Xcel Energy Guidelines for Interconnection of Electric Energy Storage with the Electric Power Distribution System

Adopted Based on State and Tariff Interconnection Rules Applicable to Northern States Power, Wisconsin, Electric Service Territory

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1.0 Scope

The Northern States Power Company Wisconsin electric rate book Parallel Generation- General Rules, Schedule PGX-1 to PGX-1.2, and WI PSC 119, provides that a customer is required to execute a contract which will specify technical connection and operating requirements for the customer's generating facility. Consistent with the rate book provisions, this document provides guidance for the interconnection of electric energy storage[1].

As detailed below, configuration #1 applies to stand-alone energy storage that is not operated with other onsite generation. Configuration #1 also applies to energy storage that is operated with non-exporting generation. Configurations #2 and #3 apply to energy storage that is paired with Renewable Resources[2] that are eligible for export, such as generation used in Net Energy Metering (NEM) rates. Configuration #2 covers scenarios when the energy storage and generation are coupled on the AC side of the Renewable Resource inverter(s), whereas configuration #3 systems are coupled on the DC side of the Renewable Resource inverter(s). Each configuration description and diagram provides the operational principles that are required for interconnection of energy storage systems. In practice, the details of energy storage system interconnection designs may vary, but this document outlines the operational principles required for interconnection. The principles outlined in this document apply for all sizes of energy storage systems and generation systems, though the details of system design are expected to differ based on the specifics of an installation. Diagrams showing the general principles are attached at the end of the text and are considered part of this guidance.

2.0 General

Interconnection of energy storage includes many factors in common with prevalent inverter-based distributed energy resources, such as photovoltaic solar generation. Energy storage also introduces a few additional considerations which are detailed in this document. Section 2 addresses selecting energy storage configurations. Also discussed are the general guidelines for interconnection of energy

[1] Electric energy storage will be referred to simply as energy storage for the remainder of this document.

[2] "Renewable resource" means any of the following: **1.** A resource that derives electricity from any of the following: **a.** A fuel cell that uses, as determined by the commission, a renewable fuel. **b.** Tidal or wave action. **c.** Solar thermal electric or photovoltaic energy. **d.** Wind power. **e.** Geothermal technology. **g.** Biomass. **h.** Synthetic gas created by the plasma gasification of waste. **i.** Densified fuel pellets made from waste material that does not include garbage, as defined in s. 289.01 (9), and that contains no more than 30 percent fixed carbon. **j.** Fuel produced by pyrolysis of organic or waste material. **k.** Heat that is a byproduct of a manufacturing process. **1m.** A resource that derives electricity from hydroelectric power. **2.** Any other resource, except a conventional resource, that the commission designates as a renewable resource in rules promulgated under sub. (4).

storage, such as interconnection applications and review, telemetry and control, metering, and inadvertent export, which are common considerations for most parallel interconnections[3].

Below is a summary of the eight configurations and the associated illustrative diagrams.

- Standby Energy Storage Interconnections, without Generation, complying with NEC 702 (Diagram No. 1a)
- Energy Storage Operation in Parallel without Generation (Diagram No. 1b)
- Energy Storage Operation in Parallel with Non-Net Metered Self-Generation[4] (Diagram No. 1c)
- Standby Energy Storage Operation with Renewable Resources (Diagram No. 2a)
- Parallel Energy Storage Operation Charged 100% by Renewable Resources and Storage Eligible for Export (Diagram No. 2b)
- Parallel Energy Storage Operation Subject to No-export Restrictions (Diagram No. 2c)
- Hybrid[5] Inverter and Storage charged 100% by Renewable Resource with a Second Load Meter, Storage Eligible for Export[6] (Diagram No. 3a).
- Hybrid Inverter and Storage charged 100% by Renewable Resources with a Transfer Switch, Storage Eligible for Export (Diagram No. 3b).

Figure 1 shows a matrix of the attributes associated with each configuration found in this guidance document. This guidance may be modified from time to time to be consistent with the Company's policies for interconnection and operation of customer-sited storage.

[3] Standby energy storage systems do not parallel with the grid and are not impacted by many guidelines associated with parallel generation. Configuration 1a and 2a are standby configurations.
[4] Self-generation is a customer supplying part or their entire load from onsite generation with no intent of export or payment for export.
[5] A hybrid inverter has multiple ports to accept DC input from energy sources with a single AC interface to an electric power system.
[6] Configurations 3a and 3b energy storage systems may be charged by sources other than 100% NEM eligible sources if export of power from the energy storage system is prevented.

