NREL
NATIONAL RENEWABLE ENERGY LABORATORY

IEEE 1547.4 and Beyond

Microgrid Symposium

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JeJu, South Korea

Understanding Islanding

Presentation Outline

- Unintentional Islanding and IEEE 1547 requirements
- IEEE 1547 Standards
- Intentional Islanding

- IEEE 1547.4 Overview
- Planning and Operations of Intentional Islands
- What's next?

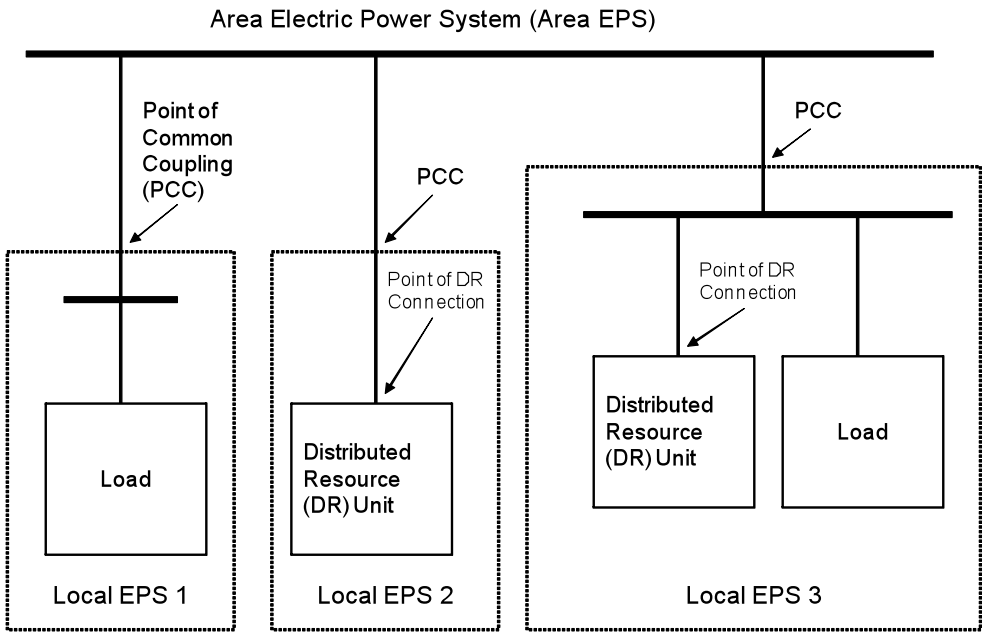
Islanding definitions in IEEE 1547

IEEE 1547 Standard for Interconnecting Distributed Resources with Electric Power Systems

IEEE 1547

- **island:** a condition in which a portion of an Area EPS is energized solely by one or more Local EPSs through the associated PCCs while that portion of the Area EPS is electrically separated from the rest of the Area EPS.

- **island, intentional:** a planned island.
- **island, unintentional:** an unplanned island.



Note: Dashed lines are EPS boundaries. There can be any number of Local EPSs

Area EPS ~ Utility

Unintentional Islanding Requirement

IEEE 1547

Unintentional Islanding

- For an unintentional island in which the DR energizes a portion of the Area EPS through the PCC, the DR interconnection system shall detect the island and cease to energize the Area EPS within two seconds of the formation of an island.

Intentional Islanding

- This topic is under consideration for future revisions of this standard.

→ IEEE 1547.4

Unintentional Island Detection Methods

IEEE 1547

Some examples by which this requirement may be met are:

1. The DR aggregate capacity is less than one-third of the minimum load of the Local EPS.
2. The DR is certified to pass an applicable non-islanding test.
3. The DR installation contains reverse or minimum power flow protection, sensed between the Point of DR Connection and the PCC, which will disconnect or isolate the DR if power flow from the Area EPS to the Local EPS reverses or falls below a set threshold.
4. The DR contains other non-islanding means such as a) forced frequency or voltage shifting, b) transfer trip, or c) governor and excitation controls that maintain constant power and constant power factor.

