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- For any question or issues, please email serdp-estcp@noblis.org or call 571-372-6565

"Cost-Effective and Resilient Building-Scale Microgrid Solutions for Increased Energy Security"

May 5, 2016

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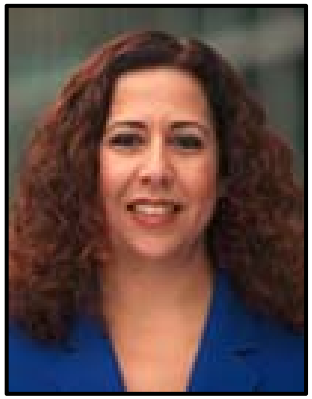
Welcome and Introductions



Rula A. Deeb, Ph.D.
Webinar Program Coordinator

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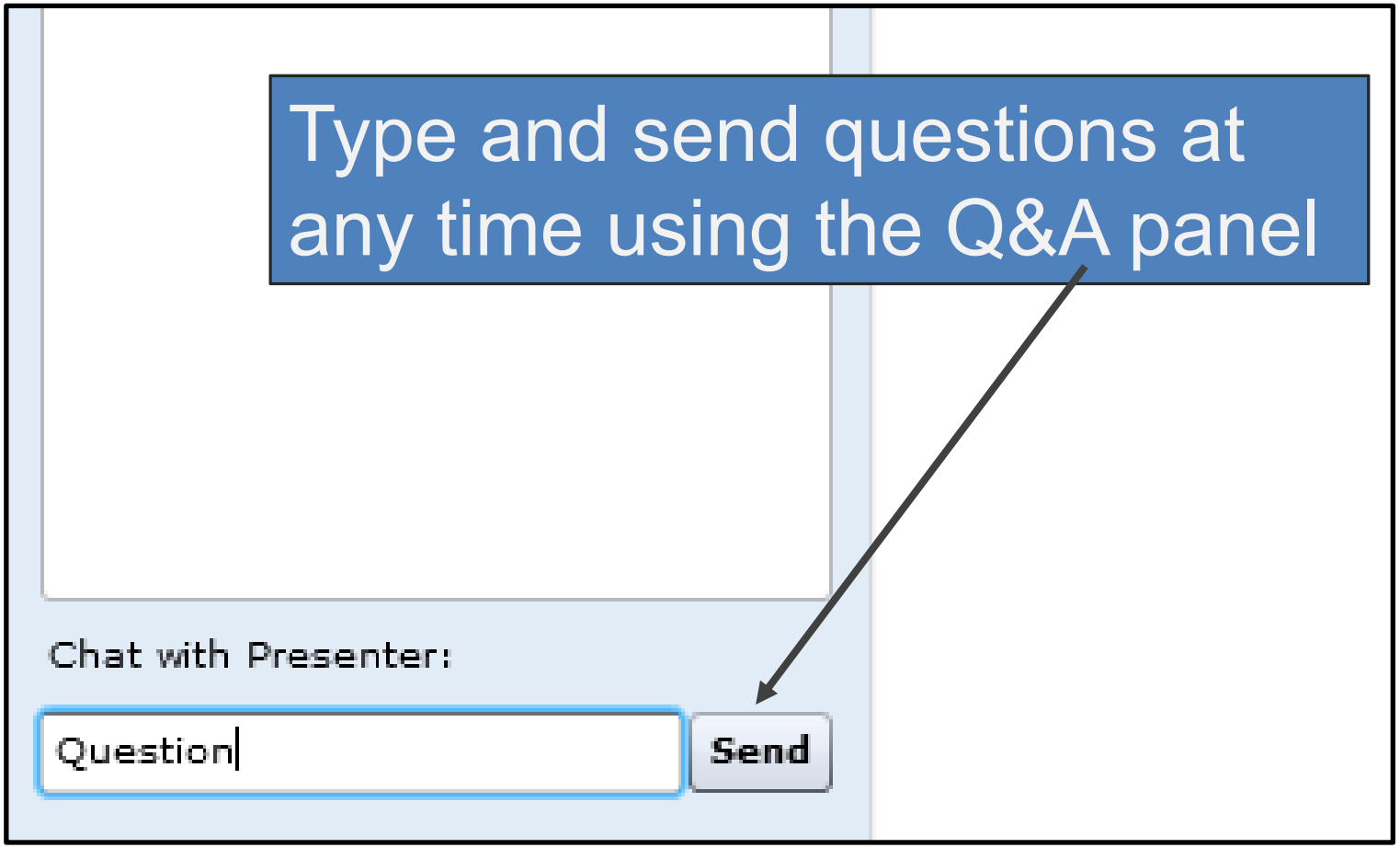
Agenda

- **Webinar Logistics**
  Dr. Rula Deeb, Geosyntec Consultants (5 minutes)
- **Overview of SERDP and ESTCP**
  Mr. Timothy Tetreault, SERDP and ESTCP (5 minutes)
- **Development to Demonstration: Results and Experience Using a ZnBr Flow Battery for a Microgrid**
  Mr. Ryan Faries, Raytheon (25 minutes + Q&A)
- **Building-Scale Direct Current (DC) Microgrid Platform**
  Mr. John Saussele, Bosch (25 minutes + Q&A)
- **Final Q&A session**

How to Ask Questions



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- Submit a question using the chat box

SERDP and ESTCP Overview

Timothy Tetreault
Energy and Water Program Manager

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SERDP

Strategic Environmental Research and Development Program

- Established by Congress in FY 1991
  - DoD, DOE and EPA partnership
- SERDP is a requirements driven program which identifies high-priority environmental science and technology investment opportunities that address DoD requirements
  - Advanced technology development to address near term needs
  - Fundamental research to impact real world environmental management

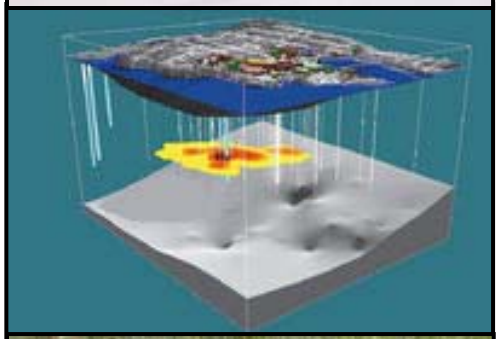
ESTCP

Environmental Security Technology Certification Program

- Demonstrate innovative cost-effective environmental and energy technologies
  - Capitalize on past investments
  - Transition technology out of the lab
- Promote implementation
  - Facilitate regulatory acceptance

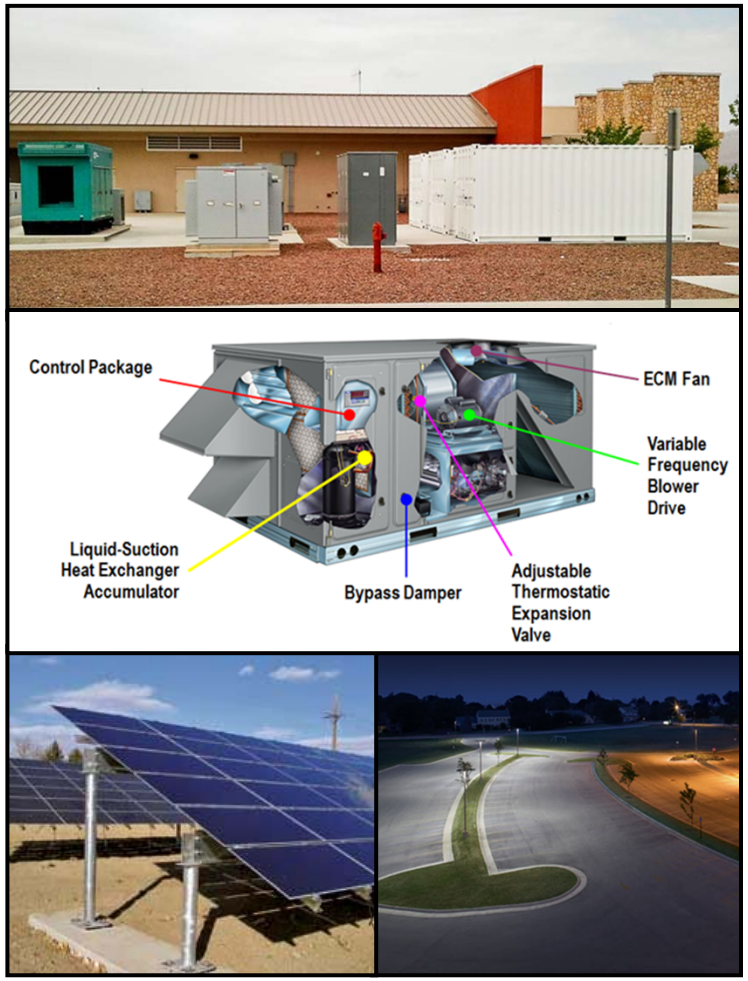
Program Areas

1. Energy and water
2. Environmental restoration
3. Munitions response
4. Resource conservation and climate change
5. Weapons systems and platforms



Energy and Water

- Smart and secure installation energy management
  - Microgrids
  - Energy storage
  - Ancillary service markets
- Efficient integrated buildings and components
  - Design, retrofit, operate
  - Enterprise optimized investment
  - Advanced components
  - Intelligent building management
  - Non-invasive energy audits
- Distributed generation
  - Cost effective
  - On-site
  - Emphasis on renewables



