

Advanced Microgrid Concepts

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Complexity of DER-based Distribution

When it comes to a utility figuring out how to manage this wide, dynamic set of distributed energy resources and control points, the only way they can do that efficiently is to ***break their networks down into small nodes i.e. microgrids—***

Dave Pacyna, senior vice president of Siemens Energy's North American

CERTS Microgrid Architecture

Objective of CERTS Microgrid architecture is to reduce cost and improve the performance/flexibility of clusters of different *DER technologies* and loads that operate as an integrated system or microgrid.

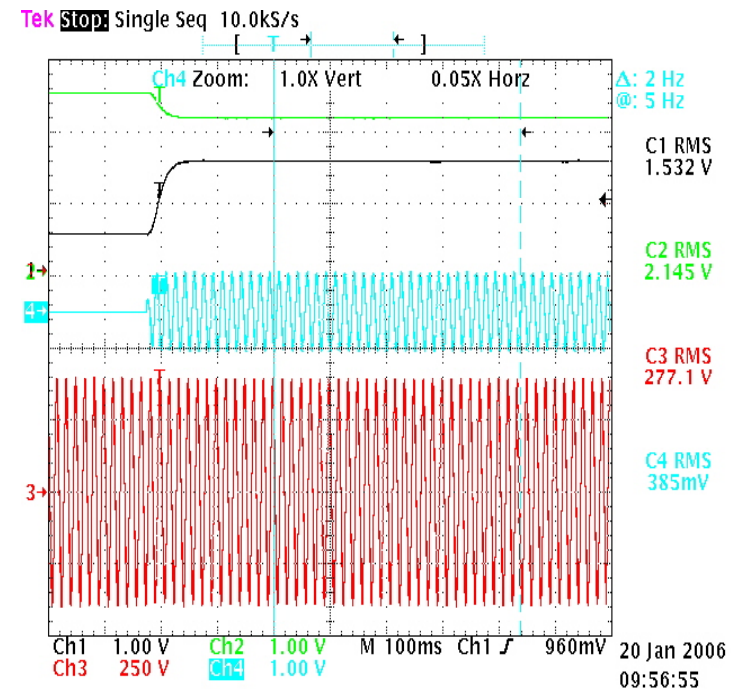
To achieve this objective we need to specify the expected dynamics of microgrid capable DER components and the system behavior of a collection of such DER technologies and loads.

1. Functional requirement for each microgrid capable DER component (or building block).
1. Expected microgrid behavior for a system of CERTS and other components. (Examples AEP, SMUD & Santa Rita Jail)

Functional requirements for a microgrid capable DER component

Independent of central controller

- ✓ Uses local information for all fast events
- ✓ Plug-and-Play architecture (same control for all applications)
- ✓ Regulates ac voltage (V vs. Q droop)
- ✓ Regulates frequency (P vs. frequency)
- ✓ Autonomous load following
- ✓ Autonomous response to overload. (insures load transfer from overload source to other sources and load shedding when all sources are overloaded)



50% step load in island operation
(1% frequency droop)

Advantages of CERTS Architecture

Microgrid Stability

Fast, agent-based control in response to transients without centralized control

Power System Security

Limited interface with power system and related communications makes the microgrid robust against threats

Minimizes engineering errors/cost/and maximizes flexibility

Requires minimum site engineering, testing and design (~90% cost reduction).

Self-healing

Allows for seamless recovery from utility and equipment failures.

Reduces system cost through use of appropriate technologies

Microgrid can utilize storage, PV, synchronous generators and inverter based ICE to achieve the needed functionality for minimum cost.