2.1 Selecting a Configuration

	AC Coupled Battery						DC Coupled Battery	
	1A	1B	1C	2A	2B	2C	3A	3B
Configuration^	***Standby Energy Storage Only***	***Energy Storage Operation in Parallel without Generation***	***Energy Storage Operation in Parallel with Self-Generation***	***Standby Energy Storage with Renewable Resource***	***Parallel Energy Storage Charged 100% by a Renewable Resource***	***Parallel Energy Storage Operation Subject to Non-Export***	***Hybrid Inverter with a Second Load Meter******	***Hybrid Inverter with a Transfer Switch***
Interconnection type	Customers without Generation or Storage in Parallel with Self-Generation			Net Energy Metering (NEM) or other qualifying facilities				
Pair with Renewable Energy	Yes or No			Yes				
Parallel Operation Allowed	No	Yes		No	Yes		Yes	
Interconnection Review Required	No^^ ^^^	Yes		No^^ ^^^	Yes		Yes for Parallel Operation. Otherwise, No	
Battery Charging	Utility or Self-Generation			Utility or Generation	100% Renewable Generation	Utility or Generation	100% Renewable Generation if Exporting	
Battery Discharging	Standby System^^^	Non-Export*		Standby System^^^	Export of 100% Renewable Generation Only, Otherwise Non-Export*	Non-Export	Export of 100% Renewable Generation Only, Otherwise Non-Export*	
Telemetry and Control	Determined by total Distributed Energy Resources (DER) as addressed in PSC Rules, Interconnection Requirements							
Production Meter	No			Any DER > 250 kW			Any DER > 250 kW	
Agreements	None	Interconnection Agreement (IA), Declaration, Operation Mode to be Identified in IA**		None	Interconnection Agreement, Declaration, Operation Mode to be Identified in IA**		Interconnection Agreement, Declaration, Operation Mode to be Identified in IA**	

* Inadvertent Export allowed per the Guidelines for Interconnection of Electric Energy Storage, Section 2.5

** Operating Mode needs to be identified and also include requirements as indicated above for battery charging and battery discharging, such as charging from on-site renewable energy source that is net metered, non-export requirements or stand-alone storage systems.

*** Second Load Meter required only if a production meter is installed

^ Configuration and Operating Modes must be inaccessible to user. If no inaccessible, all available modes must be reviewed, mitigated as needed, and documented in the IA Operating Agreement

^^ Authority Having Jurisdiction inspection required. If a DER is installed at the same time as the battery, it must be reviewed.

^^^ If operating mode is not inaccessible to user, a full review and Interconnection Agreement is required.

Figure 1 - Matrix of Configuration Characteristics

2.2 Interconnection Application

The interconnection application submitted by customers shall clearly define which configuration is being applied for in the Application Form, as well as on the one-line diagram. Along with stating the configuration number from this document, and meeting other applicable interconnection application requirements, the one-line diagram and supporting documentation shall answer the following questions about the configuration's operational characteristics:

1. Does energy storage export energy to the grid?
2. What source or sources charge the energy storage (i.e. utility, PV, diesel, etc.)?
3. Is a Renewable Resource part of the interconnection?
    a. Is the storage 100 % charged by a Renewable Resource?
4. Does the energy storage parallel[7] with the grid or is it a stand-alone system?
5. What is the process for changing operational modes of the energy storage?
    a. Are the modes of operation settings accessible to the end user?
6. For non-export, how does the system control output so that storage power is not exported to the grid under normal conditions?

These questions and answers must be submitted as an attached sheet with the Application Form.

2.3 Interconnection Reviews

All electrical sources, including storage, that operate in parallel with the Xcel Energy distribution grid are required to have an interconnection review and an Interconnection Agreement to ensure safety, system reliability, and operational compatibility. For purposes of this guidance document, a source is considered to be operating in parallel with the grid when it is connected to the distribution grid and can supply energy to the customer simultaneously with the Company supply of energy. Any source operating in parallel to the grid is required to have an Interconnection Agreement.

