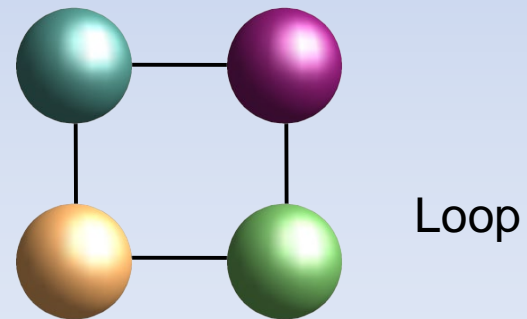
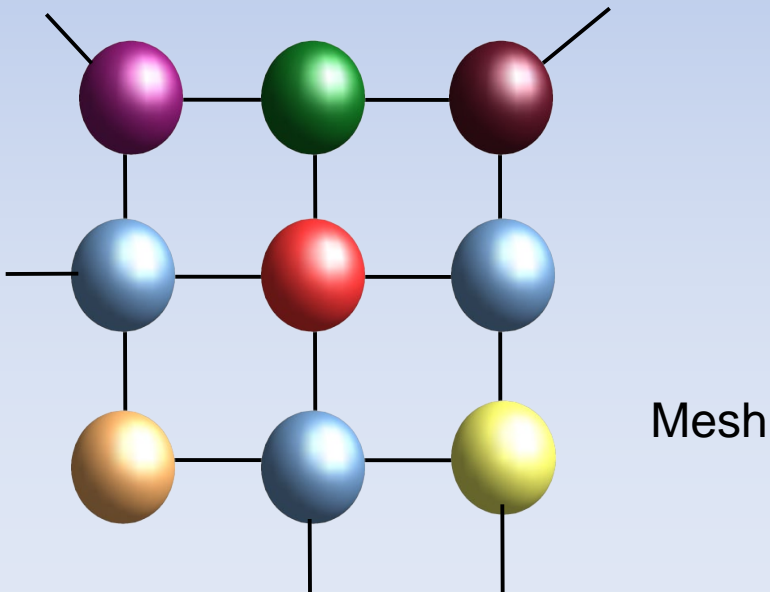
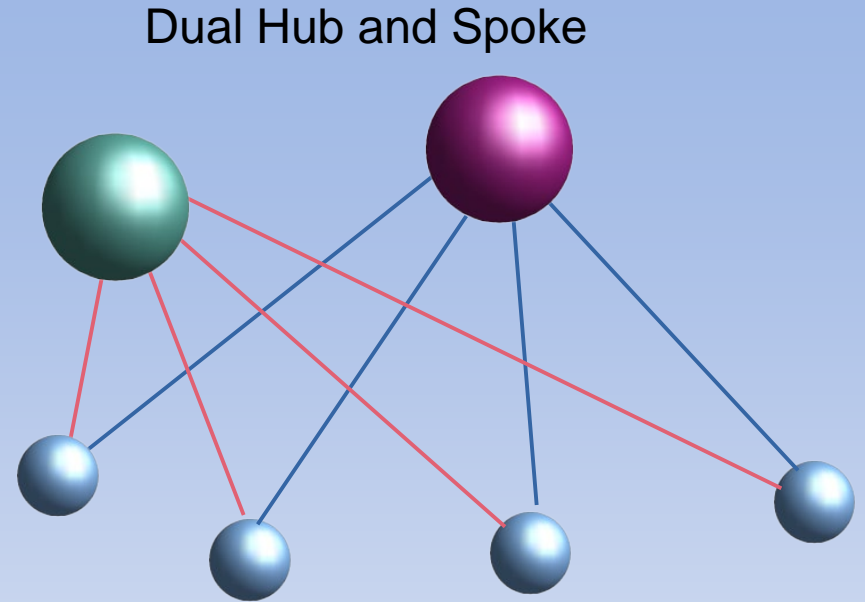
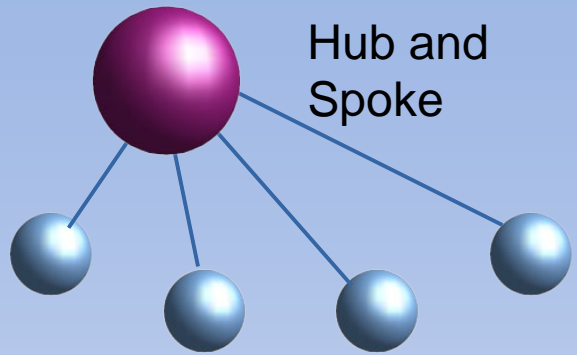
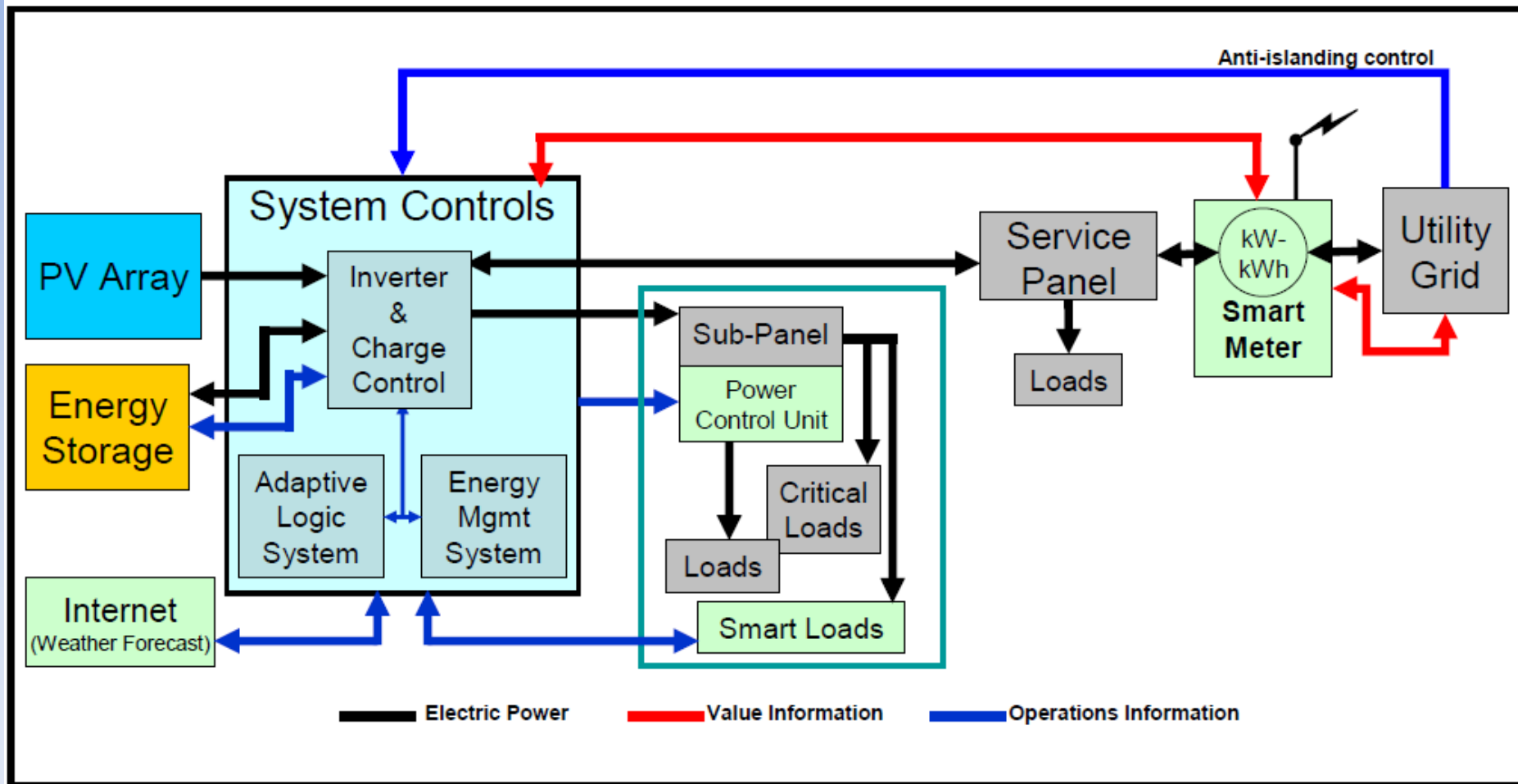