SERDP and ESTCP Webinar Series

DATE	Topics
May 19, 2016	Quality Assurance Project Plan (QAPP) for Geophysical Classification Investigations – Part 1
June 02, 2016	Insensitive Munitions: Environmental Health Criteria, Fate and Transport
June 16, 2016	Quality Assurance Project Plan (QAPP) for Geophysical Classification Investigations – Part 2
June 30, 2016	Geophysics 101: Realistic Expectations for Geophysics When Used for Site Characterization and Remediation Monitoring
July 14, 2016	Remote Methods for Water Conservation
July 28, 2016	An Environmentally Acceptable Alternative for Fast Cook-off Testing: Demonstration, Validation and Implementation Efforts

SERDP and ESTCP Webinar Series

http://serdp-estcp.org/Tools-and-Training/Webinar-Series

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Development to Demonstration: Results and Experience Using a ZnBr Flow Battery for a Microgrid

Ryan Faries
Raytheon

SERDP DOD • EPA • DOE | ESTCP

Agenda

- Demonstration system overview
- Demonstration objectives
- How system came together
- Demonstration results
- Demonstration lessons learned

Project Overview

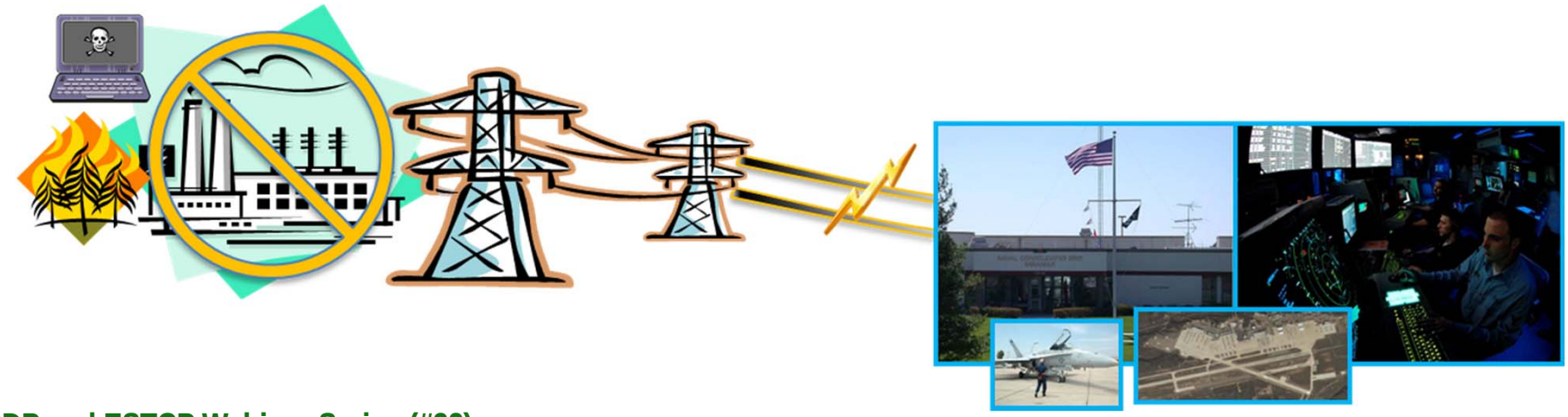
- EW-201242
  - "*Zinc Bromide Flow Battery Installation for Islanding and Backup Power*"
- Technology
  - Integration of advanced Zn/Br battery and Intelligent Power and Energy Management (IPEM) microgrid control technologies with the MCAS infrastructure, providing energy security, islanding capability, and reducing costs

Project Overview (Cont'd)

- Demonstration
  - Demonstrate the energy security, RE integration, and cost benefits of implementing a Zn/Br flow battery and microgrid controller at MCAS Miramar. Success is defined by ability to peak shave and island a building circuit per IEEE1547.4 Guidelines
- Technology transfer outlook
  - Energy storage and microgrid controllers demonstrated for use in future microgrid designs
- Demonstration site
  - MCAS Miramar, California

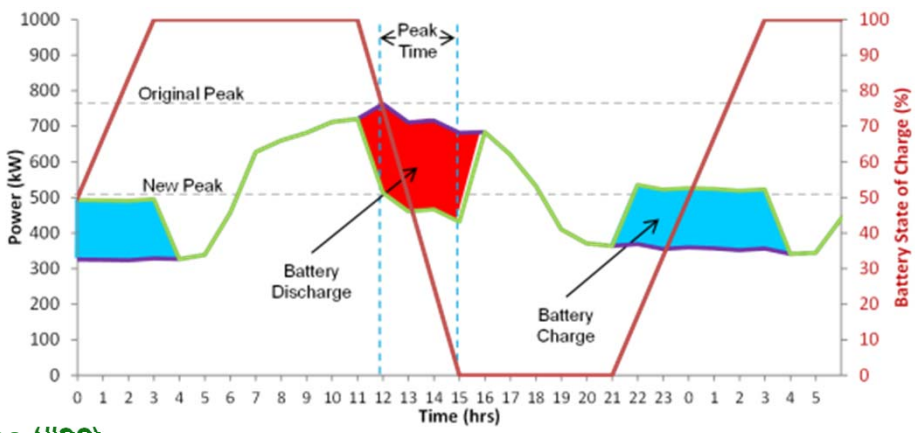
Operational Objectives
Islanding Scenario

- Objective: Demonstrate ability to operate in islanded mode for 72 hours under controlled loads
  - Simulated grid interruption
  - Buildings powered by PV and storage
  - ESS controlled and power usage data collected by Monitoring and Control System
  - Data will be analyzed to determine if building loads were met during operational day scenarios

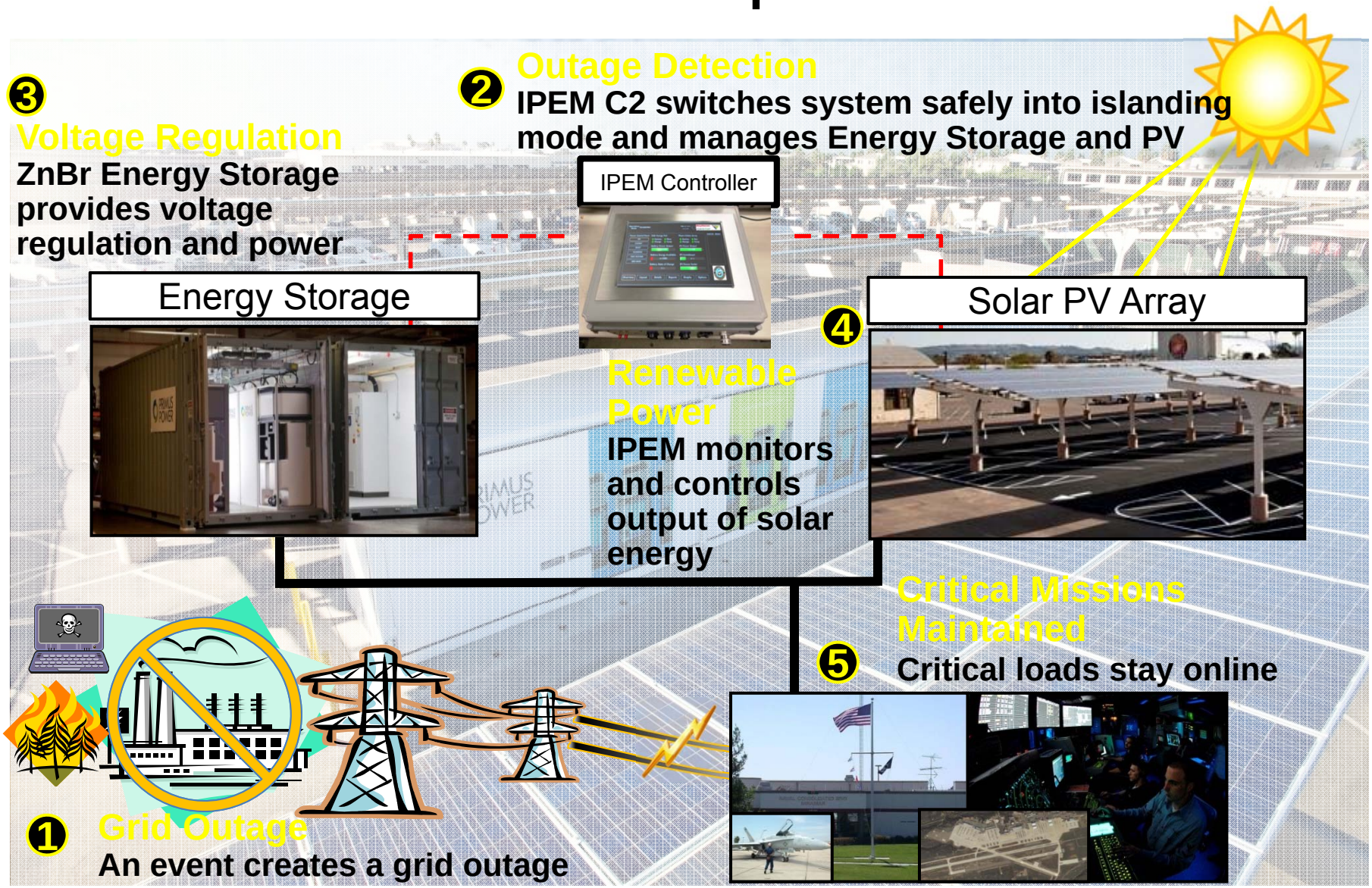


Operational Objectives
Peak Shaving Scenario

- Objective: Demonstrate ability to charge and discharge on a programmed schedule
  - ESS is charged off peak times
  - ESS is discharged at peak times
  - Peak demand is reduced for demand charge avoidance
  - Data is collected at the Monitoring and Control System and Zn/Br battery
  - Data analyzed to determine power output of ESS as a function of time to assess peak shaving capability

