the International City Managers Association (ICMA) was conducted last Spring. Using what was learned from the pilot, this version of the seminar will explore the linkage between critical infrastructure resilience and the partnerships that are addressed in the Army Installation Strategy as key to mission capability and mission assurance.

The value and penetration of the seminar contents would be greatly enhanced by partnering with AUSA as well as ICMA. We would propose that the 8-hour seminar be conducted over 2 days in the AUSA Facility in the Hot Topic style/format in the April time frame. Your facility would allow us to reach both an in person and a virtual audience composed of OSD, Department of Army, AMC, IMCOM and local government leaders that have a stake in the success of America's installations and the communities that support them. The concept envisions AUSA providing the facility and audio-visual support and Norwich/ICMA providing the content.

Former Secretary of Defense Leon Panetta about is willing to keynote the seminar. He believes this issue to be critically important and has committed to support us assuming we can coordinate schedules.

If AUSA is willing to co-sponsor this effort, the NUARI Team will initiate coordination with the other suggested speakers.

Appendix B, Enclosure 2, NU Energy Track Draft FTR – Agenda and Biographies

ARMY INSTALLATION PARTNERSHIPS FOR MISSION ASSURANCE

A Professional Development Forum

Executing the Army Installations Strategy

13 April 2022

General Gordon R. Sullivan Conference & Event Center
Arlington, VA

AGENDA

0700–1430 REGISTRATION

0700–0800 COFFEE SERVICE

0800–0805 ADMINISTRATION, SAFETY, SECURITY
Mr. Alex Brody
Director, Meetings – Association of the United States Army

0805–0815 WELCOME
GEN Robert B. Brown United States Army Retired President and CEO
Association of the United States Army

0815–0845 OPENING REMARKS
Mr. Daniel M. Klippstein
Assistant Deputy Chief of Staff, G-9 United States Army

0845–0915 KEYNOTE SPEAKER
Mr. Paul W. Farnan
Principal Deputy, Assistant Secretary of the Army (Installations, Energy, and Environment)

0915–0930 BREAK

0930–1020 PANEL DISCUSSION – Climate Change and Resilience
MODERATOR
Mr. Britt Harter
Partner – Energy, Sustainability, & Infrastructure Guidehouse

PANEL MEMBERS
HON Sharon E. Burke – Founder and President Ecospherics

Ms. Lynn E. McConnell
Director, Business Administrations Grid Assurance

Mr. Mark McVey
Principal Engineer, Operations Engineering Group Dominion Energy

1020–1110 PANEL DISCUSSION – Threats to Critical Infrastructure
MODERATOR
Mr. Fred E. Meurer, Owner and Management Consultant Meurer Municipal Consulting, LLC

PANEL MEMBERS
Mr. Jonathon Monken
Principal, Converge Strategies, LLC

Mr. Michael P. Coe
Director, Defense Critical Electric Infrastructure Program United States Department of Energy

Mr. David Forbes
Principal, Booz Allen Hamilton

1110–1120 BREAK

1120–1200 BROWN BAG SESSION – Cyber Pearl Harbor
SPEAKER
HON Leon E. Panetta Former Secretary of Defense Former Director of the CIA

1200–1230 NETWORKING BREAK

1230–1320 PANEL DISCUSSION – Risks: From Fort to Port and to the Fight
MODERATOR
Mr. Tristan Bannon
Executive Director, Renewable Energy and Climate Change Leidos

PANEL MEMBERS
HON Lucian L. Niemeyer
CEO, Building Cyber Security

Mr. Christopher I. Thomas
Director, Information & Technology Office of the Deputy Chief of Staff, G-9 United States Army

Mr. Phil Susmann
President, Norwich University Applied Research Institutes

1320–1330 BREAK

1330–1420 PANEL DISCUSSION – Infrastructure Lessons Learned

MODERATOR

Ms. Kahwa C. Douoguih
Senior Fellow, Center for Global Resilience and Security Norwich University

PANEL MEMBERS

Mr. Adam Wright
Former Community Planning and Liaison Officer Submarine Base New London, United States Navy

Ms. Monica DeAngelo
Director, Federal Partnerships Southern Company

Mr. Randy Monohan
Energy Project Officer–Public Works Marine Corps Installations Command

Mr. Thomas A. Bozada
Research Scientist, Engineer Research and Development Center United States Army Corps of Engineers

1420–1510 PANEL DISCUSSION – When the Grid Goes Down

MODERATOR

Mr. Jeffrey S. Cairns
Program Manager, Norwich University Applied Research Institutes

PANEL MEMBERS

Mr. Alexander Pina
Director, Converge Strategies, LLC

COL Lisa M. Lamb Garrison
Commander, Fort Hunter Liggett United States Army

Mr. Mick Wasco, PE, CEM
Utilities and Energy Program Manager, Marine Corps Air Station Miramar United States Marine Corps

Mr. David A. Poland
Client Solutions Executive, AT&T Global Public Sector – DoD Segment, Army Division AT&T

1510–1530 WRAP-UP/NEXT STEPS

LTG Jason T. Evans Deputy Chief of Staff, G-9 United States Army

1530 CLOSING REMARKS

GEN Robert B. Brown United States Army Retired, President & CEO Association of the United States Army

PARTICIPANT BIOGRAPHIES

The Honorable Leon E. Panetta

Former Secretary of Defense; Former Director of the CIA

Leon Edward Panetta served as the 23rd Secretary of Defense from July 2011 to February 2013.

Before joining the Department of Defense, Mr. Panetta served as the Director of the Central Intelligence Agency from February 2009 to June 2011. Mr. Panetta led the agency and managed human intelligence and open-source collection programs on behalf of the intelligence community.

Secretary Panetta has dedicated much of his life to public service. Before joining CIA, he spent 10 years co-directing with his wife, Sylvia, the Leon & Sylvia Panetta Institute for Public Policy, based at California State University, Monterey Bay. The Institute is a nonpartisan, not-for-profit center that seeks to instill in young men and women the virtues and values of public service. In March 2006, he was chosen as a member of the Iraq Study Group, a bipartisan committee established at the urging of Congress to conduct an independent assessment of the war in Iraq.

From July 1994 to January 1997, Mr. Panetta served as Chief of Staff to President William Clinton. Prior to that, he was Director of the Office of Management and Budget, a position that built on his years of work on the House Bud- get Committee. Mr. Panetta represented California's 16th (now 17th) Congressional District from 1977 to 1993, rising to House Budget Committee chairman during his final four years in Congress.

Early in his career, Mr. Panetta served as a legislative assistant to Senator Thomas H. Kuchel of California; special assistant to the Secretary of Health, Education and Welfare; director of the U.S. Office for Civil Rights; and executive assistant to Mayor John Lindsay of New York. He also spent five years in private law practice.

He served as an Army intelligence officer from 1964 to 1966 and received the Army Commendation Medal.

Secretary Panetta holds a Bachelor of Arts degree in political science and a law degree, both from Santa Clara University. He was born on June 28, 1938, in Monterey, where his Italian immigrant parents operated a restaurant. Later, they purchased a farm in Carmel Valley, a place Secretary and Mrs. Panetta continue to call home. The Panetta's have three grown sons and six grandchildren.

Lieutenant General Jason T. Evans

Deputy Chief of Staff, G-9, United States Army

Lieutenant General Jason T. Evans is the U.S. Army's first Deputy Chief of Staff, G-9. Lieutenant General Evans assumed duties Sept. 27, 2019, as the Deputy Chief of Staff, G-9 and serves as the expert and champion for the world's most capable and efficient installations.

The Deputy Chief of Staff, G-9 develops regulatory guidance, administers installation resource programming, and provides expertise and advocacy for all Army infrastructure and installation services to enable Total Army readiness.

He previously served July 2017 to July 2019 as Commanding General of the Army Human Resources Command, Fort Knox, Kentucky, before assignment to the Pentagon.

Lieutenant General Evans was raised as an Air Force family member. He attended Wentworth Military Academy, Lexington, Missouri, where he earned an Associate Degree in Business Administration. He completed his Bachelor of Science Degree in Business Administration from Bellevue University, Bellevue, Nebraska. He holds master's Degrees in Business Administration from Webster University and National Resource Strategy from the National Defense University.

Lieutenant General Evans has served in command and staff positions in the continental United States, Italy, Somalia, Kosovo, Germany, and Iraq with the 13th Corps Support Command, III U.S. Corps, 510th Personnel Services Battalion, 1st Personnel Command, U.S. Army Europe, Installation Management Command, Multi-National Force – Iraq, and Office of the Assistant Secretary of the Army.

His key assignments include:

- Commanding General, U.S. Army Human Resources Command
- Director of Military Personnel Management, Army G-1, Headquarters Department of the Army
- Deputy Commanding General (Support), U.S. Army Installation Management Command, Joint Base San Antonio, Texas
- The Adjutant General; Executive Director, Military Postal Service Agency, Fort Knox
- Executive Officer, Assistant Secretary of the Army, Manpower and Reserve Affairs
- CJ1, Multinational Force – Iraq, (Director Personnel)
- Commander, U.S. Army Garrison, Fort Monroe, Virginia
- Chief, Department of the Army, Secretariat for Officer Centralized Selection Boards, Personnel Command, Alexandria, Virginia
- Commander, Task Force 510th Personnel Services Battalion (Kosovo)
- Commander, 510th Personnel Services Battalion, 1st Personnel Command
- Military Assistant to the G-1, Deputy Chief of Staff Personnel, Headquarters Department of the Army
- Deputy Chief, General Officer Management Office, Office of the Chief of Staff, Army
- Majors/Lieutenant Colonels Assignments Officer, Headquarters Department of the Army Personnel Command
- Executive Officer, 502nd Personnel Services Battalion, 3rd Personnel Group, Fort Hood, Texas

- Headquarters and Headquarters Detachment Commander, 502nd Personnel Services Battalion, 3rd Personnel Group
- G-1, Joint Task Forces Logistics Command (Mogadishu, Somalia)
- Chief, Strength Management, G-1, 13th Corps Support Command, Fort Hood
- Executive Officer, U.S. Army Element, Allied Forces South, Naples, Italy

Lieutenant General Evans is a graduate of the Adjutant General's Officer Basic and Advanced Courses, Combined Arms Staff Services School, Command and General Staff College, the Army Resource Management Course, and the Industrial College of the Armed Forces.

Lieutenant General Evans' awards and decorations include the Distinguished Service Medal (with two Oak Leaf Cluster), Legion of Merit (with two Oak Leaf Clusters), Bronze Star Medal, Defense Meritorious Service Medal, Meritorious Service Medal (with four Oak Leaf Clusters), Army Commendation Medal (with Oak Leaf Cluster), Army Achievement Medal (with Oak Leaf Cluster), Parachutist Badge, and the Army Staff Identification Badge.

Mr. Daniel (Dan) M. Klippstein

Assistant Deputy Chief of Staff, G-9, United States Army

Dan Klippstein serves as the Army's Assistant Deputy Chief of Staff, G-9. The Deputy Chief of Staff, G-9 serves as the Army senior leaders' military staff adviser for Army installation operations.

The office of the DCS, G-9 enables the Army to train, deploy, fight, win and reset from a secure Strategic Support Area by administering a $17 Billion Army-wide installation program and providing expert advice, data analysis, and assistance to Army leaders on facilities and infrastructure, installation support services, and Soldier, Family and Army Civilian quality of life critical for Total Army readiness.

Mr. Klippstein was appointed to the Senior Executive Service in March 2013 and assumed his position as Assistant Deputy Chief of Staff, G-9 in May 2020.

He previously served as the Resources Director for the Deputy Chief of Staff, G-9. He became Resources Director in September 2018. He administers the Installations Program Evaluation Group to enable all aspects of planning, programming, budget formulation and execution for a $17 billion annual program that equates to $85 billion across the five-year Program Objective Memorandum. The program encompasses 72 Management Decision Pack- ages that represent requirements championed by seven Army staff principals and special staff offices and supporting 38 commands Army-wide.

Mr. Klippstein previously served as the Director of the U.S. Army Nuclear and Combating Weapons of Mass Destruction Agency and concurrently as the Deputy Director, Plans and Policy, office of the Deputy Chief of Staff, G-3/5/7.

