U.S. DEPARTMENT of ENERGY | Federal Energy Management Program

Long-Duration Energy Storage

T04-S06, August 6th, 2025

FEMP Summer CAMP (Courses Aligned with Mission Priorities)

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Senior Project Manager

Pacific Northwest National Laboratory

Agenda

- Session Learning Objectives
- Grid Storage Launchpad
- Resilience Energy Brief
- Conclusion and Q&A

Session Learning Outcomes

1. Identify key long-duration energy storage technologies, including flow batteries, zinc batteries, and hydrogen fuel cells
2. Recognize the role of long-duration energy storage in enhancing grid reliability and resilience for federal facilities
3. Analyze case studies to understand implementation strategies and lessons learned
4. Select appropriate long-duration storage solutions to support mission-critical work

Overview: Long Duration Energy Storage Technologies

Flow Batteries

- A type of rechargeable battery that stores energy in liquid electrolytes
- Batteries charge through an electrochemical reaction and store energy in chemical bonds

Hydrogen Fuel Cells

- Fuel cells convert the chemical energy of a fuel (like hydrogen) and oxidizing agent into electricity
- Fuel cells produce electricity and heat as long as fuel is supplied

Zinc Batteries

- A type of electrochemical energy storage device
- Zinc-Ion and Nickel-Zinc batteries can be used for energy storage and uninterruptible power supplies

Vincent Sprenkle, PhD

Director, Grid Storage Launchpad (GSL)

Pacific Northwest National Laboratory

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Inside the Grid Storage Lab (GSL) – Quick Facts

$75 Million
Facility Cost

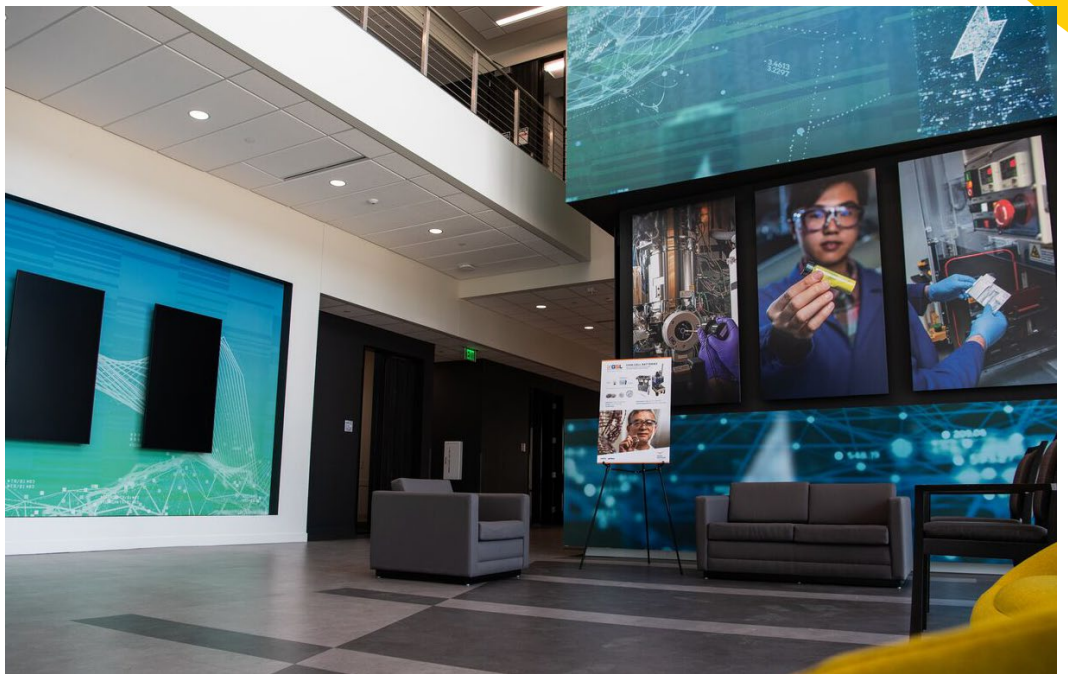
$35 Million
Cost Share

93,000 ft²
30 labs

90
projects supported

24
project sponsors

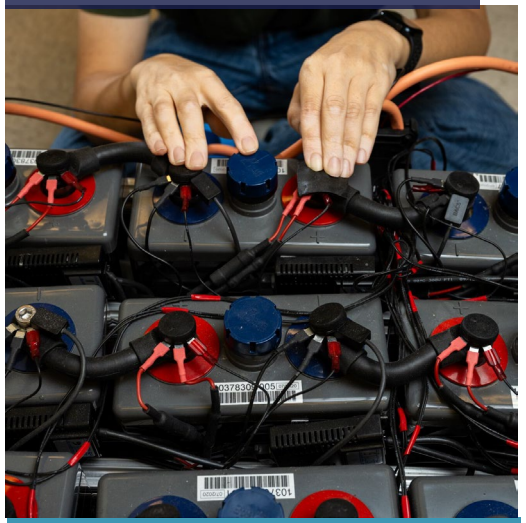
10,000 ft²
larger scale testing



GSL supports more than **200 staff** across PNNL working on energy storage. Their innovations have garnered more than **95 U.S. patents**, with nearly **280 patent applications** pending.