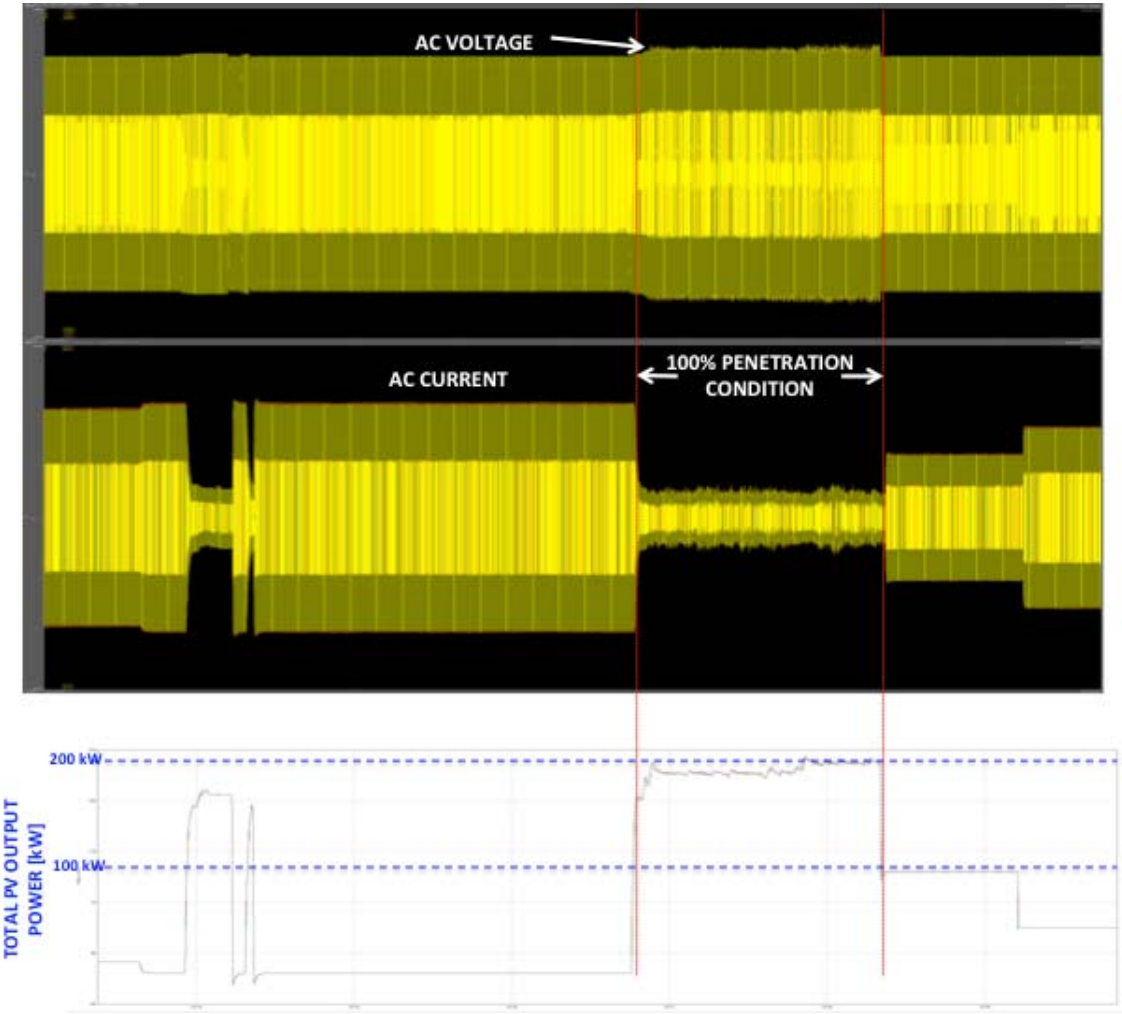


ESTCP Miramar Operational View



Hardware in the Loop Testing at NREL ESIF Facility Late 2014

Photos Courtesy of NREL



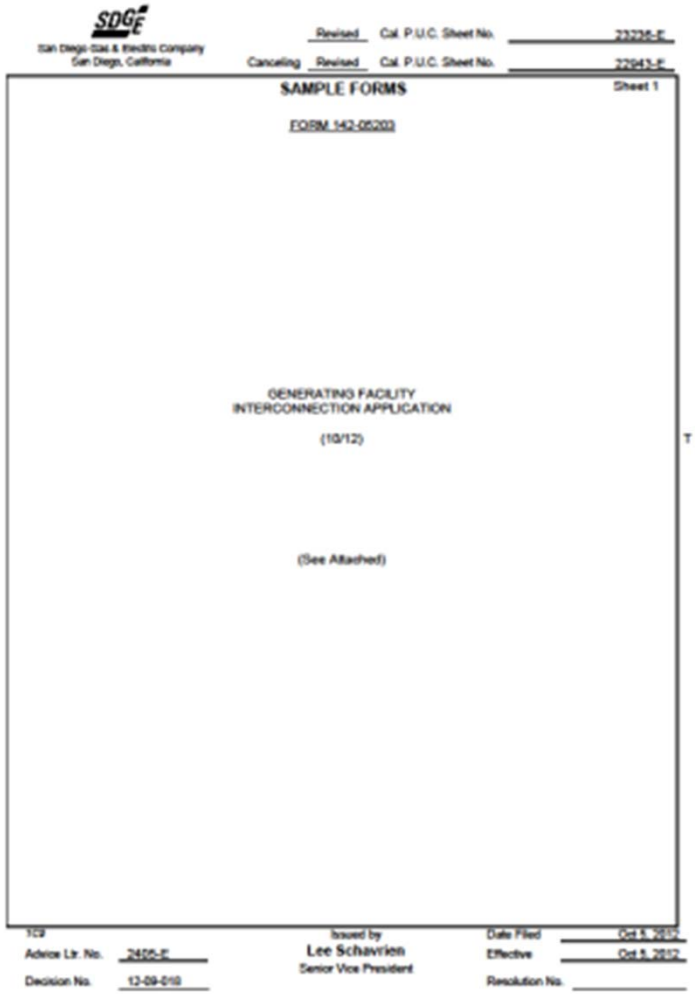
Battery Delivered May 2015

IPEM Installed July 2015

Switchgear Installed September 2015

SDGE Interconnect Agreement

- Interconnect agreement with SDGE submitted on May 6 and 19, 2014
- Permit to operate granted once battery was inspected and meter installed in September, 2015
- Important to have UL and safety information on inverter for approval


SDGE
San Diego Gas & Electric Company
San Diego, California

Revised Cal. P.U.C. Sheet No. 23236-E
Canceling Revised Cal. P.U.C. Sheet No. 22943-E

SAMPLE FORMS

Sheet 1

FORM 142-05203

GENERATING FACILITY
INTERCONNECTION APPLICATION

(10/12)

(See Attached)

TCB
Advice Ltr. No. 2455-E
Decision No. 12-09-010

Issued by
Lee Schavrien
Senior Vice President

Date Filed Oct 5, 2012
Effective Oct 5, 2012
Resolution No.

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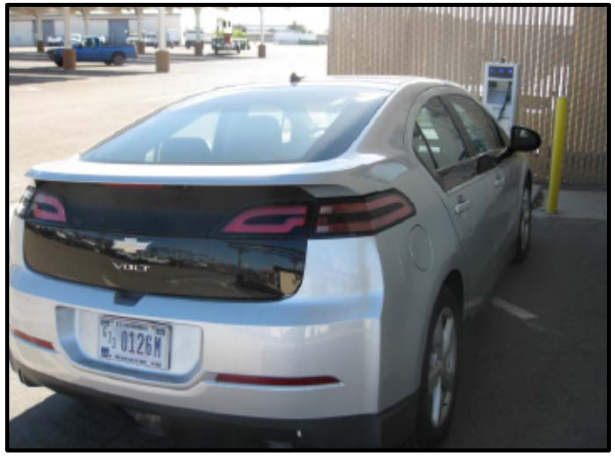
System Commissioned
October 2015

