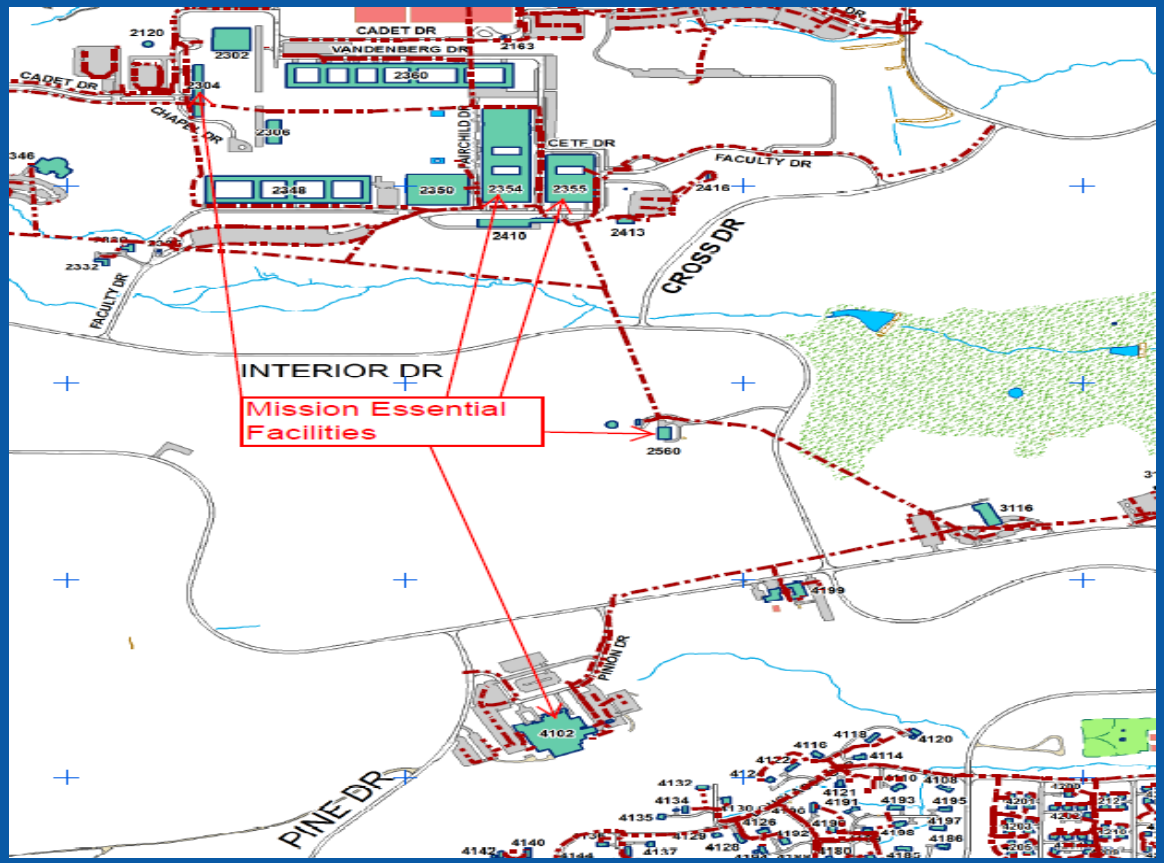
NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Microgrid Planning and Design – MCAS Miramar, US Air Force Academy, and Fort Carson