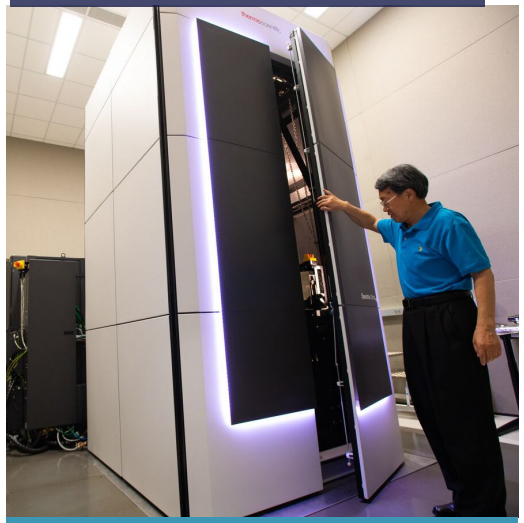
GSL Pillars

VALIDATE



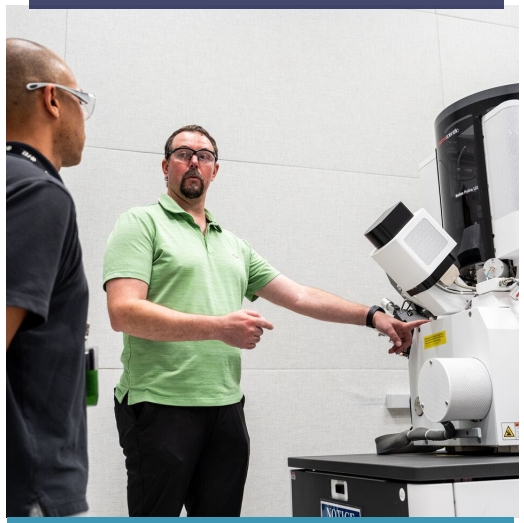
Conduct independent testing of commercial grid batteries and systems up to 100kW under realistic grid operating conditions.

ACCELERATE



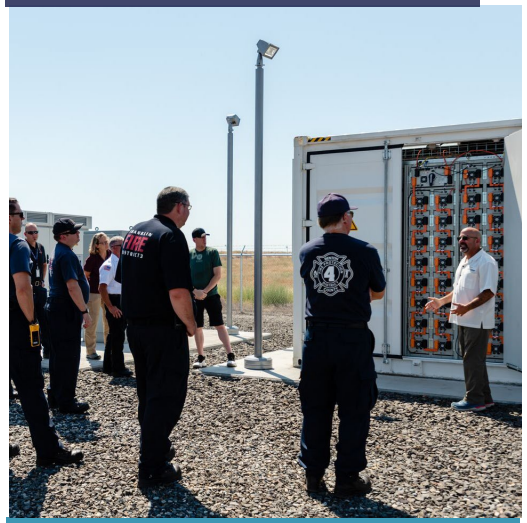
Accelerate deployment of new technologies by propagating rigorous grid performance requirements and safety standards in all stages of development.