Mr. Klippstein holds a Master of Arts in Strategic Studies from the U.S. Army War College, Carlisle, Pennsylvania; a Master of Arts in Management from Webster University, Fort Leonard Wood, Missouri; and a Bachelor of Arts in Business Administration from Western Illinois University, Macomb, Illinois.

His professional memberships include the Association of the United States Army and the Association of U.S. Military Strategists.

Mr. Paul W. Farnan

Principal Deputy Assistant Secretary of the Army (Installations, Energy, and Environment)

Mr. Paul Farnan has been the Principal Deputy Assistant Secretary of the Army for Installations, Energy and Environment since October 2021; he is also serving as the Acting Assistant Secretary of the Army for Installations, Energy and Environment. Prior to his appointment, he served with U.S. Northern Command, performing COVID-19 response operations. He has also served in the operational energy office in the Pentagon and as a senior civilian advisor to the commanding general in Afghanistan, where he focused on civil-military cooperation. He was on active duty for nine years as a Naval helicopter pilot; he is still an officer in the Naval Reserve. Mr. Farnan has a BA in Electrical Engineering from Villanova University, an MA in Environmental Policy from the University of Denver and an MS in Global Energy Management from the University of Colorado, Denver.

The Honorable Sharon E. Burke

Founder and President, Ecospherics

Honorable Sharon E. Burke is the Founder and President of Ecospherics, a research and advisory firm. Throughout her career, she has worked to balance national security and environmental sustainability, with a focus on ideas that scale through public policy. Burke has been a leader at several civic organizations, including the Center for a New American Security. She started her government career at the Office of Technology Assessment of the U.S. Congress, worked at the State Department for Deputy Secretary of State Rich Armitage, and first joined the Department of Defense as a Presidential Management Fellow. Her most recent Pentagon duty was as the Assistant Secretary of Defense for Operational Energy and then as a member of the Biden-Harris presidential transition team. A frequent public speaker, writer, and strategic advisor, Burke lives in the Washington, DC area with her husband and two sons.

Ms. Lynn E. McConnell

Director, Business Administrations, Grid Assurance

Lynn E. McConnell, Director of Business Administrations, is responsible for the development and communication of financial forecasts, budgets, reports and controls.

Lynn’s career in Finance has spanned the energy, retail and financial services industries. In her 17-year tenure with AEP, Lynn has provided financial analysis support to Transmission, Corporate Sustainability, Strategy & Policy, Corporate Finance, Retail and Risk Oversight departments. Areas of expertise include financial forecasting, economic modeling and project management. In addition to her energy industry experience, Lynn was a Financial Consultant with Merrill Lynch and a Financial Analyst in the Retail industry.

Lynn earned her Bachelor of Science degree in Business Administration, Finance and Marketing, from The Ohio State University. She also has a Master of Business Administration degree from The Ohio State University.

Mr. Mark McVey

Principal Engineer, Operations Engineering Group, Dominion Energy

Mark McVey is a principal engineer in Dominion Energy's transmission operations engineering organization. He holds a BSEE degree from Virginia Tech and has more than 35 years of experience in the energy industry. He serves as chair and is a member of several IEEE working groups. He also is actively involved in CIGRE and IEC working groups as a convener, advisor and U.S. delegate. These working groups are focused on capacitors, high-volt- age and air-insulated substations, and standards.

Mr. Fred Meurer

Meurer Municipal Consulting, LLC

Mr. Meurer graduated from the United States Military Academy at West Point in 1966. He was commissioned as a Corps Engineer Officer. Mr. Meurer received graduate degrees from Stanford University in Water Resources Planning and Civil Engineering in 1971. He had overseas assignments in Germany, Vietnam and Korea. He also served as the Test Director for the operational test of the Apache Helicopter and the Hellfire Missile Systems.

His final tour of active duty was as Director of Public Works and Housing at Fort Ord. During his time at Ft. Ord, he pioneered the idea of the Army recapitalizing its family housing inventory through public-private partnerships. His concept was ultimately embraced by all of the Services as a very rapid and cost-effective way of providing quality family house for America's warriors. Mr. Meurer retired from the Army as a Colonel in 1986. Mr. Meurer was hired by the City of Monterey in 1986 where he served as Public Works Director for five years until his appointment to City Manager in July 1991. As City Manager, Mr. Meurer was instrumental in developing working relationships between businesses and residential neighborhoods, as well as with City Hall. He led the development of the City's neighborhood improvement, neighborhood policing, and waterfront acquisition and tourism development programs. He also was the catalyst for creating Intergovernmental Support Agreements and partnership agreements between the Cities on the Monterey Peninsula, Monterey County and the State of California for shared serviced services. He also developed partnerships with the private sector to augment City services and recapitalization of infrastructure needs.

Building on the City-to-City partnerships, Mr. Meurer led the effort to develop cooperative relationships between the City of Monterey and the Department of Defense (DoD) activities in Monterey. This effort focused on further increasing DoD mission effectiveness while reducing their operating costs. His goal was to provide the same high quality municipal services to DoD activities and personnel as the city provides its civilian neighborhoods. He has been successful in obtaining language in several defense authorization bills to demonstrate the viability of Public-Public partnerships. This concept was embraced by the Secretary of Defense as a model for Community-Installation Collaboration and led to legislation in the FY 13 and FY15 National Defense Authorization Act. This legislation authorized Service Secretaries to enter into Intergovernmental Support Agreements (IGSA) with local governments when in the best interest of the services to do so. Mr. Meurer retired from the City of Monterey in

December of 2013. He now works as an independent consultant to Norwich University Applied Research Institutes (NUARI), Booz Allen Hamilton (Crystal City), and the Cities of Carmel, Ca. and Fairfield, Ca. He currently is serving as the Interim Public Works Director, Carmel, Ca.

The Honorable Lucian L. Niemeyer

Chief Executive Officer, Building Cyber Security

The Honorable Lucian Niemeyer was appointed on March 1, 2021 the Chief Executive Officer and Chairman of the Board of Building Cyber Security, a non-profit organization advancing physical security/safety in a smarter world.

Prior to this appointment, Lucian served in the White House as the Deputy Program Associate. Director, National Security Programs, in the Office of Management and Budget providing budgetary, policy, and management over- sight for U.S. national security programs of the Department of Defense, the National Nuclear Security Agency, and National Intelligence Programs.

In August 2017, he was appointed by the President and confirmed by Congress as the Assistant Secretary of Defense for Energy, Installations, and Environment. In this role, he provided budgetary, policy and management oversight of the Department of Defense's real property portfolio, which encompasses 28 million acres, over 500 installations with over 500,000 buildings and structures valued at a trillion dollars. Secretary Niemeyer also served the Secretary of Defense as a strategic advisor for mission assurance, energy resilience and cybersecurity programs, and as an Assistant Secretary of the Navy.

Prior to his appointment, Secretary Niemeyer worked in the private sector from 2014 to 2017 as the founder of The Niemeyer Group, LLC. From 2003 to 2014 he served on the professional staff of the United States Senate Commit- tee on Armed Services where he was responsible for a wide portfolio of national security programs.

Lucian is an Air Force veteran, retiring in 2008 at the rank of Lieutenant Colonel with 15 years of active and five years of Virginia Air National Guard service. He holds a Bachelor of Architecture, from the University of Notre Dame, a Master of Business Administration from The George Washington University, and a Master of National Security and Strategic Studies from the Naval War College.

Mr. David Forbes

Principal, Booz Allen Hamilton

Dave Forbes is a cybersecurity leader who drives Booz Allen's service offerings around industrial cybersecurity and infrastructure engineering. He has more than 24 years of experience in defense-related operations and consulting and leads Booz Allen's Navy and Marine Corps infrastructure and environment business, supporting clients in the National Capital Region, as well as across the U.S. and the Asia Pacific.

While at Booz Allen, Dave has led teams supporting key initiatives such as Quadrennial Defense Review, Maritime Domain Awareness, Navy Strategic Planning Process, Marine Corps Expeditionary Energy, and Marine Corps Expeditionary Force Development.

Dave engages with leaders across the defense and federal space to understand their current environment, assess their ability to protect critical infrastructure and support mission readiness, and help them make sound program decisions.

Prior to joining Booz Allen, Dave worked as a strategic planner in the Office of the Secretary of Defense (OSD), Under Secretary of Defense for Policy. In this role, he worked and coordinated with OSD leadership, combatant commands, secretaries of military departments and service chiefs, as well as service staffs and the defense policy community.

Dave also served for 11 years in the U.S. Army, where he was posted to command or staff positions at the company level through the division level. He culminated his time in service as a staff officer in the Office of the Deputy Chief of Staff for Logistics, Headquarters, U.S. Army.

Dave earned a master's degree in public policy with a concentration in science and technology from the George Mason University School of Public Policy and a B.A. in international relations from Norwich University, the Military College of Vermont. He is the vice chair of the Norwich University Board of Fellows for the School of Cyber- security, Data Science, and Computing.

Mr. Michael P. Coe

Director, Defense Critical Electric Infrastructure Program, United States Department of Energy

Michael P. Coe serves as the Director of the U.S. Department of Energy's (DOE) Defense Critical Electric Infrastructure program within the Office of Cybersecurity, Energy Security, and Emergency Response. Mr. Coe is responsible for leading the Department's efforts working with industry and

Federal agency partners to mitigate risks to non-government owned electric infrastructure in support of defense mission assurance. Mr. Coe has nearly two decades of experience in energy policy and communications, including DOE/U.S. Government involvement in Puerto Rico, DOE's Bulk Power System Initiative, and resilience investments.

Mr. Coe most recently served as the Director of Energy Planning and Strategy within the Office of Electricity's (OE) Transmission Permitting and Technical Assistance division at DOE. He was responsible for leading the Department's technical assistance efforts for state, local, territorial, and tribal jurisdictions to facilitate the development of resilient and reliable electricity infrastructure. Prior to that, Mr. Coe served as a senior advisor to the Assistant Secretary for Electricity, providing strategic counsel and serving as a liaison between OE and the four Power Marketing Administrations, coordinating the adoption of tools and technologies developed by OE and the National Laboratories to harden critical electric infrastructure. Prior to joining the Department, he consulted for energy clients with multi-state and national footprints. Mr. Coe holds a Juris Doctor from the University of Balti- more School of Law and a Bachelor of Arts from the University of Richmond.

Mr. Tristan Bannon

Executive Director, Renewable Climate and Technology, Leidos

Tristan Bannon is Leidos' Executive Director for Renewable Energy and Climate Change. In this role he is responsible for developing and executing an externally focused strategy to deploy Leidos' world class technologies, technical expertise, and delivery abilities to help clients mitigate and adapt to the impacts of climate change. His primary areas of focus are renewable energy technologies, climate data modernization, smart installations and infrastructure, strategies to electrify transportation, and the impact of climate change on national security.

Prior to joining Leidos, Tristan served at CACI International, most recently as a Vice President in their Engineering Solutions and Services operating group where in five years he was instrumental in securing over $5B in new single award contract wins. Prior to that Tristan held spent over ten years in leadership, management, growth, and technical roles at KGS Inc. and Lockheed Martin.

In addition to his role at Leidos, Tristan serves as the Vice Chair of the Washington Executive Climate Change Council and participates in numerous industry advisory and trade association.

Tristan holds a Master of Science in Computer Science from the Johns Hopkins University Whiting School of Engineering, as well as a Bachelor of Science in Computer Science from the University of California at Santa Barbara. He resides in Arlington, VA with his wife and two children.

Mr. Christopher I. Thomas

Director of Information & Technology,

Office of the Deputy Chief of Staff, G-9, United States Army

Mr. Christopher I. Thomas is the Information and Technology Director for the U.S. Army Deputy Chief of Staff G9 (DCS-G9) Installations. Mr. Thomas was appointed to the Senior Executive Service in January 2019 and assumed his current duties on Jan. 7, 2019.

Mr. Thomas supported the Department of Homeland Security and the U.S. Coast Guard as the Deputy Chief Information Security Officer, Coast Guard

Chief of Cybersecurity Policy and Coast Guard Acting Deputy Chief Privacy Officer from September 2011 to January 2019.

