Rethink the delivery of electricity

New Energy Paradigm: Dynamic Distribution

Energy Systems Integration 101
NREL
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Commercial DER is approaching parity with central generation creating possibilities for new energy paradigms.

Central generation

+ Equipped to design/build/finance/operate large scale energy systems
+ Very effective system technically/finically

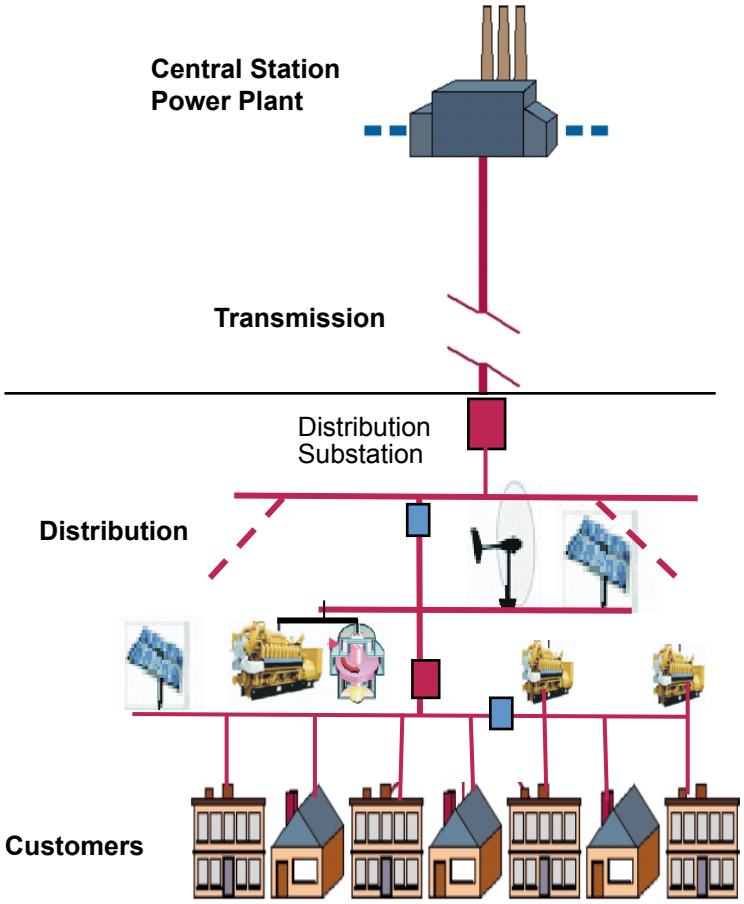
− Losses/emission too large
− Carbon tax could disable many existing plants
− Difficult to handle high penetration of intermit sources
− Excessive ramping is inefficient
− DER is reducing revenue

Distributed Energy Resources

+ Diverse range of technologies
+ Reduces line losses & enhance local reliability
+ Double efficiency through use of waste heat
+ Low cost enables incremental growth

− Complex of system with thousands of units
− Potential high cost of operation and management of the system
− Could have major impact of current business models