COLLABORATE



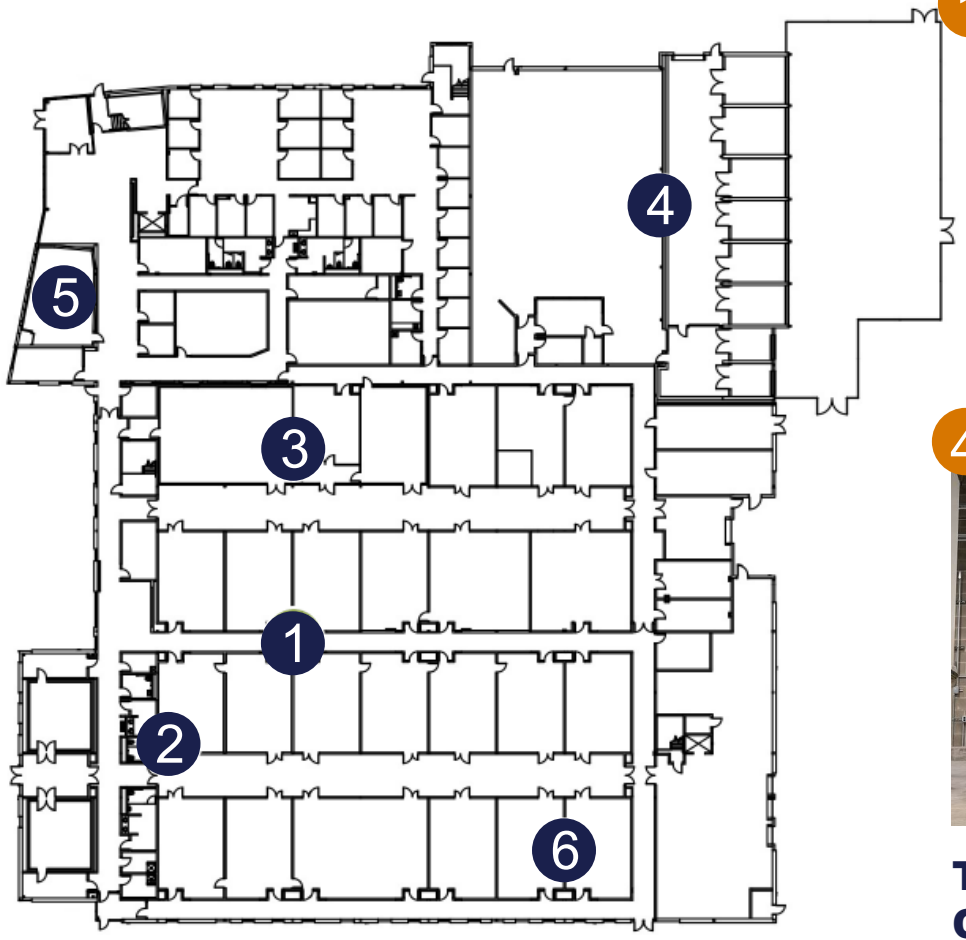
Link DOE storage R&D communities in a new collaboration center to solve crosscutting challenges.

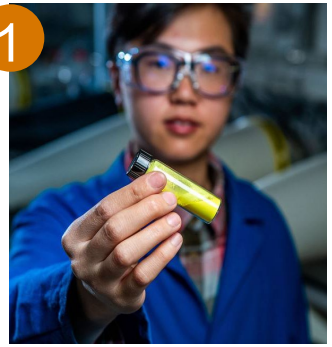
EDUCATE



Train the next generation workforce, from skilled labor to first responders and safety officials, to utility planners and regulators.

Inside the GSL Laboratories and Amenities





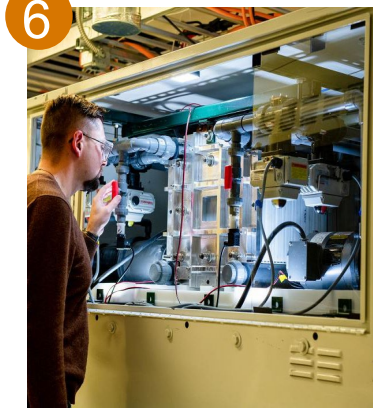
New Materials

Advanced Characterization

Pilot Prototyping

Testing Capabilities

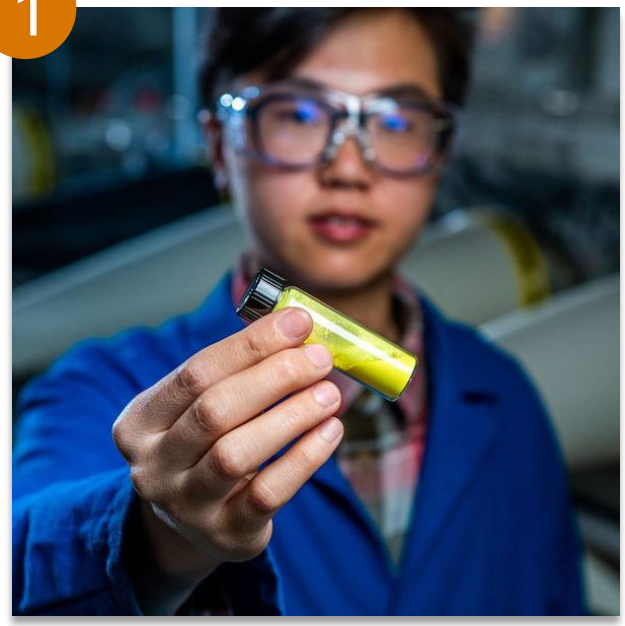
Visualization Laboratory



Education/Training Laboratory

Inside the GSL
New Materials Laboratory

1



- Individual Technology labs supporting
  - Li-ion
  - Li metal (Li-S, Li-NMC)
  - Na-ion
  - Na-metal (high temperature)
  - Redox Flow (organic, iron, etc)
  - Zn-ion
  - AI/Automation Laboratory

