

Microgrid Training for Advanced Careers in Energy



Dr. Nathan Johnson

Associate Professor, The Polytechnic School

Director, Laboratory for Energy And Power Solutions (LEAPS)

The far-reaching impact of energy security

Civilian



Defense



Humanitarian



Microgrids to improve resilience and counter threat



Technology

Policy

Service

People

Financing

Delivery

Warranty

Standards

Microgrid training content for a growing workforce

100+ hours of content in simulation-based design and hands-on integration delivered in customized training packages

Topic	Hours	Format	Job Category Recommendation
Introductory Topics	3-7	Online	Manager, Engineer/Designer, Operator, Technician
Microgrid Concepts and Motivations	3-5	Online, Classroom	Manager, Engineer/Designer, Operator, Technician
Feasibility Assessment	12-14	Online, Classroom	Manager, Engineer/Designer
Preliminary System Design	8-10	Online, Classroom	Engineer/Designer
Power Engineering	10-12	Online, Classroom	Engineer/Designer, Operator
Business Model Development	6-8	Online, Classroom	Manager
Permitting and Procurement	3-5	Online, Classroom	Manager
Commissioning/Deployment	15-22	Online, Classroom, Hands-on	Operator, Technician
Operation and Controls	10-12	Online, Classroom, Hands-on	Operator, Technician
Maintenance and Troubleshooting	3-6	Online, Classroom, Hands-on	Technician








Training for Veterans, active-duty, and government services



Microgrid boot camp for microgrids and grid modernization

One-week introductory course for design, installation, operation, maintenance, and safety.

Monday	Tuesday	Wednesday	Thursday	Friday
<u>Introduction</u>	<u>On-grid and Off-grid Systems in HOMER</u>	<u>Hands-on Integration Microgrid Test Bed</u>	<u>Distribution Network Simulation & Analysis</u>	<u>Walking Tours of Local Facilities</u>
<ul style="list-style-type: none">Basics of microgrids and energy infrastructureSmall-scale hands-on activity	<ul style="list-style-type: none">System sizing and component selectionApplying HOMER to personal case studyMobile microgrids	<ul style="list-style-type: none">Safety trainingSystem deployment and testingPrimary controlsController configuration	<ul style="list-style-type: none">XENDEE asset sizing and placementPower flow analysisQSTS analysisShort circuit analysisVoltage stability	<ul style="list-style-type: none">Power plant tour (SRP Santan Generating Station – 1.2 GW)Grid-operator control center tour
				

Video: <https://www.youtube.com/watch?v=LeRRq0o8SP8>

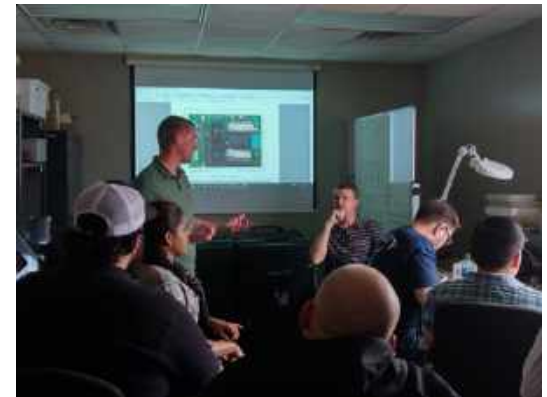
Expansion through extension education at partner locations

- Point Loma
- MCAS Miramar
- MCAS Yuma
- Port Hueneme
- University of Alaska Fairbanks
- World Bank
- Navajo Nation
- More...



Microgrid design and control courses

- 10 credits of special topics courses offered at ASU
- Topics including feasibility assessment, high-level system design, power engineering, and business models for microgrids
- Hands-on labs focused on asset commissioning and controls



Online microgrid design courses

Beginning with 20 hours of content (free to Navy). Includes videos and activities on the following topics:

Basics of Microgrids (6 hours)

- Basics of Energy Infrastructure (1 hour)
- Microgrid Motivations and Stakeholders (1 hour)
- On-grid Architectures (2 hours)
- Off-grid Architectures (2 hours)

Selecting and Sizing Assets (6 hours)