IEEE 1547 Series Standards

1547-2003 Standard for Interconnecting Distributed Resources with Electric Power Systems
Reaffirmed in 2008

1547.1-2005 Conformance Test Procedures for Equipment Interconnecting DR with EPS

1547.2-2008 Application Guide for IEEE 1547 Standard for Interconnecting DR with EPS

1547.3- 2007 Guide for Monitoring, Information Exchange and Control of DR

Current Projects

P1547.4 Guide for Design, Operation, and Integration of DR Island Systems with EPS

P1547.5 Guidelines for Interconnection of Electric Power Sources Greater Than 10 MVA to the Power Transmission Grid

P1547.6 Recommended Practice for Interconnecting DR With EPS Distribution Secondary Networks

P1547.7 Draft Guide to Conducting Distribution Impact Studies for Distributed Resource Interconnection

P1547.8 Draft Recommended Practice for Establishing Methods and Procedures that Provide Supplemental Support for Implementation Strategies for Expanded Use of IEEE Standard 1547

Microgrids

Urban distribution networks

http://grouper.ieee.org/groups/scc21/index.html

IEEE 1547.4

IEEE 1547.4 Information

IEEE 1547.4 provides alternative approaches and good practices for the design, operation, and integration of distributed resource (DR) island systems with electric power systems (EPS). This includes the ability to separate from and reconnect to part of the area EPS while providing power to the islanded local EPSs. This guide includes the distributed resources, interconnection systems, and participating electric power systems.

Chair: Ben Kroposki, Secretary: Tom Basso

PAR started:	2005
1st Ballot (Draft 10):	March 2010, 250 people on ballot group
	over 400 comments, 88% affirmative
2nd Ballot (Draft 11):	March 2011, 25 comments, 91% affirmative
3rd Ballot (Draft 12):	May 2011, ___ comments, ____% approval
Expected Pub Date:	June 2011