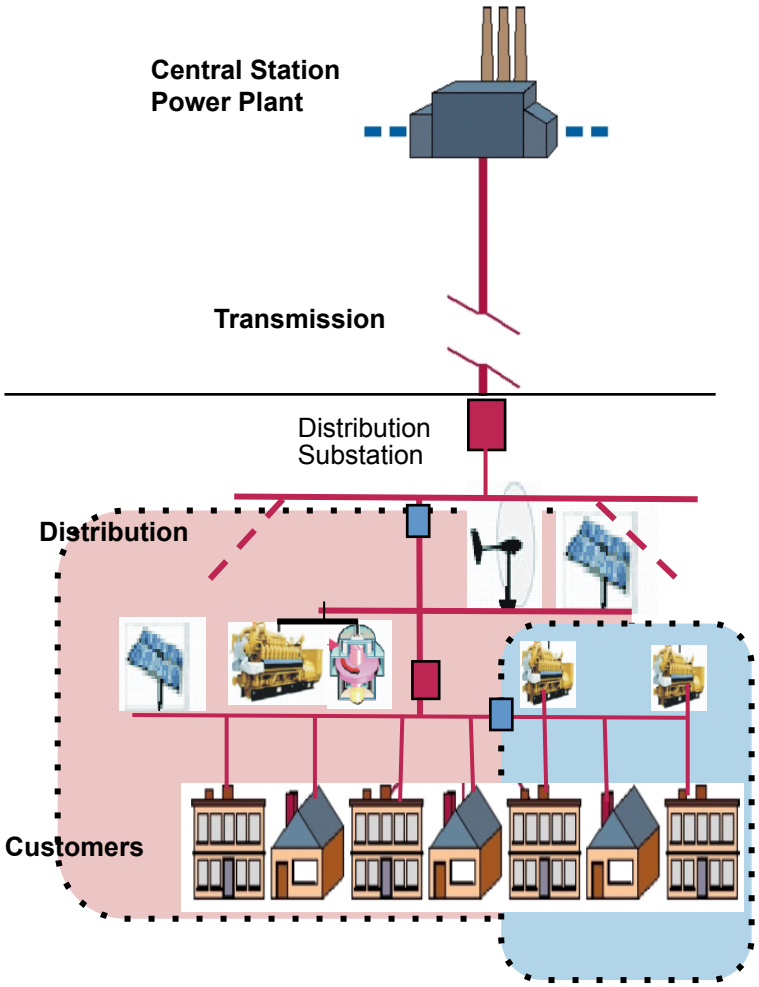
100s of thousands of energy resources



The issue is figuring out how to manage this wide, dynamic set of distributed energy resources and their control points.

Move DER control and marketplace to the distribution system

Microgrids

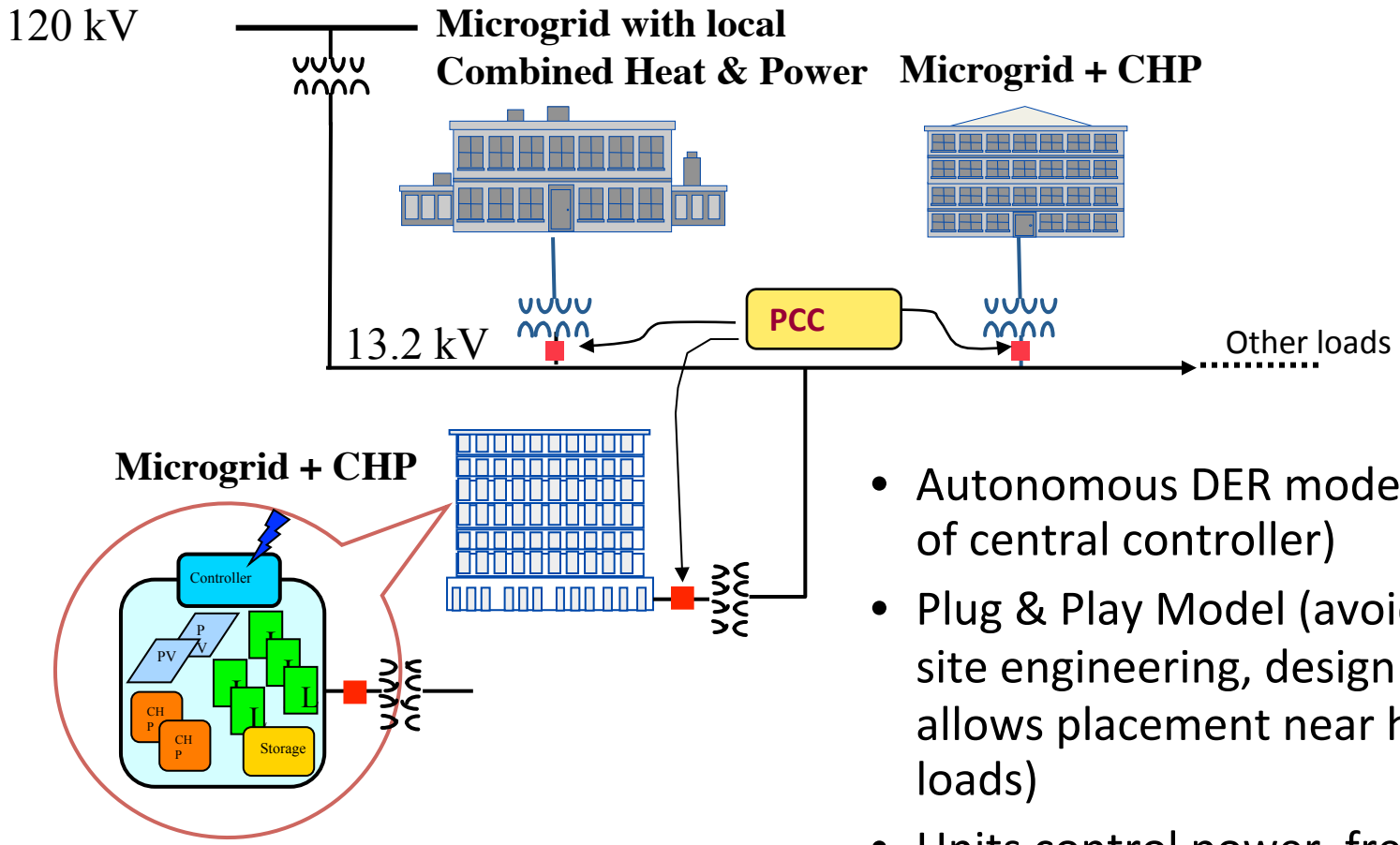


Microgrids are a cluster of loads and DER units which can smoothly disconnect from and reconnect to the grid.