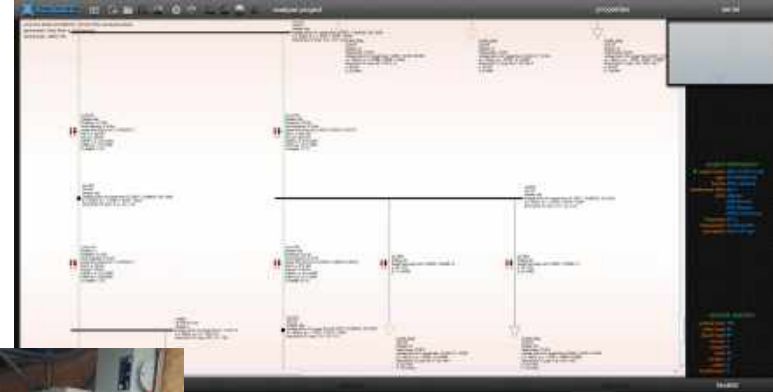
- Preliminary Technical Design (4 hours)
- Financial Analysis (2 hours)

Power Engineering (4 hours)

- Power Flow Analysis (4 hours)

Commissioning and Deployment (4 hours)

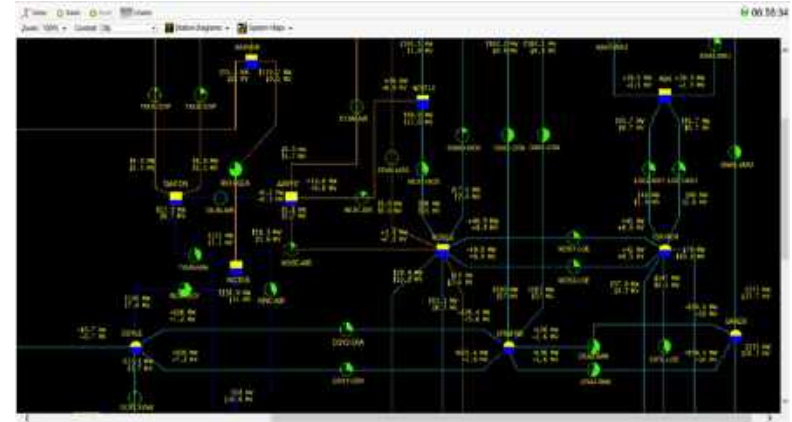
- Safety (1 hour)
- Inverter Setup (1.5 hours)
- Microgrid Integration (1.5 hours)



Grid operator training

Power4Vets

- Real-time electric grid simulator
- Interactive self-guided lessons and videos on generation and transmission-scale energy markets, frequency balancing, power flow, voltage control, and fault isolation/recovery

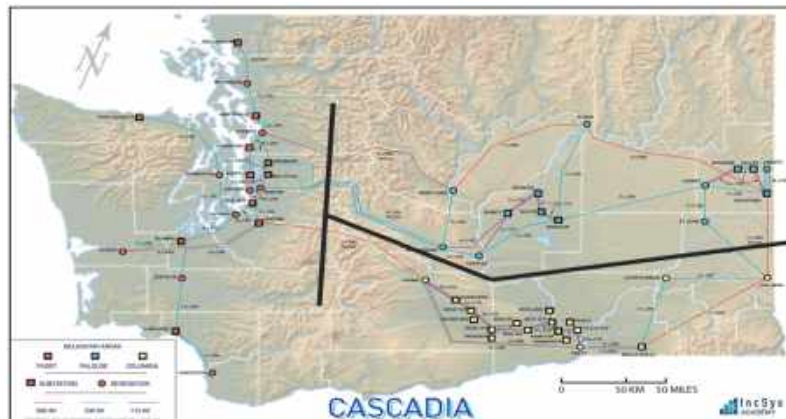


Customized Operator Training

- Location and equipment-specific training
- Focused on understanding and implementing system-specific control strategies for optimizing operation

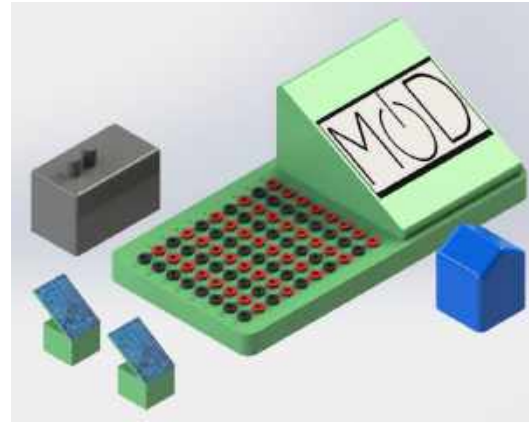
Cyber and kinetic vulnerabilities in electrical infrastructure

2-3 days of NERC continuing education credits for electric grid protection and reliability to threats