From 2006 to 2011, Mr. Thomas supported the Defense Intelligence Agency as the Deputy Chief of the Systems Certification Division and senior DIA certifier. He travelled throughout the world conducting management and technical evaluations of Department of Defense sensitive compartmented information certification and accreditation processes and procedures, network security measures, and other measures that supported and defended Intelligence Community systems and networks.

Mr. Thomas spent more than three years as a contractor with the Defense Information Systems Agency where he performed as an Information Assurance Systems Engineer majoring in Cross Domain Systems development, testing and implementation. Additionally, Mr. Thomas spent a short time with the Computer Scientific Corporation providing support to the National Security Agency.

He is a graduate of the Department of Homeland Security SES Candidate Development Program where he received his Key Executive Leadership Certificate from American University. He also is a graduate of the National Defense University Advanced Management Program (AMP).

Mr. Thomas holds a Master of Science Degree in Information Assurance, and a Bachelor of Science Degree in Liberal Studies (Computer Information Systems). He is a certified Information Systems Security Professional and Microsoft Certified Systems Engineer, as well as the recipient of the National Defense University Chief Information Officer certificate, and National Security Telecommunications and Information Systems Security Instruction and Committee on National Security Systems 4011-4016 certificates.

Mr. Thomas served more than 20 years in the U.S. Navy as a Cryptologic Technician Collection Analyst and Cryptologist. He was awarded four Navy Commendation Medals, one Navy Achievement Medal, two Meritorious Unit Commendation Medals, five Navy Good Conduct Medals, two National Defense Service Medals, and one Expert Marksmanship Medal.

Mr. Phil Susmann

President, Norwich University Applied Research Institutes

Phil founded NUARI in 2002 with the support of Senator Patrick Leahy. In 2005 he assumed the position of President. Phil has led the NUARI effort to develop tactics, tools, and processes for critical infrastructure and organizations to prepare, respond and recover from Cyber events. NUARI developed the DECIDE cyber wargaming platform and exercise management tool, in cooperation with Department of Homeland Security Science and Technology and the Finance Industry, creating the Quantum Dawn exercises. DECIDE is now engaging with Energy and Transportation organizations and supported the Jack Voltaic 3 Cyber and Critical Infrastructure exercises and forums.

During his time at NUARI, Phil has been a part of the development of the Vermont Army National Guard Information Operations Schoolhouse and the Vermont Air National Guard 229th Cyber Operations Squadron. He has also been involved in the development of Cyber Exercise tools, training developments in mobile and virtual laboratories, and more recently the Security Situation Center: a cyber-threat hunting and security program and platform that trains through engagement with a live data security center. NUARI currently provides a virtual exercise plat- form that enables decentralized interaction across all levels of government, industry, academia, and private entities.

Phil and the NUARI team are also engaged in energy resilience with the development of training with US Army Engineering Research Development Center, Construction Engineering Research Lab for Installation personnel and Senior Leaders and exploring cold regions microgrid architecture. NUARI provides program management and independent verification and validation in visual augmentation systems to the Department of Defense.

Phil is also the Vice President of Strategic Partnerships for Norwich University and the senior leader responsible for the Senior Military Colleges Department of Defense Cyber Institutes in support of USCYBERCOMMAND. Phil is responsible for all Norwich Cyber Strategies and led the team to develop the DOD Center of Academic Excellence in Cyber Defense Education recognized in 2001 by NSA.

Phil began his tenure at Norwich as a faculty member in the Business School in 1987, Department Chair of Computer Information Systems in 1990, Chief Information Officer in 1994, Vice President of Technology and Strategic Partnerships in 1998, and Vice President of Strategic Partnerships and President of NUARI in 2005.

Education: Bachelor of Science from Norwich University in 1981 and MBA from Clarkson University in 1983.

Mr. Jonathon Monken

Principal, Converge Strategies, LLC

Jonathon has deep public and private sector experience in the areas of national security, emergency preparedness, risk management, and energy resilience planning. During the past several years he pioneered programs to build enterprise-level resilience for the utility sector through information sharing, public and private sector integration, and large-scale exercise development and execution. Most recently Jonathon served as the Senior Director of System Resilience and Strategic Coordination for PJM Interconnection.

In that role, he worked within the areas of business continuity, physical and cyber security, risk management and resilience planning for the world's 2nd largest grid operator. Jonathon earned a Bachelor of Science Degree from the United States Military Academy at West Point and holds a master's degree in Business Administration from Northwestern University's Kellogg School of Management. Jonathon serves in the Army Reserves supporting the National Cybersecurity and Communications Integration Center (NCCIC) at the U.S. Department of Homeland Security.

Ms. Kahwa Douoguih

Senior Fellow, Center for Global Resilience and Security, Norwich University

Kahwa Douoguih is a Managing Partner of Constelor Investment Holdings, a Pan African advisory and investment company, founded in 2008, where she heads the firm's trade, energy, and early-stage venture initiatives. Kahwa plays a key role in global strategy, public-private partnerships and business development, driving Constelor's objective to harness Africa's abundant natural and human resources to develop a vibrant, self-sustaining private sector. Prior to joining Constelor, Kahwa worked as a mineral economist and commodity market research consultant at Inco (Vale). She has a broad scope of international experience in Africa and the Americas in the areas of economics, development and finance at both public and private sector institutions including the Africa Finance Corporation and the International Monetary Fund. Since 2019, Kahwa has been a Senior Fellow at Norwich University's Center for Global Resilience and Security where she mentors and advises undergraduate students engaged in research and experiential learning related to the CGRS initiative in entrepreneurship, energy and technology. She also works with the interdisciplinary team in the design and implementation of curriculum for Energy Resilience and Resilient Infrastructure education. Kahwa holds a PhD in Economics from the University of Maryland, a MS in Mineral Economics from Colorado School of Mines and a BA from Stanford University.

Mr. Adam Wright

Former Community Planning and Liaison Officer, Submarine Base New London, United States Navy

Adam Wright joined the DoD's Office of Local Defense Community Co- operation (OLDCC) as a Project Manager in March 2021 and was selected to serve as the Program Activity Lead for the Defense Community Infrastructure Pilot Program this year. Prior to joining OLDCC, he served as the Community Planning & Liaison Officer for Naval Submarine Base New London, working on projects and initiatives that benefitted both the installation and the local community. With strong support from the State of Connecticut, Mr. Wright helped turn ideas into projects that supported the Sub Base's mission while providing value to the surrounding region. Prior experience included serving as one of two Lead Coordinators for all DoD activities within the Chesapeake Bay Program Partnership, a collaborative, state led, federally supported Bay restoration effort. In the early 2000s, Mr. Wright was the Environmental Manager at the Vermont Air National Guard during the F-35 basing Environmental Impact Statement process and was the main point of contact at the installation during public outreach efforts conducted under the environmental restoration program assessment and cleanup process. Mr. Wright also has experience as a regulator with the Massachusetts Department of Environmental Protection, and in the private sector working for environmental consulting and contracting companies, where he worked on a variety of environmental cleanup and restoration projects. Mr. Wright holds a Bachelor of Science Degree in Environmental Science from the University of Massachusetts.

Ms. Monica DeAngelo

Director, Federal Partnerships, Southern Company

Monica DeAngelo is the Director of Federal Partnerships for Southern Company. In this role, she is responsible for engaging with Federal customers in DC related to regulated and unregulated interests on behalf of Southern Company and its operating companies and subsidiaries. Ms. DeAngelo seeks to align Federal customer requirements and Company capabilities. As a senior member of the Southern policy team, Ms. DeAngelo leads education and advocacy efforts that impact federal legislation and Departmental policy and guidance that results in collaborative public-private partnerships.

Prior to joining Southern she held leadership positions as a civil servant with the Dept of Navy & Dept of Energy and began her federal career as an engineer with FERC. She also provided energy expertise to DoD in former consulting roles. Ms. DeAngelo received a MS in Environmental Engineering from Columbia University, New York, NY, a BS in Environmental Engineering from Wilkes University, Wilkes Barre, PA and holds a CEM certification.

Mr. Thomas A. Bozada

Research Scientist, Engineer Research and Development Center, United States Army Corps of Engineers

Mr. Bozada is a senior Project Manager (PM) for the U.S. Army Corps of Engineers, Engineer Research and Development Center. He is currently one of two Technical Managers for the Secure

Tactical Advanced Mobile Power (STAMP) Joint Capabilities Technology Demonstration and Project Manager for multiple installation focused power research projects. These include the use of modeling and simulation for analyzing installation electrical infrastructure, creating digital representations of Army installations, and exploring the impacts of electrical vehicles. Previously, he was the PM for the Operational Energy Capability Improvement Fund (OECIF), Tactical Microgrid Standards Consortium (TMSC) project. He led a multinational microgrid interoperability effort and the Chair of a government interagency panel on Power System Interoperability, Integration and Architectures. He advises multiple advanced power research and development efforts in the installation, air, sea and tactical power domains and autonomous vehicles R&D. He is a former Army Officer and completed multiple assignments in command, plans and operations, and intelligence.

Mr. Jeffrey S. Cairns

Program Manager, Norwich University Applied Research Institutes

Jeff Cairns is currently serving as the Program Manager of the NUARI CGRS Energy Resilience Track, Modular Microgrids in Cold Regions, and Information Operations programs. He served 30 years in the US Army as a Special Forces Officer which included multiple operational assignments as well tours as the Garrison Commander of the Presidio of Monterey, the SOCOM Chair at the National Defense University, and the Deputy Region Director of South- east Region, IMCOM. He holds a bachelor's degree from Norwich University and master's degrees in Management and Strategic Studies.

Colonel Lisa M. Lamb

Commander, U.S. Army Garrison Fort Hunter Liggett

Colonel Lisa M. Lamb grew up in Pittsburgh, Pennsylvania and began her military career with the U.S. Air Force as an enlisted Supply Specialist.

Following her four years of service, Lamb attended Christopher Newport University where she earned a Bachelor of Science degree in Business Administration, and an Army ROTC commission as a Second Lieutenant. She also earned three other graduate degrees: a Master of Business Administration from Southern Connecticut State University; a Master of Public Administration from the University of Michigan; and most recently, a Master of Strategic Studies from the United States Army War College.

Colonel Lamb's military education includes the Quartermaster Officer Basic Course, the Combined Logistics Captains Career Course (CLC3), Combined Arms Services Staff School (CAS3), Command and General Staff College (CGSC), Advanced Joint Professional Military Education (AJPME), the Army Force Management Functional Area Qualification Course, the Reserve Component National Security Course, and the United States Army War College.

Colonel Lamb's previous assignments include: Director, Secretary of the Joint Staff, at U.S. Africa Command, Stuttgart, Germany; The Pentagon, as Headquarters Department of the Army, Force Integration Officer; 311th Signal Command, Honolulu (Hawaii), as the G37 Branch Chief; United States Forces Afghanistan as the Strategic Movements Branch Chief; 196th Support Battalion,

Honolulu (Hawaii) as the Battalion Executive Officer; 9th Mission Support Command, Honolulu (Hawaii) as the HQ Commandant, G4 Plans Officer and Deputy G4; the University of Michigan, as an Assistant Professor of Military Science for the Army ROTC Detachment, Ann Arbor, Michigan; and the 80th Training Division, G4 Plans and Operations Officer, Richmond, Virginia.

Colonel Lamb's awards and decorations include: the Defense Meritorious Service Medal, the Meritorious Service Medal with 6 Oak Leaf Clusters, Army Commendation Medal, Operation Iraqi Freedom/Operation Enduring Freedom Campaign Medals and the Army Staff Badge. Lisa is married to Colonel (retired) Patrick A. Lamb, who is an Accredited Financial Counsellor (AFC) specializing in support to military families. They have four daughters.

Mr. Alex Pina

Director, Converge Strategies, LLC

Alex Pina is a Director at Converge Strategies working at the intersection of infrastructure resilience, clean energy, and national security. He has assisted more than 35 military installations across the world identify energy resilience solutions and conduct exercises. Alex focuses on the impacts to DoD operations during wide-scale power outages and develops cost-effective solutions to addressing those impacts. He created OSD's black start exercise program which identifies gaps between mission requirements and infrastructure capabilities, and he trained many of the team members currently conducting those exercises across the Services. He also created the Energy Resilience Assessment Tool used by OSD ERCIP to compare the performance and life cycle cost of available technology combinations. Alex holds a Master of Science in Engineering and Management and a Bachelor of Science in Aerospace Engineering, both from the Massachusetts Institute of Technology.