They enhance local reliability/flexibility with significant system efficiency improvements

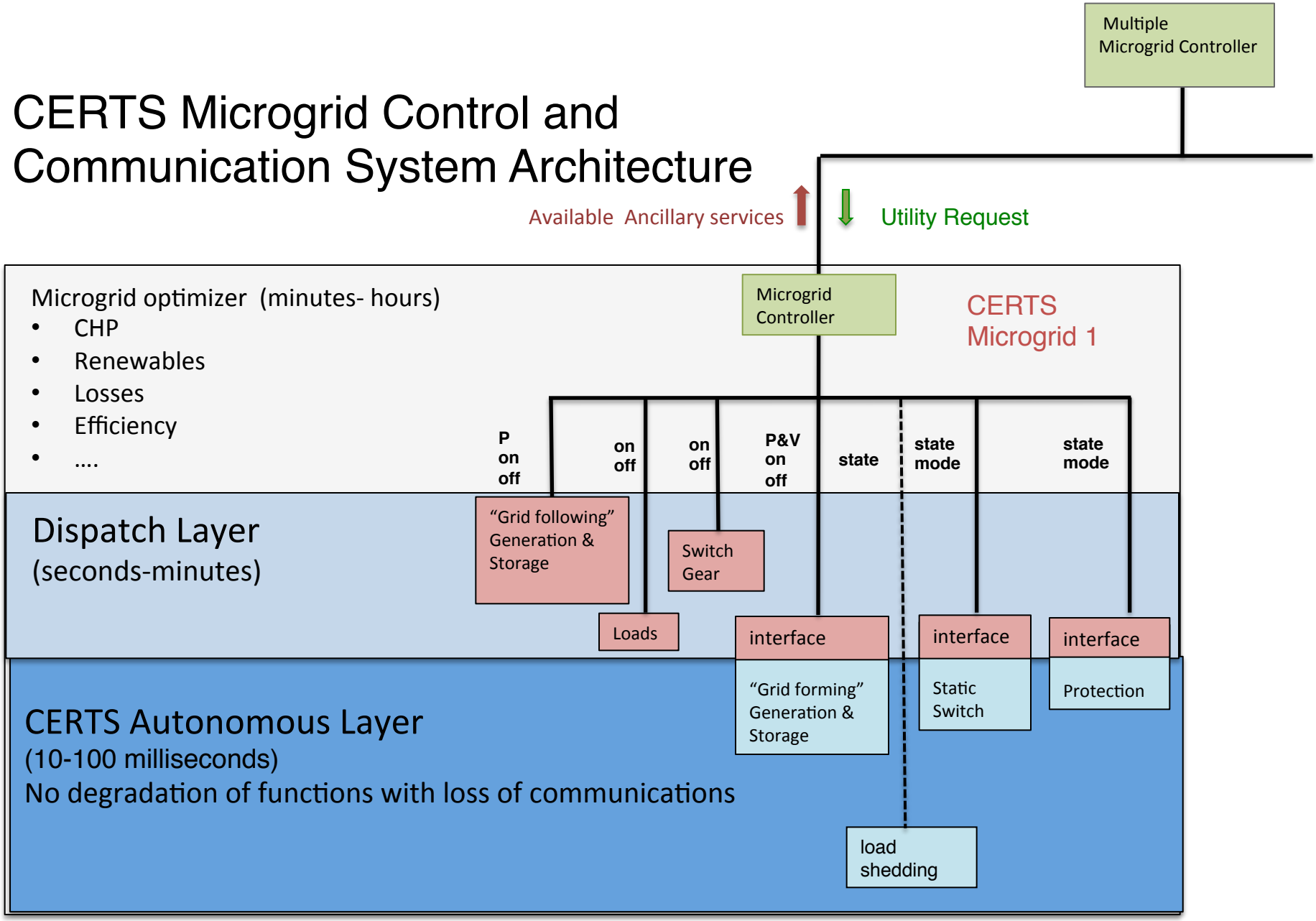
* Distributed energy resources

Multi-Microgrids



- Autonomous DER model (independent of central controller)
- Plug & Play Model (avoids extensive site engineering, design errors & allows placement near heat/cooling loads)
- Units control power, frequency & voltage using local information