Energy Storage and PSC 119



Typical ?? Distributed Generation System with Storage



U.S. DOE

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.

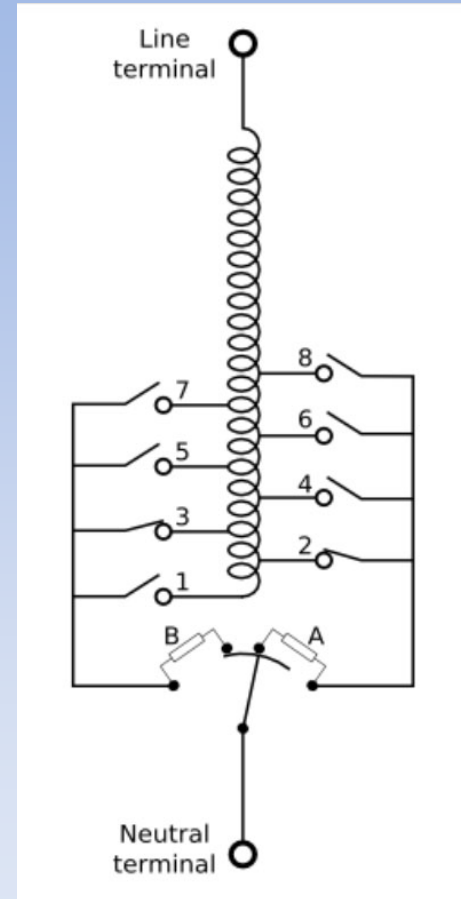
A second AC disconnect means may be required to be installed in proximity to the energy storage system if the main disconnect is not within sight.