Robert Butt, NREL Grid and Dispatchable Power Group

E^2S^2 - New Orleans

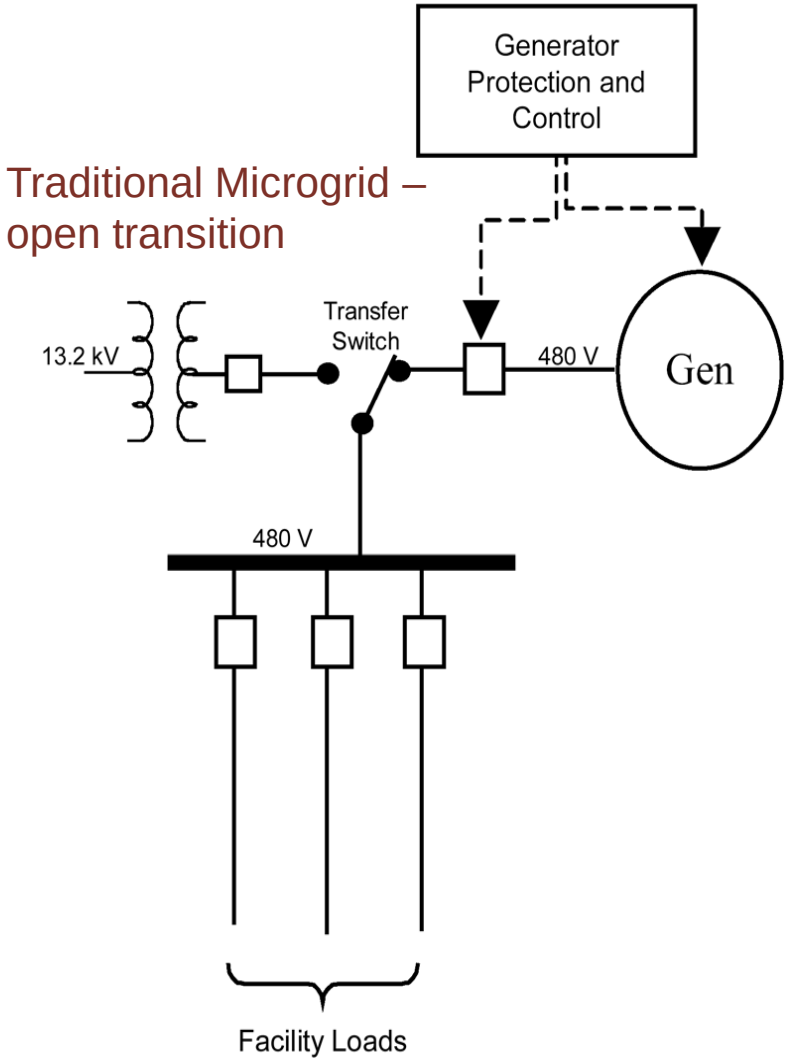
May 13, 2011

NZEI Projects at MCAS Miramar, US Air Force Academy, and Fort Carson

Miramar NZEI Report Completed June 2010
Ft Carson NZEI Report Completed September 2010
USAFA Draft NZEI Report April 2011

As part of its move toward net zero energy, MCAS Miramar installed this 250-kilowatt solar carport in April 2010. Courtesy of MCAS Miramar

Microgrids – what/why?