CERTS Microgrid Control and Communication System Architecture



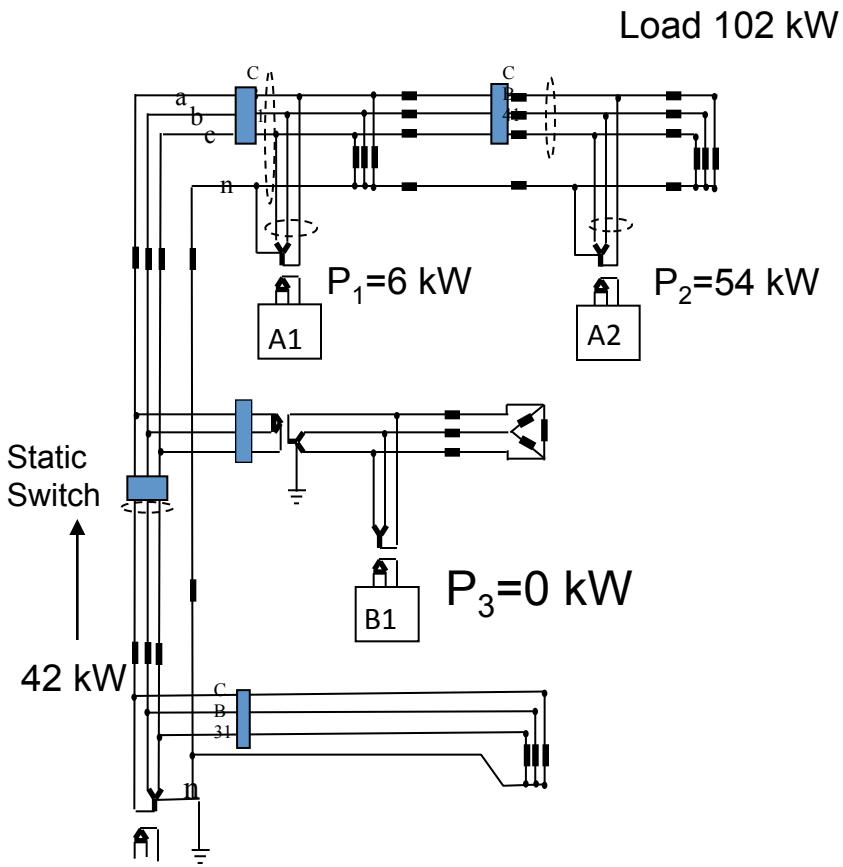
CERTS Microgrid Autonomous Layer

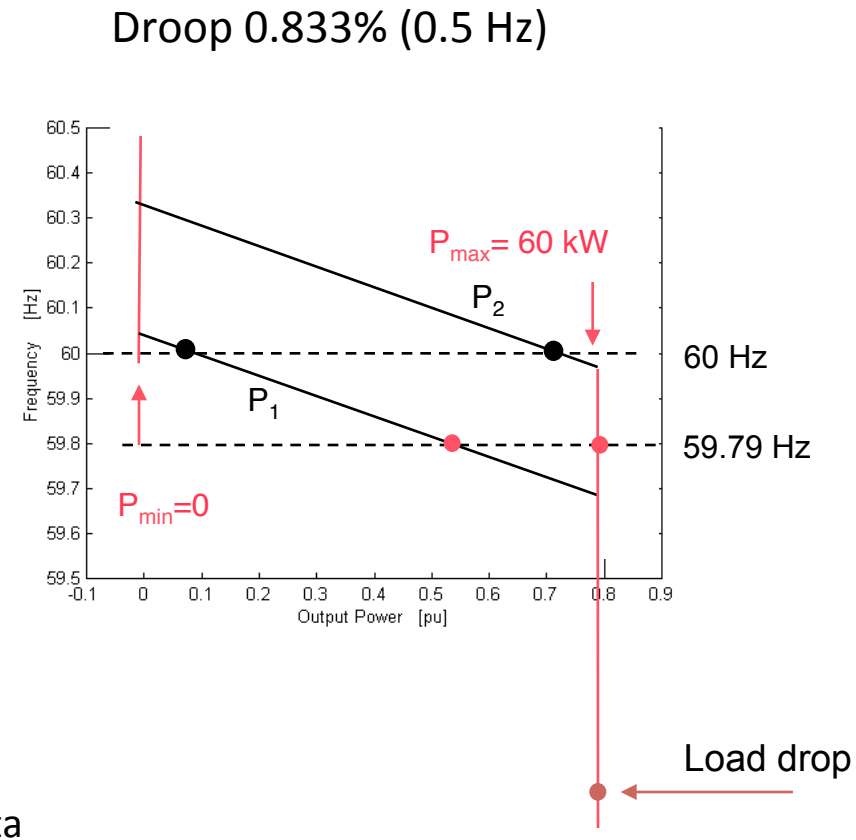
Each DER unit is a grid-forming (controls ac voltage and frequency) component and is plug-and-play.

- Autonomous load following
- Insures multi-unit stability (local voltage control)
- Autonomous load transfer from overloaded source to other sources
- Minimize reactive power circulation.
- Intelligent load and source shedding

The interface switch provides for autonomous islanding and re-synchronizing to the network