When an energy storage system is installed in conjunction with a generation system, both may be reviewed at the same time and be included in one Interconnection Agreement[8]. When an energy storage system is installed after the generation system, the review level will be based on the combination of the onsite generation rated capacity and the storage nameplate capacity for the selected operating mode[9] of the storage system. The operating modes will be part of the

[7] For this document, parallel operation is defined as a device producing power while in grid connected mode.

[8] Interconnections are reviewed based on the combined nameplate ratings of the sources that can be simultaneously supplied to the grid, such as two inverters. The ongoing operation capacity portion of the review is based on the actual simultaneous performance AC ratings. If the contribution of the energy storage to the total contribution is limited by programing or by some other on-site limiting element, the reduced ongoing capacity will be used for interconnection reviews.

[9] Operating Modes includes such requirements as charging the energy storage only from an on-site renewable energy source that is net-metered, non-export requirements, or stand-alone storage systems.

Interconnection Agreement requirements and any change in operating modes, firmware updates, or software updates to the energy storage control system which impacts operating modes of the unit, may require another review of the facility interconnection and possibly mitigations. If a storage system is installed at the same time as a generation source, a combined review is to be encouraged as the total time and cost will be less than two separate reviews.

Customers with a stand-alone energy storage interconnection are not required to have an interconnection agreement with the Company if they are in compliance with NEC 702, obtain an appropriate safety inspection, and can provide verifiable proof that those systems are operated such that they cannot enter parallel operation with the grid. If the operating mode that prevents parallel operation is controlled by firmware, the selection of this mode must be inaccessible to the end user to be eligible for this provision.

2.4 Telemetry and Control

Whenever a paralleled energy storage system is located on the same site with a generation system, its AC rated nameplate capacity will be included with the onsite generation AC nameplate capacity for determining whether or not telemetry and/or remote separation control are needed.[10] This applies regardless if all sources are installed at the same time or at separate times. The AC nameplate determination is also based upon the selected operating modes of the energy storage as stated at the time of installation. Change in operating modes that impact the ability of the energy storage system to adhere to the requirements may require additional review which may result in a change in the necessary telemetry functionality. The telemetry and control requirements as defined by statewide rules, tariffs, and company guidelines should be reviewed by the interconnection customer at the time of application.

2.5 Inadvertent Export

The customer remains responsible for inadvertent energy exports. The term “no export” allows occasional de minimis “inadvertent export” of power. This recognizes that any parallel operation of a source with the utility may encounter brief upsets due to feeder or customer disturbances, sudden load changes, etc.

Inadvertent export is the unscheduled and uncompensated export of real power generated from a customer’s parallel operation and delivered to the Company. The use of an internal transfer relay,

[10] Less than full nameplate will be considered if the added source is limited by programing or onsite equipment element rating.

energy management system, or other customer facility hardware or software system(s) intended to prevent reverse power flow, or net export, from the customer's energy sources across the point of interconnection is required. The magnitude of export shall be less than the total Distributed Energy Resource facility nameplate rating (AC kW-gross)[11] and the duration of export of power from the customer's shall be less than 30 seconds for any single event.

The cumulative amount of energy from the customer and delivered to the Company in any billing month shall be less than the on-site combined nameplate real power source ratings (kW-gross)[12] multiplied by one (1) hour.

Any amount of inadvertent export of real power across the point of interconnection lasting longer than 30 seconds for any single event shall result in a cease-to-energize[13] state of the customer's energy sources within two (2) seconds of exceeding the 30-second duration limit.

Where applicable, any failure of the Customer's control system for thirty (30) seconds or more shall cause the customer's energy sources to enter a non-export operational mode where no energy will be inadvertently exported to the grid. Equipment considered part of the control system includes but is not limited to an internal transfer relay, energy management system, or other customer facility hardware or software system(s) intended to prevent the reverse power flow.

2.6 Metering

In addition to this document, the tariff and program rules under which the interconnection is applying should be consulted for metering requirements. Metering requirements, including the need for a Production Meter, depends on the size as well as program rules[14]. Various tariffs measure capacity (demand) and energy (kWh) separately in time intervals. Some tariffs apply time-of-use rates. Any meter upgrade that is required for directional measurement will employ the same methodology for

[11] The magnitude of export is based on the combined nameplate ratings of the sources that can actually be simultaneously supplied to the grid, such as storage and self-generation. If the contribution of the energy storage to the total contribution is limited by programing or by some other on-site limiting element, the reduced ongoing capacity will be used.