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 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)

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

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

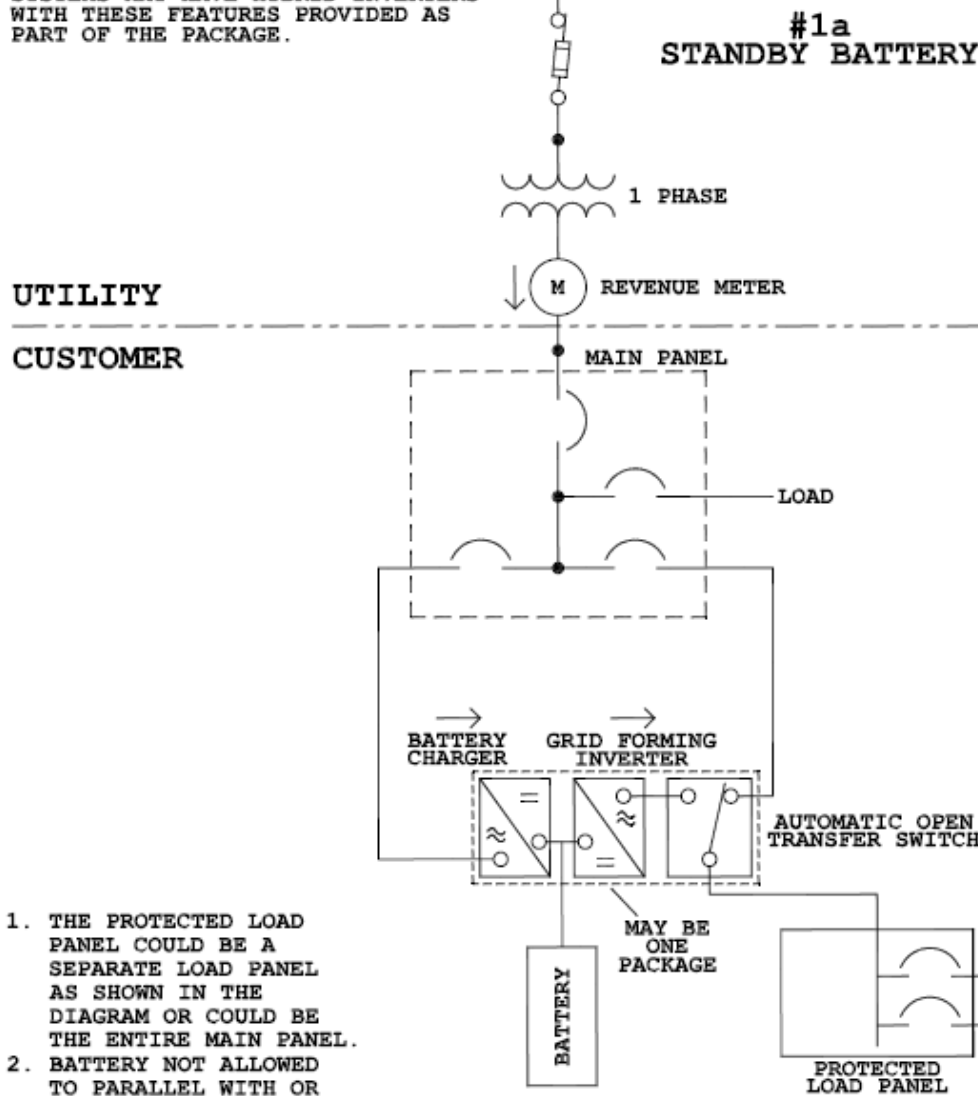
Developing a Guidance Document for Wisconsin

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.



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.