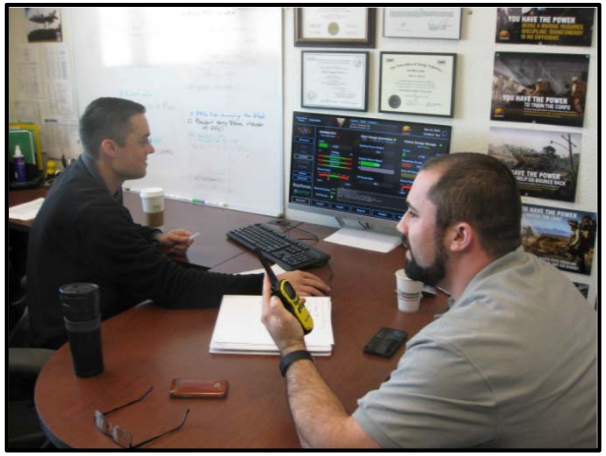
Photo courtesy of Primus Power

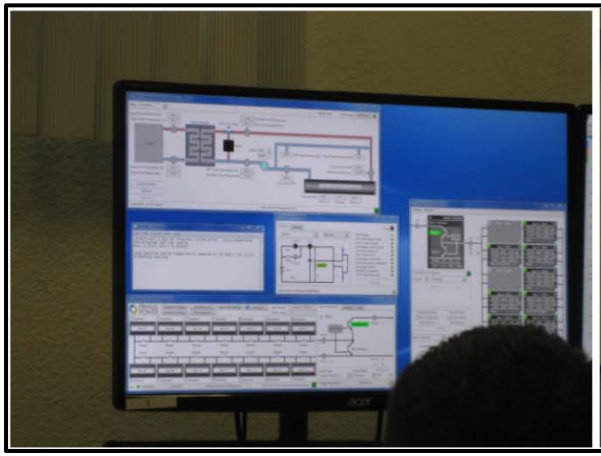
1st Islanding Test
October 23-25, 2015

- On October 23, planned and executed first attempt at demonstrating the system in Islanding Mode
- The test validated many of the subsystem elements functioning together for the 1st time
  - Tested safety interlocks of the Main Breaker
  - Tested the sequence for transitioning the entire system into islanding mode
  - Flushed out sequence for returning the system back into islanding mode

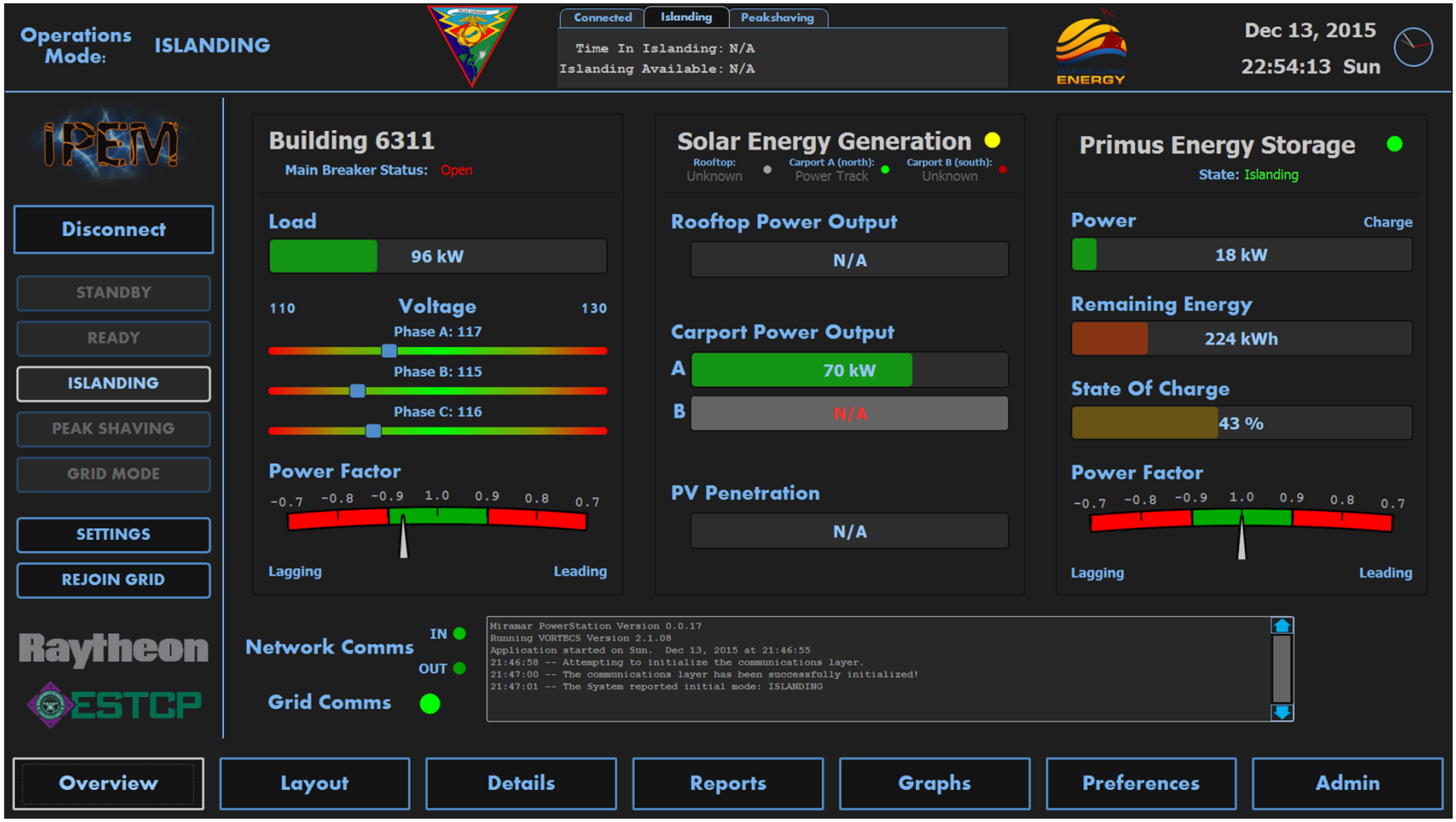
2nd Islanding Test
December 11-13, 2015



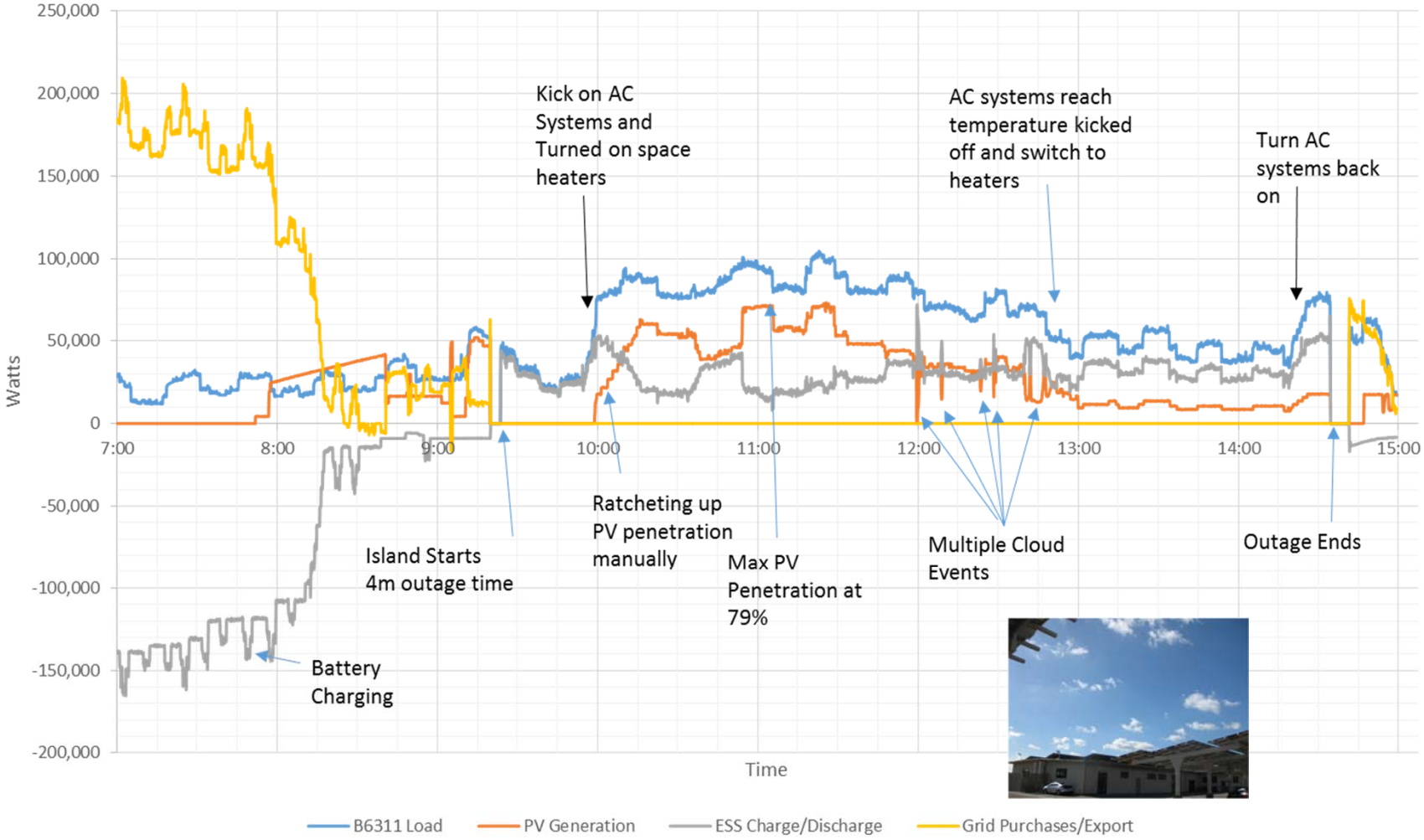




IPEM HMI Screen During Test



2nd Islanding Test Data



Lessons Learned

- Testing each subsystem thoroughly eliminates a lot of bugs before system level demonstration
  - Consider high fidelity hardware in the loop testing
- Do not underestimate the software required to make these systems operate smoothly
  - The more elements in a microgrid, the more complex the software
  - Have it modelled well and organized for easy troubleshooting
- If you have the ability to test the system without disrupting power, include that in your plan
  - Planned outages required a 21-day review
  - Coordinate base operations support each time