Current Status

All materials development labs moved into GSL

Inside the GSL
Advanced Characterization Laboratories

2

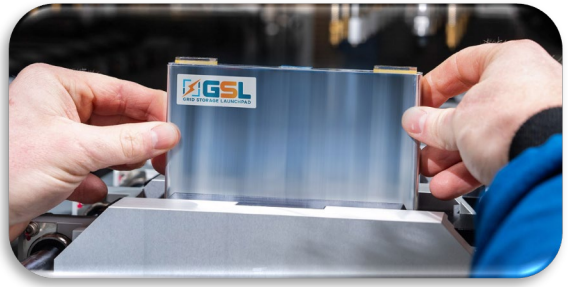
- Supports $8.3M WA State Equipment Investment in GSL <u>Dedicated to Battery Research</u>
  - ThermoFisher NEXSA X-ray photoelectron spectrometer combined with Raman spectroscopy
  - Spectra Ultra Scanning Tunning Electron Microscope
  - ThermoFisher Helios Hydra UX PFIB-SEM

Inside the GSL Pilot Prototyping

3

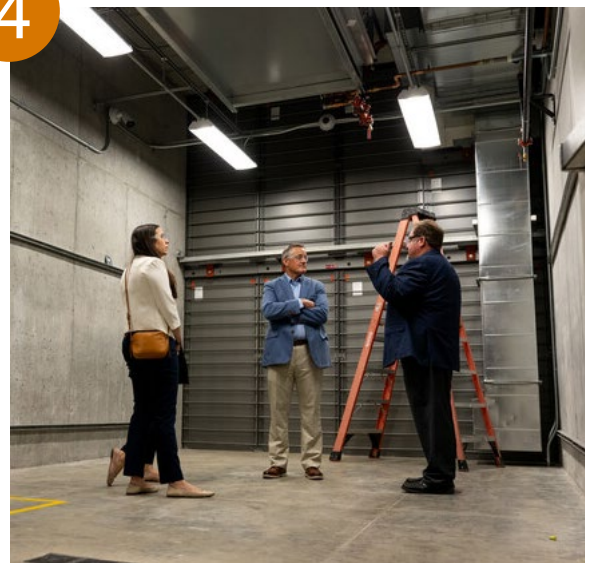
GSL Pilot Capabilities include:

- Pouch Cell line (2-10 Ah)
- Prismatic cell line (10-20 Ah)
- Redox flow prototyping (1-5 kW)
- Materials Synthesis scale-up



Inside the GSL Testing Capabilities

4



Larger Scale Testing Capabilities

T&V 1

- 6000 ft^2 of cell to module testing (max 10kW/40kWh)
- ~ 600 single cell channels
- 13 channels (5 kW)
- 16 channels (10 kW)

T&V 2

- (6) 100kW/400kWh test chambers

Andrew Oddo

MCMWTC Resilience Energy Brief

Facilities Director, Marine Corps Mountain Warfare Training Center Bridgeport, CA

