



# ESTCP Large Scale Energy Storage Microgrids, Phase 2

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# Overview

- Background & Partner Teams
- Microgrid Model for Hardware-in-the-Loop Validation
- Test Setup and Execution



# Background

## Environmental Security Technology Certification Program (ESTCP)

- Large Scale Energy Storage Microgrids Project
  - Phase 1: Techno-economic performance simulations
    - Five industry teams participated
  - Phase 2: Lab hardware-in-the-loop validation testing
    - Three prior teams plus one new participant
  - Phase 3: Field demonstration at an actual military base
    - One or more prior teams may be selected

# Spotlight Article

Title: High-Impact Project Helps U.S. Department of Defense Power Military Bases with Large-Scale Energy Storage and Microgrids

“Phase 2 of the project is being hosted at NREL to validate the phase 1 results with actual hardware-in-the-loop (HIL) testing of microgrid controllers, controllable switchgear, advanced battery systems, and other distributed energy resource (DER) equipment at the ESIF labs and Flatirons campus. The hardware-intensive 34-megawatt microgrid test system is based on Naval Air Station Patuxent River. Three successful teams of strategic partners from phase 1 were selected to proceed to phase 2. The Ameresco team includes S&C Electric and Invinity Energy. The Arizona State University team includes 350 Solutions, Ageto, and XENDEE. The Raytheon team includes Typhoon HIL and PXiSE. In addition, Cummins Power Systems joined as a fourth team since they were already testing their advanced microgrid systems with storage at ESIF as part of a separate project.”

# Desired HIL Validation

Detailed plans developed by companies and approved by ESTCP

- Operate grid parallel to achieve modelled economic savings
- Successfully island during grid outage
- Stable/reliable operation while islanded
- Reconnect successfully at end of grid outage

Includes a continuous 168-hour **unattended** reliability test

Outcomes include round-trip efficiency of flow battery, auxiliary power draw, cybersecurity, control algorithms, sensitivity of sizing/costs, high speed control, seamless UPS elimination, diesel reduction, and behind-meter DER.

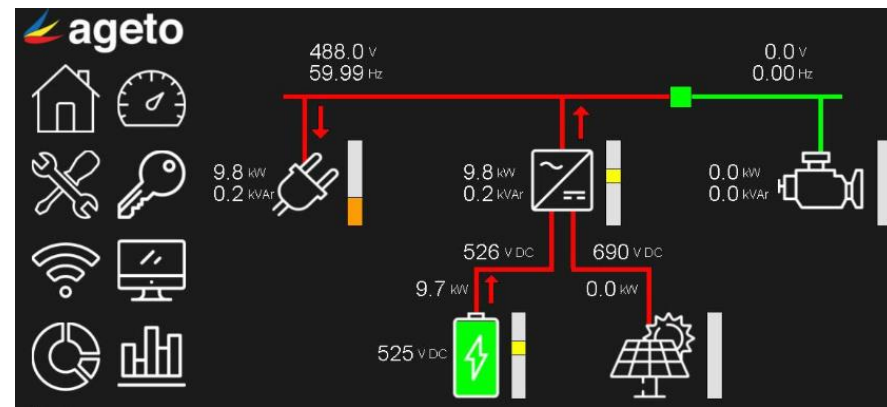
# Ameresco Team

## Demonstration of Flow Battery Storage for DoD Microgrids

- Team- **Ameresco**; Invinity Energy; S&C Electric
- CHIL- S&C Electric GridMaster IPC microgrid control system
- ESIF PHIL
  - Grid sim + RTDS model
  - Solar PV + PV sims
  - 2x load banks (one with load shed relay)
  - Microgrid switch
- Partner PHIL
  - 30KW BESS with 26KW/74KWH battery
    - Vanadium flow batteries



