Energy Storage and PSC 119

Hub and Spoke

Dual Hub and Spoke

Mesh

Loop

WIDRC
Wisconsin Distributed Resources Collaborative
Typical Distributed Generation System with Storage

- PV Array
- Energy Storage
- Internet (Weather Forecast)
- System Controls
  - Inverter & Charge Control
  - Adaptive Logic System
  - Energy Mgmt System
- Sub-Panel
  - Power Control Unit
- Critical Loads
- Smart Loads
- Service Panel
  - kW
  - kWh Smart Meter
- Utility Grid
- Anti-islanding control

Electric Power: Black
Value Information: Red
Operations Information: Blue
The DG and Energy Storage Landscape Has Changed Since PSC119 Was First Developed

**AC Batteries** - AC batteries are the combination of batteries (typically lithium), a battery management system and inverter-charger in a single unit - allowing AC coupling to a power system.

**AC Coupled System** - AC coupled systems utilize a PV inverter coupled with a hybrid inverter, or combination inverter-charger, to manage battery storage.

**Vehicle-to-Grid** - The use of batteries that power plug-in electric vehicles (PEVs) as energy storage capable of providing electrical services to the grid.
Issues

How to assure the source of battery charging?

How to prevent export and/or paralleling when not allowed?

Should inadvertent or momentary export be allowed?

How to assure that only renewable generation is used for NEM

Systems combining energy storage and DG may not both simultaneously discharge to the electric distribution system UNLESS the operational rating of the transformer (serving the customer) is not exceed.

A second AC disconnect means may be required to be installed in proximity to the energy storage system if the main disconnect is not within sight.

Telemetry is required for dispatchable storage systems
On Load Tap Changer OLTC for voltage control

Electric Distribution Connected Energy Storage is a Load
Non-Export Mitigation

**Operational Mode Programming**
The energy storage inverter’s software programming will control the appropriate charging, discharge, and bypass of the energy storage system.

For energy storage which parallels with the grid, the inverter software programming must be inaccessible to the customer so only the inverter manufacturer or installer can change to an operating mode.

Another means of achieving this may be provided as part of the Interconnection Agreement and Interconnection Application.

**Protection Functions (relays)**
ANSI Type 32 Directional Power Relay Function, reverse power relay, monitors the direction of power from ac generators.

If current flow from the generator becomes reversed and exceeds the adjustable setting, the relay will trip.
Energy Storage System Standards

**Inverter:**
UL 1741 SA, P1547.8x’s electrical interconnection standards for electric storage and hybrid generation/storage

**Batteries:**
UL 1973, UL 1642
# States with Energy Storage Interconnection Rules (Standards)

<table>
<thead>
<tr>
<th>State</th>
<th>Rule/Standard</th>
<th>Description</th>
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<tr>
<td>California</td>
<td>Rule 21</td>
<td>Load aspects storage devices will be treated pursuant to Rules 2, 3, 15, and 16 just like other loads</td>
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<tr>
<td>Nevada</td>
<td>Rule 15</td>
<td>Pilot program, non-export, for NEM only</td>
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<td>Hawaii</td>
<td>Rule 14H and Rule 22</td>
<td>DG with storage will subject to interconnection review and must meet applicable interconnection standards</td>
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<tr>
<td>Maryland</td>
<td>COMAR 20.50.02 and 20.50.09</td>
<td>Working group and study in progress</td>
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<tr>
<td>Minnesota (Xcel Energy)</td>
<td>Xcel Energy Guidelines for Interconnection of Electric Energy Storage</td>
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Southern California Edison

Mode 1: No Grid Charging
Storage is charged only from on-site generation, not the electric distribution system.

Mode 2: Peak Shaving
Storage is charged from the electric distribution system under “certain” or “limited” conditions. Storage system discharges during customers peak load with the intent of reducing net load.

Mode 3: Unrestricted Charging
Storage that can charge from the electric distribution system at any time regardless of customer loads.
Wisconsin Energy Storage Interconnection Rules (Standards)?

The Federal Energy Regulatory Commission (FERC), on February 15, 2018, voted to remove barriers to the participation of electric storage resources in the capacity, energy and ancillary services markets operated by Regional Transmission Organizations and Independent System Operators.

Docket Nos. RM16-23-000; AD16-20-000; Order No. 841
Instead of reinventing the “wheel”, why not utilize Xcel Energy energy storage interconnection configurations as a starting point in writing a consensus-based guidance.

Xcel Energy defined 8 configurations.

These are currently being utilized in Xcel’s Wisconsin service territory.
FIGURE ILLUSTRATES REPRESENTATIVE CONCEPTS & INTENT. PACKAGED SYSTEMS MAY HAVE HYBRID INVERTERS WITH THESE FEATURES PROVIDED AS PART OF THE PACKAGE.

#1a
STANDBY BATTERY

1 PHASE

UTILITY

REVENUE METER

CUSTOMER

MAIN PANEL

LOAD

BATTERY CHARGER

GRID FORMING INVERTER

AUTOMATIC OPEN TRANSFER SWITCH

MAY BE ONE PACKAGE

PROTECTED LOAD PANEL

1. THE PROTECTED LOAD PANEL COULD BE A SEPARATE LOAD PANEL AS SHOWN IN THE DIAGRAM OR COULD BE THE ENTIRE MAIN PANEL.

2. BATTERY NOT ALLOWED TO PARALLEL WITH OR EXPORT TO GRID.

Xcel Energy

Standby Energy Storage Only

No parallel operation

Non-export

No renewable generation required

Any battery charging

AC coupled battery

No interconnection review
Energy Storage Operation in Parallel without Generation

Parallel operation

Non-export

No renewable generation required

Any battery charging

AC coupled battery

Interconnection review

1. The protected load panel could be a separate load panel as shown in the diagram or could be the entire main panel.

2. The main service meter may be changed to a bi-directional meter in order to verify compliance with inadvertent export provisions.
Parallel operation

Non-export

No renewable generation required

Any battery charging

AC coupled battery

Interconnection review

Xcel Energy
Standby Energy Storage with NEM Eligible Renewable Generation

No parallel operation
Non-export
Renewable generation required
Any battery charging
AC coupled battery
No interconnection review

Xcel Energy
Parallel operation

Export renewable generation

Renewable generation required

Renewable battery charging

AC coupled battery

Interconnection review
Parallel Energy Storage Operation
Subject to Non-Export

Parallel operation
Non-export
Renewable generation required
Any battery charging
AC coupled battery
Interconnection review

*3. Production meter is required based on the DER size and program under which the application is submitted. See the applicable tariffs.

**4. The protected load panel could be a separate load panel as shown in the diagram or could be the entire main panel.
Parallel operation
Export renewable
Renewable generation required
Renewable battery charging
DC coupled battery
Interconnection review

Xcel Energy
Parallel operation

Export renewable

Renewable generation required

Renewable battery charging

DC coupled battery

Interconnection review

Xcel Energy
Next Steps

Continue updating ES-DER glossary

Develop scoping document of ES-DER interconnection technical requirements

Involve stakeholder committee

Produce first draft of ES-DER interconnection technical requirements

Update draft(s) and circulate (recursive action)

Cross-reference latest draft with PSC 119

Seek peer review of draft from PSCW (engineer: Lipinski, et al)

Finalize draft and update / augment PSC119

Seek WIDRC consensus vote on final draft
Questions ?