MCMWTC Energy Resiliency Brief

FEMP Summer Workshops

Why the Eastern Sierra Nevada

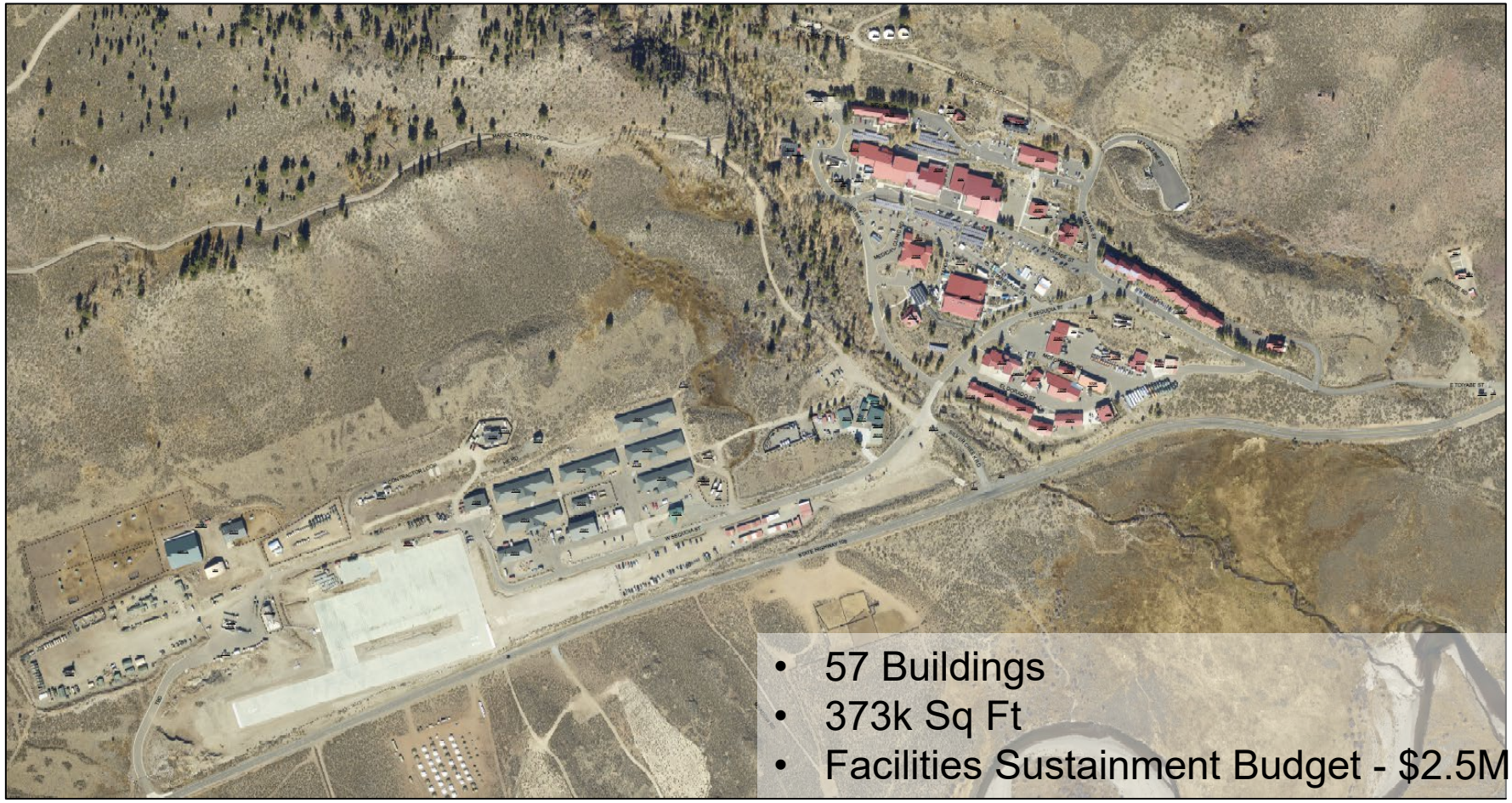
"We've got to get our people tougher to survive..."
- Col Lewis B Puller, 1950

- Located at 38th parallel; terrain and weather similar to Korea
- Access to 60,000+ acres of Humboldt-Toiyabe National Forest
- Mountainous, compartmentalized terrain from 6,700-11,200ft
- Variable weather—summer temperatures up to 100 degrees F and winter temperatures down to -30 degrees F
- Heavy winter snowfall up to 70'+ total per year
- Isolated, but easily accessible to CONUS units