[12] The magnitude of export is based on the combined nameplate ratings of the sources that can actually be simultaneously supplied to the grid, such as storage and self-generation. If the contribution of the energy storage to the total contribution is limited by programing or by some other on-site limiting element, the reduced ongoing capacity will be used.

[13] the DER shall not deliver active power during steady-state or transient conditions. For Local EPS with aggregate DER rating less than 500 kVA, the reactive power exchange in the *cease to energize* state shall be less than 10% of nameplate DER rating and shall exclusively result from passive devices. For Local EPS with aggregate DER rating 500 kVA and greater, the reactive power exchange in the *cease to energize* state shall be less than 3% of nameplate DER rating and shall exclusively result from passive devices. See IEEE 1547-2018, section 4.5, for more information.

[14] Program rules and tariffs may change over time and the interconnection customer should review the most recent revision of relevant documents at the time of the interconnection application.

export measurement as is required by the tariff for delivered power and will be read at the same intervals.

2.7 Operational Mode Programming

The energy storage inverter's software programming will control the appropriate charging, discharging, and bypassing of the energy storage system. For energy storage which parallels with the grid, the inverter software programming must be inaccessible[15] to the customer. For energy storage inverters involved in a configuration that requires 100% renewable resource charging, the programming selected must be protected[16] from modification by the customer so only the inverter manufacturer or installer can change to an operating mode that can charge the energy storage from any non-renewable resource. The means of achieving this shall be provided as part of the Interconnection Agreement and Interconnection Application. Other means of securing the settings may be mutually agreed upon on a case-by-case basis. Xcel Energy reserves the right to conduct an inspection to verify compliance at a later date if problems arise or indications of possible non-compliance are present. If the operating mode selection cannot be made inaccessible to the customer, the energy storage system must be reviewed under each accessible operating mode.

2.8 Energy Storage System Export Eligibility

In order for a storage system to be eligible for exporting to the grid under a Net Energy Meter (NEM) arrangement, the storage system must be charged 100% by a NEM eligible generation resource, as defined by the applicable tariffs, PSC 119, and PSCW interconnection rules. Charging from any non-NEM eligible source disqualifies the energy storage system from exporting. NEM eligible renewable generation, is typically synonymous with the Wis. Stat. § 196.378 definition of Renewable Resource, which applies to Rate Schedule Pg-1. This Rate Schedule only applies to systems 100 kW or smaller. Larger sized systems with energy storage systems would need to have a contract with Xcel Energy if seeking compensation for energy exported to Xcel Energy. An Interconnection Agreement is required when energy storage is paired with a system eligible for NEM rates.

Some energy storage system operating modes that are charged exclusively by a Renewable Resource will charge from the grid when depleted beyond a given threshold; storage systems operating in this manner are not eligible for exporting. If the proper controls are in place and approved during the interconnection review, it is possible for a generation system with an energy storage system to export Renewable Resource energy while preventing export of the energy storage that is not eligible for export.

[15] Inaccessible may include locks or other physical security. Inaccessible and/or password protection must be restricted to the manufacturer/developer/ installer.

[16] Programing protection may be by means of password protection or other means of making access physically inaccessible to the customer. The mode selection must be inaccessible to the customer in order to review an application under a single configuration.

2.9 Declaration Documents

Historically, Distributed Energy Resources (DER) were assembled from discrete components or functional assemblies where the logic and operational approaches could be seen and analyzed. Today, much of the functionality is handled by an on-board computer following firmware and software instructions in order to achieve the desired results. To determine these actions requires extensive detailed review of the operating manuals and often inquiries with the manufacturer. Declarations are used to affirm the desired functionality is present to expedite extensive and time consuming documentation interconnection reviews. An update to the firmware which modifies or adds operation modes or changes the required functionality is considered a material modification[17] and subject to a partial or full interconnection review when appropriate. This applies to all sources, whether generators or energy storage. The declaration document will be included in and be a part of the Interconnection Agreement as an Operating Agreement attachment per PGX-1, item 3, and subject to the Interconnection Agreement's remedies for non-compliance.