# Arizona State Team



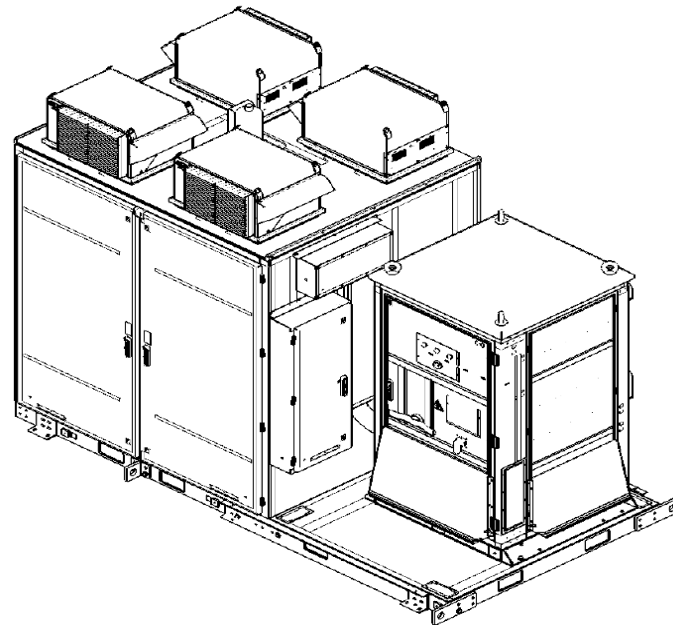
## Design, Modelling and Control of Hybrid ESS for DoD Microgrids

- Team- **ASU**; ~~Southern Company~~ 350 Solutions; XENDEE; Ageto
- CHIL- Ageto ARC controller; XENDEE algorithms
- ESIF PHIL: none
- ASU PHIL (at ASU): ultracapacitor; lithium ferrous phosphate battery; vanadium flow battery; solar PV; diesel genset; UPS

# Cummins Team

## Cummins Advanced Microgrid Controller

- Team- **Cummins Power Systems**
- CHIL- Cummins MGC300 microgrid control
- ESIF PHIL
  - Grid sim + RTDS model
  - Solar PV + PV sims
  - Load bank
  - Microgrid switch
- Partner PHIL
  - 125KW BESS with 250KWH lithium battery