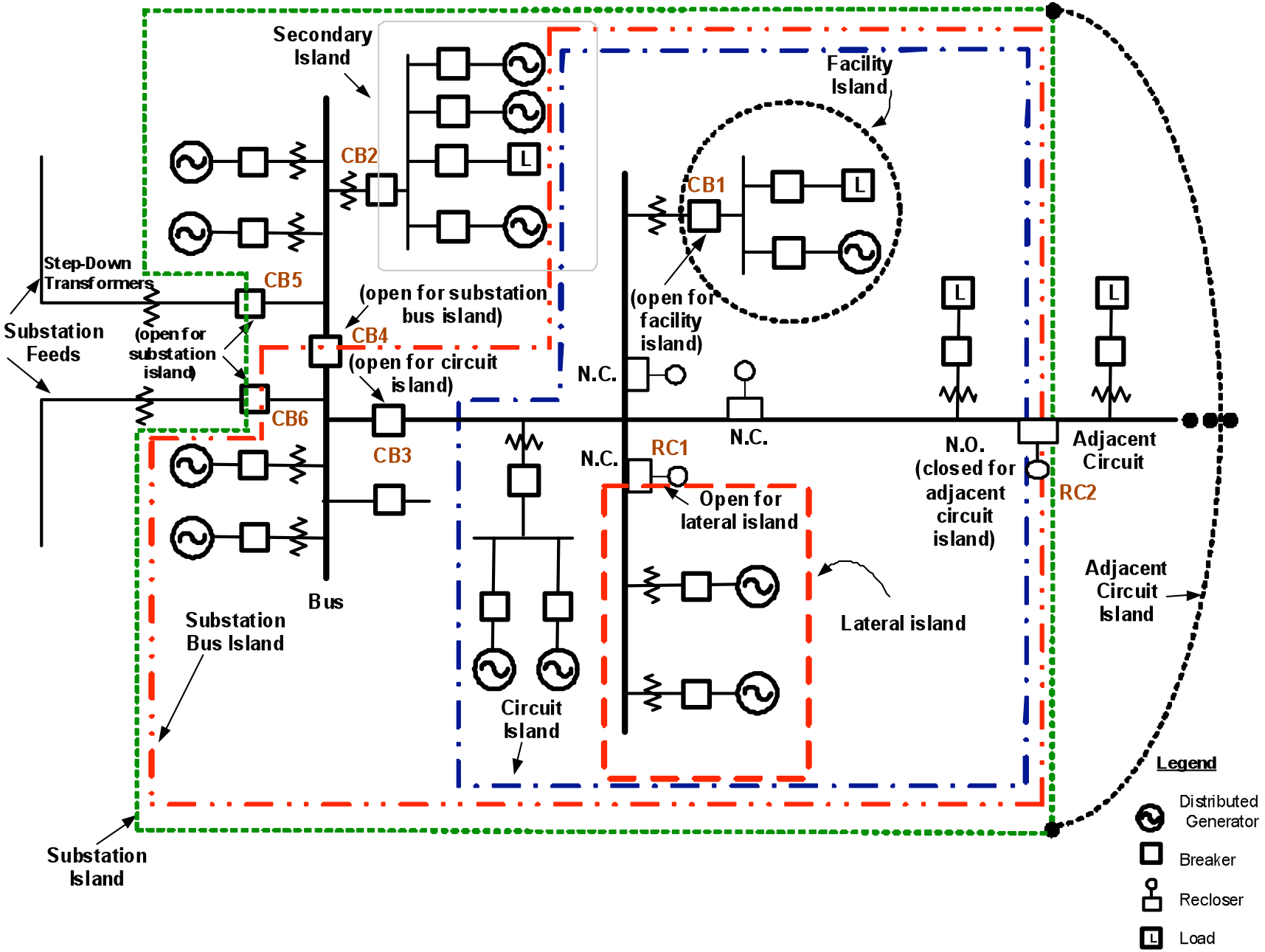
IEEE 1547.4 Information

Due to some of the confusion surrounding the definition of microgrid in 2005 (and continues today), IEEE 1547.4 developed the term **Distributed Resource Island System.**

The term "DR island systems", sometimes referred to as microgrids, is used for electric power systems that:

1. have DR and load
2. have the ability to disconnect from and parallel with the area EPS
3. include the local EPS and may include portions of the area EPS, and
4. are intentionally planned.

DR island systems can be either local EPS islands or area EPS islands.



Clause 4 – DR Island System Overview

4.0 DR island systems overview

4.1 General DR island system considerations

4.2 Specific considerations for DR island systems that include a portion of the area EPS

4.3 DR island system configurations

4.4 Functionality of the DR island system

Clause 4 – DR Island System Overview

4.1 General DR island system considerations

Power Flow

Voltage, Frequency

Single or Multiple PCCs

Fault Protection

Load Requirements

Reserve Margins

Adequate DR

Power Quality

Transients

A Range of Conditions that Grid-Tie Only Operations may not need to worry about

Clause 4 – DR Island System Overview

4.2 Specific considerations for DR island systems that include a portion of the area EPS

- There is an agreement with the area EPS operator to operate the DR island system.
- The participating and non-participating DR need to be identified.
- During transition to and operation of the planned island, one or more of the participating DR may be allowed to operate according to a predefined set of requirements outside of IEEE Std 1547-2008.
- The area EPS is modified to operate in the planned island mode.
- It may be necessary to conduct load flow and stability studies to identify any risks that operation of the nonparticipating DR may be compromised or may compromise the DR island system.
- The planned DR island system should maintain voltage and frequency for the entire island system including the non-participating DR systems and loads.