3.0 Configuration Guidelines

The principles outlined in this document apply for all sizes of energy storage systems and generation systems, though the details of system design is expected to differ based on the specifics of an installation. Diagrams showing the general principles are attached at the end of the text and are considered part of this guidance. While production meters are shown in many of the diagrams and mentioned in many of the configurations, installation of the production meter is typically not required for DER systems whose aggregate AC nameplate ratings are less than 250 kW.

3.1 Configuration No. 1a, 1b, and 1c -- Stand-Alone Energy Storage and Energy Storage Associated with Non-Exporting DER Systems

This section provides guidance for the interconnection of energy storage systems as a standby source or for operating in parallel with the utility to provide the customer with desired services such as demand reduction. This document applies to non-renewable generation when existing self-generation is present.

Three storage configurations are achievable under this section:

- Standby Energy Storage Interconnections without Generation under NEC 702 (Diagram No. 1a)
- Energy Storage Operation in Parallel without Generation (Diagram No. 1b)

[17] PSC 119.02 (26) "Material modification" means any modification that changes the maximum electrical output of a DG facility or changes the interconnection equipment, including:
(a) Changing from certified to non−certified devices.
(b) Replacing a component with a component of different functionality or UL listing.

- Energy Storage Operation in Parallel with Non-Export Self-Generation[18] (Diagram No. 1c)

Each diagram provides the representative configuration in principle. Individual interconnection designs may have other features not reflected in the diagram, but the operational principle shall be consistent with the operational principle demonstrated by the diagram. The desired functionality may be controlled by inverter or control system programming. The diagrams are attached at the end of the text and are considered a part of this guidance.

Customers with stand-alone energy storage interconnections are not required to have an interconnection agreement with the Company if they are in compliance with NEC 702, obtain an appropriate safety inspection, and can provide verifiable proof that those systems are operated such that they cannot enter into parallel operation with the grid. In order to be eligible for stand-alone energy storage interconnection, settings used to modifying the operating mode such that the energy storage system parallels with the grid must be inaccessible to the customer or end-user. Customers with stand-alone energy storage interconnections are required to have an interconnection agreement when their system is operated in parallel with the grid by serving their main electrical panel and/or protected load panel.

3.1.1 Standby Energy Storage Interconnections without Generation under NEC 702 (Diagram No. 1a)

NEC 702 provides for optional standby (i.e. backup) systems. Optional standby systems are intended to supply power to public or private facilities or property where life safety systems do not depend on the performance of the system. Optional standby systems are intended to supply on-site generated or stored power to selected loads, either automatically or manually. The generators or energy storage do not operate in parallel with the utility. The energy storage may be charged from the utility but may not supply power to the customer's load outside of standby operations. The design is in conformance with the National Electric Code (NEC) Article 702 Optional Standby Power. This configuration is commonly used in conjunction with a Protected Load Panel that is normally fed from the main panel and can be fed by the standby system when the utility is unavailable.

If the above standby conditions are met, in order to be eligible for stand-alone energy storage interconnection, settings used to modify the operating mode such that the energy storage system will parallel with the grid must be inaccessible to the customer or end-user. Xcel Energy reserves the right to conduct an inspection to verify compliance at a later date if problems arise or indications of possible non-compliance are present.

[18] Self-generation is a customer supplying part or their entire load from onsite generation with no intent of export or payment for export.

3.1.2 Energy Storage Operation in Parallel without Generation (no export[19]) (Diagram No. 1b)

If the customer has onsite energy storage operating in parallel with the utility, meter registration will occur for exported power[20]. Subject to the Inadvertent Export provisions below, as a part of the interconnection review, the customer must provide the control system settings to ensure the power source does not export to the system. Xcel Energy reserves the right to conduct an inspection to verify compliance at a later date if problems arise or indications of possible non-compliance are present.

Metering for this operating mode will use bi-directional meters. The bi-directional meters will register for power exported and will be used to check for compliance with inadvertent export requirements. At some future date, meters may be upgraded for increased functionality.[21] Where bi-directional measurement of delivery point power is used, both in and out quantities will be read with only the register for power serving the customer's facility used for billing purposes.

3.1.3 Energy Storage Operation in Parallel with Non-Export Self-Generation[22] (Diagram No. 1c)

If the customer has onsite self-generation, meter registration will occur for exported power regardless of the source providing the power[23]. Subject to the Inadvertent Export provisions below, as a part of the interconnection review, the customer must provide the control system settings to ensure the energy storage power source does not export to the system. Xcel Energy reserves the right to conduct an inspection to verify compliance at a later date if problems arise or other indications of possible non-compliance are present.