Mr. Randy Monohan

Energy Projects Officer–Public Works, Marine Corps Installations Command

Mr. Randy Monohan serves as the Headquarters Marine Corps (HQMC) lead for all energy project development. In this capacity, he has facilitated and managed the award of more than $1.5 billion in projects including MCAS Miramar's base-wide microgrid; MCRD Parris Island's comprehensive resilience project (CoGen, Solar, Storage, Microgrid); MCB Camp Lejeune's steam decentralization; and MCAS Yuma's enhanced-use lease that provides unlimited base-wide backup power during any outage. Mr. Monohan has more 40 years of Marine Corps experience, first serving his country for 20 years on active duty and then 20 years as an energy professional, six of those as an energy consultant, before converting to federal service as the Installation energy manager at MCAS Miramar before his promotion to Lead Energy Projects Officer at HQMC.

Mr. Mick Wasco, PE, CEM

Utilities and Energy Management Director,

Marine Corps Air Station Miramar, United States Marine Corps

Mick Wasco is the Utilities and Energy Management Director at Marine Corps Air Station (MCAS) Miramar. He is responsible for the installation's energy and water efficiency, renewable, behavior, and resilience programs. At MCAS Miramar, the assets managed include over 1.7 MW of distributed PV systems, a 3.2 MW PPA for landfill power, central HVAC control system, advanced metering infrastructure, a base wide reclaimed water utility system, and smart irrigation controllers. The installation has recently commissioned an installation-wide microgrid system and proven capability to island the base as well as support the local community during recent rolling blackouts in California. A 1.8 MW / 2 MWH energy storage system and enhanced load shed capability for demand response is funded and currently in design. This program has amounted to over $65M in projects over the last 8 years and operates at an annual utility budget of $14M per year. Mick has a BS in Structural Engineering from the University of California, San Diego. He is a licensed Professional Engineer in California for Civil, Certified Energy Manager by the Association of Energy Engineers, and previously held a Project Management Professional certification by the Project Management Institute. In 2016, he received the Federal Engineer of the Year Agency Award for the United States Marine Corps from the National Society of Professional Engineers. Also, received the award for Energy Manager of the Year in Region V from the Association of Energy Engineers. In 2020, he received Civilian of the Year for MCAS Miramar and received a Meritorious Civilian Service Award for accomplishments and devotion to duty.

Mr. David A. Poland

Client Solutions Executive, AT&T Global Public Sector, DoD Segment, Army Division, AT&T

Dave Poland is a Client Solutions Executive for the AT&T Public Sector and FirstNet. He consults for DoD customers who need solutions regarding communications, reducing costs, and improving operations. He works with AT&T Trifecta – Fiber, 5G and FirstNet. He also works with IoT, cellular infrastructure, other mobility solutions, and a range of other services and products to implement advanced mobility use cases.

Dave came to AT&T after serving 32 years in the Army and Active Reserve (AGR) as an armor officer, engineer, and systems automation officer/information network engineer. As an AGR officer in the USARC G-6, he worked directly with hurricane operations including hurricanes Maria and Matthew, keeping the Army Reserve network in operation, and providing communications on Puerto Rico. Dave has also researched public private partnerships for cyber security.

He deployed to Iraq and Afghanistan, and held roles at Army Human Resource Command, an expeditionary sustainment command, and the Army Reserve Command. Dave transitioned from the Army as a Colonel in 2019.

Dave attended a War College Fellowship at the Fletcher School for Law and Diplomacy. He has an M.S. in Systems Management from University of Southern California and a B.S. in Finance from West Virginia University. He is PMP, and KM certified.

Enclosure 3, NU Energy Track DRAFT FTR - Task 3 - Create a pilot internship program with ERDC-CERL for Norwich University Undergraduate students

Contract Requirement: In conjunction with Task 1, the NUARI shall establish the Knowledge, Skills, and Abilities (KSA) required to successfully contribute to energy-related research. The internship program will use the KSA to provide two student candidates for Fall 2021 and Spring 2022 to participate in ERDCCERL research projects. The internship shall be executed virtually. The contractor shall provide ERDCCERL a written report detailing the preparation and execution of the internship program, participant assessment, a summary of lessons learned and recommendations for continuing the Internship Program.

Method of Surveillance: Review by COR Criteria for Acceptance
Submitted by the date agreed upon in the contractor's schedule.
Select 2 students and train at Norwich for internship with CERL
Begin internship with CERL by October
Students will provide a report as a product of their internship
CERL researchers and Norwich faculty provides feedback on internship

In Phase 3 of the NU Energy Resilience Track, four student internships were offered to Norwich undergraduate engineering and science majors. The internships were paid, not for academic credit and primarily lead and supervised by ERDC-CERL. As delineated by the internship structure from Phase 2, the pilot internship in Phase 3 had a common core of required academic products and satisfied the following structure:

- A Norwich faculty member served as the administrative coordinator and faculty mentor for the internship.
- An institutional or agency supervisor/mentor – ERDC-CERL – served as the primary mentor or point-of-contact (POC) for each internship activities.
- Readings for this course were supplied first by the Norwich faculty mentor and then by the internship organization, ERDC-CERL.
- Resources and further structure for the internship was directed by the supervisors at ERDC-CERL as part of the organization's work with undergraduates at other universities.

The student interns also had the title of Student Fellows in the CGRS Student Fellowship programs that identifies Norwich undergraduates with interests in a broad range of interdisciplinary research topics related to Resilience and Security. The CGRS Student Fellow program offered the students resources and guidance related to the conducting of academic research and a network of over 12 other student fellows.

The students selected for the pilot Energy Track internship had the opportunity to apply and expand their knowledge within their engineering and math disciplines to applications related to Energy and Critical Infrastructure Resilience in the context of the US Army. Prior to meeting their project supervisors, the interns were asked to read the National Defense Strategy and reading materials related to energy resilience and to identify several topic areas of interest to them. Topic areas included electric vehicles, national and grid security, preventing grid failure, renewable energy hybrid systems and microgrids. This exercise was intended to familiarize students with the topic areas relevant to energy resilience and begin to develop their interest in preparation for their work with ERDC-CERL. After a briefing from ERDC-CERL in November, the Norwich Energy Track team confirmed the participation of the selected four students representing engineering and science programs to participate in the research-focused internship supervised by CERL. Students met regularly with their internship supervisors for the remainder of the Fall 2021 semester and for all of Spring 2022 and produced research papers.

The research produced by the interns covered the five cross-disciplinary knowledge areas identified by the Energy Track: Energy Fundamentals, Risk Assessment, Policy and Funding, Master Planning and Cyber Security. The pilot Energy Track internship program conducted in Phase 3 satisfied the following learning objectives:

- Develop the capacity to think critically about a given problem or question related to Resilience of critical infrastructure systems.
- Build skills in conducting analysis in a variety of industries and develop an understanding of the challenges present in a global environment.
- Raise the consciousness about the importance of Energy Resilience in the real world.
- Develop powers of managerial judgment, build skills in assessing business risk, and improve the ability to create results-oriented plans.
- Be able to operate effectively as a team in an unstructured environment under conditions of uncertainty and incomplete information.

Example NU Energy Track Internship Contract

This internship course has a format of directed study. You are responsible for regular meetings throughout the semester with a mentor from your Academic Department or Research Center, but the expectation is that the structure of the internship will be primarily guided by your supervisor at the host institution or agency. A series of set assignment deadlines will be established that will help you to stay on track and develop your final academic products for this internship.

Instructor:
Office:

Phone:
Office hours:
Email:

Student Responsibilities: For internships where security clearances or confidentiality preclude any of the following academic work products or other requirements, alternatives may be possible (such as redacting names or specific content in a technical report, or substituting in its place a critical synthesis paper or literature review pertinent to the internship).

1. Communication

   Communication is CRITICAL in this course. The logistics of this course require weekly communication with your Norwich University Faculty mentor as well as your institutional or agency supervisor/mentor (hereinafter, 'point-of-contact' or POC).

2. Internship Projects

   Internships for any credit level require weekly reports or regular task logs (initialed or signed off by your POC) as well as a final evaluation by your POC (see #3 below). Internships above 1-credit hour also require submission of an experience journal (see #4 below) and one or more technical reports or literature reviews of the topic. Two-credit internships require a technical report (or other written work product), a literature review, or other critical synthesis paper, of the topics associated with the internship.

   Three-credit internships require both a technical report and a literature review. As the number of possible credit hours earned increases, additional academic products are required. Academic products required for internships beyond three credit hours are similar in nature to those of three-credit-hour internships, but students must submit either additional, substantively different reports or work products, or more extensive ones (see Table 1 for estimates of task time relative to credit hours). These projects will be presented to both the internship POC and Faculty mentor by the last day of classes of the semester in which the internship is being pursued.

3. Supervisor Evaluation Form

   Interns are required to provide their supervisors with an evaluation form that will be sent directly to the Faculty internship mentor. It is the intern's responsibility to make sure that this completed form is sent on-time to the Faculty mentor.

4. Experience Journal
   An experience journal associated with the internship is based on: a) reflective essay that explains the knowledge, skills, and abilities the intern learned and how these relate to their field, b) demonstrates some progression of knowledge, and c) shows a progression in the intern's skills of observation and discovery.

Course Goals: 1) Experience an active setting where Energy Resilience is being addressed or studied and pursue work that would not be experienced in a typical classroom setting. 2) Work with the technical and scientific literature as it pertains to your project. 3) Learn and follow/apply best-practices for professional conduct and specific to the internship organization or profession; 4) Practice, through drafting and finalizing required academic work products, proper scientific/technical writing.

Grading:

- 1-credit: Reports/Task logs initialed by supervisor weekly (10%), final supervisor evaluation (15%), and internship experience journal (75%) – Pass/Fail grade only
- 2-credit: Reports/Task logs initialed by supervisor weekly (10%), final supervisor evaluation (15%), internship experience journal (25%), critical synthesis paper based from appropriate literature or technical report (50%)
- 3-credit: Reports/Task logs initialed by supervisor weekly (10%), final supervisor evaluation (15%), internship experience journal (15%), critical synthesis paper based from appropriate literature (30%) and technical report (30%)
- 4-, 5-, and 6-credit: Reports/Task logs initialed by supervisor weekly (5%), final supervisor evaluation (10%), internship experience journal (10%), critical synthesis paper based from appropriate literature (20%) and technical report (20%). Students may meet the additional academic product requirements for internships of four, five, or six, credit hours by submitting multiple, substantively-different technical reports (one per additional credit hour). Alternatively, students may complete more extensive internship work, and submit a more extensive related work products or technical reports. Guidelines for internship students, mentors, and POCs, regarding approximate contact and work time per credit hour are shown in Table 1 below.

Schedule: To be developed based on the internship and complimentary project design.