Power vs. Frequency Control with Limits

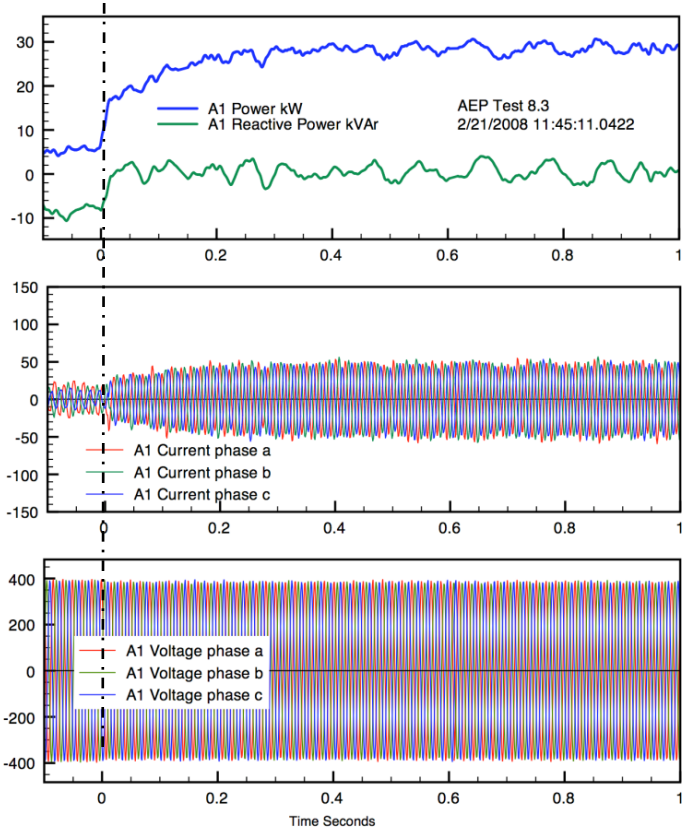




Reports, publication and test data
http://certs.lbl.gov/certs-der-pubs.html

Autonomous overloaded transfer: AEP Test site

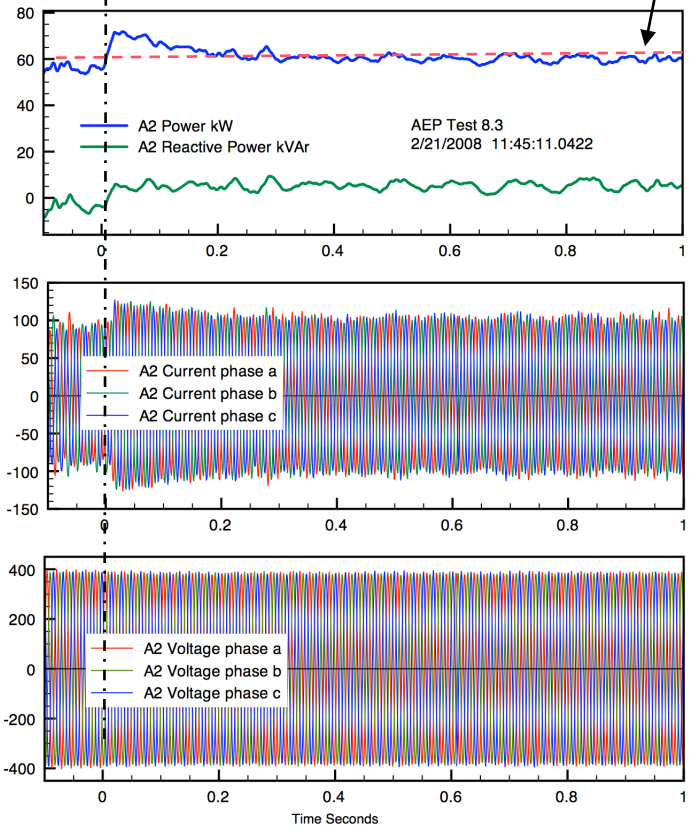
SS opens



Source A1

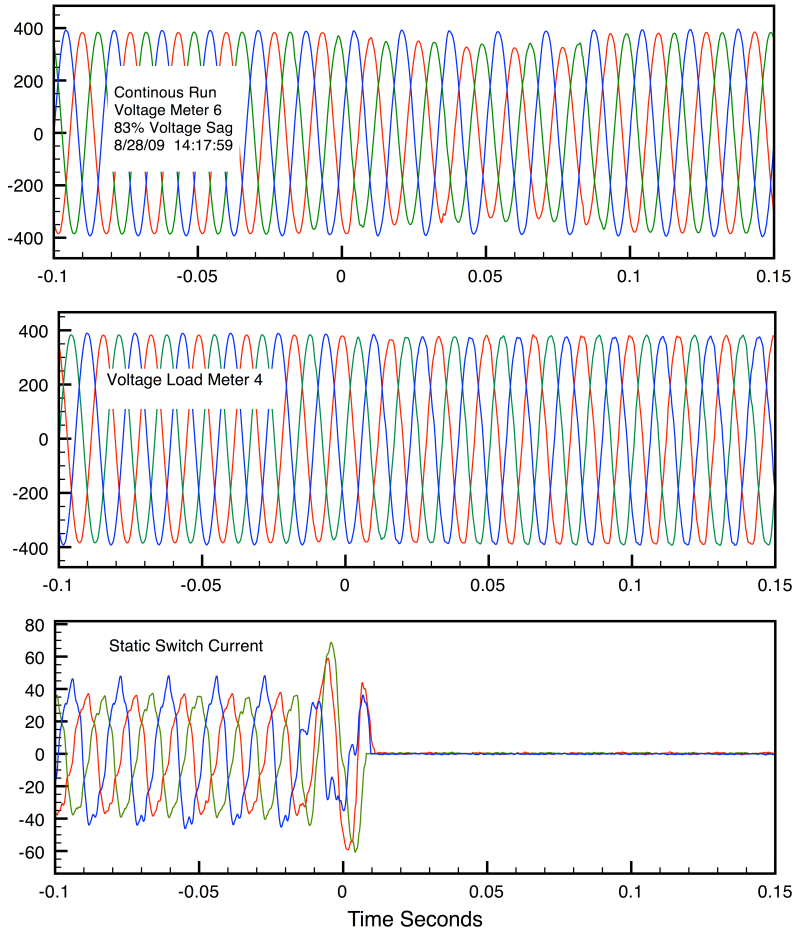