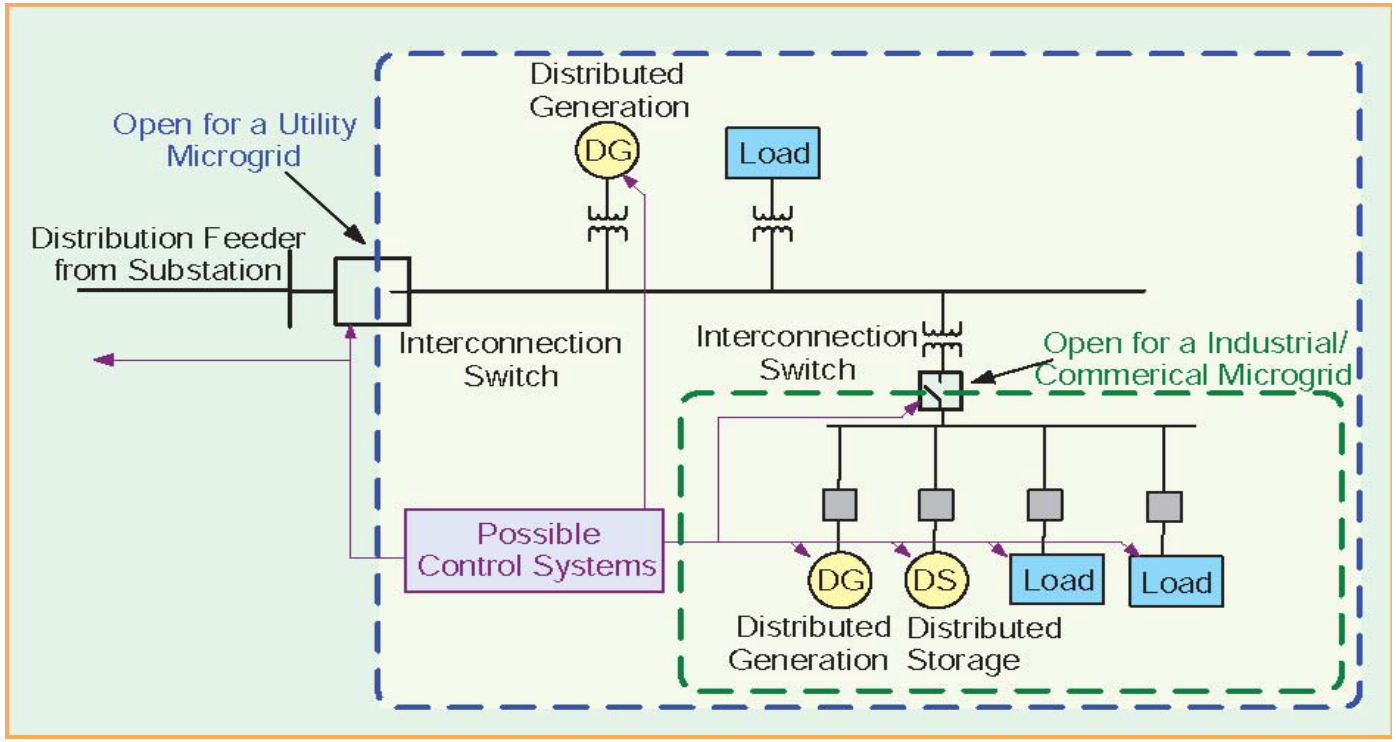


- A coordinated energy and electrical distribution system capable of independent operation that includes power sources for mission critical facilities during outages
- Renewables can be incorporated to extend the fuel supply of conventional generators and provide a perpetual, reliable source of energy
- They provide remote locations with a more robust , cost – effective power supply

Types of microgrids

Types of microgrids:

- **Facility/building**
- **Multiple Facilities/Campus**
- **Regional**



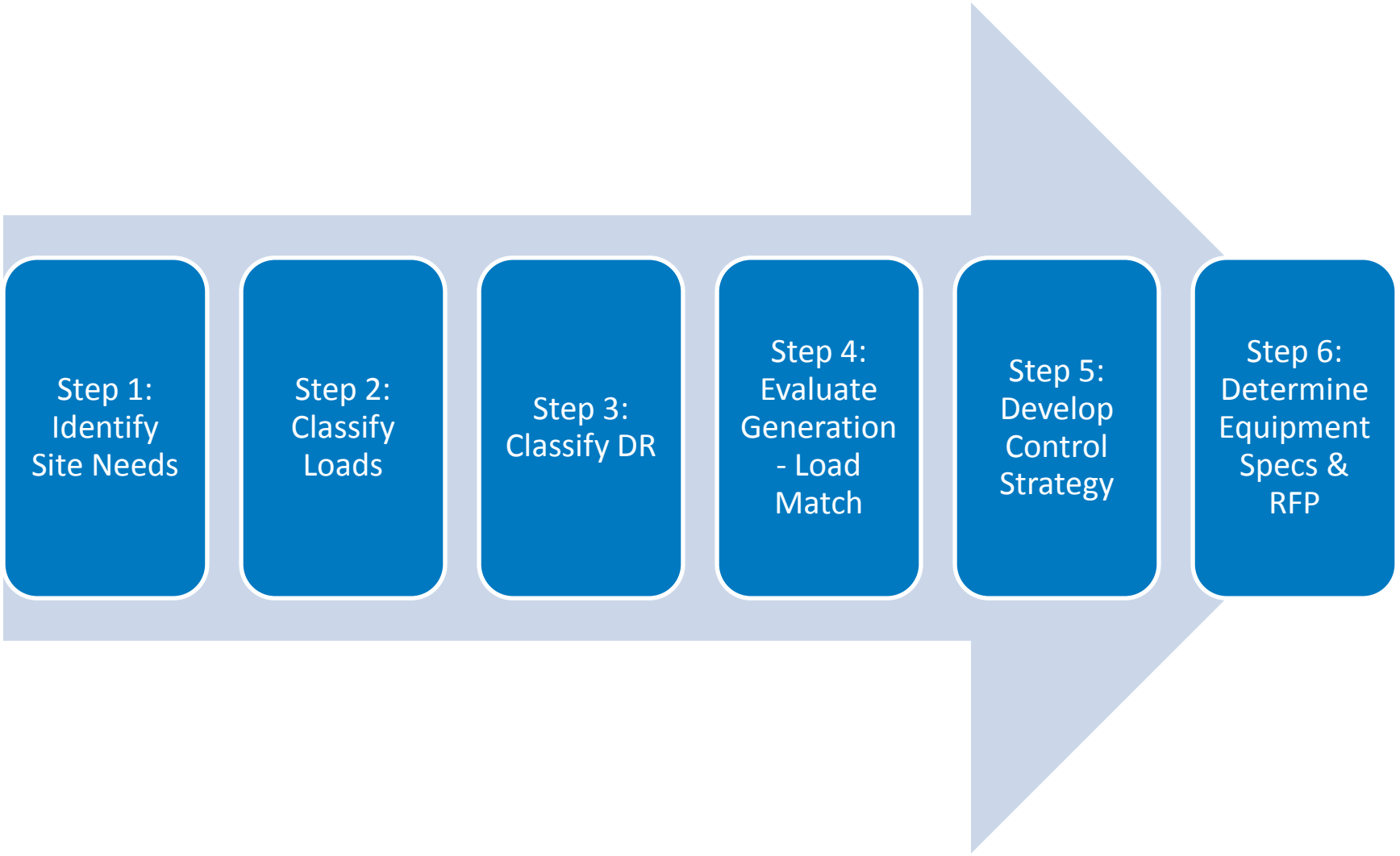
Microgrid and components (Source: Kroposki, et al. 2008)