Clause 4 – DR Island System Overview

4.4 Functionality of the DR Island System

- **Area EPS-connected mode (normal parallel operation)**
  - DR operate in IEEE 1547 mode
- **Transition-to-island mode**
  - Recognize that island condition has occurred
- **Island mode**
  - Operate disconnected from main grid
- **Reconnection mode**
  - Only reconnect within correct voltage, frequency, and phase angle windows specified in IEEE 1547.
  - passive, active, or open transitions are acceptable

Clause 5 – Planning and Engineering

5. Planning and engineering of DR island systems

- 5.1 Load requirements and planning
- 5.2 EPS requirements and planning
- 5.3 DR requirements and planning
- 5.4 System studies
- 5.5 Motor Starting Studies
- 5.6 Additional planning considerations
- 5.7 Testing and commissioning

Clause 5 – Planning and Engineering

5.1 Load requirements and planning




5.2 EPS requirements and planning

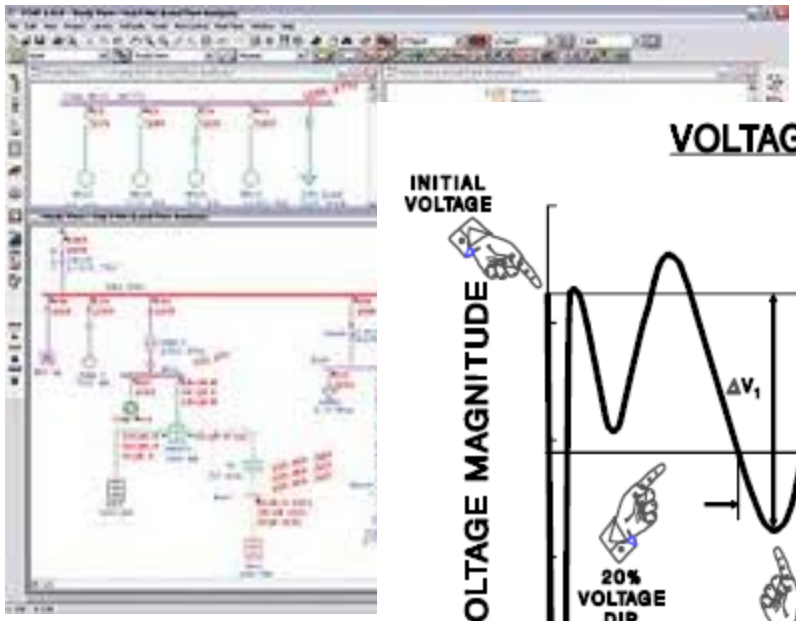


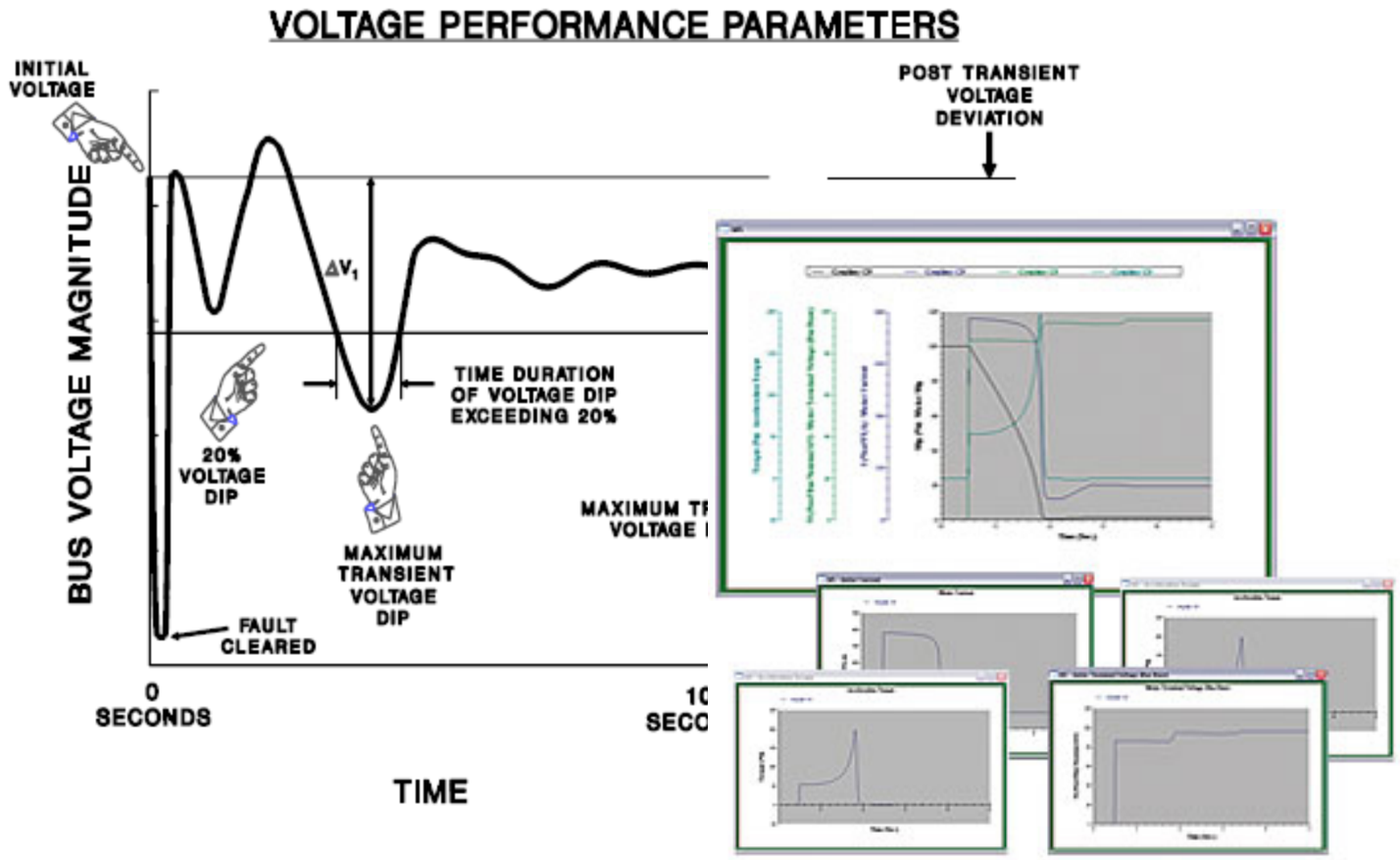
5.3 DR requirements and planning


Clause 5 – Planning and Engineering

5.4 System Studies

5.5 Motor Starting Studies





Clause 6 – Operations

6. Operations of DR island systems

- 6.1 DR island system management
- 6.2 DR island system transitions
- 6.3 Control strategies of DR island systems
- 6.4 Restoration after disturbances
- 6.5 Safety considerations
- 6.6 Periodic review, maintenance, and testing
- 6.7 Protection consideration
- 6.8 Monitoring, information exchange, and control
- 6.9 Power quality

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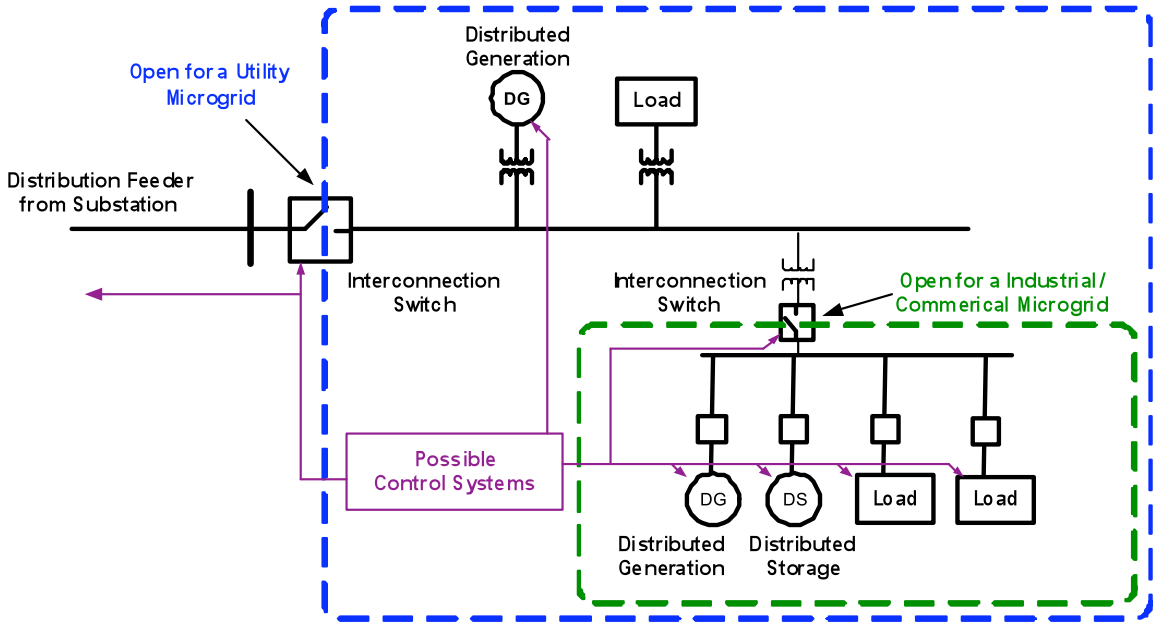