SS opens

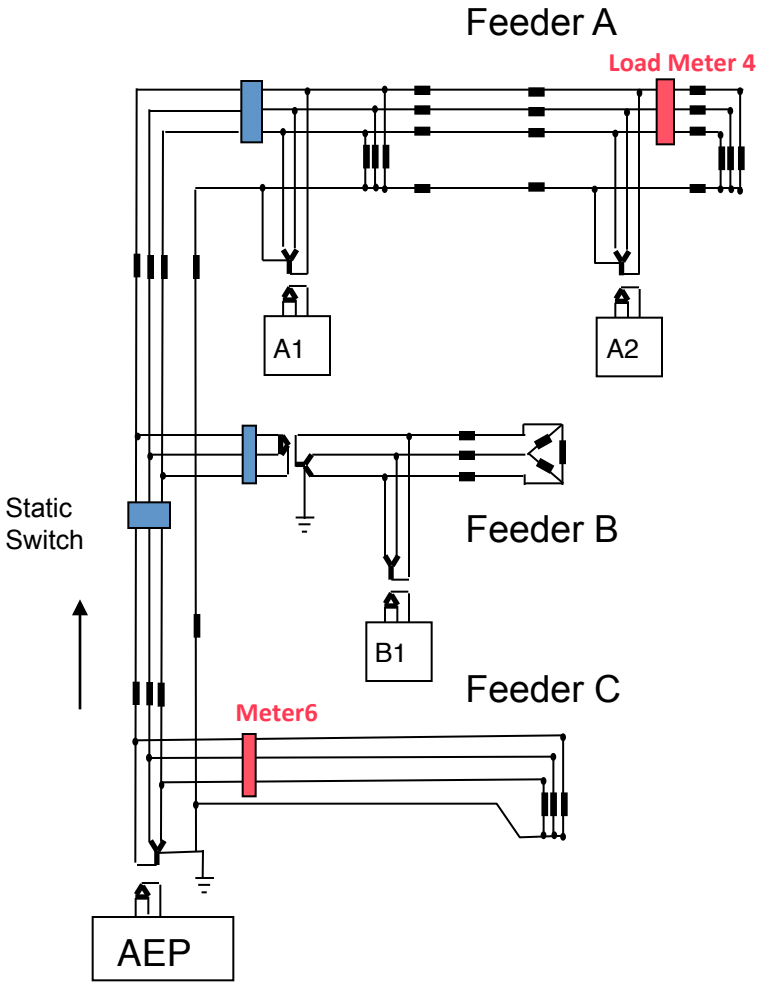
Power Limit



Source A2

Voltage Sag event AEP Test Site



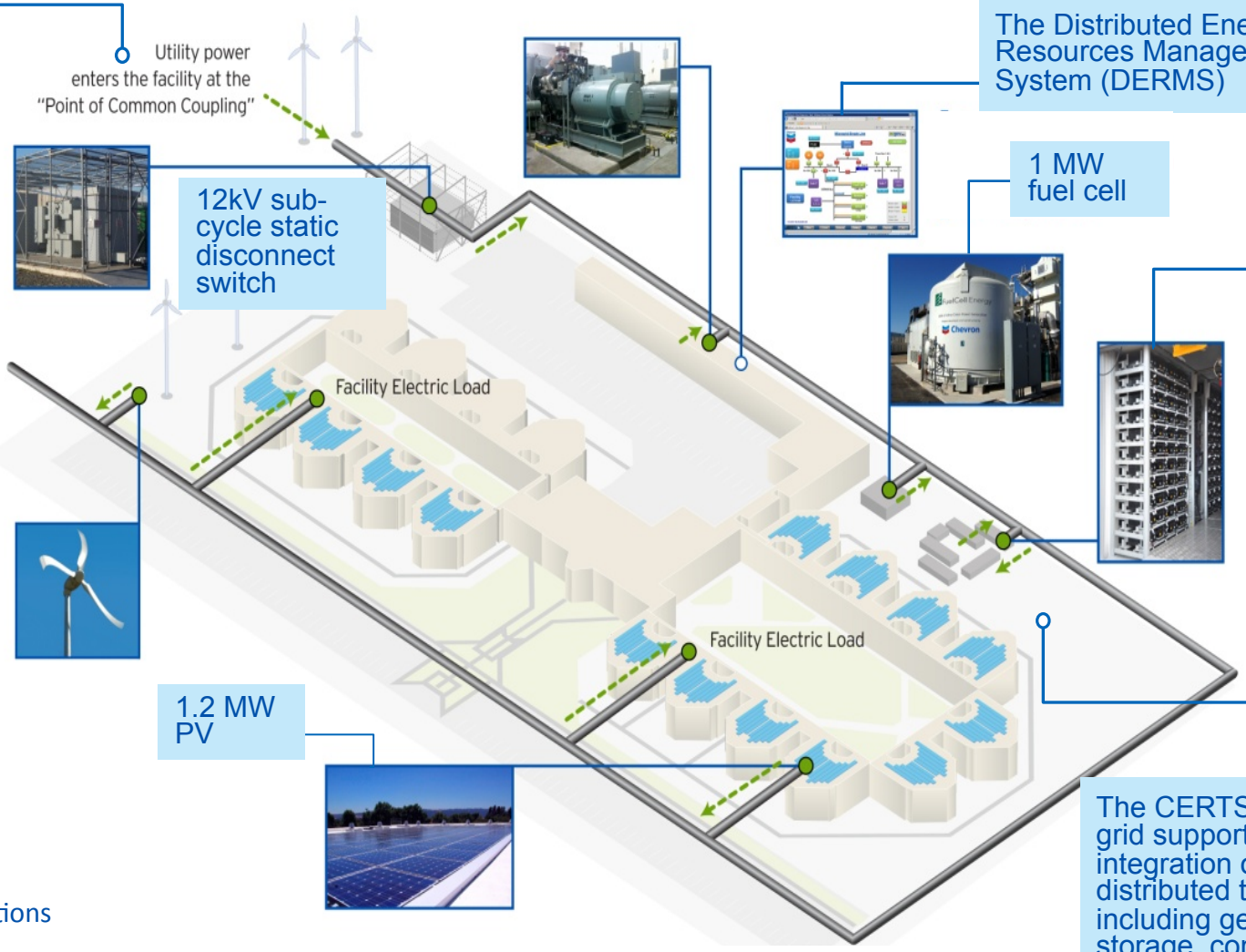


Santa Rita Jail Microgrid

Dedicated 3/22/2012

CERTS Microgrid: Santa Rita Jail, Ca.

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.



The Distributed Energy Resources Management System (DERMS)

1 MW fuel cell

Energy Storage System:

Lithium Ion
4 MW-hr
2 MW power

The CERTS-enabled smart grid supports the seamless integration of additional distributed technologies, including generation, storage, controls and communications.