Creating a workforce pipeline with K-12 STEM outreach

- **Microgrid-on-a-Desk (MOD)**
- Stand-alone curriculum with guided interactive control interface
- Gamified interface for completing lessons
- Real and representative components
- Large-scale breadboard to help students make connections between small-scale circuits and full-scale systems
- Banana plug connections for easy plug-and-play
- Score tracking and data analytics available for teachers



<https://www.horizoneducational.com/juniorproducts/horizon-energy-box/>

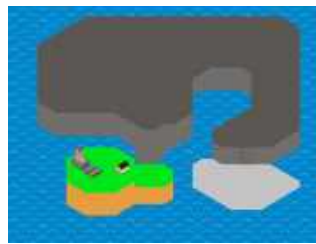
<https://www.irwinscienceeducation.com/national-grid-kit>

<https://www.stemfinity.com/Alternative-Energy/KNEX-Renewable-Energy-Kit>

MOD Gameplay Overview

- **Module** = World map of all lessons within specific topic area
- **Lesson** = Area within world to complete with specific LO's and activities (i.e. Design a microgrid)
- **Level** = Part of lesson (i.e. Connect the battery to the system and verify voltage)

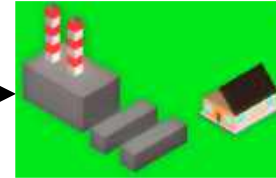
Interactive Level Mockup



Module



Lesson



Level

Levels will have more interaction and detail than shown.

Similar to:
Super Mario World



Training Outcomes

Veteran outcomes



"I cannot thank Dr. Johnson enough for allowing me to be a part of Power4Vets and the Microgrid Boot Camp. I strongly believe those two experiences significantly helped open the door for me at General Electric, and more specifically to be involved in the power industry that I was keen on starting my career in upon graduation"
– Timothy Ward, USN Veteran

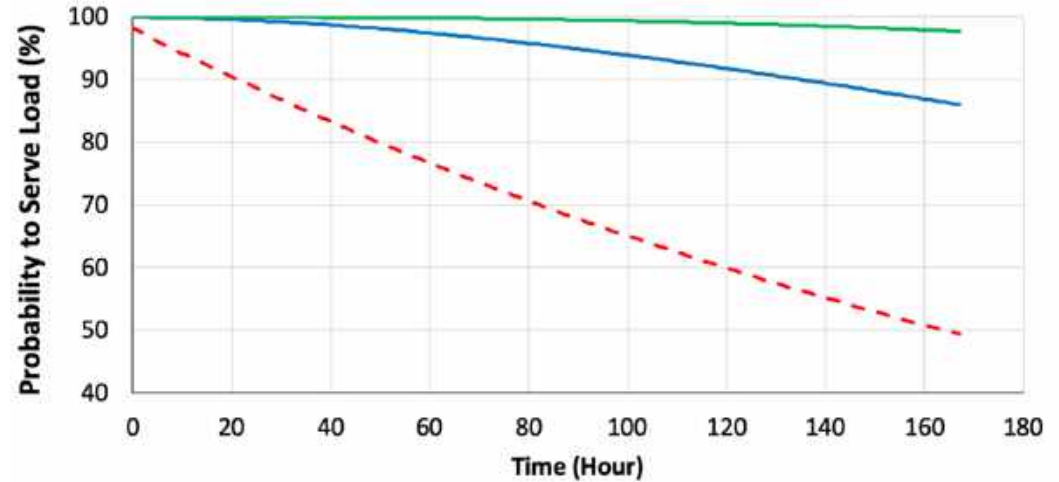
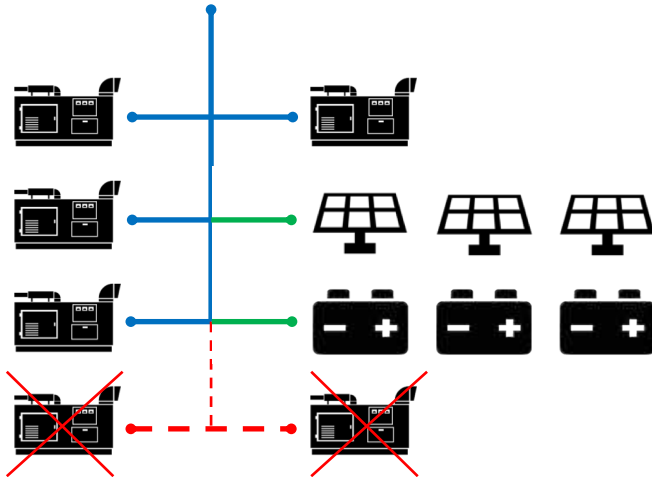