Metering for this operating mode will be bi-directional meters. The bi-directional meters will register for power exported which will be used to check for compliance with inadvertent export requirements. At some future date, standard service meters may be upgraded for increased functionality.[24] Where bi-directional measurement of delivery point power is used, both in and out quantities will be read with only the register for power serving the customer's facility used for billing purposes.

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[19] Self Supply Service per NSP Wisconsin Electric Rate Book, Schedule Pg-2D
[20] Exported power will be recorded in a non-billing register that will be used for verifying compliance with inadvertent export provisions..
[21] Meters may require upgrading due to changing metering standards, metering technology changes, or new system control installation.
[22] Self-generation is a customer supplying part or their entire load from onsite generation with no intent of export or payment for export.
[23] Exported power will be recorded in a non-billing register that will be used for verifying compliance with inadvertent export provisions.
[24] Meters may require upgrading due to changing metering standards, metering technology changes, or new system control installation.

3.2 Configuration No. 2a, 2b, and 2c -- Dedicated Inverter Energy Storage Configuration Coupled with a Renewable Resource

This section provides guidance for the interconnection of electric storage to operate in parallel with the utility and a customer's renewable generation. The following configurations apply to systems which have separate inverters for the energy storage and onsite generation. The energy storage is connected between the utility's Main Service Meter and Production Meter[25], when applicable.

This section addresses an energy storage system that is paired with a Renewable Resource, often in a NEM arrangement, to be operated in parallel with the grid provided that (i) an interconnection review is completed; and either (ii) the storage system is charged exclusively by the Renewable Resource, or (iii) the customer can demonstrate the storage system will never export to the grid.

There are three basic energy storage configurations that are permitted under this guidance. The second configuration has three alternative arrangements:

- Standby Energy Storage Operation Coupled with a Renewable Resource (Diagram No 2a)
- Parallel Energy Storage Operation 100% Charged by a Renewable Resource (Diagram No. 2b)
- Parallel Energy Storage Operation Subject to No-export Restrictions (Diagram No. 2c)

Each diagram provides the representative configuration in principle. Individual interconnection designs may have other features not reflected in the diagram but the operational principle shall be consistent with the operational principle demonstrated by the diagram. The desired functionality may be controlled by inverter or control system programming. The diagrams are attached at the end of the text and are considered a part of this guidance.

Metering will be the same as standard service NEM. At some future date, the meters may be upgraded with increased functionality.[26]

3.2.1 Standby Energy Storage Operation with a Renewable Resource (Diagram No 2a)

Standby batteries may charge from the onsite Renewable Resource or the utility grid, but cannot discharge into the customer's main panel. Standby operation is applied to a Protected Load Panel in a manner consistent with National Electric Code Article 702. No change in metering is required from

[25] Production meters requirements differ depending on specifics of the program and the size of generation proposed.
[26] Meters may require upgrading due to changing metering standards, metering technology changes, or new system control installation.

what is described in 3.2 above for this arrangement. See Guidance No. 1 for standby energy storage interconnection with non-Renewable Resource self-generation.

3.2.2 Parallel Energy Storage Operation Charged 100% by Renewable Resources (Diagram No. 2b)

This configuration allows energy storage systems that are 100% charged with onsite renewable generation to be connected in parallel to the grid and to export to the grid. If a Production Meter is present, the energy storage system can be connected on the utility side of the Production Meter with this configuration. A transfer switch is provided to divert renewable AC power to the energy storage for charging. This diversion of power may be accomplished internally with the inverter package either via a built-in switch or through inverter programming. The inverter's software programming will control the appropriate charging, discharge, and bypass of the energy storage system. The inverter software programming must be inaccessible[27] and/or password protected.

This configuration shall use a separate energy storage inverter from the PV inverter.

3.2.3 Parallel Energy Storage Operation Subject to No-export Restrictions (Diagram No. 2c)

If the parallel energy storage can be charged by power from the utility via the main panel and thus is not 100% charged from a Renewable Resource, the energy storage must not export to the grid. Subject to the Inadvertent Export provisions below, the energy storage may not export power at the delivery point meter onto the grid. Nothing in this guidance document shall be construed to limit the export of actual onsite renewable self-generation that is net metered.