MCMWTC Mission

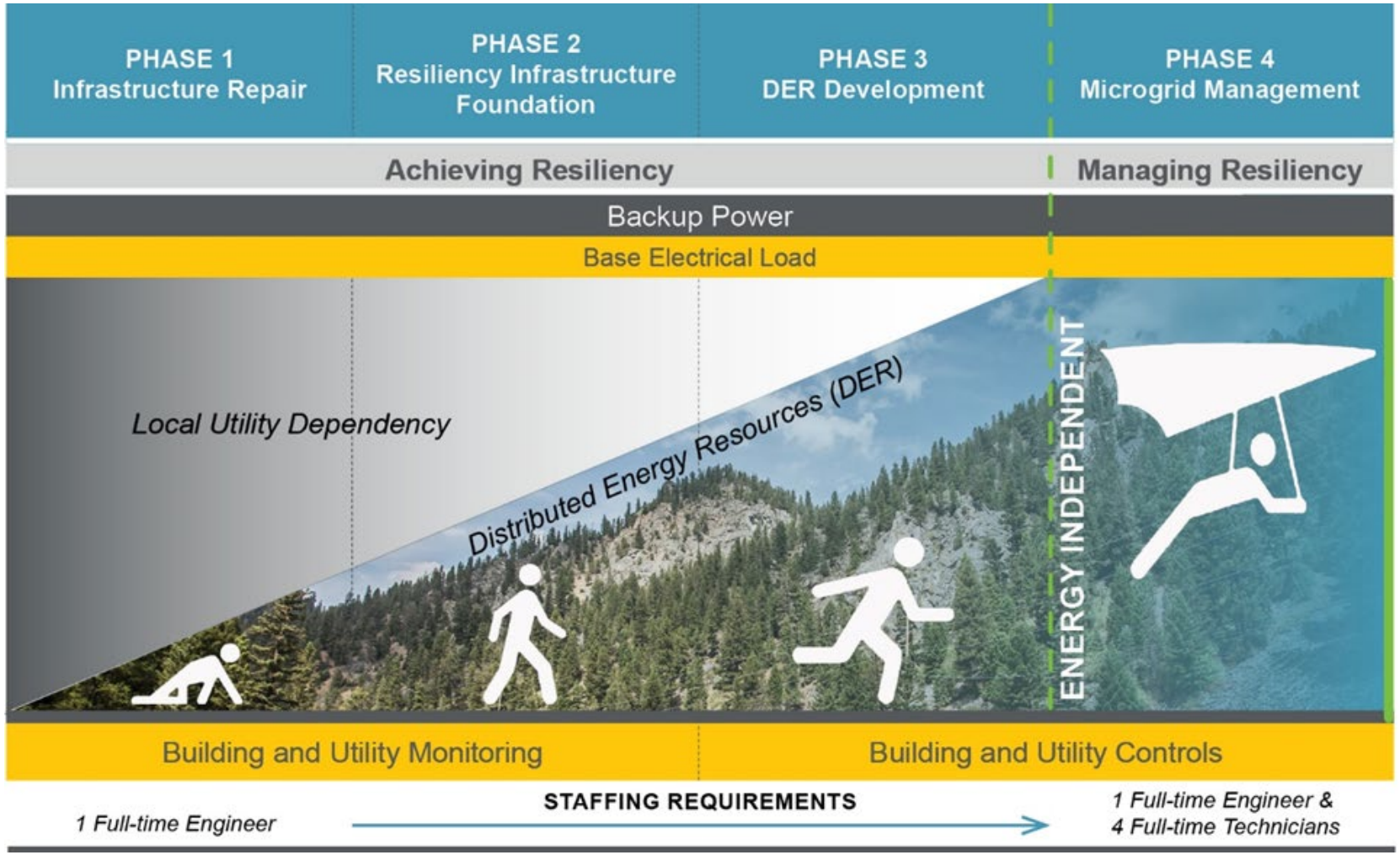
1. The MCMWTC conducts advanced individual training as the formal school for Mountain Warfare and Cold Weather Operations, develops warfighting doctrine, supports Research, Development, Test, and Evaluation for specialized equipment, and conducts service level Marine Air Ground Task Force integrated exercises in order to facilitate increased Marine Corps readiness.
2. As a Service Level Training Installation, the MCMWTC manages facilities, services and support to the operating force, permanent and tenant personnel and their families to ensure the readiness and mission accomplishment of this command.