"Being a student researcher in Dr. Johnson's lab has been one of the most rewarding experiences of my post-military career. My contribution to the development of the Resilient Infrastructure Simulation Environment (RISE) has helped strengthen my software development skills and I love that I can apply some of the knowledge I gained while in the Navy to this project"
– Joseph Aorahim, USMC Veteran



"Dr. Johnson's programs have allowed me to solve contemporary issues regarding energy security for Stationary and Forward Operating Bases. Having formerly on several such bases, I feel that I bring a unique perspective to share with other Veterans and dependents, and Dr. Johnson's programs allow me to continue to impact our national security in a meaningful way"
– Eitan Gerson USMC Veteran

Designing installation resilience, with an ROI



- 5 installations with 1.7-12.5 MW critical load
- Increased mission autonomy up to 30%
- Annual energy expenses 1.5-20 \$M/year
- Reduced energy costs up to 50%
- Payback periods 3-15 years

Turnkey infrastructure for humanitarian aid and disaster response

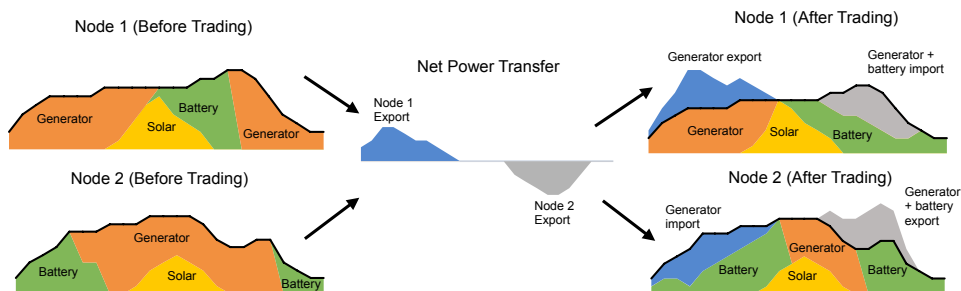


Refugee camp
Northern Uganda
12,000 people
Limited healthcare
Insufficient water
No power



Creating vendor-agnostic controls for scalable microgrids

Linking microgrids to maximize solar utilization



**Reduce fuel use by
20-50%**

**Touch-screen
interface**



Hardware integration and testing

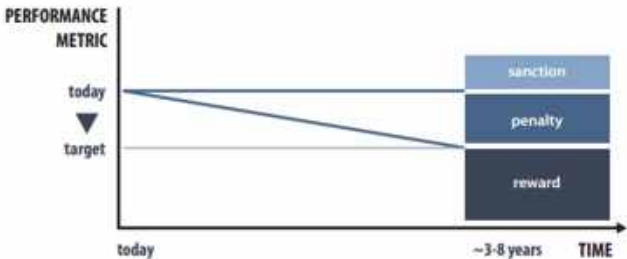
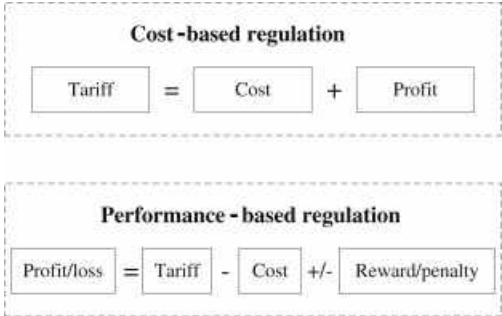


Policy change to create a common ground for customers and utilities

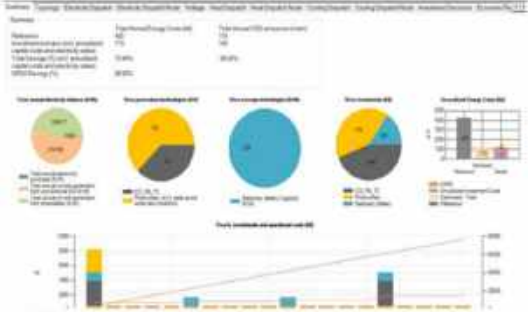
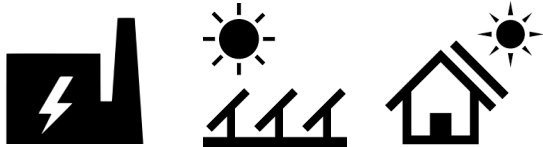
Customer



Policy



Business



Thank you!

For more information, please contact:

Nathan Johnson

✉ nathanjohnson@asu.edu

☎ 480-727-5271

🌐 leaps.asu.edu