The customer is responsible for dynamically managing the energy storage operation so that these conditions are met regardless of the eligible renewable generator's output and any variations in the eligible renewable generator's output or the customer's load.

The no-export requirement does not allow compensation to be paid for exported energy storage power that is other than 100% renewable energy.

Xcel Energy reserves the right to conduct an inspection to verify compliance at a later date if problems arise or indications of possible non-compliance are present.

[27] Inaccessible may include locks or other physical security. Inaccessible and/or password protection must be restricted to the manufacturer/developer/ installer.

3.3 Configuration No. 3a and 3b -- Hybrid Inverter Energy Storage Configuration Coupled with Renewable Resource

This document provides guidance for the interconnection of energy storage to operate in parallel with the utility and a customer's Renewable Resource. The energy storage is connected to a hybrid inverter that serves both the energy storage and a Renewable Resource. The storage system must be charged exclusively by the onsite Renewable Resource in order to be eligible for exporting.

There are two basic energy storage configurations that are permitted under configuration #3. In the two configurations, the energy storage is assumed to be using a shared hybrid inverter along with the Renewable Resource. These configurations would be necessary when a Production Meter is required.

- Hybrid Inverter and a Renewable Resource with a Second Load Meter (Diagram No. 3a)
- Hybrid Inverter and a Renewable Resource with a Transfer Switch (Diagram No. 3b).

Each diagram provides the representative configuration in principle. Individual interconnection designs may have other features not reflected in the diagram but the operational principle shall be consistent with the operational principle demonstrated by the diagram. The desired functionality may be controlled by inverter or control system programming. The diagrams are attached at the end of the text and are considered a part of this guidance.

There may also be a configuration without a Protected Load Panel. This would be identical to Diagram No. 3b, but without a transfer switch or Protected Load Panel.

For configuration 3b, metering will be the standard service meter for NEM. Large commercial and industrial customers will use bi-directional meters suitable for their rate class.

This guidance requires the energy storage to be 100% charged with renewable energy from the on-site Renewable Resource if the energy storage is capable of exporting energy. Energy storage systems that are not capable of exporting to the grid do not have restrictions on the source of charging. The installation must be designed and programed to comply with this condition. For inverters, the programming selected must be protected[28] from modification so only the inverter manufacturer or installer can change the renewable only charging programming. The means of achieving this shall be provided as part of the Interconnection Agreement and Interconnection Application. Other means of securing the settings may be mutually agreed upon on a case-by-case basis. Xcel Energy reserves the right to conduct an inspection to verify compliance at a later date if problems arise or indications of possible non-compliance are present.

[28] Inaccessible may include locks or other physical security. Inaccessible and/or password protection must be restricted to the manufacturer/developer/ installer.

3.3.1 Hybrid Inverter and Renewable Resource with a Second Load Meter (Diagram No. 3a)

When a Production Meter is required, and a Protected Load Panel is installed with the hybrid inverter and supplied through that inverter, a second uni-directional Load Meter must be installed between the hybrid inverter and the Protected Load Panel. The requirements for this, and payment for this, will be specified in the Operating Agreement attachment to the Interconnection Agreement. The main Production Meter will be a dual-register bi-directional meter. When interval data is used, the Production and service meter must be able to be synchronized for the same time intervals. These three meters will enable the derivation of renewable energy production and load energy usage. The inverter software programming must be inaccessible and/or password protected.[29]

3.3.2 Hybrid Inverter and Renewable Resource with a Transfer Switch (Diagram No. 3b)

If a Transfer Switch is used to supply the Protected Load Panel from the grid under normal conditions, no power will flow in reverse through the Production Meter, if applicable. This eliminates the need for the second load Meter. The required Main Metering and Production Metering, if applicable, will be the standard meters for net-metered eligible generation. At some future date, the meters may be upgraded to bi-directional meters[30]. The inverter software programming must be locked down and password protected.

Illustrative diagrams of approved configurations are attached.

[29] Inaccessible may include locks or other physical security. Inaccessible and/or password protection must be restricted to the manufacturer/developer/installer.

[30] Meters may require upgrading due to changing metering standards, metering technology changes, or new system control installation.