Microgrid Standard – IEEE 1547.4

Draft Guide for Design, Operation, and Integration of Distributed Resource Island Systems with Electric Power Systems

- Covers **intentional** islands in electric power systems that contain distributed resources (DR)
- The term “DR island systems”, sometimes referred to as microgrids, is used for these intentional islands
- Draft standard is in comment stage

Microgrid Planning & Design - Approach



Step 1: Identify Site Requirements

Clarify the goals of the microgrid?

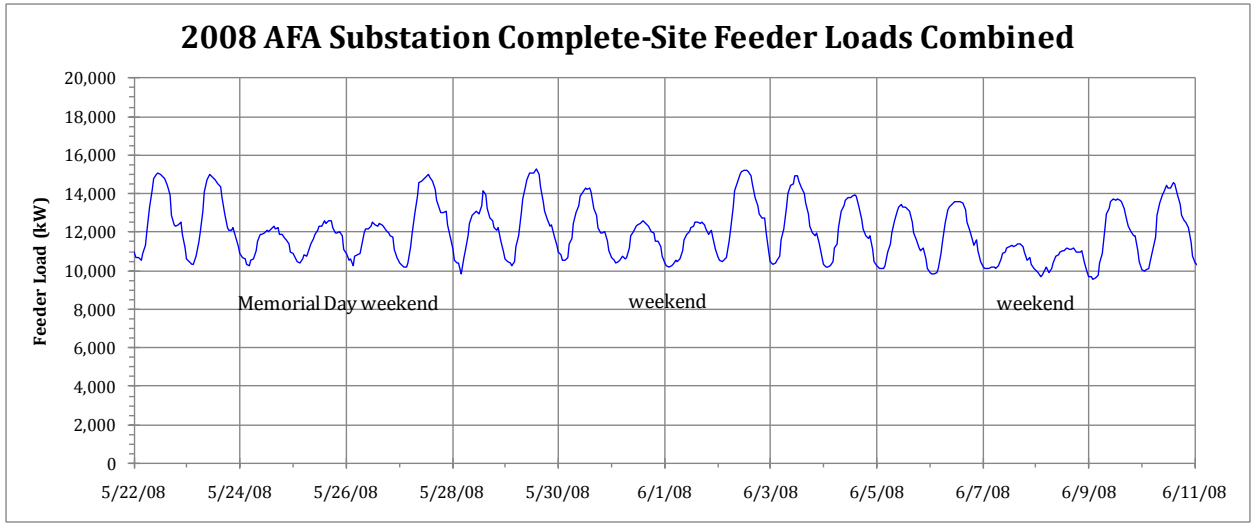
- What are the critical facilities that must be included in the microgrid?
- What are the thresholds and how long should a utility disturbance persist before transitioning to islanded mode?
- What is the maximum amount of time the microgrid must operate?