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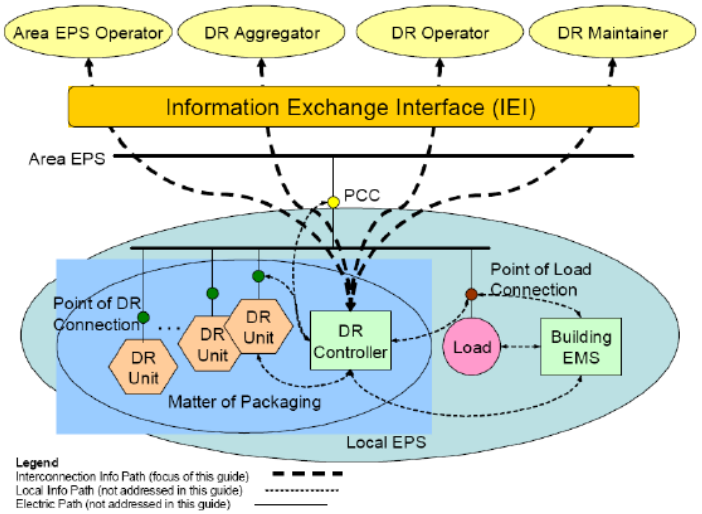

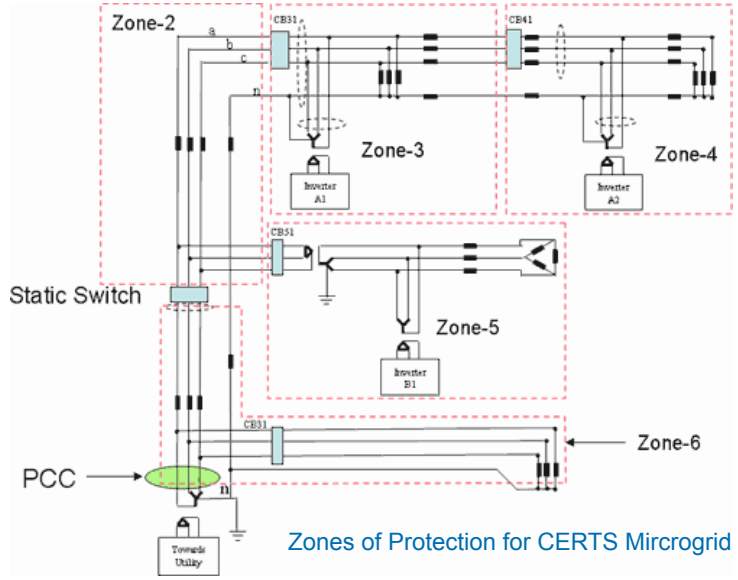

Zones of Protection for CERTS Mircrogrid

Beyond IEEE 1547.4