AEP/CERTS test site

Demonstrated at Test Site

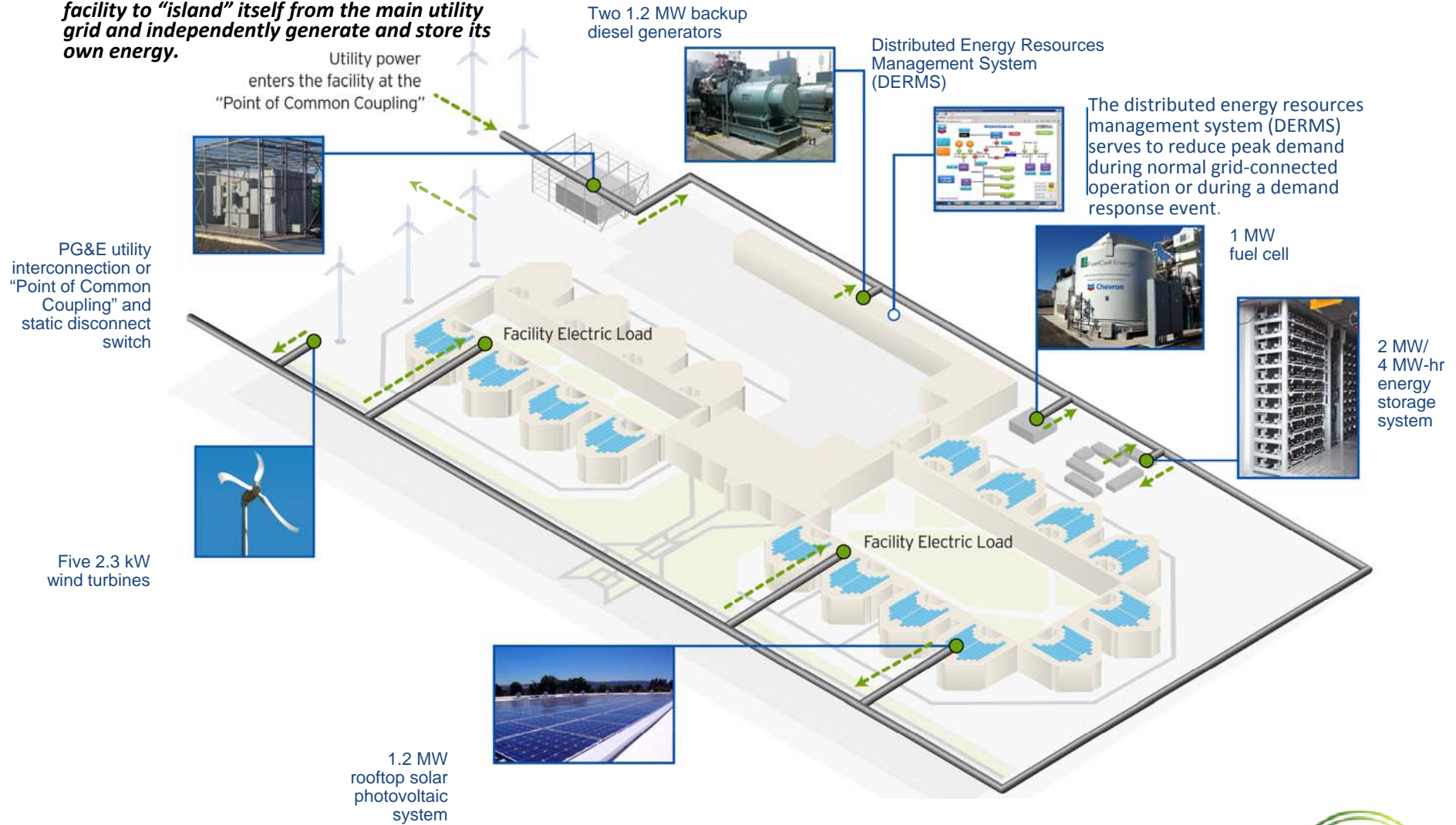
(no communications & no storage)

- ✓ Autonomous load following
- ✓ Seamless separation & automatic re-synchronizing with the grid.
- ✓ Autonomous load transfer from overload source to other sources
- ✓ UPS level power quality
- ✓ Plug-and-Play architecture
- ✓ Mechanical & static interface switches



Alameda County Santa Rita Jail

When a disturbance to the utility grid occurs, the automatic disconnect switch enables the facility to "island" itself from the main utility grid and independently generate and store its own energy.