Conclusions

- Energy storage can be utilized as an alternative to fossil fuel generators to improve energy security by enabling islanding
  - This requires higher up front capital costs for installation than generators but energy storage can also be utilized for peak shaving to offset higher costs
- All renewable microgrids are achievable utilizing inverter based generation
  - Meeting IEEE power quality standards is achievable if voltage regulation source is designed properly to handle the load conditions
- Advanced inverter controls provide new capabilities to existing PV installations (with UL 1741) to be utilized in microgrid scenarios

For additional information, please visit

https://www.serdp-estcp.org/Program-Areas/Energy-and-Water/Energy/Microgrids-and-Storage/EW-201242

Speaker Contact Information

rfaries@raytheon.com; 310-647-9719

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Q&A Session 1

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Building-Scale Direct Current (DC) Microgrid Platform

John Saussele
Bosch

SERDP DOD • EPA • DOE | ESTCP

Agenda

- DC devices in buildings
- Benefits of DC versus AC
- Ideal building applications
- DoD demonstration project
- Other pilot projects
- Cost-benefit analysis
- Conclusions and next steps

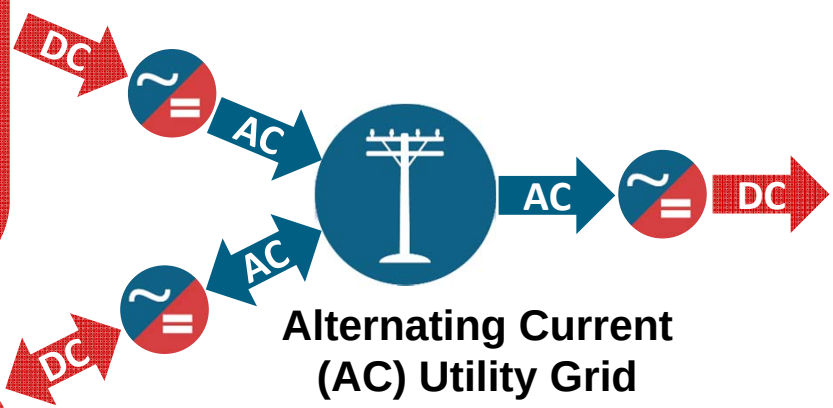
Most Building Devices Already Use DC

Local Sources

- Solar photovoltaic
- Modern generators
  - Gensets
  - CHP
  - Wind
- Fuel cells

Energy Storage

- Battery
- Ultra capacitor
- Flywheel
- Bi-directional EV



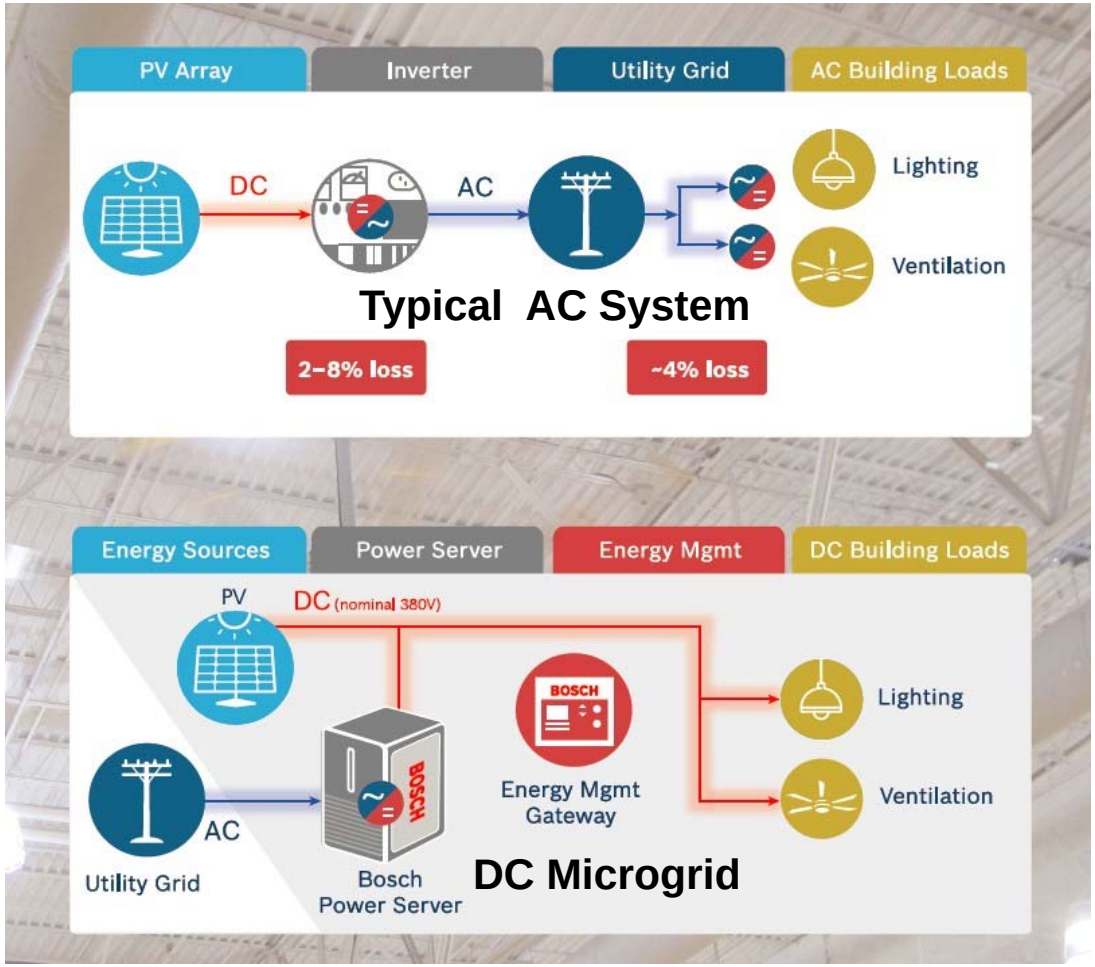
Electrical Loads

- Efficient lighting
  - LED
  - Fluorescent
  - Induction
- Motors (VFDs)
  - Industrial fans
  - HVAC
  - Refrigeration
  - Automation
- EV chargers
- IT equipment

…but must utilize power conversion equipment to operate on the existing AC grid

Conventionna AC System versus Core DC Microgrid

- Benefits of DC Microgrid
  - Lower energy losses
  - 7-10% average improvement in utilization of on-site generation
  - Higher reliability
  - Resiliency during grid outages
  - Emergency lighting support
  - Reduced interconnection costs
  - Lower investment
  - Minimizes emissions



