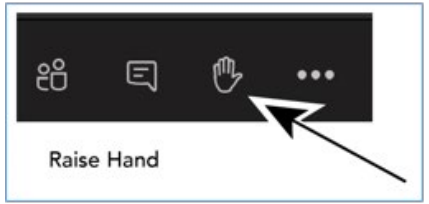
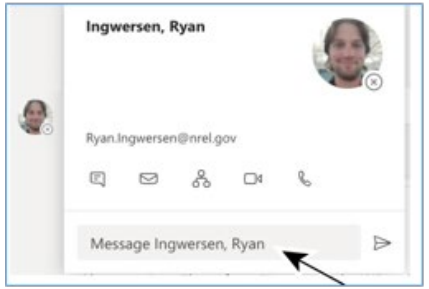
# Breakout III

Distribution level storage solutions for microgrids, defense bases, and disadvantaged and remote communities

Ben Kroposki, Director Power Systems Engineering Center

# Meeting Logistics


- **Please mute** yourself when not speaking.
- You are welcome to have your camera on for today's conversation.
- **Use the chat box** and raise hand features to ask questions or provide comments.
- The first part of the workshop will be recorded, but the breakout sessions will not to promote candid discussion (Chatham House rules)
- Use chat or direct message our Teams workshop coordinator Ryan if you have questions or concerns throughout the workshop
- **Teams does not support call-in users in breakout sessions.**
  - If you joined the meeting using your phone for audio, you will need to hang up when we start the breakout sessions, then rejoin phone audio once the breakout has started. You will need to do this again when the breakout sessions close and you rejoin the main session.
- There will be a slight delay when we start and end the breakout sessions. You will be automatically transferred to your chosen breakout session and back to the main session.
- If you **have a question** anytime during today's workshop and would prefer not to use the chat, send an email to aries@nrel.gov.

# Objectives for This Breakout Session

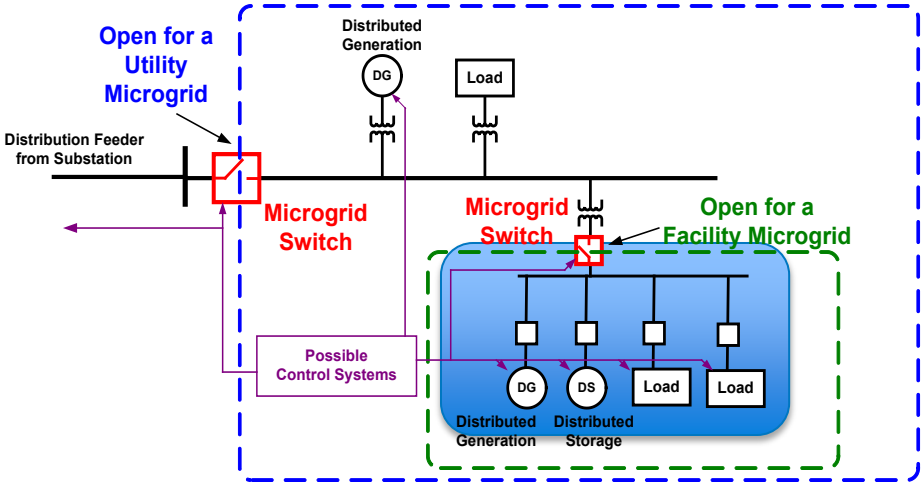
1. Get your perspective on research needs for energy storage, areas of interest for energy storage advancement, and potential opportunities for collaboration.

2. Any additional feedback you would like to share on how we can make ARIES a more valuable research platform to help you achieve your goals.

# ARIES' role in creating resilience through energy storage applications in microgrids

- Combined storage and renewables creates opportunities for customers and portions of the grid to safely island, remain energized during an outage, black start, and increase contributions from renewable resources.
- But we need a better understanding of how storage technologies can be designed/configured for scalable and affordable functionality.
- This breakout session will address capabilities needed to **identify cost-effective storage solutions that maintain critical services for a sufficient duration following extended power outages and improve local resilience and flexibility** for distribution systems/microgrids with wide variation in load profiles, climate zones, and energy markets.
- Energy storage technologies will include ultracapacitors, batteries, flywheels, pumped hydro, water electrolysis/hydrogen generation, and various types of thermal storage.