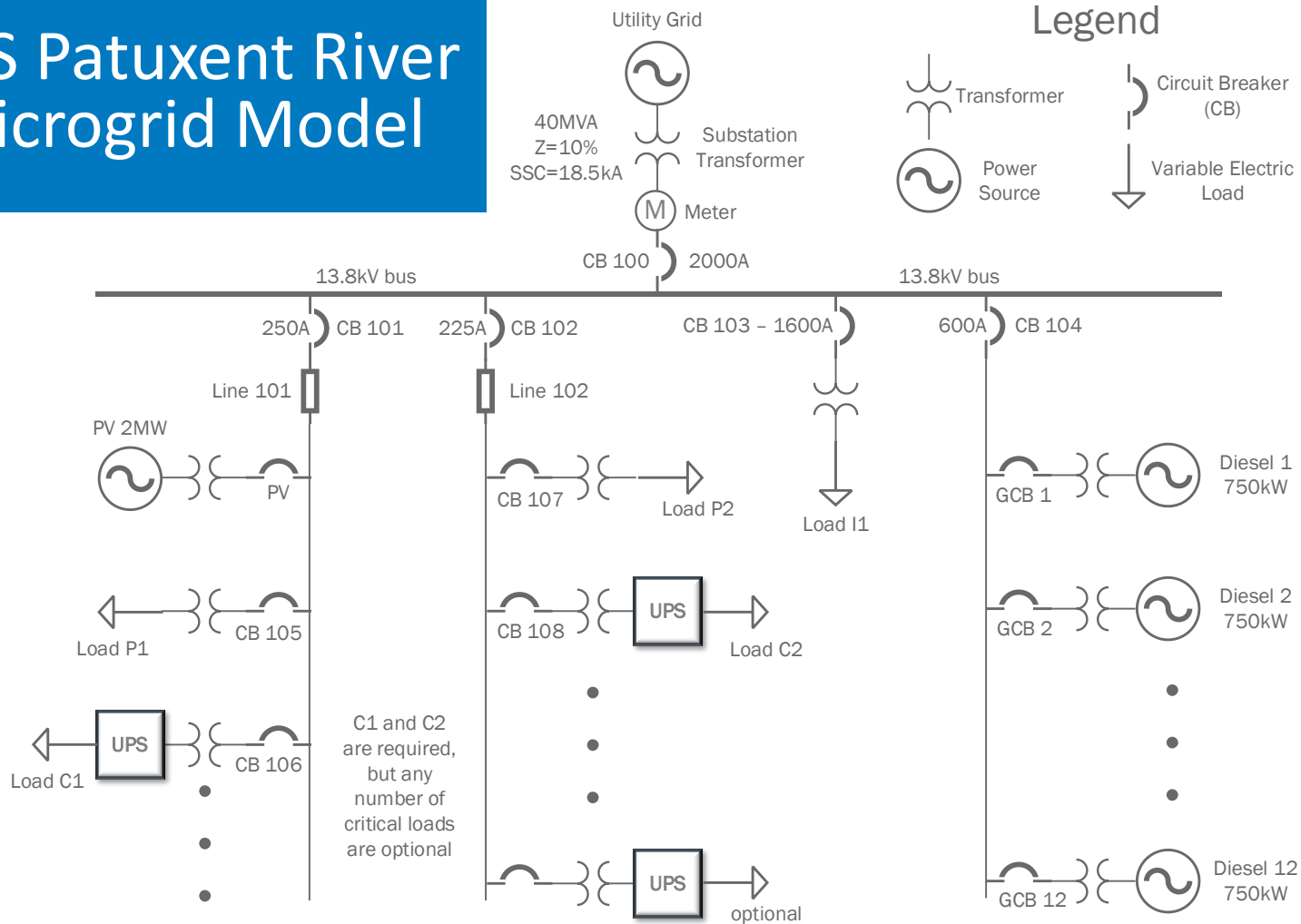
# Raytheon Team

## Modular, Scalable Li-ion Microgrid with Phasor-based Control

- Team- **Raytheon**; PXiSE; EPC Power; ABB
- CHIL- phasor-based PXiSE ACT microgrid controller
- ESIF PHIL
  - Grid sim + RTDS model
  - Solar PV + PV sims
  - Load bank
  - AV900 battery simulator
- Partner PHIL
  - 250KW BESS (inverter only)
  - ABB 600A solid state static switch



# NAS Patuxent River Microgrid Model



# Outdoor Test Area

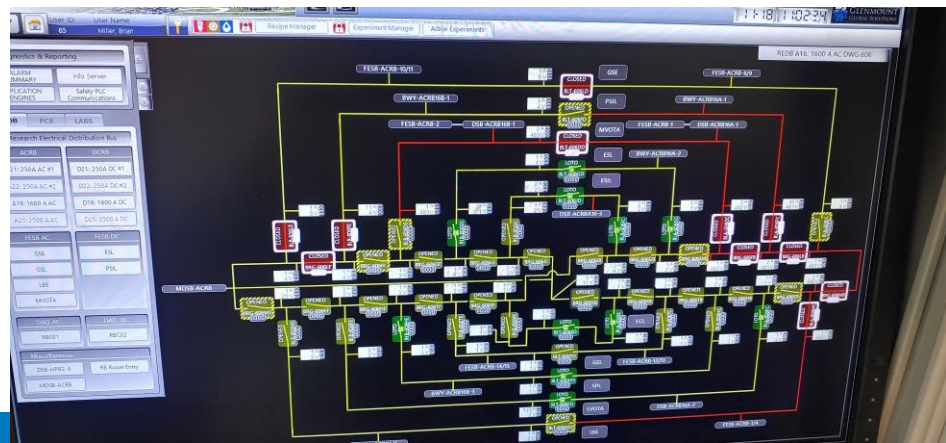
Cummins BESS:

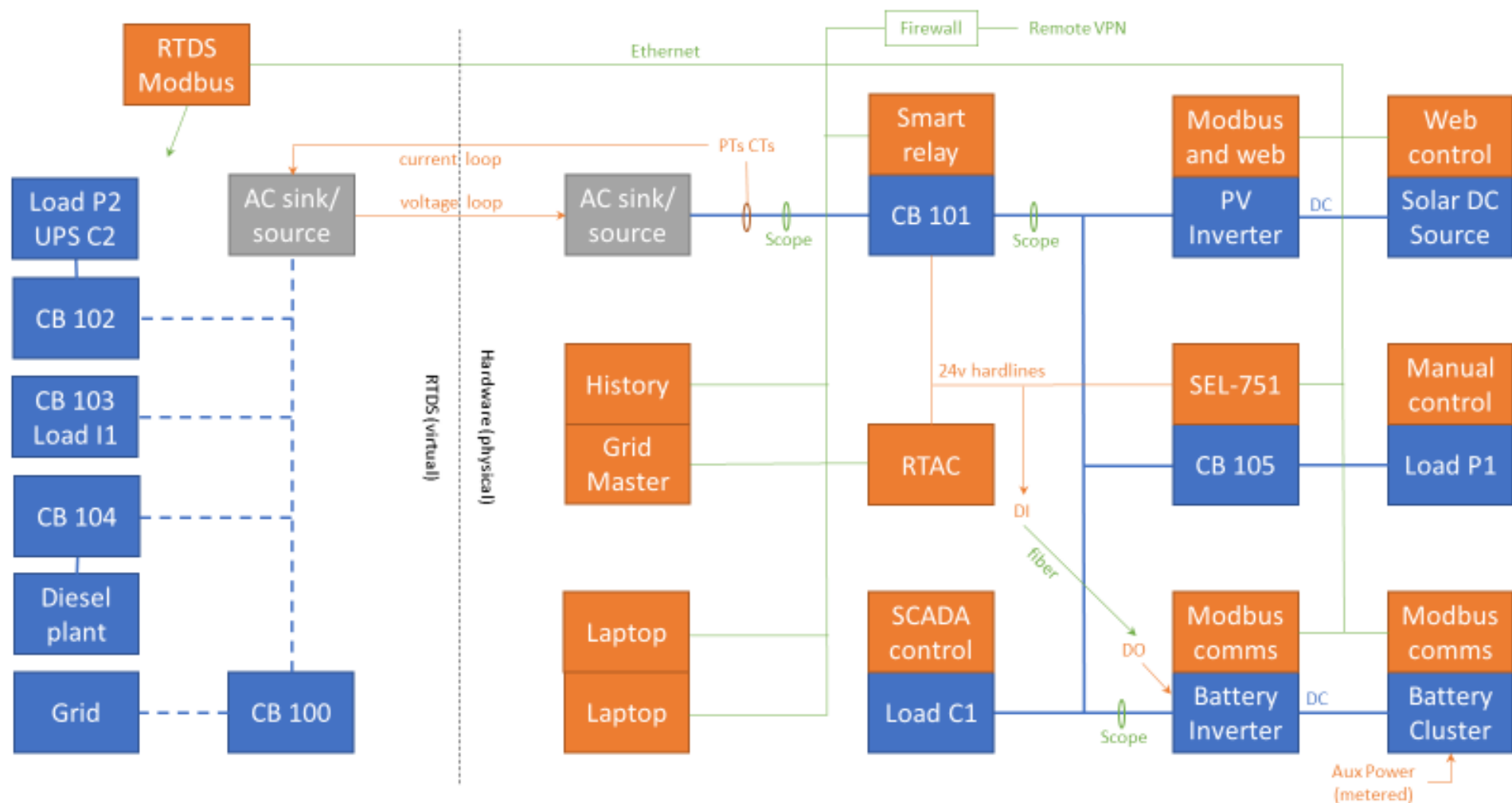
Dynapower inverter and  
Samsung lithium batteries

Ameresco BESS:

CE+T inverter and  
Invinity flow batteries







# Execution

- Execution in early-mid 2022
- Data analysis and reporting by late 2022
- ESTCP will then release information to the public



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# Thank You!

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# Goals and Impact

- Additional deliverables for US Department of Energy (DOE) high impact project
  - Videos of testing
  - Presentation and storyboard
    - Highlight DOE goals
    - Flatirons link; remote partner lab (ASU) link
  - Outreach
  - Phase 3 deployment plan is also a deliverable
  - ESTCP stakeholders should attend tests in person