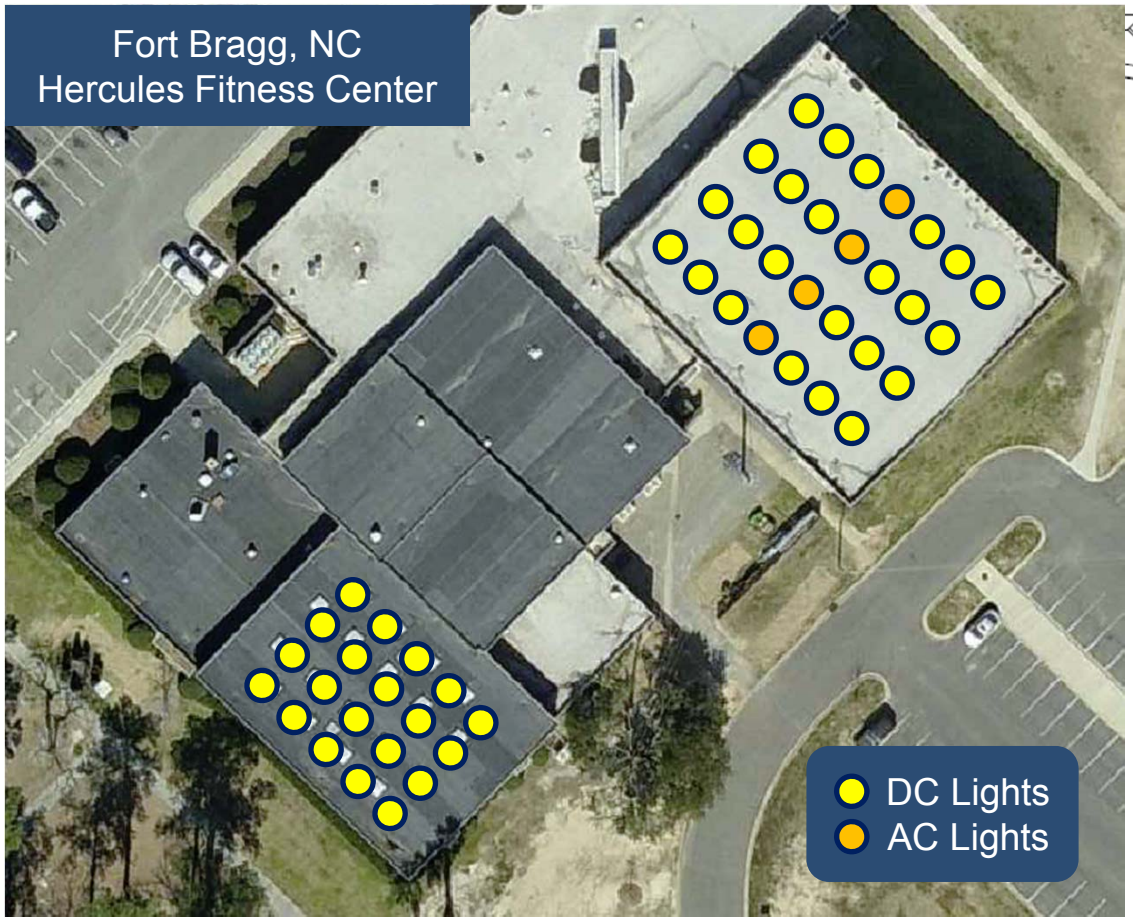
Ideal First DC Microgrid Applications

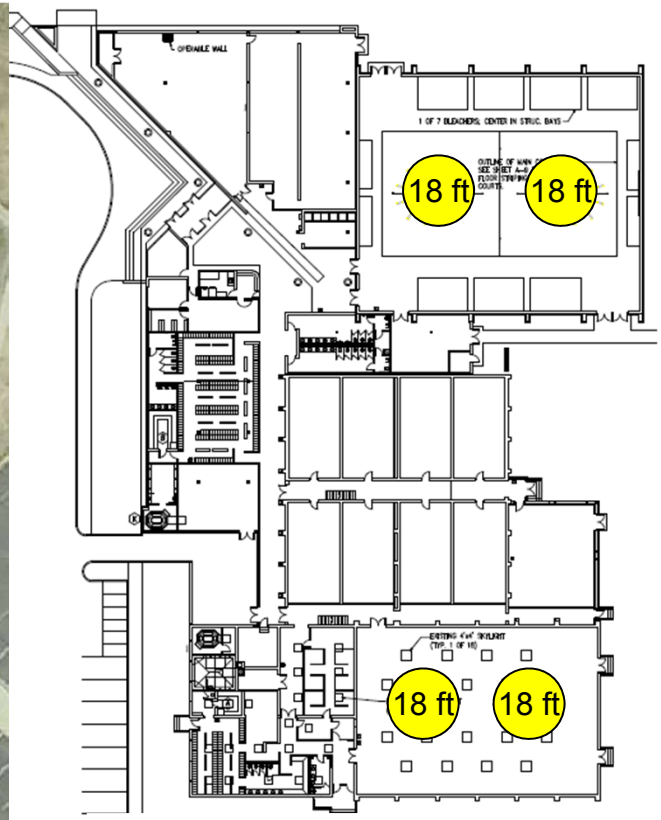
- Best economics with 7-day operation
- First target constant DC ceiling loads
  - LED lighting
  - Large industrial ceiling fans
- Attractive for “big box” buildings (i.e., warehouse, maintenance facility, manufacturing plant, fitness center, parking structure, retail store, etc.)
  - Hundreds of lights with costly O&M
  - Roof space available for solar PV array

Demonstration Location: Fort Bragg

- Good fit for demonstration
  - Small but representative
  - Daytime operation all week
  - Newer roof good for solar
  - Two high-bay areas
    - Basketball court
    - Weight room
  - Used as emergency shelter
  - In need of upgrades
    - Inefficient metal halide lights
    - Weight room ventilation