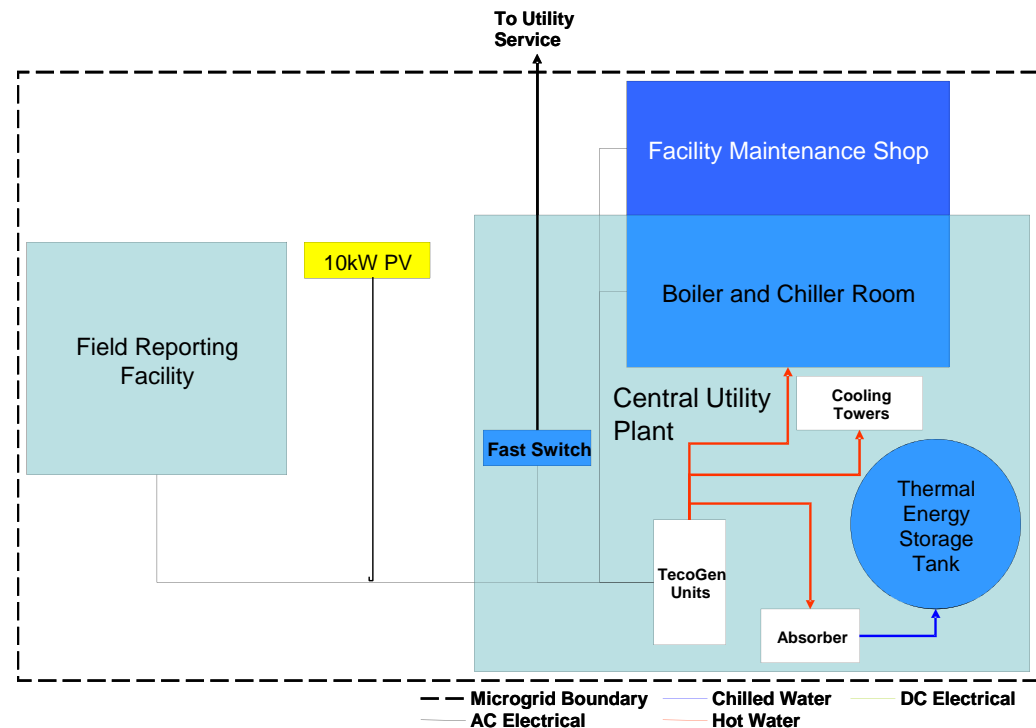
SMUD Microgrid Project

Phase-1

- 3-100 kW InVerde systems
- Collect CCHP & UPS data over 12 months
- Feeder peak load reduction
- Test technical and operational implications of exporting power from a microgrid

Phase-2

- Add 500 kW-3hr Premium Power battery



Conclusion:

CERTS Microgrid

Promotes Robust Microgrids

- Stability:** Autonomous controls on each device allows the entire microgrid to operate in a *stable manner*, regardless of whether *grid connected or islanded*.
- Plug & Play Model:** Allows microgrids to *seamlessly integrate* generation, storage, renewables and loads into a well behaved resource for the distribution system.

Smart Distribution Component

- Compatibility:** Microgrids are compatible with the existing grid, serving as a *resource that assists in building out the distribution system*.
- Flexibility:** Expansion and growth rates do not have to follow any precise forecasts since *lead times are short and can be build out incrementally*. Microgrids are also technology neutral, able to tap a *diverse mix of renewable and DER units*.
- Scalability:** Microgrids facilitate the use of many small generation, storage, and load devices in a *modular manner* in order to scale up power production and/or consumption levels
- Peer-to-Peer Model:** Microgrids represent a new paradigm – a true peer-to-peer energy delivery model that *does not dictate size, scale, numbers DER units, or growth rates*.