#1a
STANDBY BATTERY

*Standby
Energy
Storage
Only*

No parallel operation

Non-export

No renewable generation required

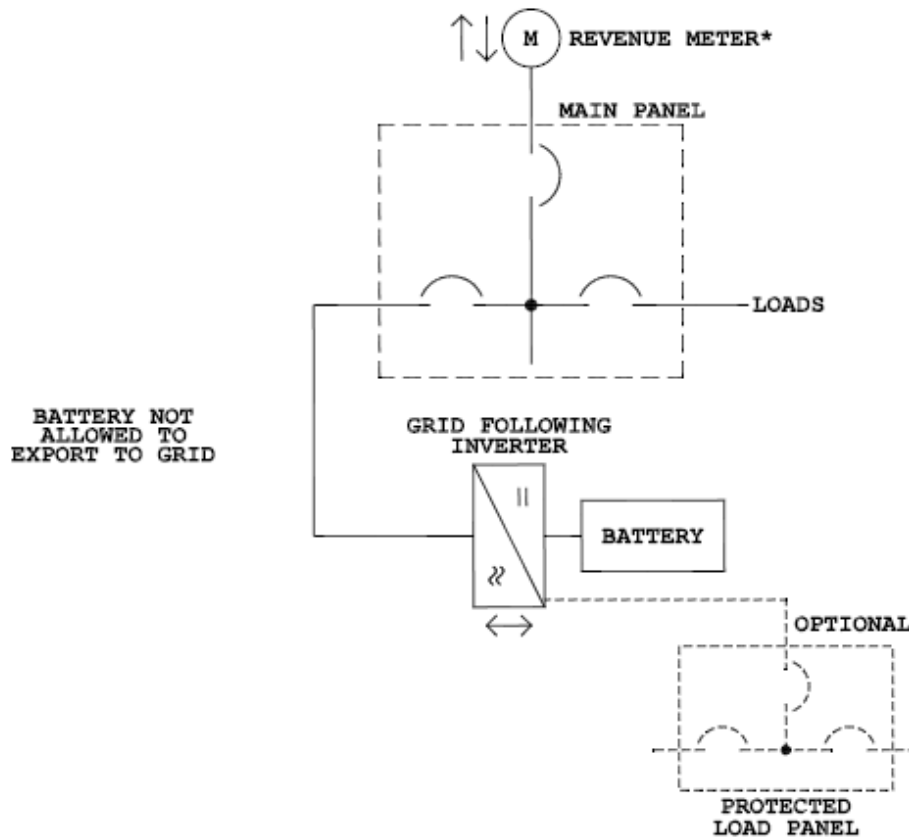
Any battery charging

AC coupled battery

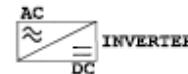
No interconnection review

FIGURE ILLUSTRATES REPRESENTATIVE CONCEPTS & INTENT. PACKAGED SYSTEMS MAY HAVE HYBRID INVERTERS WITH THESE FEATURES PROVIDED AS PART OF THE PACKAGE.

#1b PARALLEL BATTERY



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.



Energy Storage Operation in Parallel without Generation

Parallel operation

Non-export

No renewable generation required

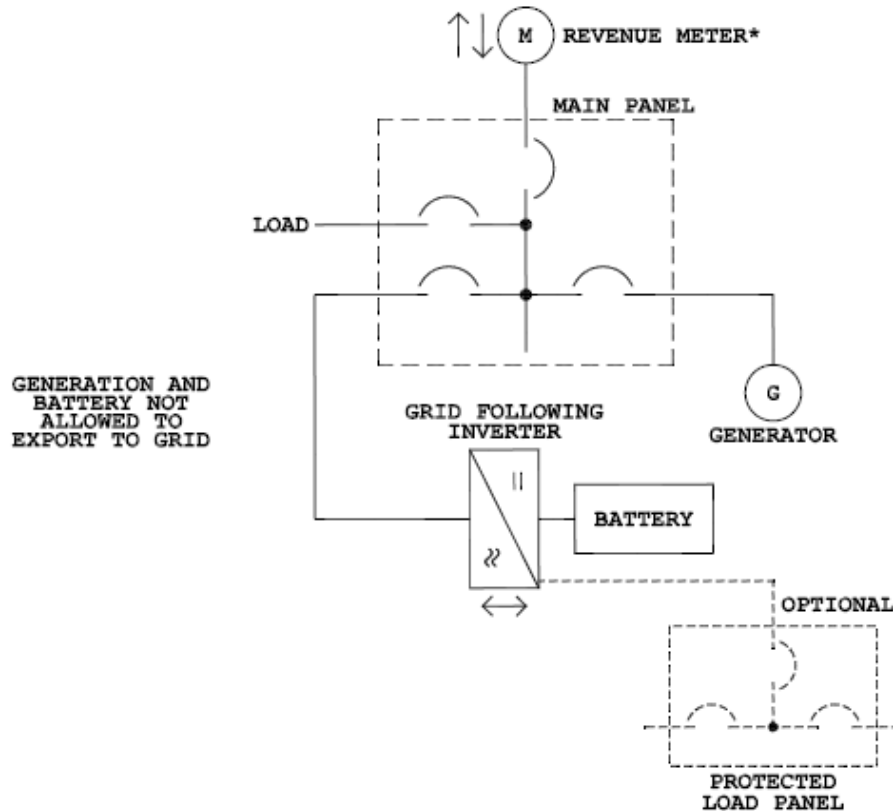
Any battery charging

AC coupled battery

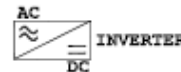
Interconnection review

FIGURE ILLUSTRATES REPRESENTATIVE CONCEPTS & INTENT. PACKAGED SYSTEMS MAY HAVE HYBRID INVERTERS WITH THESE FEATURES PROVIDED AS PART OF THE PACKAGE.

