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, South Dakota, Electric Service Territory

Table of Contents

1.0 Scope

The Xcel Energy Section 9 Cogeneration and Small Power production tariff for South Dakota provides that if the planned interconnection is with a unique electric power system, the Interconnection Customer must obtain the additional requirements for interconnecting with Xcel Energy[1]. It provides that that for some unique interconnections, additional and/or different protective devices, system modifications and/or additions will be required by Xcel Energy and that Xcel Energy will provide the final determination of the required modifications and/or additions. Consistent with the tariff provisions, this document provides guidance for the interconnection of electric energy storage[2].

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 Net Energy Metering (NEM) eligible generation. Configuration #2 covers scenarios when the energy storage and generation are coupled on the AC side of the inverter(s) whereas configuration #3 systems are coupled on the DC side of the 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 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.

2.0 General

Interconnection of energy storage includes many factors in common with prevalent inverter based distributed 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 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.

[1] Detailed interconnection requirements can be found in SD §20:10:36:01-73 and supplemental requirements in Xcel Energy Distributed Generation Interconnection Manual

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

[3] Standby energy storage systems do not parallel with the grid while in discharge mode and are not impacted by many guidelines associated with parallel generation. Configuration 1a and 2a are standby configurations.

- Standby Energy Storage Interconnections without Generation under 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 NEM Eligible Generation (Diagram No. 2a)
- Parallel Energy Storage Operation Charged 100% by NEM Eligible Generation 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 NEM Eligible generation with a Second Load Meter, Storage Eligible for Export[6] (Diagram No. 3a).
- Hybrid Inverter and Storage charged 100% by NEM Eligible generation 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.

[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 NEM Eligible Renewable Generation*	*Parallel Energy Storage Charged by NEM Eligible Renewable Generation !*	*Parallel Energy Storage Operation Subject to No-export*	*Hybrid Inverter with a Second Load Meter !*	*Hybrid Inverter with a Transfer Switch !*
Interconnection Type	For Customers without Generation or Storage in Parallel with Self-Generation			For Net Energy Metering (NEM) and Solar* Rewards				
Pair with Renewable Energy?	Yes or No			Yes				
Parallel Operation Allowed?	No	Yes		No	Yes		Yes	
Interconnection Review Required	No^^ ^^^	Yes		No^^ ^^^	Yes		Yes	
Storage Charging	Utility or Self-Generation			Utility or Generation	100% Renewable Generation	Utility or Generation	100% Renewable Generation	
Storage Discharging	Standby System^^^	Non-Export*		Standby System^^^	Export of 100% Renewable Generation Only	Non-Export*	Export of Renewable Generation Only	
Production Meter?	No			May be required at company cost			May be required at company cost	
Telemetry and Control?	Determined by total DER as addressed in PUC Rules, Interconnection Requirements							
Agreements	Attestation of Conformance to NEC Article 702^^^	Interconnection Agreement, Operation Mode to be Identified in IA**		Attestation of Conformance to NEC Article 702^^^	Interconnection Agreement, Operation Mode to be Identified in IA**		Interconnection Agreement, Operation Mode to be Identified in IA**	

*** Inadvertent Export Allowed per Settlement Guidance documents.**

**** Operating modes need 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 system.**

***** All storage configurations require an Attestation Form to be completed by the installer and submitted with the application. The attestation specifies the Configuration designation, the means used to lock-down access to the Configuration, and Operating Mode selection.**

^ Configuration and Operating Modes must be locked-down so user cannot change. If not lock-down, all available modes must be reviewed, mitigated as needed, and documented in IA Exibit D.

^^ AHJ inspection required. If a PV or other source is installed at the same time as the storage, the facility must be reviewed.

^^^ If operating mode is not locked-down, a full review and Interconnection Agreement is required.

! Variations from diagram drawings allowed. 2B, 3A, and 3B may be configured for non-exporting with mixed source charging.