Enclosure 4, NU Energy Track DRAFT FTR – Consolidated Energy Resilience Lessons Learned

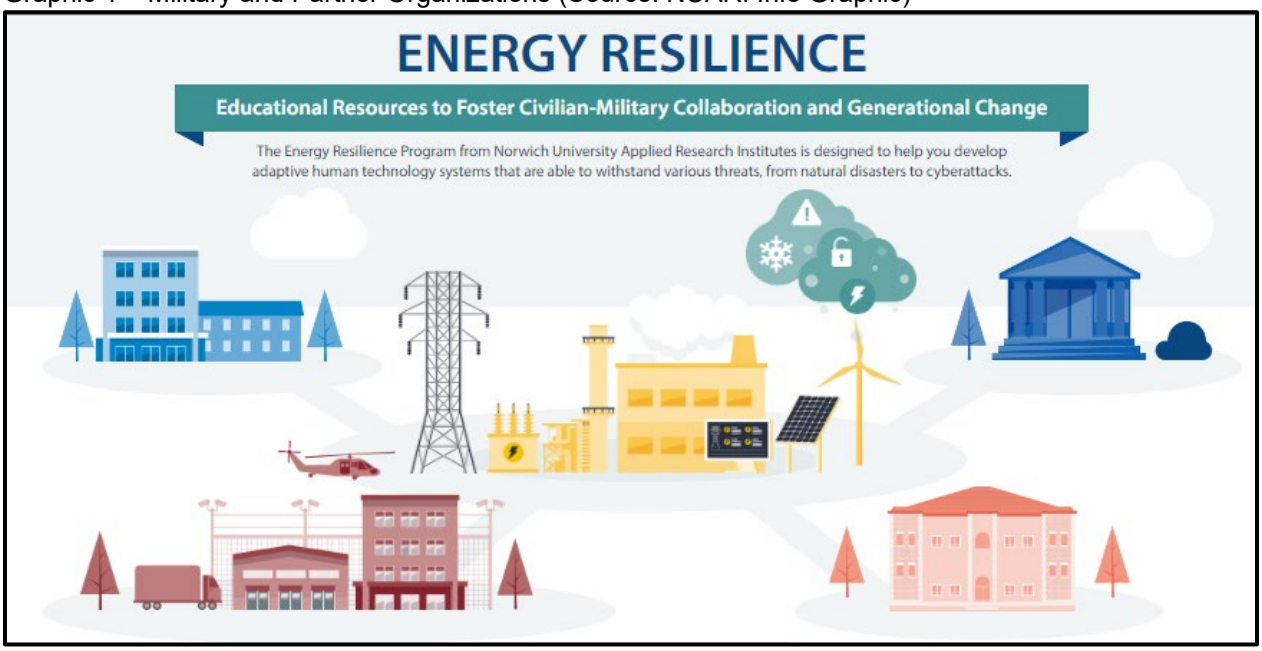
Task: The task is to consolidate the lessons learned in Phase 3 of the NU Energy Track for the purpose of providing an Energy Resilience planning and operations framework for DoD.

Situation – The following is subject to change yet provides the reasoning for addressing Energy Resilience tasks:

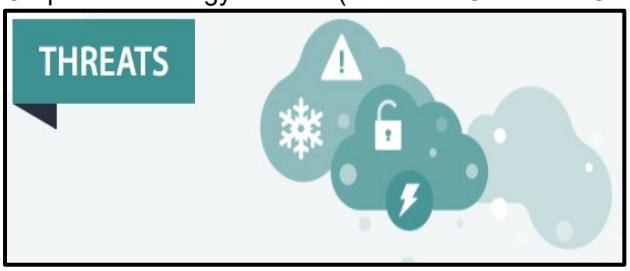
> *"The National Defense Strategy (NDS) states the "homeland is no longer a sanctuary." Threat assessments and national-level strategic guidance make it clear Army activities in the homeland and on our installations are at increasing risk of disruption and attack."*
>
> *"Installations facilitate the Army's ability to mobilize, deploy, and sustain forces in support of Combatant Commanders. TRADOC Pamphlet 525-3-1, The U.S. Army in Multi-Domain Operations 2028 (MDO 2028), redefined the battlespace, adding the SSA. The strategic importance of Army installations in the execution of the National Security Strategy through multi-domain power projection will continue to be a critical dimension of the military element of national power. The challenge for the Department of Defense and the Army is establishing the necessary conditions to ensure that Installations will be fully capable of supporting their increasingly critical role as Power Projection Platforms (PPPs)." Army Installation Strategy, 2021,p 3&4*

Energy Resilience Partnership Framework: An Installation Energy Resilience posture and program should include partnerships and providers that are intertwined in the resilience of military Installations. Each community, or activity, shown in the information graphic below plays a role in an effective Energy Resilience program that ensures the accomplishment of the military mission.

Graphic 1 – Military and Partner Organizations (Source: NUARI Info Graphic)



Graphic 2 – Energy Threats (Source: NUARI Info Graphic)



Dangers to our energy and power systems can impact other critical infrastructure and disrupt our lives in myriad ways. A natural disaster striking a power station, for example, can bring down electricity to hospitals, schools, and families for miles. Developing energy resilience in the face of threats both new and old, human and environmental, can thus improve our resilience more broadly. Unfortunately, the threats to energy resilience are varied, having technological and natural, human and organizational dimensions. They include:

- Natural Disasters and extreme climate events
- Cyberattacks
- Terrorist Attacks
- Civil Unrest
- Foreign Military Attacks
- Equipment failures

Graphic 3 – Military Installations and Service Command Structure (Source: NUARI Info Graphic)

While each US Military installation has its own geographic location and particular functions in support of the US Department of Defense, all require energy resilience in order to successfully fulfill their various missions. Given the increasing and broad-based cyber and climate threats, the resilience challenges facing military installations have growing importance in the defense of the homeland and their national security missions.

Leaders at all levels must understand the composition of the critical infrastructure, whose overall resilience in the face of natural or manmade interruptions, is key to mission success of Army installations and their ability to project combat power. Leaders must understand the critical infrastructure both on and off base that must be operational for the installation and its tenant units to accomplish their assigned missions. Further, Leaders must familiarize themselves with the following:

- Threats to critical infrastructure both kinetic and non-kinetic, and the tools available for identifying these threats and potential partners in addressing the issue.
- The Federal Agencies, local governments, non-profit and for-profit organizations that will play key roles in managing the critical infrastructure that impacts Installation resilience.
- Risk management of Installation assets as well as the critical infrastructure owned by others.
- Execution of critical infrastructure analysis to develop an understanding of threats.
- Conducting Energy Resilience exercises that include critical partners.
- Knowledge of policies controlling resilience standards.
- Broaden the field of view as to what could/would happen if there was a wide area blackout for even the 14 days that the Army currently plans for- the critical human infrastructure and the communities they live in are not prepared for a 14 day outage.
- Consider the Community Lifelines that are essential for mission success with specific emphasis on workforce housing off the installation

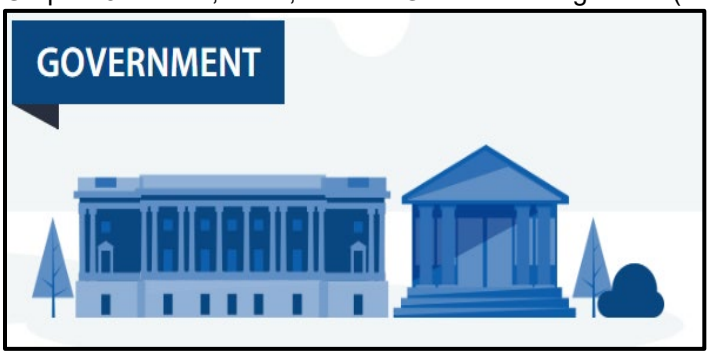
Graphic 4 – Defense Communities (Source: NUARI Info Graphic)

The majority of US Military installations rely on critical community lifelines, such as power, water and sanitation, in addition to schools, housing, retail and many other goods and services. The installation's reliance on the local civilian infrastructure means that an installation's resilience is intertwined with the resilience of the surrounding community.

The technological, political and economic ties between community and installation are at the heart of all efforts to build resilient installation energy and power systems.

Local events can have cascading effects on the security and economy of vast areas. Flooding or a Cyber attack in one city, for example, can disrupt vital energy and power systems throughout an entire state or even region. National resilience, therefore, relies on communities assessing and enhancing the resilience of their local systems as well as the concept of more distributive/distributed systems.

Graphic 5 – Local, State, Federal Government Agencies (Source: NUARI Info Graphic)



While the work of developing resilient installation energy systems ultimately occurs at the installation, in the surrounding communities and on utility infrastructure, it begins with government leadership, public funds, and increasingly public-private partnerships. Energy resilience is a matter of national security and, therefore, government policy should, but does not always support its development.

Graphic 6 – Utilities and Critical Infrastructure (Source: NUARI Info Graphic)

Power sources, generating stations, electrical grids, storage, control systems — the nuts and bolts of energy resilience lies in utility infrastructure. As such, that infrastructure must not only be maintained, controlled and protected, but further developed to withstand new or growing threats, such as cyberattacks and climate change.

Graphic 7 – Academia, Training, Exercises (Source: NUARI Info Graphic)

Academic institutions play a key role in educating, researching, and shaping resilience-driven mindsets. As energy resilience will continue to be an underlying foundation across multiple sectors and society at large, academic focus in this area is critical.

At Norwich University, the energy track ensures that students in classes across disciplines are introduced to energy fundamentals and are able to research policies, economics and social considerations. They put these lessons into practice through internships at the undergraduate level, by optimizing workplace operations at the mid-career level, and through organizational strategy at the senior leadership level.

Students will also collaborate with Norwich University's research center partners, including the Center for Global Resilience and Security, the Peace and War Center, and the Center for Cybersecurity and Forensics Education and Research.

Concept of Energy Resilience on US Military Installations—Black Start Exercises: The tasks associated with an effective Energy Resilience posture aligns with an effective tabletop, virtual, or hands-on exercise program. Like general military training doctrine, the exercise program begins with an evaluation of individual and collective tasks that impact the management of critical infrastructure in order to maintain military mission readiness. The DoD Black Start Exercise program framework is intended to provide the template (or doctrine) to identify gaps between mission requirements and critical infrastructure capabilities. The objective of this exercise process is to identify training and project requirements to improve Installation energy resilience. The following figures provide the framework to address an Installation Black Start Exercise and thus mission success with regards to energy resilience:

The value of using Black Start Exercises as a framework for coordinating Energy Resilience tasks is outlined in the following figure:

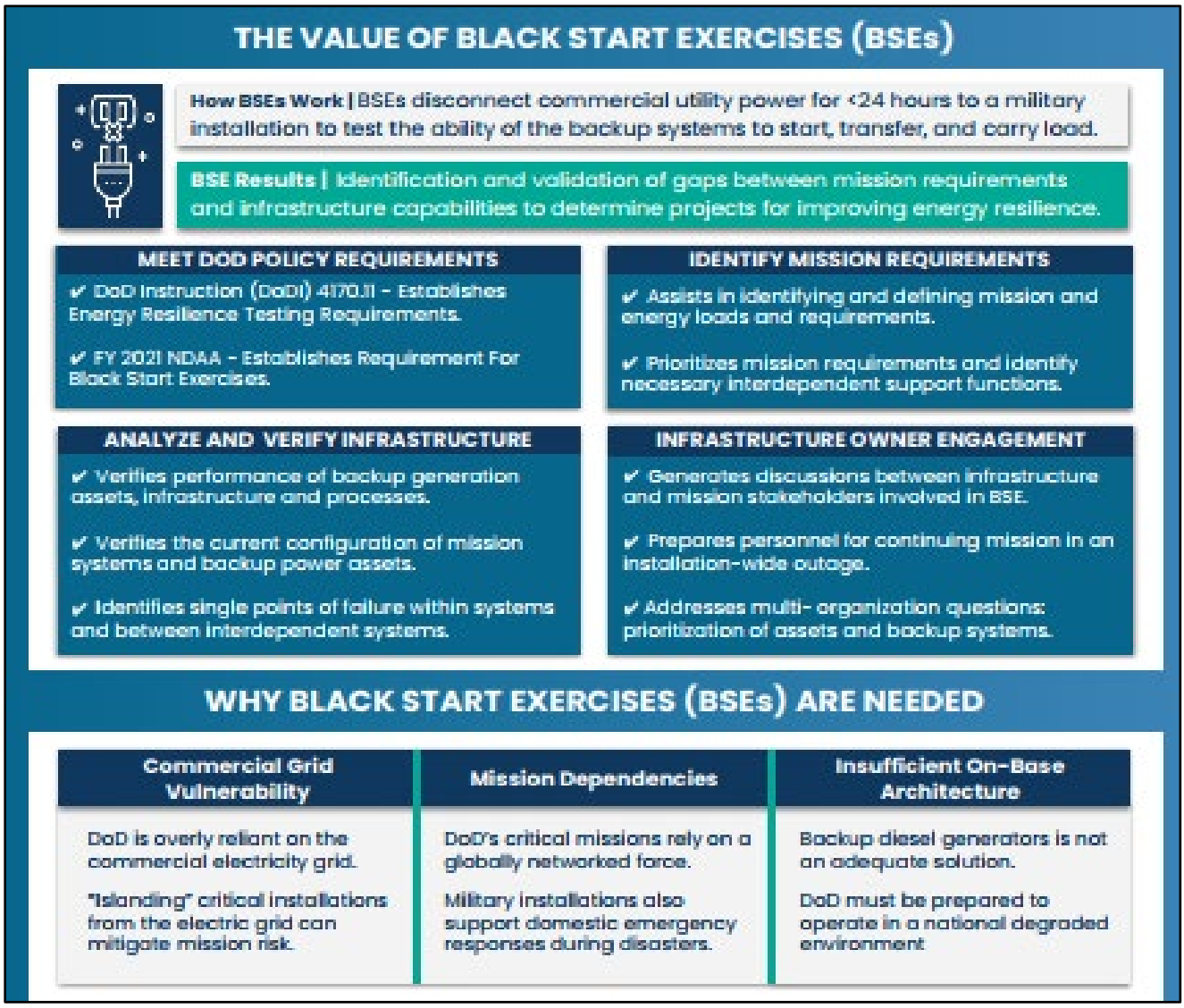


Figure 1: Value of Black Start Exercises (Source: Converge Strategies (CSL)) Also, The last phrase in the last box of figure 1 is critical. Leaders must include the local government and the social order component of a national degraded environment to examine the needs and availability of the civilian workforce (employees and contractors) and the uniformed workforce that live in the civilian region around an installation. They are critical to the installation mission assurance, but most of the focus is on the hardware component of the problem.