# Microgrid Overview




*NREL led the development of* ***IEEE 1547.4-2011 Guide for Design, Operation, and Integration of Distributed Resource Island Systems with Electric Power Systems*** *– first international standard on microgrid design and operation*

In today's discussion we are going to focus on:

- DoD microgrids
- Community microgrids
- Remote communities

## Definition

*"group of interconnected loads and distributed energy resources that acts as a single controllable entity with respect to the grid. It can operate in both grid-connected and island-mode"*

## Benefits

- **Reliability:** near 100% uptime for critical loads
- **Security:** enable cyber and physical security
- **Quality:** better power quality for sensitive loads
- **Efficiency:** lower energy use and dist. sys. losses
- **Sustainability**: use renewables and cleaner fuels

Source: Office of Electricity, DOE Microgrid Workshop Report, 2011

Source: R. Dohn, "The business case for microgrids," *Siemens*.

# ARIES Microgrid Project Examples

## DoD Microgrids

# DoD Microgrid: MCAS Miramar Base

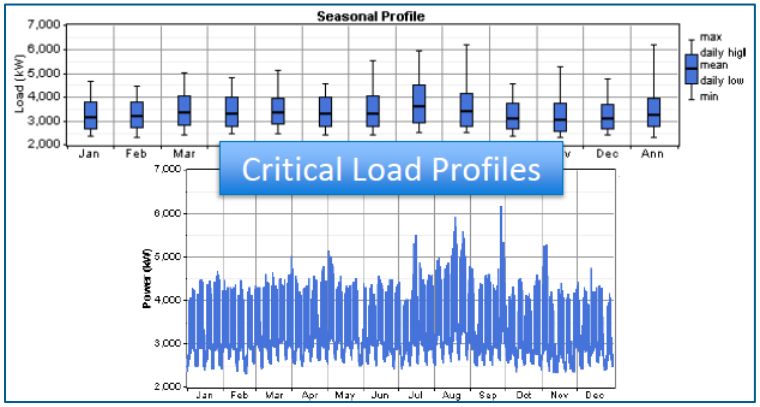
**NREL Support**

- Conceptual design, financial and resilience analyses, procurement, construction reviews, and commissioning
- Supporting many microgrids worldwide for all the DoD services

**Microgrid**

- Enables operation of the flight line during a power outage
- 1.3 MW solar, 3.2 MW landfill gas, 6.5 MW diesel and natural gas power plant, integrated 2 MW data center backup generator
- Energy and Water Operations Center (EWOC)
- SCADA upgrades, and microgrid controller

Depiction of microgrid (actual circuitry not shown due to sensitivities)





# ARIES DOD Installations With Varying Climate Zones

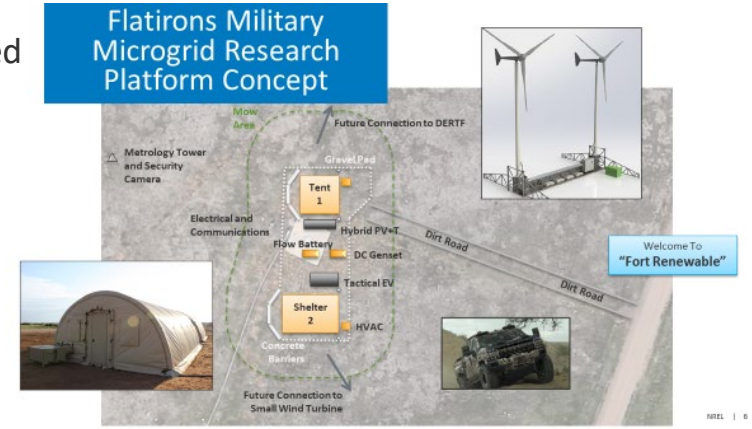
**Goal: Validate large scale storage hardware and advanced controls for high-renewable resilient microgrids.**

**Description:** Perform HIL validation to prove proposed power system designs for DoD installations in different climate zones, energy markets, and with moderate to large renewable energy capacities.

**Objectives:**

- Transforms future microgrids to optimally exploit on-site renewable energy
- Advances microgrid controller features and technology for direct real-world application.
- Provide round-trip efficiency of VRF battery, auxiliary power draw, cybersecurity, control algorithms, sensitivity of sizing/costs, high speed control, UPS elimination, ICS security, diesel reduction.