Figure 1 - Matrix of Configuration Characteristics

2.2 Interconnection Application

The interconnection application and oneline diagram submitted by customers shall clearly define which configuration is being applied for. Along with stating the configuration number from this document, and meeting other applicable interconnection application requirements, the oneline 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 NEM eligible generator part of the interconnection?
    a. Is the storage 100 % charged by a NEM eligible generator?
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 mode 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?

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, 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 a 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 a storage system is installed after the generation system, the review level will be based upon 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 Interconnection Agreement requirements and any change in operating modes, or firmware 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.

[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 actually 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.

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 operate in parallel 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 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. Changes 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 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, energy management system, or other customer facility hardware or software system(s) intended to prevent the 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 (kW-gross)[11] and the duration of export of power from the customer's shall be less than 30 seconds for any single event.

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

[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.

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 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] 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 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, discharge, and bypass 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

[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] Cessation of active power delivery under steady state and transient conditions and limitation of reactive power exchange. This may lead to momentary cessation or trip. This does not necessarily imply, nor exclude disconnection, isolation, or a trip. Limited reactive power exchange may continue as specified, e.g., through filter banks, or approved arrangement. Energy storage systems are allowed to continue charging (IEEE P1547-2018/D6.2).

[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.

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

a configuration that requires 100% NEM eligible 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-NEM eligible source. 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 available 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 NEM arrangement, the storage system must be charged 100% by a NEM eligible generation resource as defined by the applicable tariffs. Charging from any non-NEM eligible source disqualifies the energy storage system from exporting. NEM eligible renewable generation, also referred to as eligible renewables in this document, is typically synonymous with Xcel Energy's Section 9 Tariff's definition of Qualifying Facility[17] which applies to Rate Codes E50 and E52. These Rate Codes only apply to systems up to 100 kW, and larger sized systems with batteries would need to have a PPA if seeking compensation for energy exported to Xcel Energy. A South Dakota PUC Distributed Generator Interconnection Rules and Forms Interconnection Agreement is required when energy storage is paired with a system eligible for NEM rates.

Some energy storage system operating modes that typically are charged exclusively by NEM eligible generation 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 plus energy storage system to exhibit the characteristics of exporting NEM eligible generation energy while preventing export of energy storage which is not eligible for exporting.

2.9 Attestation 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

[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.

[17] QUALIFYING FACILITY (QF). A qualifying facility is a cogeneration or small power production facility which satisfies the conditions in 18 Code of Federal Regulations, part 292.

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. Attestations are used to affirm the desired functionality is present in lieu of extensive and time consuming interconnection documentation reviews. An update to the firmware which modifies or adds operation modes or changes the required functionality is considered a facility modification and subject to a partial or full interconnection review. This applies to all sources, whether generators or energy storage. The attestation document will be included in and be a part of the Interconnection Agreement 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.

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 batteries 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)
- Energy Storage Operation in Parallel with Non Net Metered 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

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

appropriate safety inspection, and can provide verifiable proof that those systems are operated such that they cannot discharge in parallel 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 battery 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, the applicable state or local safety inspection has been obtained, and verifiable proof that the system operates in compliance with NEC 702 has been provided to Xcel Energy[19], the installation may proceed to operate without further approval or inspection and will not need an Interconnection Agreement. 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. 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.

[19] Attestation is required and should include sign-off by installer/developer and customer. Attestations should identify specific hardware and software associated with the installed systems and those settings used to comply with the specified configuration as well as the settings being inaccessible and/or password protection must be restricted to the installer/developer/manufacturer.

3.1.2 Energy Storage Operation in Parallel without Generation (no export) (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 be 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 Net Metered 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.

[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 Net Energy Metered DER

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, in a NEM arrangement.