Stakeholders: Installation leadership should consider the following figure regarding potential stakeholders when coordinating Energy Resilience exercises, planning actions, and proficiency training:

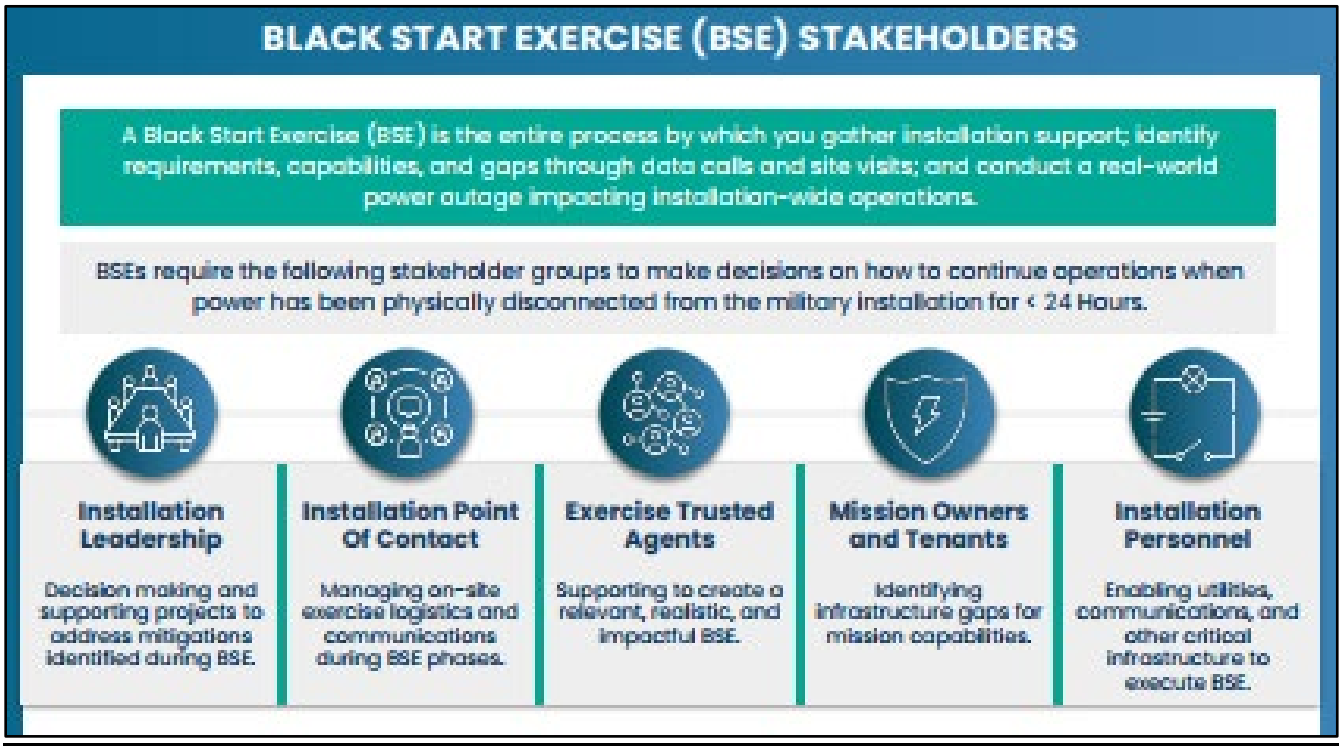


Figure 2 – Energy Resilience Stakeholders (Source: Converge Strategies (CSL)) Further, consider the need another "button" on this chart that talks about off installation critical infrastructure that may impact mission capability.

Phases: Consider integrating the following phases into Installation planning and operations elements (units, staffs, partners inside and outside the fence line) in order to address Energy Resilience capabilities in relationship to mission assurance:

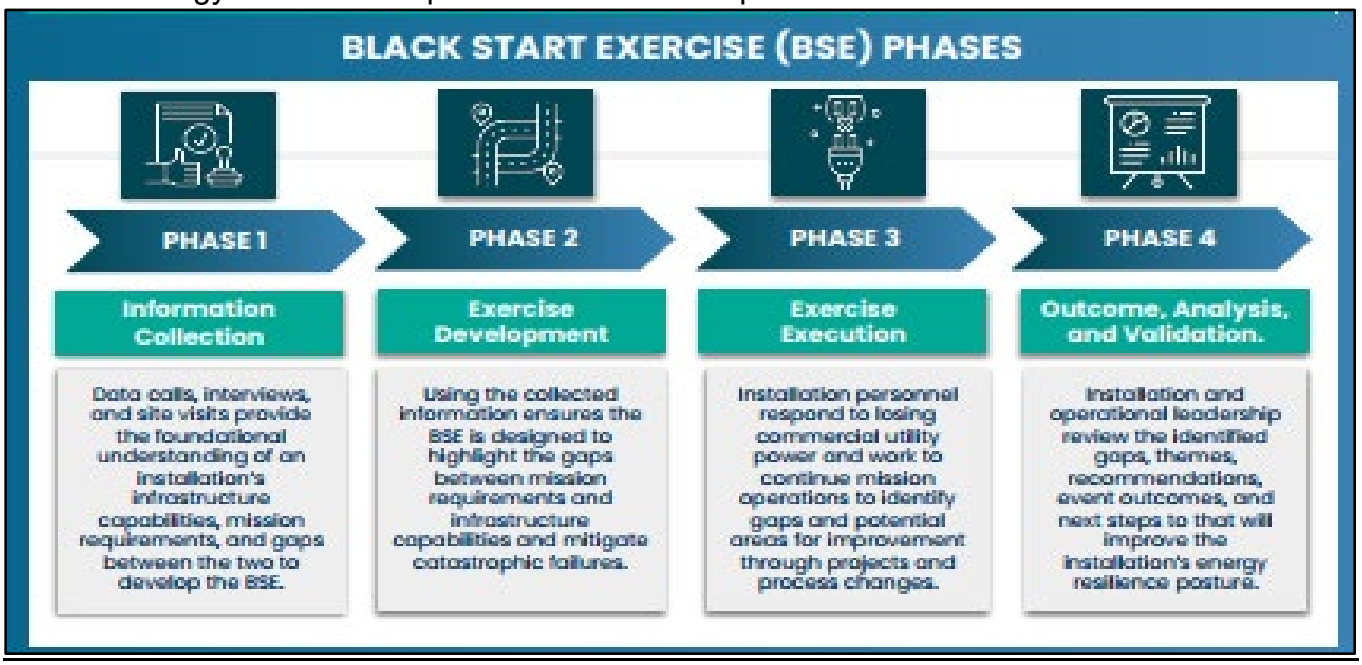


Figure 3 – Energy Resilience Exercise Phases (Source: Converge Strategies (CSL)) Also, Consider a phase 5 that at least tabletops what would happen outside the fence line in a wide area outage of a long duration. 12 hrs is a necessary start, but an insufficient standard to measure success of mission assurance.

Lessons Learned: As a tool for establishing Energy Resilience goals and objectives, consider the following lessons learned and value for DoD leadership in the figure below:

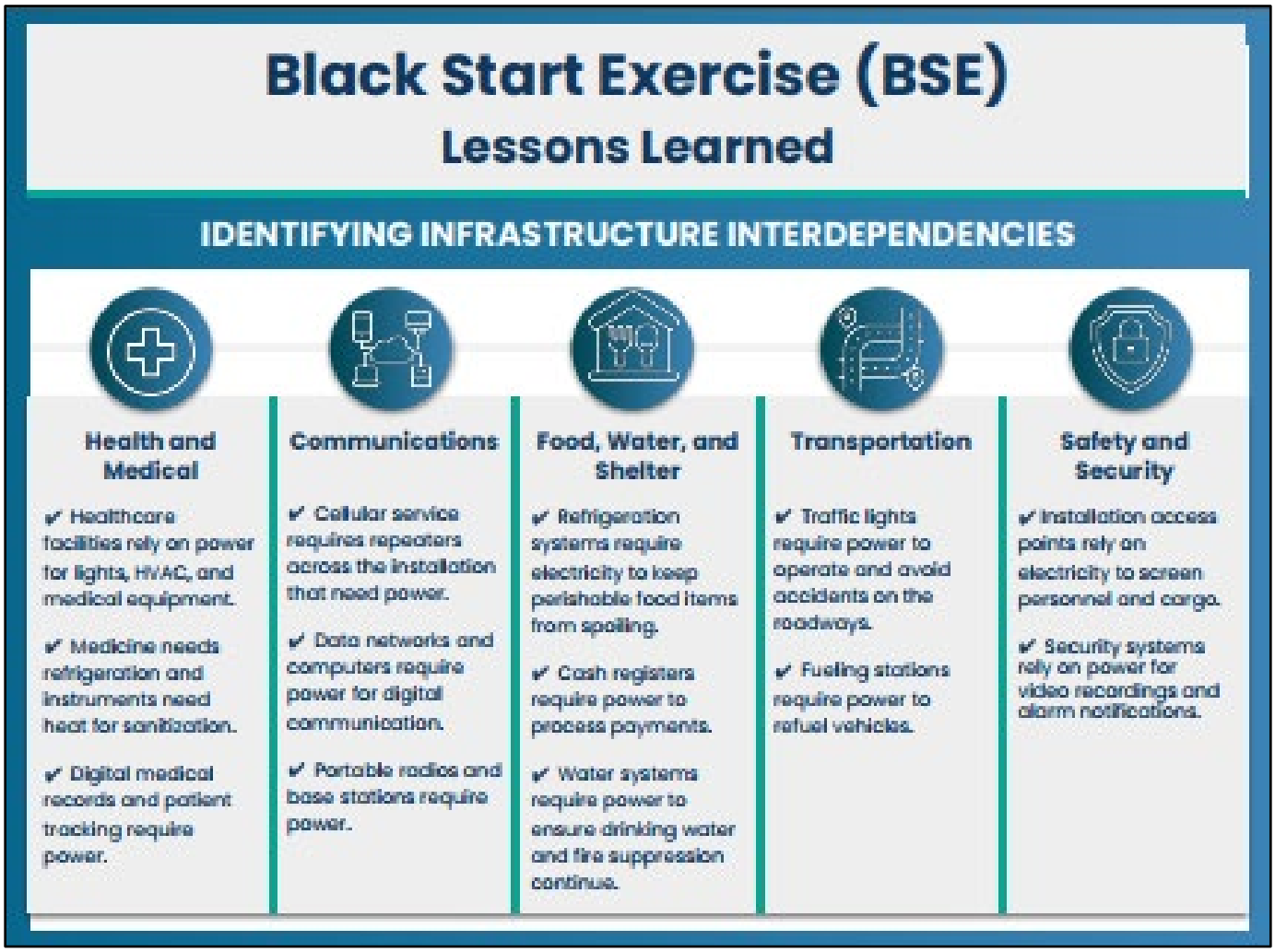


Figure 4 – Energy Resilience Lessons Learned (Source: Converge Strategies (CSL)) Leaders *must start think of the critical physical and human infrastructure interdependencies beyond the fence line and for ever lengthening outage durations.*