#1c PARALLEL BATTERY + GENERATION



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.



Energy Storage Operation in Parallel with Self-Generation

Parallel operation

Non-export

No renewable generation required

Any battery charging

AC coupled battery

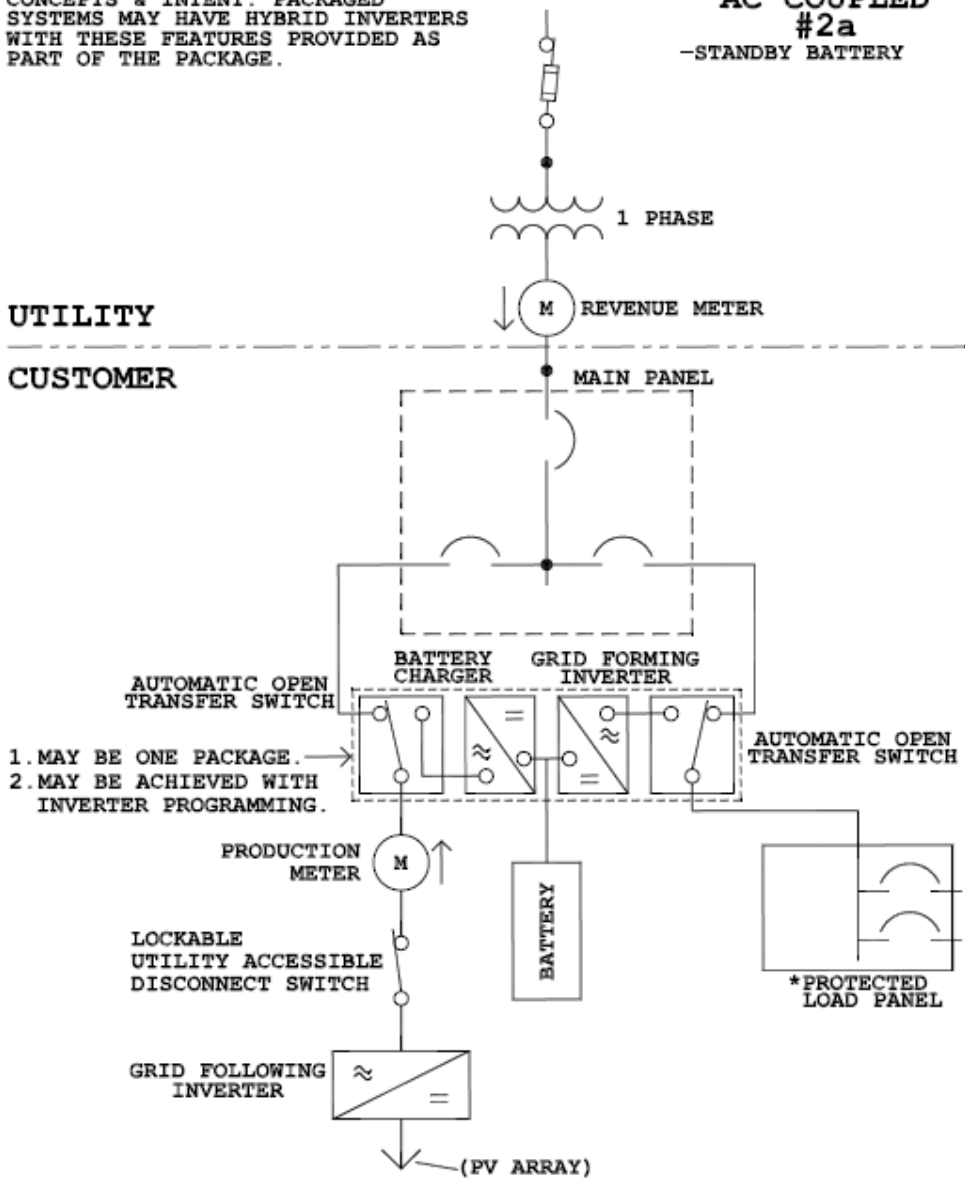
Interconnection review

FIGURE ILLUSTRATES REPRESENTATIVE CONCEPTS & INTENT. PACKAGED SYSTEMS MAY HAVE HYBRID INVERTERS WITH THESE FEATURES PROVIDED AS PART OF THE PACKAGE.