Lighting and Fan Placement

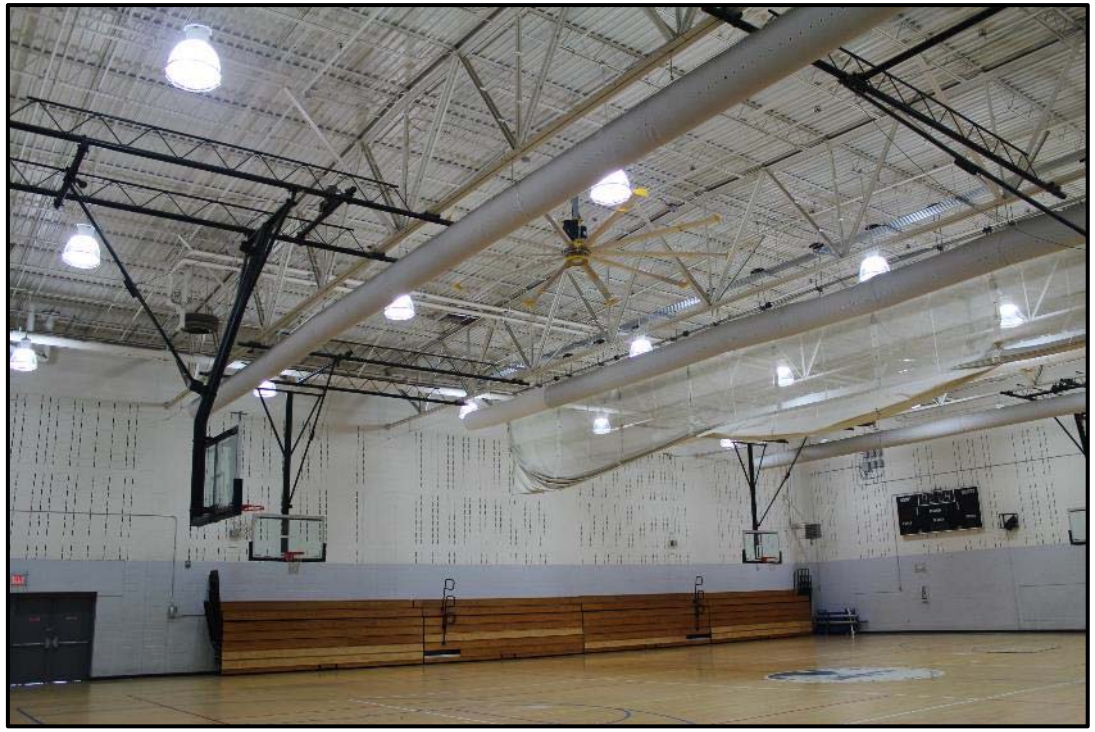




Ceiling fan mounting locations

DC Lights and Fans Installed in Basketball Court

Installing 18' diameter DC ceiling fans

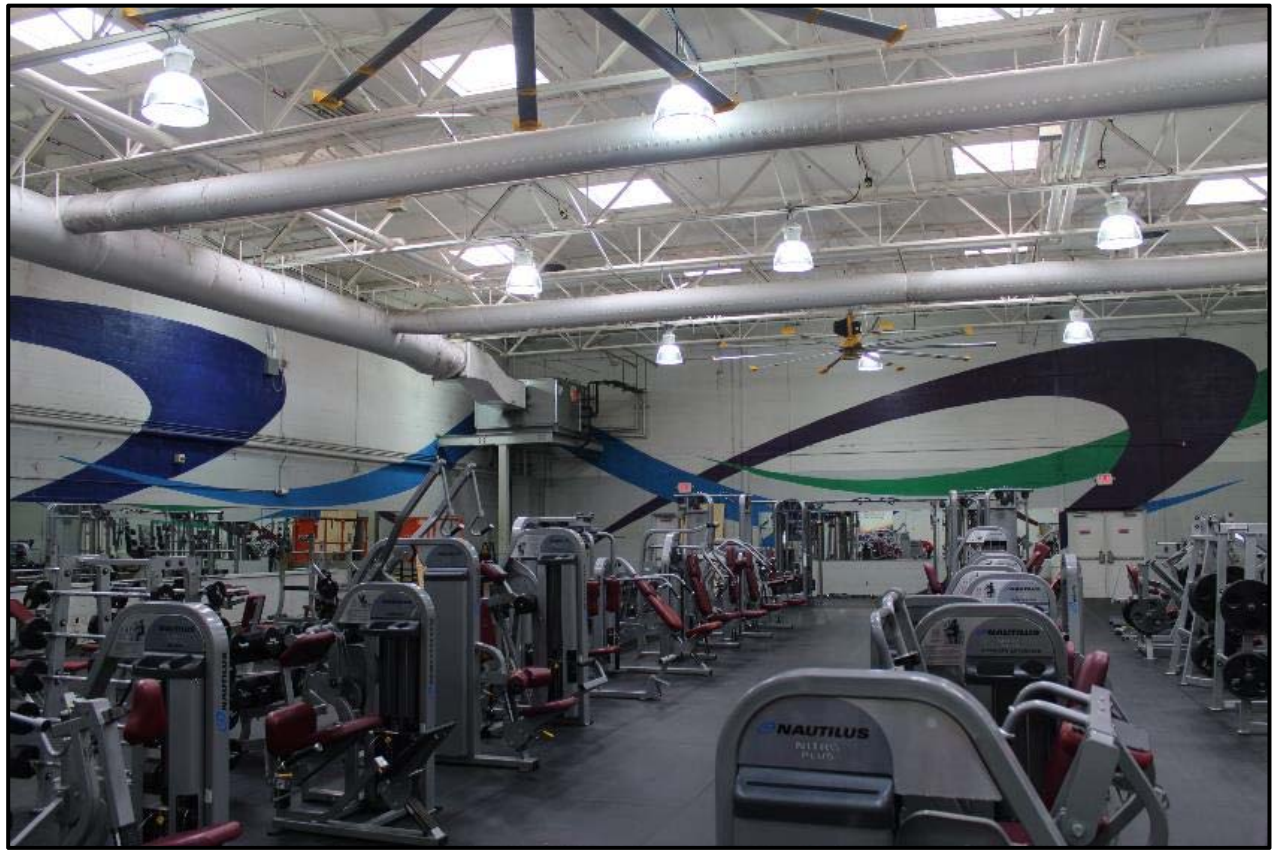


Completed basketball court with 24 DC high-bay lights and 2 DC ceiling fans

DC Lights and Fans Installed in Weight Room

Installing 18' diameter DC ceiling fans

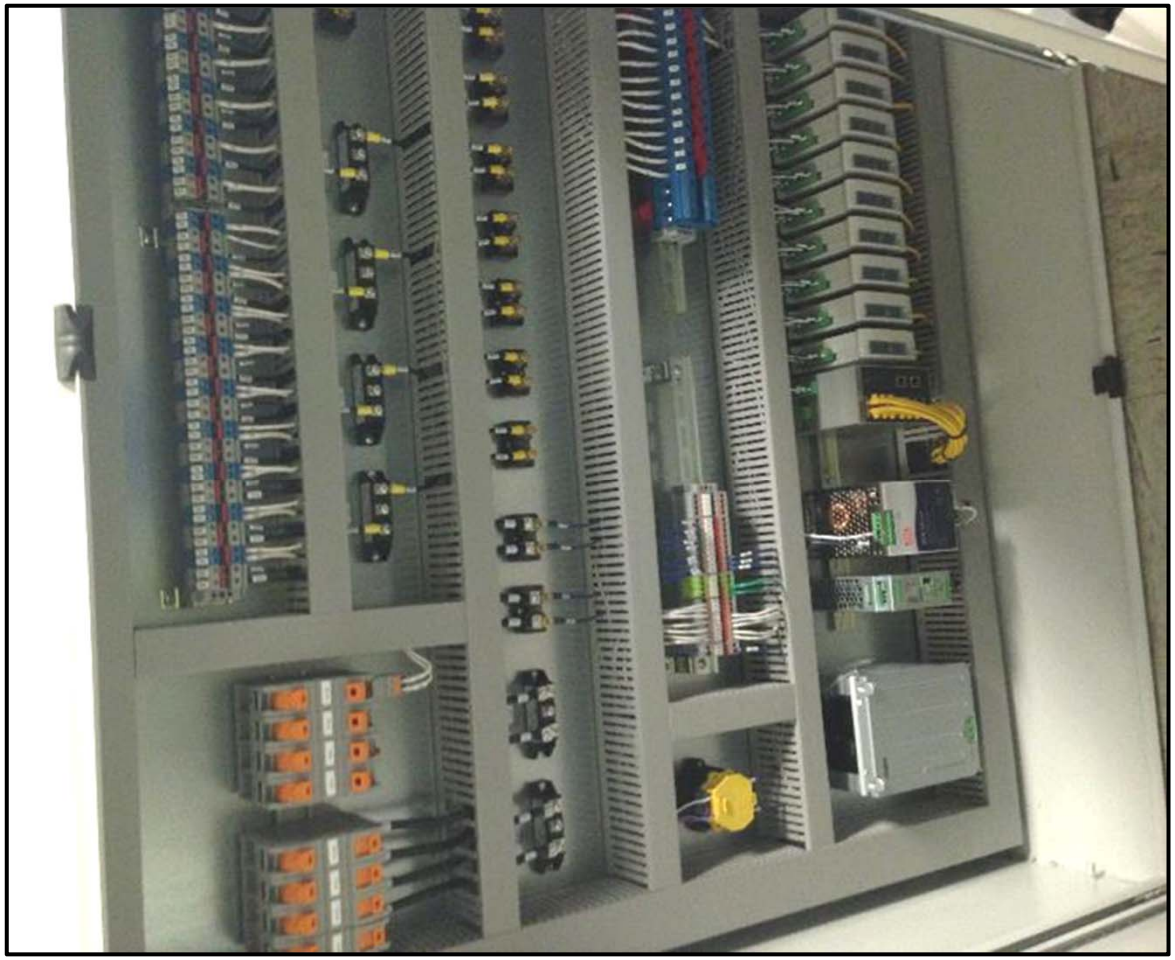
Replacing AC HID Lights



Completed weight room with 20 DC high-bay lights and 2 DC ceiling fans

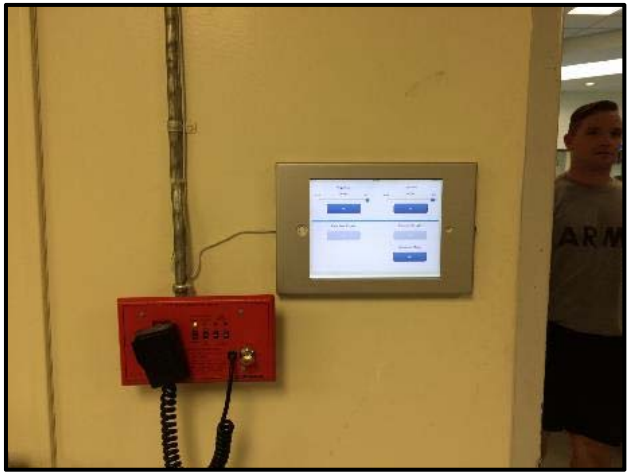
45 kW PV Array (Phase 1) Installed on Basketball Court Roof

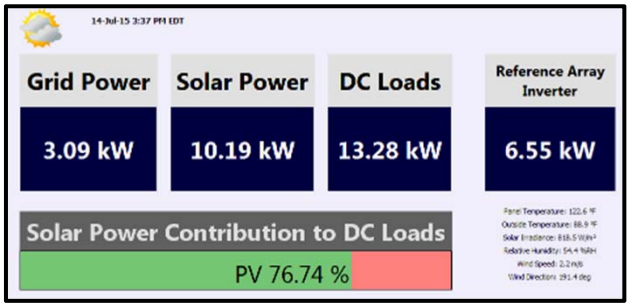
DC Power Server and DC Panel in Equipment Room



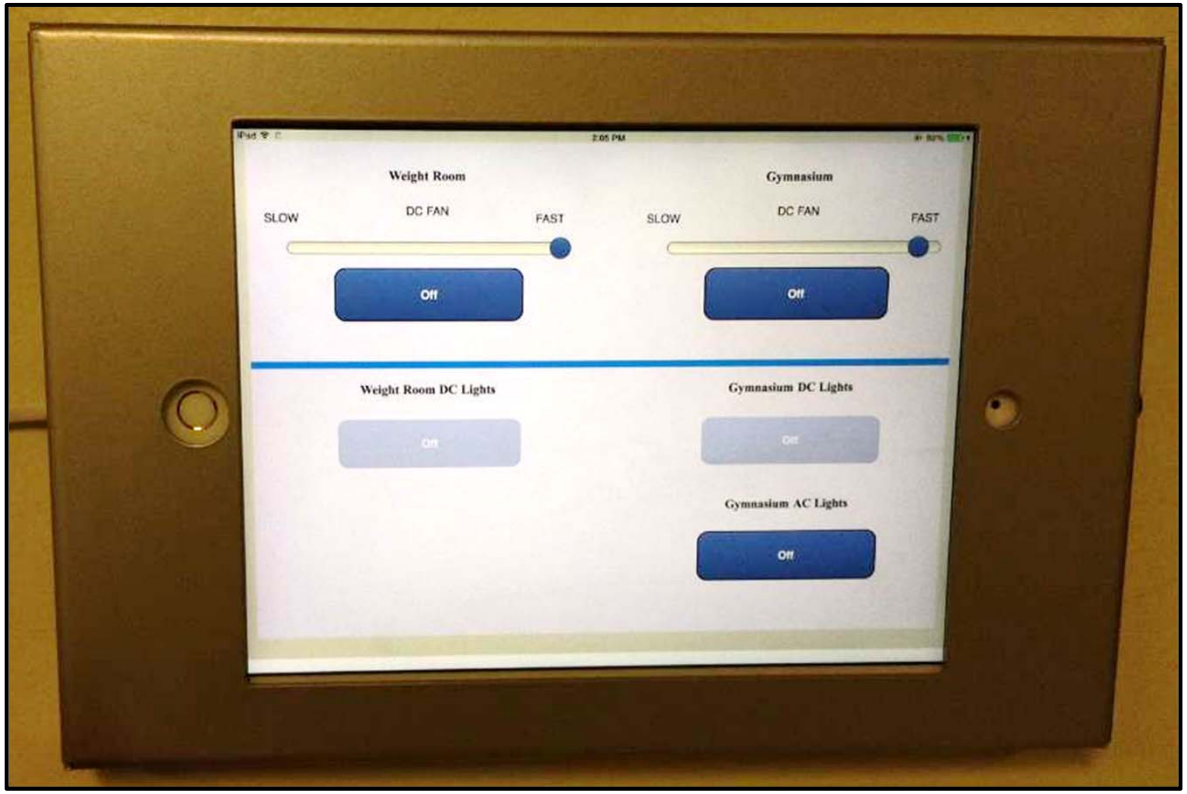
DC panel contains instrumentation for control and monitoring