Benefits of Black Start Planning: Consider the following benefits with the use of the Black Start exercise framework for addressing Energy Resilience functions:

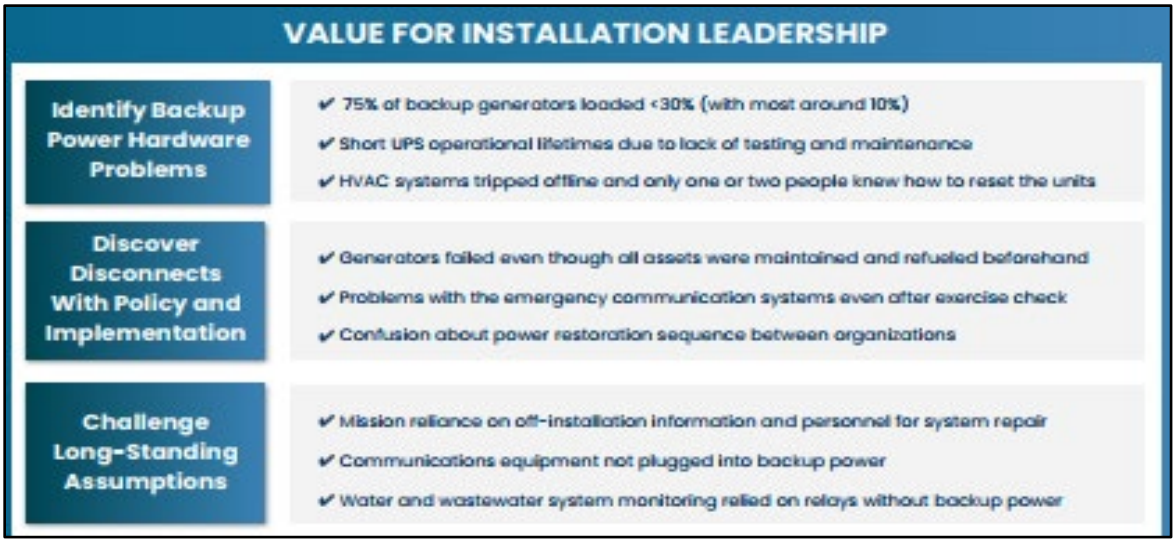


Figure 5 – Value for Installation Leadership (Source: Converge Strategies (CSL))

Coordinating Tasks/Tips/Best Practices:

Human Dimension: The integration of social, economic, political, and risk-based considerations in the energy resilience curriculum at all levels emphasized the human dimension in the evolving technological advancements, the uncertainties inherent in human decision making, and underscored the need for collaborative frameworks and partnerships that consider within and outside the fence vulnerabilities and capabilities. The need for more policy informed technical training was acknowledged by undergraduates through senior leaders. Along with experiential and hands on training components, this type of thoughtful curriculum will be a hallmark of the Norwich University energy track moving forward in support of the national security strategy.

Modern Platforms: Use of modern platforms for dissemination in multimedia formats and curricular tools such as tabletop exercises, NUARI's DECIDE platform elevated student understanding, interactions, and engagement across all levels of effort. As the NU energy track moves forward, capstones at the undergraduate level to seminars at mid-officer and senior leader levels will continue to benefit from the juxtaposition of energy resilience with Norwich University's growing leadership in cybersecurity, information warfare, artificial intelligence, and machine learning to recruit, build, and train and bring about a generational change in the DoD.

Risk and Funding: There is a correlation between risk and funding of an energy resilience project/program. Consider multiple funding opportunities such as federal

grants, state funding, industry partnerships, and programed budget opportunities to fund energy projects.

Policy Integration: Knowledge of policy documents at the Department level is relevant to the development of Installation level energy programs. For example, the Hot Topic seminar highlighted the new Army Installations Strategy (G-9) and the new Army Climate Strategy (AASA I&E) that require coordination to be effective in the realm of mission assurance. The Installation strategy is based on an assumption of a level of investment in installation modernization that has historically not happened. Leaders need to think about how to model the impacts of the pace of modernization not happening. The installation enterprise needs to be invested in as if it were a "weapon".

Energy Resilience Exercises: Training energy professionals and those that support energy efforts on an Installation is a key component to achieving energy resilience on an Installation. Virtual distributed exercises is a viable tool assess the collective ability of the Installation Management staff and Partner organizations in order to maintain mission capabilities. This is critical, but equally critical is exercising the "policy" leaders and "combat" leaders on the impact critical infrastructure failure will have on their mission success. The infrastructure community will never be resourced adequately unless the operators realize the mission assurance implications of inadequately modernized and resilient infrastructure.

Stakeholders: Networking and information sharing, particularly across military and civilian communities, is essential to the protection of critical infrastructure and Military mission assurance. Consider the following education framework to develop human capital to address building an effective energy resilience team that can work with a wide range of critical infrastructure professionals:

Undergraduate Education Framework

Module Development. The modular structure of all curricula developed in this effort at the undergraduate, mid-officer, and senior leader levels offer extreme flexibility to DoD Army, educational partners, and all entities involved in training for energy resilience. The energy track modular framework will help address specific DoD personnel knowledge gaps in energy resilience in the following categories:

- Resilience for Sustainability (sub-module of Energy Fundamentals)
- Energy and You Module
- Energy and Society Module
- Energy and Resilience Module
- Energy Nexus Module

Mid-Career Education Programs

- Microgrid Architecture course
- Industrial Control Systems course

- Critical Infrastructure/Energy Resilience Overview Module
- Identifying Mission Critical Infrastructure/Energy Systems Module
- Critical Infrastructure Threat Analysis/Risk Management Module
- Energy/Critical Infrastructure Resilience Policy and Partnerships Module
- Exercise Development Process - Capstone Exercise with DECIDE® Module
- Energy Resilience Leadership Graduate Certificate – Public Leadership, Crisis Management and Organizational Change and Critical Infrastructure Protection
- National Cybersecurity Preparedness Consortium courses: https://nationalcpc.org/

Mid-Career Education Framework

Virtual/hybrid modality: For active mid-career personnel, who cannot take in person professional development and upskilling courses due to workplace expectations, the NUARI team implemented two full courses to run completely online. The course was pre-designed, and the instructor was accessible to facilitate discussions. Several additional modules were integrated into existing graduate level programs. These as well as the certifications were also offered in virtual formats to provide the greatest flexibility.

Integration of complementary sectors to offer a complete curricular experience: In each module, certificate, and course, all areas aligned with the energy sector were covered to emphasize the embodied nature of energy resilience and security with risk analysis, partnerships, cybersecurity, critical infrastructure connections, maintenance of all interconnected systems through master planning and systems thinking, and the impact that climate change has on the sector as well as the ways in which innovations and changes in the sector can impact climate driven national security considerations.

Peer learning: The courses specifically emphasized peer interaction and feedback as a way to learn from fellow professionals. Some of these were planned and instructor facilitated, while others occurred organically. There was some pushback against this frame from a busy professional perspective, but for those that engaged, the peer interactions advanced learning and helped build connections among participants.

Senior Leader Education/Seminar Program – includes the education modules listed below and the integration of case studies as well as DoD Installation leadership presentations:

- Critical Infrastructure/Energy Resilience Overview Module
- Identifying Mission Critical Infrastructure/Energy Systems Module
- Critical Infrastructure Threat Analysis/Risk Management Module
- Energy/Critical Infrastructure Resilience Policy and Partnerships Module
- Exercise Development Process - Capstone Exercise with DECIDE® Module

Senior Education Framework In-person modality: For senior leaders and decision makers in the US DoD, research and private organizations, utility and lending companies, as well as academe and nonprofit organizations, the primary frame was an in person gathering. The goal was to build a day around a series of discussions that would involve asking and discussing some really hard to answer questions and explore the implications of potential decisions that would follow.

Multiple moderated panels with expert guests: With a mix of core and crosscutting themes and discussion areas, the key was to invite as many experts representing a range of areas as possible and debate ongoing policies, decisions, implementation techniques, shortcomings, funding mechanisms, forecasting for unanticipated vulnerabilities, etc. and evaluate best practices as well as ways to further improve upon them.

Keynote and follow up: A keynote was considered important to ensure that all senior leaders participating in the AUSA Hot Topics were oriented towards the areas that decision makers had to keep front of their mind even as they grappled with uncertainties in data, processes, systems, and funding that would influence future decision making as much as infrastructure including cyber vulnerabilities and misinformation. A follow-up survey was designed to solicit feedback on the event and to help strategize sustaining this form of gathering in the long term. The Senior Leader Seminar should continue to be conducted annually to address mission assurance issues. Further, some curricula addressing Critical infrastructure and the partnerships necessary for mission assurance needs to be integrated into the professional development of the officer corps through pre-command courses/orientations, CGSC and Senior Service College.

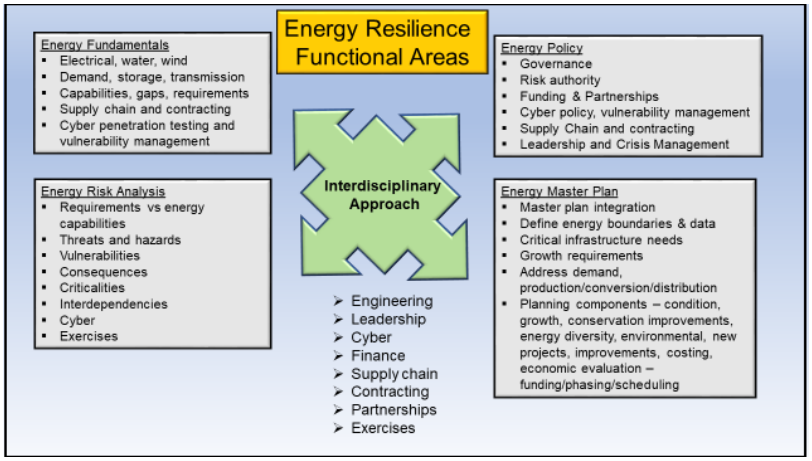
Energy Resilience Leader Checklist

Selected References:

- ☐ DoD Installation and Climate Strategies
- ☐ Cyber security and Critical Infrastructure – reference the critical infrastructure sectors - https://www.cisa.gov/critical-infrastructure-sectors
- ☐ Energy Resilience Exercise After Action reports
- ☐ Intergovernmental Support Agreements (IGSA) – current status and impact

Task Organization – identify your current status:

- ☐ Military partners
- ☐ Community partners
- ☐ Utility partners
- ☐ Other Government organizations – DoE, DHLS, DoD
- ☐ Civilian Organizations – Local Community Government structure, Civilian organizations - ICMA, ADC, SAME



Energy Resilience Framework – lead an interdisciplinary approach to maintaining installation capabilities in the following framework:

- ☐ Fundamentals – Identify the organization responsible and their capability in each of the following categories:
  - Electrical, water, wind
  - Demand, storage, transmission
  - Capabilities, gaps, requirements
  - Supply chain and contracting
  - Cyber penetration testing and vulnerability management

- ☐ Energy Risk Analysis
  - Requirements vs energy capabilities
  - Threats and hazards
  - Vulnerabilities
  - Consequences
  - Criticalities
  - Interdependencies
  - Cyber
  - Exercises

- ☐ Energy Policy
  - Governance
  - Risk authority
  - Funding & Partnerships
  - Cyber policy, vulnerability management
  - Supply Chain and contracting
  - Leadership and Crisis Management

- ☐ Energy Master Plan
  - Master plan integration
  - Define energy boundaries & data
  - Critical infrastructure needs
  - Growth requirements
  - Address demand, production/conversion/distribution
  - Planning components – condition, growth, conservation improvements, energy diversity, environmental, new projects, improvements, costing, economic evaluation – funding/phasing/scheduling

Energy Resilience Educator Checklist

The ADDIE Model of Instructional Design - To build and offer the stated education and training goals, an effective training and education program will employ the ADDIE model (or similar format) of instructional design. This model gives a focused approach in the development of course content and allows for continuous evaluation and improvement. The ADDIE model includes the following phases: analysis, design, development, implementation and evaluation.