AC COUPLED #2a
-STANDBY BATTERY

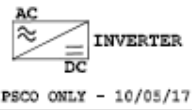
UTILITY

CUSTOMER



- 1. MAY BE ONE PACKAGE.
- 2. MAY BE ACHIEVED WITH INVERTER PROGRAMMING.

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



*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

FIGURE ILLUSTRATES REPRESENTATIVE CONCEPTS & INTENT. PACKAGED SYSTEMS MAY HAVE HYBRID INVERTERS WITH THESE FEATURES PROVIDED AS PART OF THE PACKAGE.

AC COUPLED #2b

- BATTERY MAY EXPORT ONLY IF 100% CHARGED BY NEM ELIGIBLE GENERATION SOURCE

UTILITY

CUSTOMER

METERING MUST BE TIME SYNC

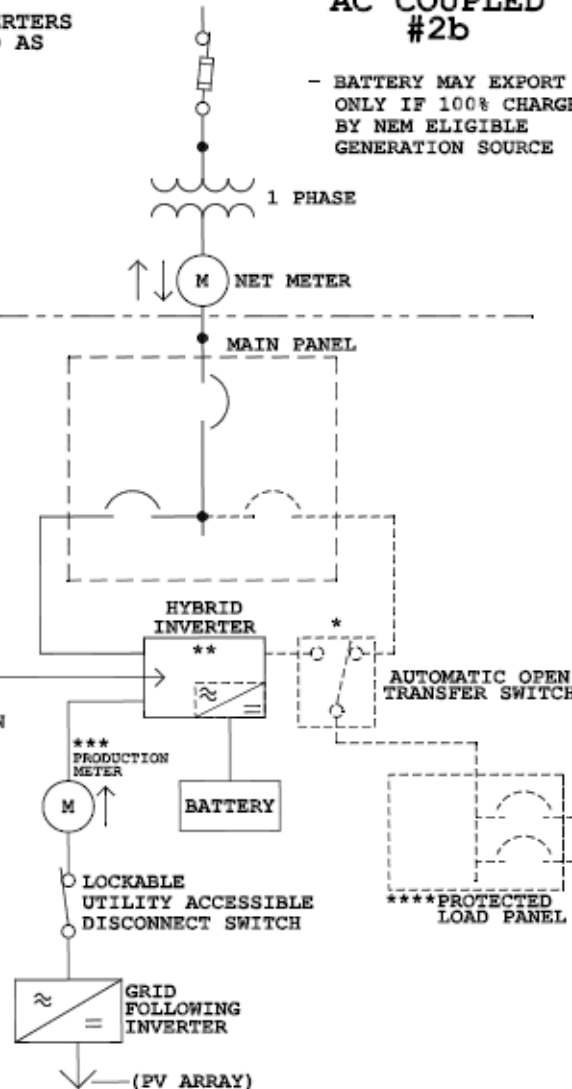
CONTROLLED BY

INVERTER PROGRAMMING:

1. PV BYPASS BATTERY WHEN BATTERY FULLY CHARGED.
2. BATTERY CHARGED BY PV ONLY.
3. BATTERY DISCHARGE TO MAIN PANEL OR PROTECTED LOAD PANEL ONLY.
- *4. OPTIONAL - ATS MAY BE OMITTED IF INVERTER CAN DELIVER UTILITY SIDE POWER WHILE BATTERY 100% CHARGED BY NEM ELIGIBLE GENERATION SOURCE.
- **5. OTHER CONFIGURATIONS MAY BE USED THAT SATISFY THE BATTERY BEING 100% CHARGED BY NEM ELIGIBLE GENERATION SOURCE.
6. REQUIRED INVERTER PROGRAMMING MUST BE LOCKED DOWN.

***7. PRODUCTION METER IS REQUIRED BASED ON THE DER SIZE AND PROGRAM UNDER WHICH THE APPLICATION IS SUBMITTED. SEE THE APPLICABLE TARIFFS.