The Installation

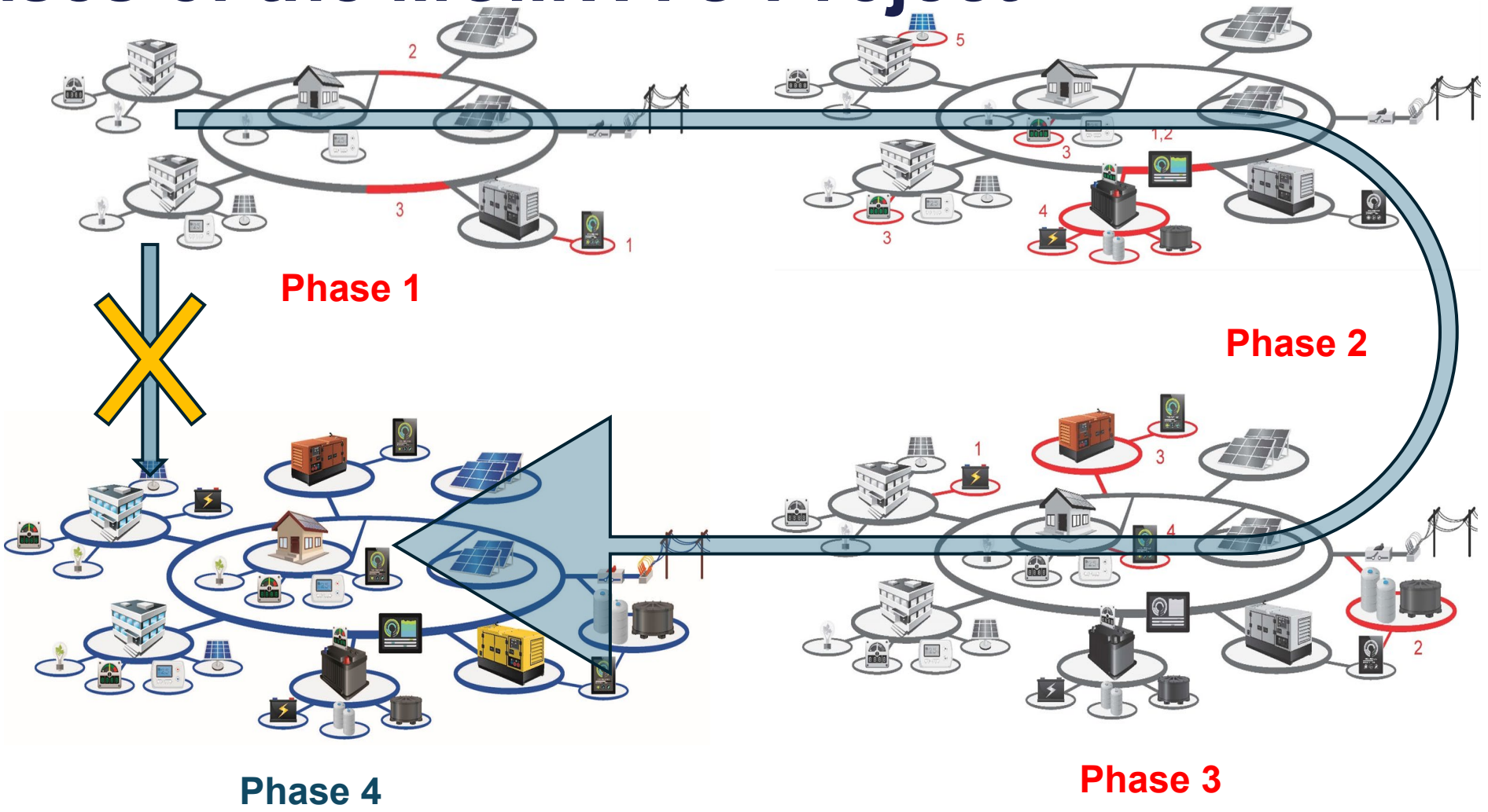


DoN/USMC Property – 346 Acres (Base Camp)

Plan – Need an Understandable Solution



Phases of the MCMWTC Project



Modes of Operation

How will you use it?

But I thought it could do anything…

Normal Mode: Connected to utility company, and operating the grid in an optimized and mutually beneficial way.

Resilient Mode: Prepare grid for an outage resulting from weather forecast, utility company PSPS message, utility request for demand reduction, or other training related operational need. This mode essentially starts storing energy vis consuming it.

Island Mode Short: Intention is to continue operating the base normally while utility is not available for 5-7 days. This isn't an uncommon scenario for the base occurring 1-3 times annually.

Island Mode Long: Intention is to power the base indefinitely due to utility power restoration not having an ETA. This has happened a handful of times with our longest outage lasting 45 days. Effort here will require the base to control load. Phase 3 and 4 project's P-481 is not likely to give the base automation overload control due to budget constraints. Either way, the system will allow for load control manually.

Armageddon: The microgrid shuts down completely, and distribution is lost– worst case scenario. Power will be provided via trailer mounted generator at each of the base's ten load center's generator plug in point. Load centers are located on the secondary side of the SCE transformers and will be constructed with kirk key isolation to allow for this capability this spring/summer. This is a foundational capability that allows for the Marines to power their base without the presence of a utility grid operator or private utility crew. Marine Corps or Navy utility active-duty personnel can power the installation.