Factors impacting microgrid Capabilities:

- Site mission
- Geographic relationship of facilities and site electrical distribution system layout/characteristics
- Existing standby generation capacity and controls
- Availability and feasibility of renewable resources
- Building management & control systems/ load control schemes
- Utility standards and response to microgrid proposal

Step 2: Classify Loads

- Load Profiles
  - Energy, annual & daily peaks, and seasonal behavior
  - AMI data
  - Install temporary metering where necessary to record load characteristics



- Operational & nameplate equipment data
- Criticality of loads & sensitivity to power quality issues
- Identify UPS (ride-through) locations
- Flexibility of load to adjust and match available generation

Step 3: Classify DR

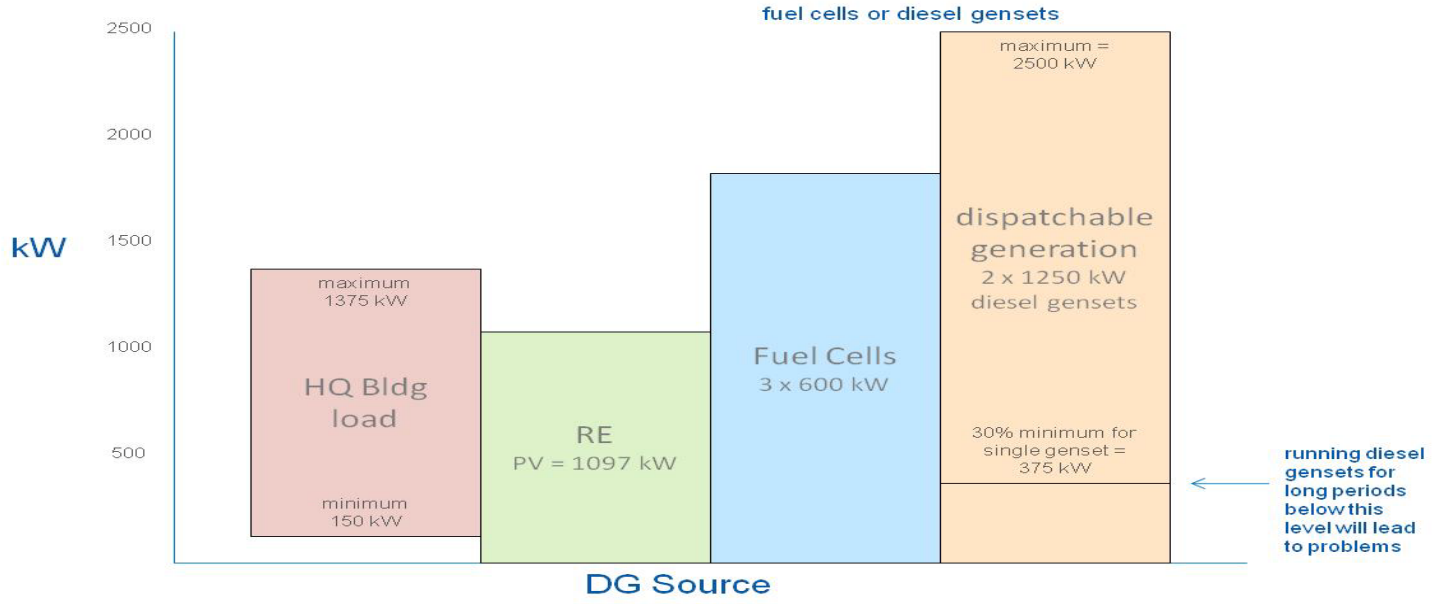
Distributed Generation & Energy Storage

- Coverage required for microgrid footprint
- Existing standby generation characteristics
- Proposed/funded generation projects
- Fuel inventory and duration requirements
- Dispatchability to intermittency ratio
- Distributed storage considerations – location, technology, capacity, & duration

Fuel cell and Wind Turbine (Source – Kroposki, et al 2008)

Step 4: Evaluate Generation/Load Match

- Can existing/projected generation capacity meet the proposed peak load and daily operating requirements?
- Can dispatchable resources handle transient disturbances on the system while maintaining satisfactory voltage and frequency?
- Can existing dispatchable generation compensate for the variability of renewable resources?