This section addresses an energy storage system that is paired with NEM eligible renewable generation 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 NEM eligible on-site generation, 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[26]. The second configuration has three alternative arrangements:

- Standby Energy Storage Operation with NEM Eligible Generation (Diagram No 2a)
- Parallel Energy Storage Operation 100% Charged by NEM Eligible Generation (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 and may include a Production Meter, when applicable. At some future date, the meters may be upgraded with increased functionality.[27]

3.2.1 Standby Energy Storage Operation with NEM Eligible Generation (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 for this

[25] Production meters are associated with tariff metering requirements, as well as program requirements and differ depending on specifics of the program and the size of generation proposed.
[26] Photovoltaics are typically installed taking service under the referenced Section 9 tariff Rate Codes.
[27] Meters may require upgrading due to changing metering standards, metering technology changes, or new system control installation.

arrangement. See Guidance No. 1 for standby energy storage interconnection with non-NEM eligible self-generation.

3.2.2 Parallel Energy Storage Operation Charged 100% by NEM Eligible Generation (Diagram No. 2b)

This configuration allows batteries that are 100% charged with onsite renewable generation to be connected in parallel to the grid on the utility side of the Production Meter, when applicable. The energy storage is connected on the utility side of the Production Meter, when applicable, and a transfer switch[28] is provided to divert renewable AC power to the energy storage for charging. 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[29] 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 eligible renewable energy, 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's output and any variations in the eligible renewable's output or the customer's load. The energy storage must be connected to the utility Main Meter side of the Production Meter, if installed, and must not be on the eligible renewable's side of the Production Meter.

The Production Meter, if installed, will need to read the same parameters using the same intervals as the Main Meter. 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.

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[28] The switch may be a built in part of the energy storage inverter package or functionally provided through internal programing.

[29] 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 Net Energy Metered DER

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

There are two basic energy storage configurations that are permitted under configuration #3[30]. In the two configurations, the energy storage is assumed to be using a shared hybrid inverter along with the renewable generation. The Diagrams provided assume there is a Protected Load Panel connected on the renewable generation's side of the Production Meter, when applicable.

- Hybrid Inverter and NEM generation with a Second Load Meter[31] (Diagram No. 3a).
- Hybrid Inverter and NEM generation 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 and may include in certain circumstances a production meter. For configuration 3a, the net meter will be the standard for service under NEM and the Production Meter, when applicable, will be upgraded to a dual register bi-directional meter. The added protected load supply meter will be a standard load-only meter. At some future date, the meters may be upgraded to meters with increased functionality including bi-directional capabilities for production meters.[32] Large commercial and industrial customers will use bi-directional meters suitable for their rate class.

[30] Photovoltaics are typically installed taking service under the referenced Section 9 tariff Rate Codes.
[31] A second load meter is only required for installations that require a production meter.
[32] Meters may require upgrading due to changing metering standards, metering technology changes, or new system control installation.

The configurations under Guidance No. 3 may result in some loss of meter recorded RECs and corresponding payments for installations eligible for REC incentive payments[33]. Batteries consume some power for maintaining a charge. A discharge - charge cycle has a round-trip efficiency that translates into energy losses. This is true whether the cycle occurs supporting the Protected Load Panel during an outage or for use of the energy storage to manage the customer's energy usage.

This guidance requires the energy storage to be 100% charged with renewable energy from the on-site NEM eligible renewable generation source 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[34] 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.

3.3.1 Hybrid Inverter and NEM generation with a Second Load Meter (Diagram No. 3a)

When 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.[35]

3.3.2 Hybrid Inverter and NEM generation 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

[33] This is as applicable per individual state and program rules.
[34] Inaccessible may include locks or other physical security. Inaccessible and/or password protection must be restricted to the manufacturer/developer/ installer.
[35] Inaccessible may include locks or other physical security. Inaccessible and/or password protection must be restricted to the manufacturer/developer/ installer.

upgraded to bi-directional meters[36]. The inverter software programming must be locked down and password protected.

Illustrative diagrams of approved configurations are attached.

Note: diagrams of approved configurations include production meters. If production meters are not required per state rules, the same diagram applies with the removal of the production meter.

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