☐ *Analysis: Identify the Requirements* - The analysis phase involves identifying the instructional problem or, from a training standpoint, identifying the performance gap and desired outcome subject areas. This phase includes identifying participant characteristics, learning resources, training methodologies, defining the learning environment, establishing instructional goals and objectives, and determining budget/ time constraints.

As an example, the NU Energy Track analysis resulted in the following as the "intent" of the program:

Purpose: Provide energy resilience resources to Norwich University students, other academic institutions, Department of the Army, other DoD entities, and local communities.

Method: The method to accomplish this "Generational Change" is a combination of academic and continuing professional education programs, consulting services, distributed exercise programs tailored to each population.

End state: The Energy Track is a sustainable, engaging educational program that delivers relevant energy resilience educational resources in support of the objectives of the DoD and other customers.

☐ *Design: Identify the Learning Objectives* - The design phase involves subject matter design broadly through storyboards or a prototype, including defining specific learning objectives and instructional strategies, structuring content, and assessments. Assessments will provide feedback on the learner's progress in achieving the learning objectives.

As an example, the Energy Track took a Modular Approach in the education and training programs:
Undergraduate Curricular Enhancements: The goal of the curricular enhancements is to provide foundational energy resilience knowledge to future military officers and civilians. This foundational knowledge will be delivered in the form of interdisciplinary curriculum, internships, research, and capstone projects that expose students to energy resilience. The modules included the following which were integrated into existing Engineering and Humanities courses:

- *Resilience for Sustainability (sub-module of Energy Fundamentals)*
- *Energy and You Module*
- *Energy and Society Module*
- *Energy and Resilience Module*
- *Energy Nexus Module*

Mid-level professional education/training programs provided energy resilience courses and certificates from a menu of relevant courses and resources to supplement knowledge gaps experienced by mid-level military and DoD civilian professionals who have the authority to positively influence the energy resilience in a military organization.

A professional seminar for senior leaders will address strategic energy guidance in order to understand strategic energy resourcing, strategic energy risk assessments, and appropriate mitigation in coordination with a dynamic strategic energy master plan.

The Internship program is to establish the Knowledge, Skills, and Abilities (KSA) required to successfully contribute to an energy research related internship.

- ☐ *Development: Develop a Performance Solution* - The development phase involves creating, curating, and assembling the content specified in the design phase. This phase included stakeholder review and validation, as well as any required revisions. This phase involved the integration of technology and related testing. Pilot programs were conducted to test the validity of the material and delivery methods and relevant case studies were integrated in courses to emphasize the learning outcomes and the concept of experiential learning.

- ☐ *Implementation: Deliver the Performance Solution*
  Implementation is the construction and application of the course curriculum, learning outcomes, and the learning space. The process should also include confirming the availability of required materials and associated applications, preparing learners to use any required tools or technology. Instructors are assigned and students then participate in the program.

- ☐ *Evaluation: Evaluate the Results Relative to the Performance Objectives* - In practice, the evaluation phase is included in every aspect of the ADDIE process. The overall design process is iterative with elements fine-tuned along the way. Quality assurance evaluations are conducted prior to implementation to confirm the course material meets the specifications established in the design phase. A summative evaluation will be conducted after implementation to determine training effectiveness on three bases: participant satisfaction, participant learning, and participant performance.

References:

The following references provide background information regarding Energy Resilience within, and outside of, DoD:

National Guidance Documents		
Title	**Link**	**Description/Key Words**
Presidential Policy Directive 21-Critical Infrastructure Security and Resilience (2013)	https://obamawhitehouse.archives.gov/the-press-office/2013/02/12/presidential-policy-directive-critical-infrastructure-security-and-resil	This directive establishes national policy on critical infrastructure security and resilience.
National Infrastructure Protection Plan (NIPP)-Partnering for Critical Infrastructure Security and Resilience and selected supplements-Dept of Homeland Security (2013)	https://www.dhs.gov/sites/default/files/publications/National-Infrastructure-Protection-Plan-2013-508.pdf	The National Plan builds upon previous NIPPs by emphasizing the complementary goals of security and resilience for critical infrastructure. To achieve these goals, cyber and physical security and the resilience of critical infrastructure assets, systems, and networks are integrated into an enterprise approach to risk management.
NPPD Resources to Support Vulnerability Assessments-Dept. of Homeland Security	https://www.cisa.gov/sites/default/files/publications/NIPP-2013-Supplement-NPPD-Resources-to-Support-VAs-508.pdf	NPPD provides additional resources, typically in the form of informational material on known vulnerabilities, to help owners and operators understand vulnerabilities at a more general level.
Executing a Critical Infrastructure Risk Management Approach-Dept. of Homeland Security	https://www.cisa.gov/sites/default/files/publications/NIPP-2013-Supplement-Executing-a-CI-Risk-Mgmt-Approach-508.pdf	The critical infrastructure risk management approach described in this supplement can be applied to all threats and hazards, including cyber incidents, natural disasters, man-made safety hazards, and acts of terrorism, although different information and methodologies may be used to understand each.
Incorporating Resilience into Critical Infrastructure Projects-Dept. of Homeland Security	https://www.cisa.gov/sites/default/files/publications/NIPP-2013-Supplement-Incorporating-Resilience-into-CI-Projects-508.pdf	This supplement includes examples of steps in the infrastructure planning and investment process that can be used to prioritize projects that promote resilient infrastructure.
NIST Brief 13-Identifying and Prioritizing Closure of	https://nvlpubs.nist.gov/nistpubs/SpecialP	This Guide Brief aims to assist collaborative planning teams with

Resilience Gaps-National Institute of Standards and Technology (2017)	ublications/NIST.SP.1190GB-13.pdf	Step 4, Plan Development, by supporting communities in identifying resilience gaps using the performance goals tables. The intended user of this Guide Brief is an analyst or resilience planning team member who helps set priorities for the overall community or for a specific building cluster or infrastructure system.
NIST Spec. Pub. 1190-Community Resilience Planning Guide	https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.1190v1.pdf	A six-step planning process for local governments, the logical conveners, to bring stakeholders together and incorporate resilience into their short- and long-term planning.
Executive Order 13834-Efficient Federal Operations-Presidential Order for Agencies to meet statutory requirements that increases efficiency, optimizes performance, eliminates unnecessary use of resources, and protects the Environment-Mar 2018	https://www.federalregister.gov/documents/2018/05/22/2018-11101/efficient-federal-operations	Statutory requirements related to energy and environmental performance of executive departments and agencies

DoD and Army Guidance Documents		
Title	**Link**	**Description/Key Words**
Office of the Assistant Secretary of Defense for Sustainment: Energy Resilience Program	https://www.acq.osd.mil/eie/ie/fep_energy_resilience.html	Official website with policy and guidance, initiatives and collaboration and partnership references.
Installation Energy Instruction DoDI 4170.11 Mar 2016 (Installation Energy Management)	https://www.acq.osd.mil/eie/Downloads/IE/DODI%204170.11%20-%20Change%201%20Effective%20March%2016%202016%20FINAL.pdf	Goals and policies for DoD Installation energy management. Includes references, responsibilities and procedures.
The National Defense Strategy-Jan 2018	https://dod.defense.gov/Portals/1/Documents/pubs/2018-National-Defense-Strategy-Summary.pdf	DoD objectives in the context of current global environment.
Memorandum-Installation Energy Plans-Energy Resilience and Cybersecurity Update requirement for ALL Installations- May 2018	https://www.acq.osd.mil/eie/Downloads/IE/IEP%20Policy_May302018.pdf	Installation Energy Plan update recognizing the foundational importance installation energy resilience and cyber security.
Memorandum- A Framework for Planning and Executing Black Start Exercises	https://www.acq.osd.mil/eie/Downloads/IE/Memo%20Framework%20for%20Planning%20and%20Executing%20Black%20Start%20Exercises_08062020.pdf	Black Start Exercises
Memorandum-Alternative Financing – Defense Energy Resilience Bank(DERB)Report_2020Feb	https://www.acq.osd.mil/eie/Downloads/IE/DefenseEnergyResilienceBank(DERB)Report_2020Feb.pdf	Financing and funding mechanisms for Energy Resilience
Army Directive 2020-03 Installation Energy and Water Security -Mar 2020	https://armypubs.army.mil/epubs/DR_pubs/DR_a/pdf/web/ARN21689_AD2020_03_FINAL_Revised.pdf	This directive issues policy to strengthen energy and water resilience to reduce the risk to Army missions posed by utility disruptions affecting installations.
Army Directive 2020-08 Installation Policy to Address Threats Caused by Changing Climate and Extreme Weather-Sep 2020	https://api.army.mil/e2/c/downloads/2020/09/14/a6aa8a40/ad-2020-08-u-s-army-installation-policy-to-address-threats-caused-by-changing-climate-and-extreme-weather.pdf	Calls for the integration of extreme weather data and projections into critical infrastructure planning at installations.
Army Climate Resilience Handbook-Aug 2020	https://www.g8.army.mil/digital_library/references/resourc	For use by installation planners to assess climate risk as they write or revise a

	es/20200900_Army_Climate_Resilience_Handbook.pdf	diversity of plans, including real property master plans, Integrated Natural Resource Management Plans, Installation Energy and Water Plans, and emergency management plans.
Army Installations Strategy-Dec 2020	https://www.asaie.army.mil/Public/SI/doc/Army_Installations_Strategy_(AIS)_FINAL_Signed.pdf	Army Installation goals and objectives
Army Climate Strategy-FEB 2022	https://www.army.mil/e2/downloads/rv7/about/2022_army_climate_strategy.pdf	Army goals in the context of changing climate

Non-Governmental Resources		
Title	**Link**	**Description/Key Words**
Beyond the Fence Line - Strengthening Military Capabilities Through Energy Resilience Partnerships-Association of Defense Communities	https://knowledge-online-defense-communities.knowledgeowl.com/help/installation-energy-water-beyond-the-fence-line-strengthening-military-capabilities-through-energy-resilience-partnerships	Public-private & public-public partnerships, energy resilience, installations, planning
What Local Government Officials Should Know and Do about Cyber-Security-International City Managers Association (ICMA)	https://www.nlc.org/wp-content/uploads/2019/10/CS-Cybersecurity-Report-Final_0.pdf	Public-private & public-public partnerships, cybersecurity, city managers
Regional Identification of Gaps for Operational Resilience Process (RIGOR) for Joint Base Elmendorf Richardson (JBER)-Converge Strategies	https://static1.squarespace.com/static/58c0207d15d5db7d6b968444/t/5e96efcddcb3ec0fc5c8d613/1586950094234/RIGOR+Report.pdf	Energy resilience exercises, best practice, case study
Report on Security in the North American Grid, A Nation at Risk - Fourth Update- George R. Cotter- Apr 2015	https://www.nrc.gov/docs/ML1511/ML15114A348.pdf	Examines technical and policy issues of cybersecurity protection for the North American Grid.
Cybersecurity and the North American Electric Grid; New Policy Approaches to address an evolving threat-Bipartisan Policy Center- Feb 2014	https://bipartisanpolicy.org/wp-content/uploads/2019/03/Cybersecurity-Electric-Grid-BPC.pdf	Energy Infrastructure, Cybersecurity, Risk Management, Threat Mitigation, National Policy
Critical Infrastructure Resilience-A Regional and National Approach (Nov 2014)-MITRE Corporation Publication	https://www.mitre.org/sites/default/files/publications/14-4047-critical-infrastructure-resilience-a-regional-and-national-approach.pdf	Regional resilience
Decide Platform-NUARI	https://nuari.net/	Exercise platform, cybersecurity
Jack Voltaic Cyber Research Project 3.0 – Army Cyber Center	https://cyber.army.mil/Research/Jack-Voltaic/	Framework to prepare, prevent, and respond to multi-sector cyberattacks on major cities