*Partners:* NREL and DOD ESTCP, plus **four** teams:
Ameresco (team lead) with S&C Electric
Arizona State U (team lead) with 350 Solutions (formerly Southern Co), Ageto, and XENDEE
Cummins Power Systems
Raytheon (team lead) with Typhoon and PXiSE




**Impact: Provides DOD and the broader community as to the economic and security benefits of storage enabled microgrids.**

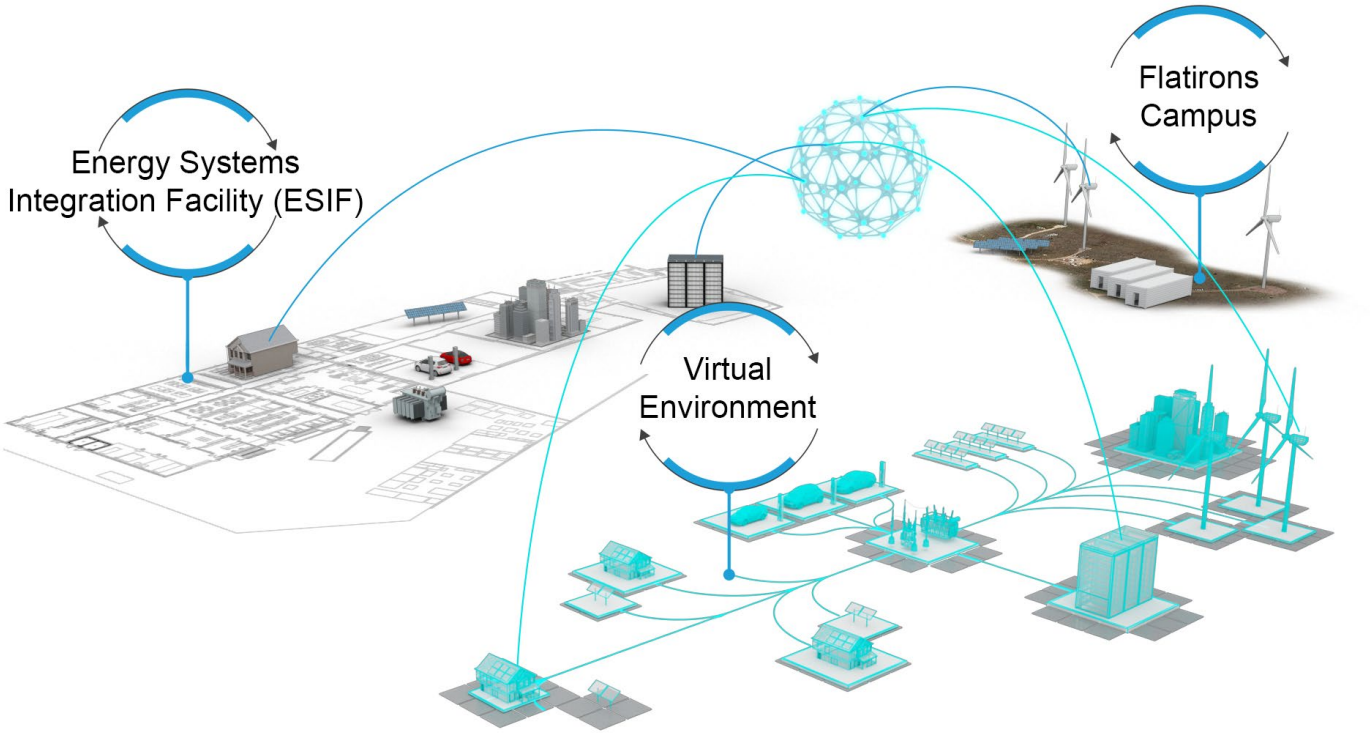
# ARIES Cybersecurity for Distribution Level

# Energy Security & Resilience

**Core Platforms and Tools Driving ESR Business Strategy:**

- **Cyber-Energy Emulation Platform (CEEP)**
- **Advanced Research on Integrated Energy Systems (ARIES)**
- Distributed Energy Resources Cybersecurity Framework (DERCF)
- Module-OT

NREL's ESR portfolio is focused on **minimizing the impact of disruptive events** in emerging large-scale distributed energy systems and interdependent infrastructures. Researchers across the lab are developing science-based design principles, operational strategies, and evaluation capabilities.




# Cyber-Energy Emulation Platform (CEEP)

Leveraging Sandia's SCEPTRE and Minimega, NREL's environment allows researchers to visualize and evaluate the interdependencies of power systems and network communication flows—and safely explore vulnerabilities and mitigation effectiveness.

# ARIES Microgrid Project Examples

## Community Microgrids

# Community Microgrid: Borrego Springs

**DESCRIPTION**
Demonstrate the viability of a microgrid to manage high amounts (up to 100%) of renewable energy to meet community load while avoiding adverse grid impacts.

**TECHNOLOGIES**
Solar (large-scale plants and residential rooftop); storage (substation and community-scale batteries; ultra-capacitors

**ESIF IMPACT**
Evaluate an advanced microgrid controller prior to deployment in the largest, highest renewable penetration, utility-owned, microgrid in the United States using an integrated, multi-technology power and controller hardware in-the-loop (HIL) testbed at the ESIF.