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



*Parallel Energy Storage
Charged 100%
by NEM Eligible
Renewable
Generation*

Parallel operation

Export renewable generation

Renewable generation required

Renewable battery charging

AC coupled battery

Interconnection review

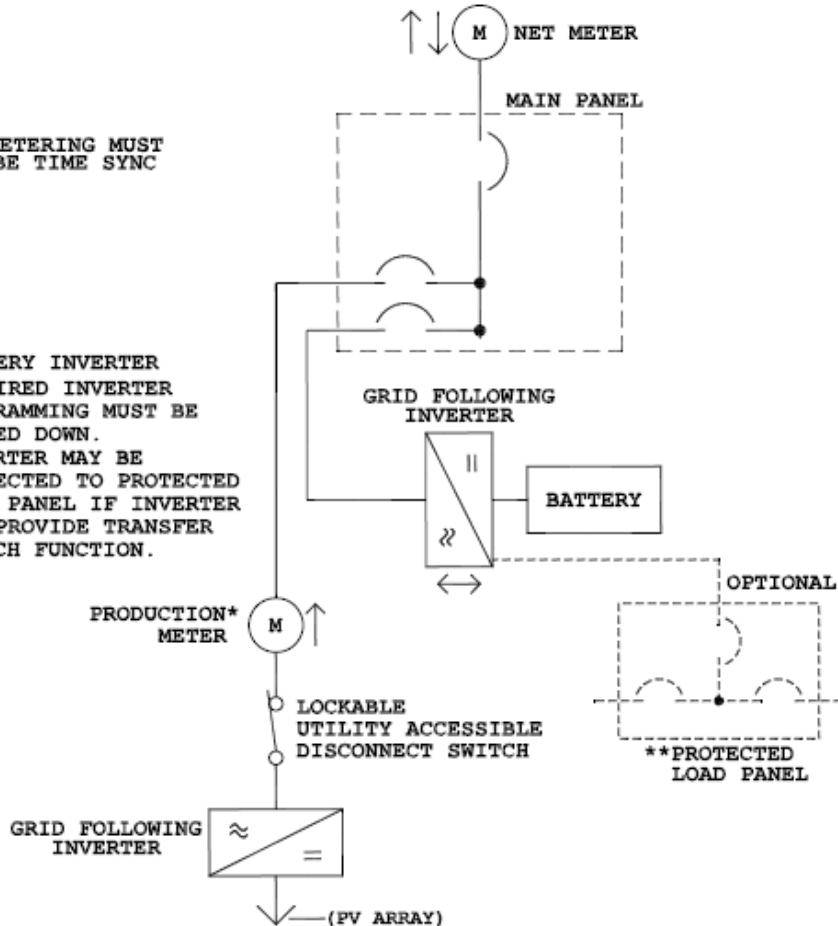
FIGURE ILLUSTRATES REPRESENTATIVE CONCEPTS & INTENT. PACKAGED SYSTEMS MAY HAVE HYBRID INVERTERS WITH THESE FEATURES PROVIDED AS PART OF THE PACKAGE.

AC COUPLED #2c

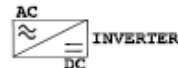
- BATTERY MAY EXPORT ONLY IF 100% CHARGED BY NEM ELIGIBLE GENERATION SOURCE

METERING MUST BE TIME SYNC

1. BATTERY INVERTER REQUIRED INVERTER PROGRAMMING MUST BE LOCKED DOWN.
2. INVERTER MAY BE CONNECTED TO PROTECTED LOAD PANEL IF INVERTER CAN PROVIDE TRANSFER SWITCH FUNCTION.



- *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.



NSPM ONLY - 10/05/17

Parallel Energy Storage Operation Subject to Non-Export

Parallel operation

Non-export

Renewable generation required

Any battery charging

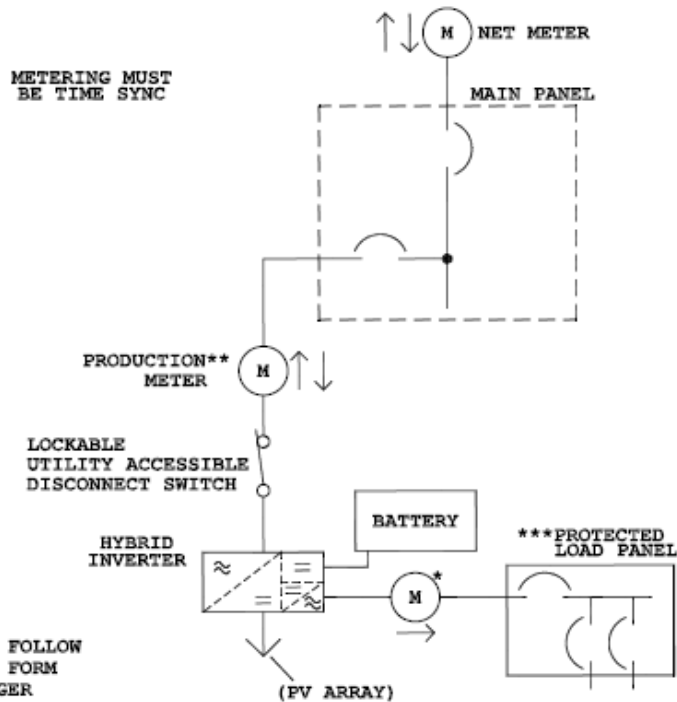
AC coupled battery

Interconnection review

FIGURE ILLUSTRATES REPRESENTATIVE CONCEPTS & INTENT. PACKAGED SYSTEMS MAY HAVE HYBRID INVERTERS WITH THESE FEATURES PROVIDED AS PART OF THE PACKAGE.