NREL MarForRes Report 2009

Step 5: Develop Control Strategy

- Appropriate control strategies for self regulation - load and generation dispatch
- Include both grid–connected and islanded conditions
- Control of utility interface (i.e., static transfer switch) to handle seamless separation and reconnection to utility power
- Utility requirements (monitoring and/or control of interface)
- Local /central control schemes to monitor & control DR and loads
- Interface with building energy management system(s)
- Integration with existing legacy communication systems/software
- Address security concerns – cyber & physical
- Integration with existing protection schemes

Schweitzer Engineering Laboratories **Real-Time Automation Controller**

Step 6: Determine Equipment Requirements

- Engineering analysis to include modeling and simulation of the microgrid under various scenarios to establish necessary control parameters, devices, infrastructure modifications, and additional generation and storage necessary for micro-grid implementation

- Assist with RFP development that specifies site micro-grid requirements

Interconnection switch and control board
(Source: Kroposki, et al. 2008)

MCAS Miramar Microgrid Project

- OSD ECIP Funded
- NZEI project identified electrical baseline and possible critical loads to be included in microgrid
- 3 MW landfill gas generator project is underway
- Some solar PV installed, more projects proposed
- Electrical distribution system at Miramar is very robust
- System peak is 13.5 MW (10/2008); average is 7.6 MW; minimum load is 5.4 MW

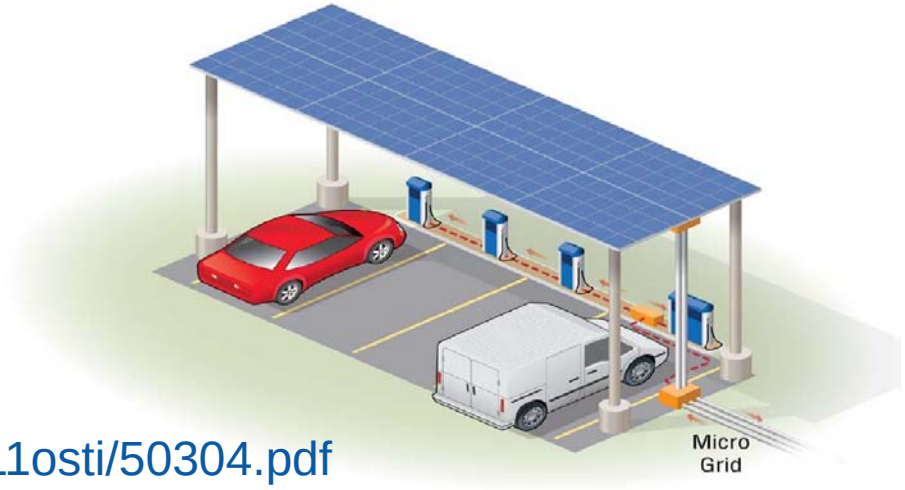
USAFA Microgrid Project

- OSD ECIP funded
- NZEI project identified electrical baseline & mission essential facilities, and proposed renewable options
- USAFA is in the process of turning over their campus distribution system to the local utility (privatization)
- 16 MW load/two substations
- Facility generators dedicated to specific buildings
- 6 MW PV utility-operated system in service spring 2011
- Microgrid will include energy storage capabilities

Large lead-acid battery bank
(Source: Kroposki, et al. 2008)

Fort Carson Microgrid Project

- Multiple funding sources & multi-Lab participation
- Conceptual microgrid design with electric vehicle assessment: 5/11
- Preliminary Design: 10/11
- Detailed Design, including controls/equipment, system reconfiguration requirements, and EV to grid: 2/12



http://www.nrel.gov/docs/fy11osti/50304.pdf

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THANK YOU!

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