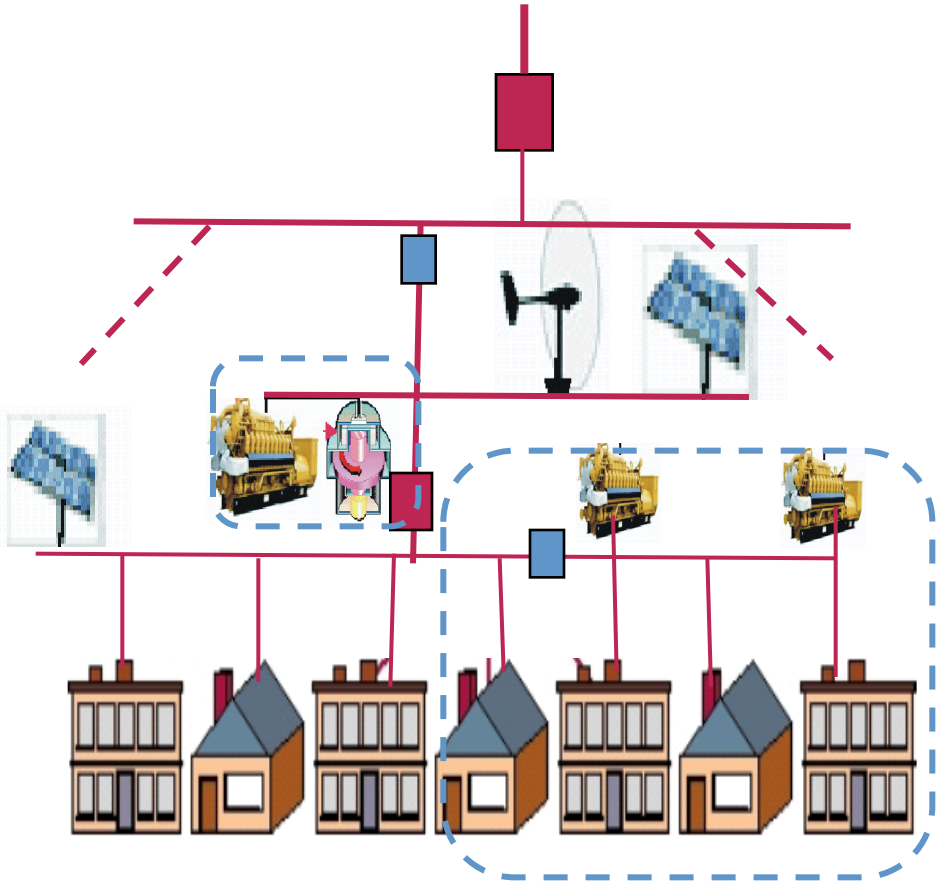
Chevron

Chevron Energy Solutions

"Microgrid-cogen system from Tecogen comes through for Greenwich Village Co-op building during superstorm Sandy"

Dynamic Distribution

Move DER control and marketplace to the distribution system



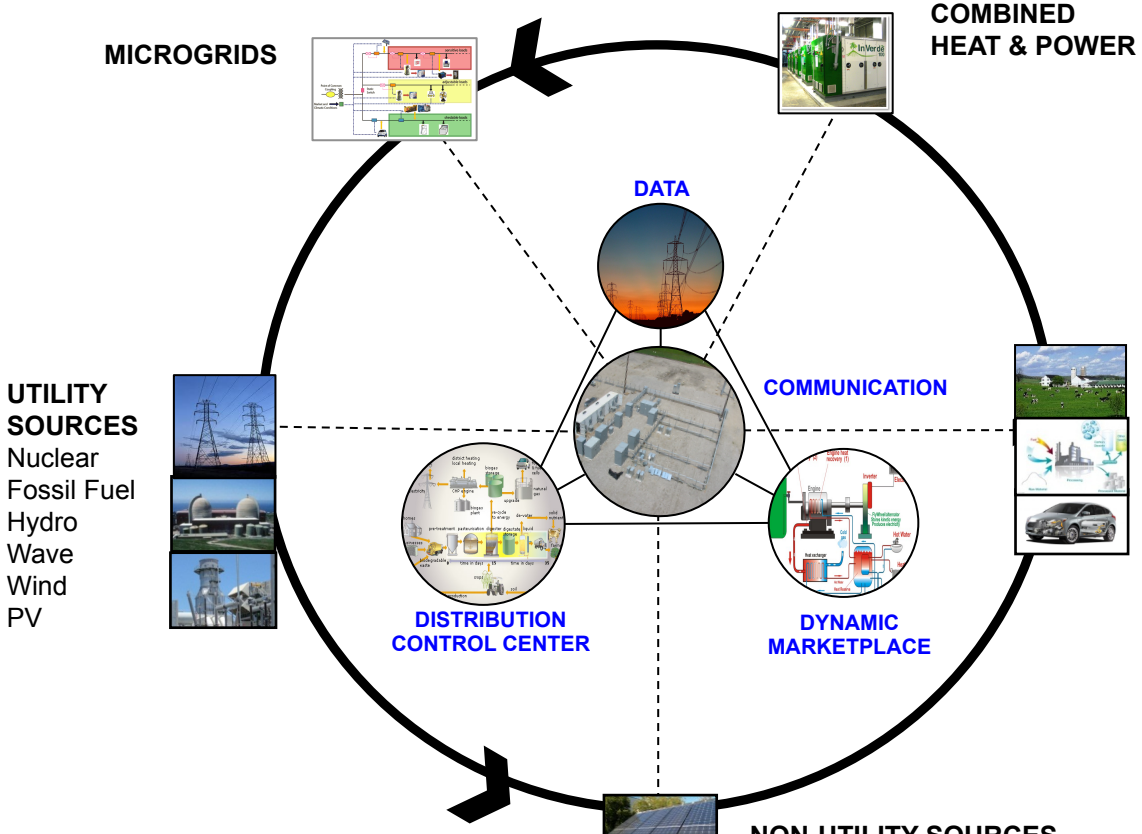
- Use DER to move troublesome dynamics from the utility to distribution system
- Enhance central generation by providing more predictable demand (reduce ramping)
- Facilitate 3-party energy providers
- Firm intermittent resources
- Reduce losses and utilize waste heat
- Use microgrids to enhance local reliability/flexibility with significant system efficiency improvements

Dynamic Distribution

DYNAMIC ENERGY MARKETPLACE
Connect Utility & Non-utility Sources With Small and Large Customers

RESILIENT SYSTEMS
Microgrids
Network Reconfiguration
Robust Fuel Sources

SIMULTANEOUS CONTROL
Energy conversion
Power Flow
Load Demands
Heat recovery
Renewable energy harvesting
Energy storage



Thank you

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