Execution Current Status

- **P-480 Phase #1** – Repair and upgrade existing 16kv distribution grid within the installation fence line
    a) Status – Complete Summer 2024
- **P-480 Phase #2** – Repair and upgrade the installation Advance Meter System, DDC System, and Energy Systems for the purpose of monitoring, and controlling installation energy consumption and production assets. Replace dilapidated pad mounted electrical cabinets (load centers), 16kv disconnect and integrated generator plug in for emergency power to load center critical loads. Replace installation backup generator switching equipment to improve functionality and reliability.
    a) Status – Active construction work now. Fiber work is 75% complete, Electrical Cabinets are scheduled for delivery in August/September (18 month lead time). Generator control installation is scheduled for August/September. Completion date is June 2027
- Defense Innovation Unit / CellCube Non-Lithium Long Duration Energy Storage Technology Demonstration 500kW, 5MWH
    a) Status – Active project. Battery and balance of plant foundations are complete. Battery and equipment are scheduled to be set on their foundations 28 July. Expect to turn on battery Winter 2025/ Spring 2026
    b) Site and electrical design allow for an additional 500kW, 5MWH of energy storage

Execution Current Status

- Installation of a second installation backup generator

    a) Status – Awarded project. In procurement phase. Estimated installation completion date 2028. Engine production timelines drive contract completion date

- **P-481 Phase #3 and #4** of installation's Energy Resilience Master Plan

    a) Status – Currently scheduled for execution next year 2026. Project will provide the MCMWTC's Housing with back up power, the base with up to 2MW of solar PV, additional electrical infrastructure to accommodate distributed energy resources (DER), controls to synchronize the DERs, Energy Management System that enables five modes of operation, and additional energy storage equal in size to project #3 discussed above.

Managing Resilience

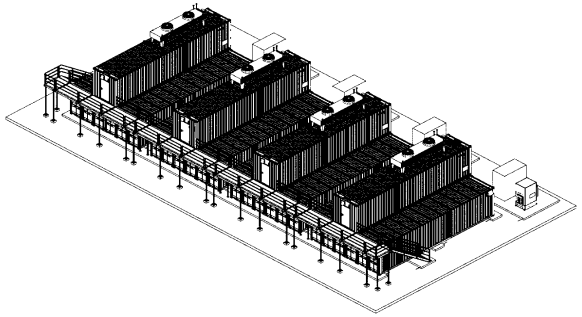
- **Property Records and Category Codes**
  - Confirmed accuracy and timely to ensure proper representation of assets and required sustainment
  - Not all category codes align with the asset's purpose, size, or design
- **Installation Utility Sustainment Funding**
  - "Fenced funding" for utility systems needed
  - Utility funds should be used to support sustainment. For privatized or service-based utilities it does, but for government owned and operated it doesn't
- **Dedicated Utility Section Needed**
  - Pay for it with utility funding
    - Incentivizes a privatized solution - Utility company UESPC, ESPC, etc., but no different then right now
  - In-house solution – Resourcing an inhouse capability allows for more flexibility. Currently requires sustainment funding; not utility funding

Way Ahead

- End state is to validate operability and resourcing requirements for an installation microgrid that survives routine hazards; wildfire, 100+ MPH wind, -20 Deg F temps, 800” of snowfall, avalanche, flooding, and limited access)
- Operate system in all prescribed modes routinely; locate maximum efficiency, resilience, and survivability capabilities
    - Integrate training through OGT to active-duty Facilities Marines
    - Integrate with Operational Training Marines through MCMWTC exercises
- Advocate for an independent utility section for the MCMWTC to properly manage utility operations, control systems, and training
- Build a lasting collaborative relationship with local community and utility service provider for support of each other’s goals, and emergency response needs

Non-Lithium Long Duration Energy Storage at the MCMWTC

(1MW, 10 MWH CellCube Energy Storage)



- Project funding from DIU, ESTCP, and DOE to advance non-lithium long duration energy storage for resilience
- Defense Innovation Unit's Other Transaction Authority (OTA) transaction and Commercial Solutions Opening capability deployed rapidly.
- For Flow Batteries, DIU selected CellCube's Vanadium Redox solution with 2.5x overcharge rate / 1.5x over-discharge rate.

- >98% availability all installations commissioned in the past 17 years
- 13+ years of stable performance
- Non-flammable
- Long life (30+ years, 30,000+ Cycles)
- Heavy duty, utility scale, industrial power
- Millisecond response time
- US sourced vanadium
  - Sourced from steel slag runoffs

- Direct integration with Installation's Energy Master Plan Projects P-480 and P-481
- Capabilities: Load/energy shifting, peak shaving, blackstart, DER Integration, extended energy/fuel backup, islanding mode (>14 Days)
- Applications: Time of use by the hour, day, and season

Progress Photos

Progress Photos

Thank You

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FEMP Summer CAMP (Courses Aligned with Mission Priorities)

Questions?

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1. Log in to https://edu.wbdg.org/ using your WBDG credentials
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   - The assessment and evaluation will close on September 22nd
2. In the list of trainings you attended, click on the Visit link by the course you wish to complete
   - If the course you're looking for is not listed, click on My Account in the top right menu
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