Building Controls and Instrumentation



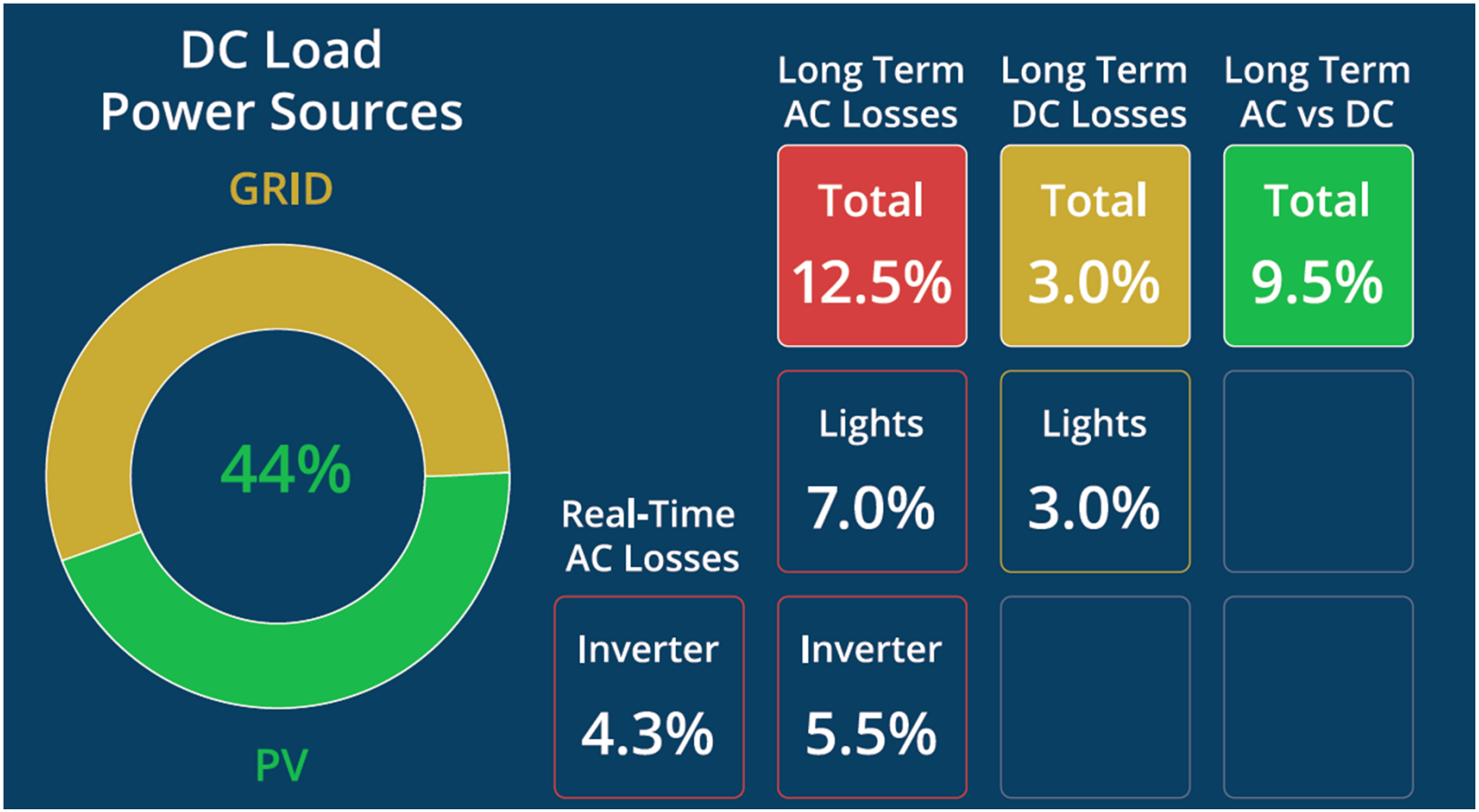


Performance monitoring begins



Simple touch screen user interface for facility managers

Long-Term Performance Monitoring Example



Solar PV Array Phase 2 Expansion

- Phase 1 PV array = 45 kW
  - DC Microgrid versus AC reference system energy loss comparisons
- Phase 2 PV array = 108 kW
  - Used to study PV and storage size versus energy security benefit

Installation of Battery Energy Storage System for Phase 2

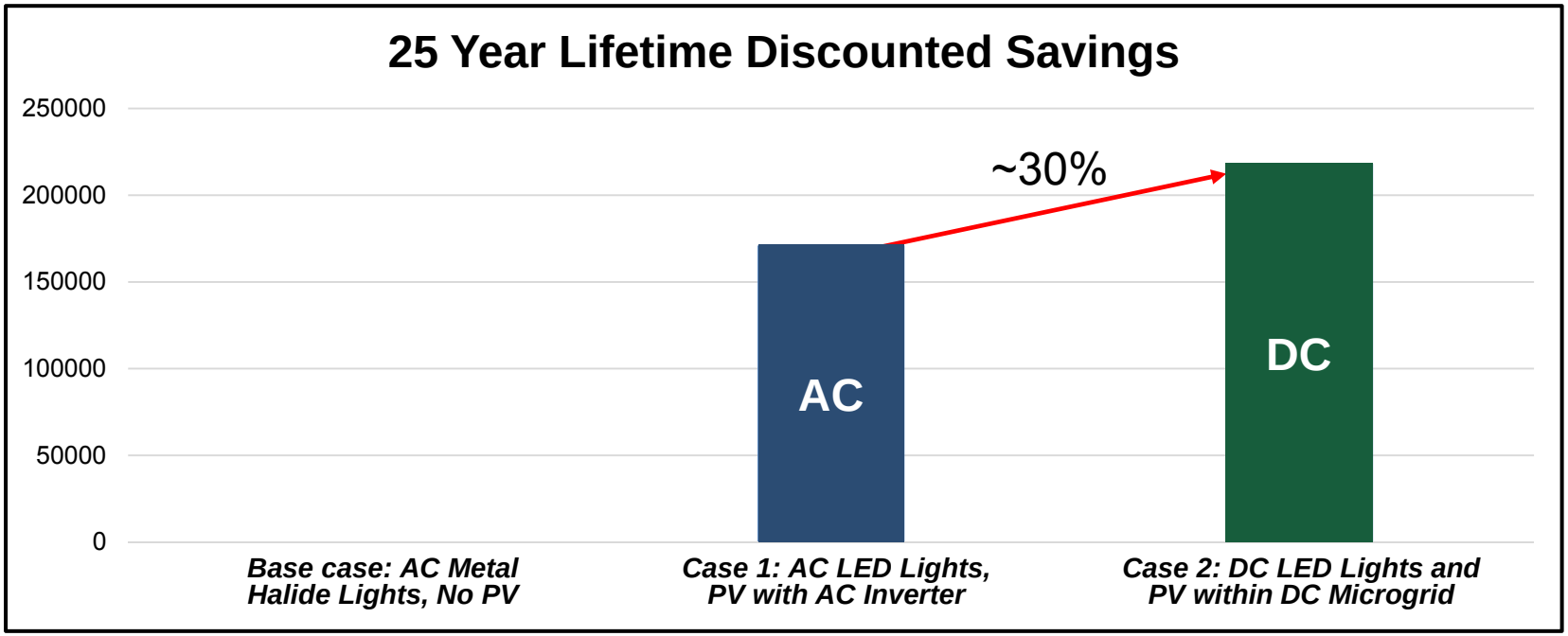
100 kW/100 kWh energy storage system installed behind facility

Other Demonstration Projects

#	Demonstration Type DC Load Size	Location	Year	Status
1	Lab Scale 3.3 kW	Plymouth, MI	2013	FINISHED
2	Building Scale 15 kW	Charlotte, NC	2014	FINISHED
3	DoD Awarded Demo 15 kW	Ft. Bragg, NC	2015	FINISHED
4	Bosch Building 30 kW	Plymouth, MI	2016	UNDERWAY
5	Bosch Dev Lab 2.0 30 kW	Mooresville, NC	2016	UNDERWAY
6	CEC Awarded Demo (Honda) 175 kW	California	2016	IN DESIGN

Preliminary Cost-Benefit Analysis

- Example case study: DC Microgrid versus Conventional AC system
  - California warehouse with approximately 100 lights
  - 48 kW metal halide lighting replaced with 20 kW LED lighting
  - 52 kW solar PV system provides 89% of the energy for lighting



Conclusions and Next Steps

- Benefits of the Bosch DC Microgrid are proven
  - Inherent resiliency provides energy security
  - 7-10% better utilization of local energy sources
  - Higher reliability through reduced electronics
  - ~30% lower lifetime costs
- Ready for first commercial applications
  - LED lighting is first available DC load
  - Suitable for retrofit or new construction
  - Ideal for large “big-box” type buildings
  - Economics best with (daytime) 7-day operation
- Bosch seeking projects for 2017 installation

For additional information, please visit

https://www.serdp-estcp.org/Program-Areas/Energy-and-Water/Energy/Microgrids-and-Storage/EW-201352

Speaker Contact Information

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Q&A Session 2

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The next webinar is on
May 19, 2016

"Quality Assurance Project Plan (QAPP) for Geophysical Classification Investigations"

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Survey Reminder

Please take a moment to complete the survey that will pop up on your screen when the webinar ends

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