Microgrid Training for Advanced Careers in Energy

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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*

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

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<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
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</thead>
<tbody>
<tr>
<td><strong>Introduction</strong></td>
<td><strong>On-grid and Off-grid Systems in HOMER</strong></td>
<td><strong>Hands-on Integration Microgrid Test Bed</strong></td>
<td><strong>Distribution Network Simulation &amp; Analysis</strong></td>
<td><strong>Walking Tours of Local Facilities</strong></td>
</tr>
<tr>
<td>• Basics of microgrids and energy infrastructure</td>
<td>• System sizing and component selection</td>
<td>• Safety training</td>
<td>• XENDEE asset sizing and placement</td>
<td>• Power plant tour (SRP Santan Generating Station – 1.2 GW)</td>
</tr>
<tr>
<td>• Small-scale hands-on activity</td>
<td>• Applying HOMER to personal case study</td>
<td>• System deployment and testing</td>
<td>• Power flow analysis</td>
<td>• Grid-operator control center tour</td>
</tr>
<tr>
<td>• Mobile microgrids</td>
<td>• Controller configuration</td>
<td>• Primary controls</td>
<td>• QSTS analysis</td>
<td></td>
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</tbody>
</table>

Video: [https://www.youtube.com/watch?v=LeRRq0o8SP8](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
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)

Similar to: Super Mario World

Interactive Level Mockup

Levels will have more interaction and detail than shown.
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**

Cost-based regulation:

\[ \text{Tariff} = \text{Cost} + \text{Profit} \]

Performance-based regulation:

\[ \text{Profit/loss} = \text{Tariff} - \text{Cost} +/- \text{Reward/penalty} \]

**Business**
Thank you!

For more information, please contact:

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