**PROJECT IMPACT**
Successful implementation of the largest microgrid in North America will prove that a community-scale, highly renewable microgrid can be implemented with economic benefits.

**PARTNERS**
SDG&E, Spirae, UCSD, OSISoft, SMA, NRG


**Borrego Springs community microgrid in SDG&E territory**

**HIL test setup with real-time digital simulators, PV inverters, and advanced microgrid controllers**

# ARIES Microgrid Project Examples

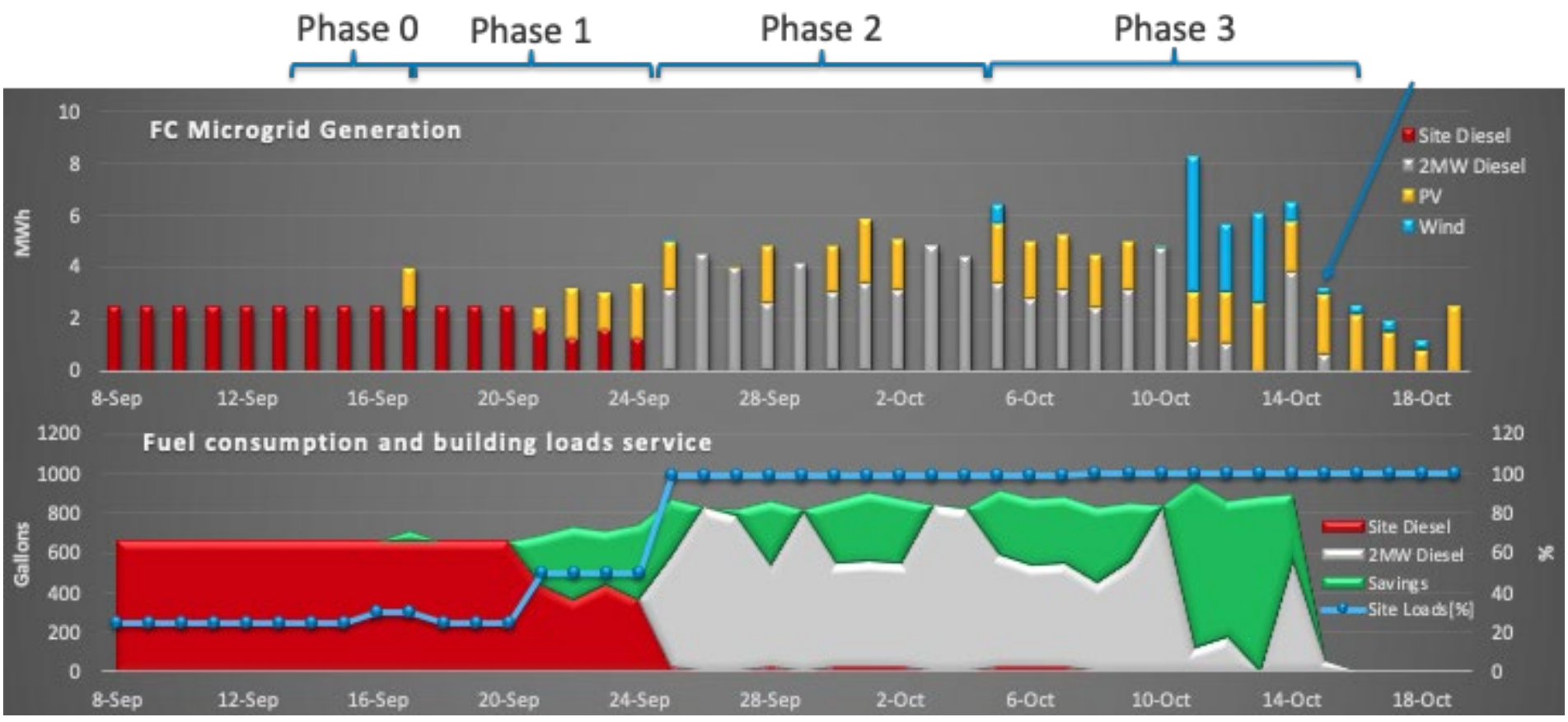
## Remote Microgrids

## (Village Power Systems)

# ARIES Campus Microgrid Experience


1MW Battery
1.5MW Wind Turbine
0.45MW PV System
Demonstrate 72 hours of operations using 100% Renewable, Inverter-Based Resources
NREL's Flatirons Campus

# Overview of microgrid operation



# Discussion Questions

- What are the most critical issues for distribution level energy storage related to off-grid communities and microgrids?
- Which technology pathways should be the focus for validation and field deployment?
- Which market or technology application requires the most technological maturation?
- What do you see as providing the most value to increase the integration of energy storage?

# Contact

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