HYBRID EXAMPLE #3a METER OPTION

-BATTERY MAY EXPORT ONLY IF 100% CHARGED BY NEM ELIGIBLE GENERATION SOURCE

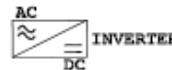


1. GRID FOLLOW
2. GRID FORM
3. CHARGER
4. TRANSFER
5. REQUIRED INVERTER PROGRAMMING MUST BE LOCKED DOWN

*6. METER REQUIRED WHEN PROTECTED LOAD PANEL IS INSTALLED ON INVERTER SIDE OF PRODUCTION METER WHERE A PRODUCTION METER IS REQUIRED.

**7. PRODUCTION METER IS REQUIRED BASED ON THE DER SIZE AND PROGRAM UNDER WHICH THE APPLICATION IS SUBMITTED. SEE THE APPLICABLE TARIFFS.

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



Hybrid Inverter with a Second Load Meter

Parallel operation

Export renewable

Renewable generation required

Renewable battery charging

DC coupled battery

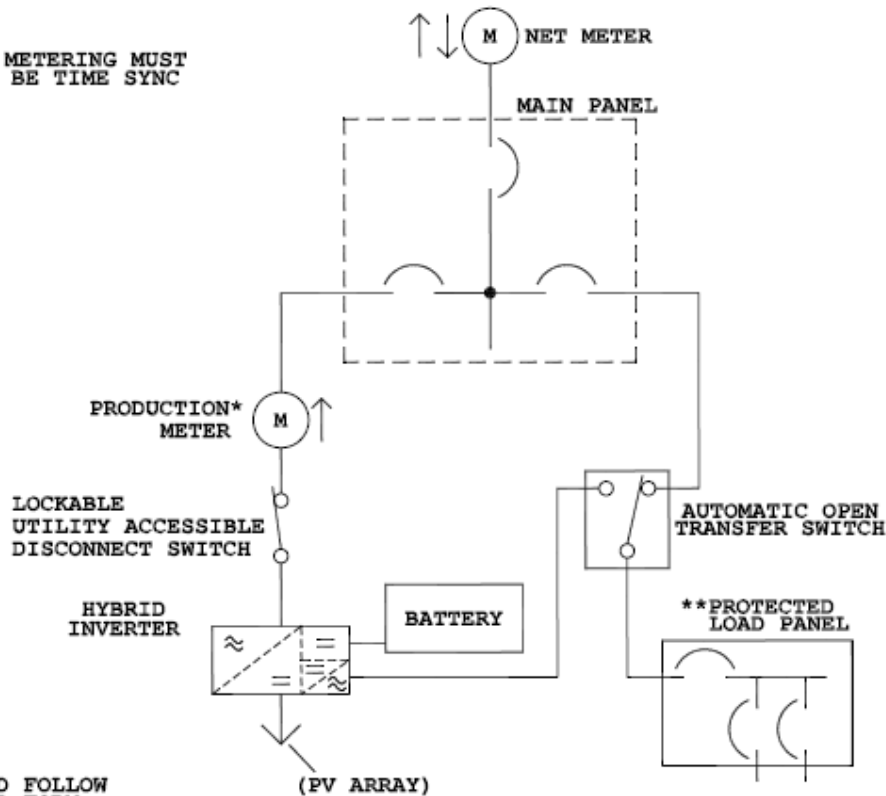
Interconnection review

FIGURE ILLUSTRATES REPRESENTATIVE CONCEPTS & INTENT. PACKAGED SYSTEMS MAY HAVE HYBRID INVERTERS WITH THESE FEATURES PROVIDED AS PART OF THE PACKAGE.

HYBRID EXAMPLE #3b TRANSFER OPTION

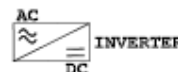
-BATTERY MAY EXPORT ONLY IF 100% CHARGED BY NEM ELIGIBLE GENERATION SOURCE

METERING MUST BE TIME SYNC



1. GRID FOLLOW
2. GRID FORM
3. CHARGER
4. TRANSFER
5. REQUIRED INVERTER PROGRAMMING MUST BE LOCKED DOWN

- *6. PRODUCTION METER IS REQUIRED BASED ON THE DER SIZE AND PROGRAM UNDER WHICH THE APPLICATION IS SUBMITTED. SEE THE APPLICABLE TARIFFS.
- **7. THE PROTECTED LOAD PANEL COULD BE A SEPARATE LOAD PANEL AS SHOWN IN THE DIAGRAM OR COULD BE THE ENTIRE MAIN PANEL.



Hybrid Inverter with a Transfer Switch

Parallel operation

Export renewable

Renewable generation required

Renewable battery charging

DC coupled battery

Interconnection review

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 ?

