NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

GADS Solar Generation

Data Reporting Instructions

Effective Date: January 1, 2024

RELIABILITY | RESILIENCE | SECURITY




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Revision History

Version	Date	Revisions
1.4	3/6/2024	Addition of Physical and Security Cause Codes in Appendix K
1.3	1/2/2024	XML File format clarification Configuration Clarification edits Event clarification edits Examples from training added to Appendix J Removal of “Equivalent” (no derates) from pertinent equations and acronyms in Appendix L
1.2	9/14/2023	General organizational consistency changes. Clarified that all curtailments are considered reserve shut down hours. Added that less than 20 MW of Plant Total Installed Capacity must be unavailable for an event to end, to prevent end event loops. Clarified an event can have multiple causes. Removed references to derates. Term was not analogous to conventional. Added several previously used, but undefined, terms to glossary. Added units and reporting locations to glossary as appropriate. Added abbreviations appendix. Clarified and added event examples. Inverter States and Hours appendix reorganized to improve readability. Rephrased some accusatory language in Outage Classification Guidelines. Organized and assigned numeric codes to Cause Codes. Corrected use of “System” and “Unit” to “Resource” and “Equipment” in equations to align with wind. Added several equations analogous to wind equations. Added list of data validations that will be checked when importing data.
1.1	5/31/2023	Updated Event Reporting Criteria. Added grammar and formatting corrections.
1.0	01/23/2023	Initial Release for Section 1600 Data Request.

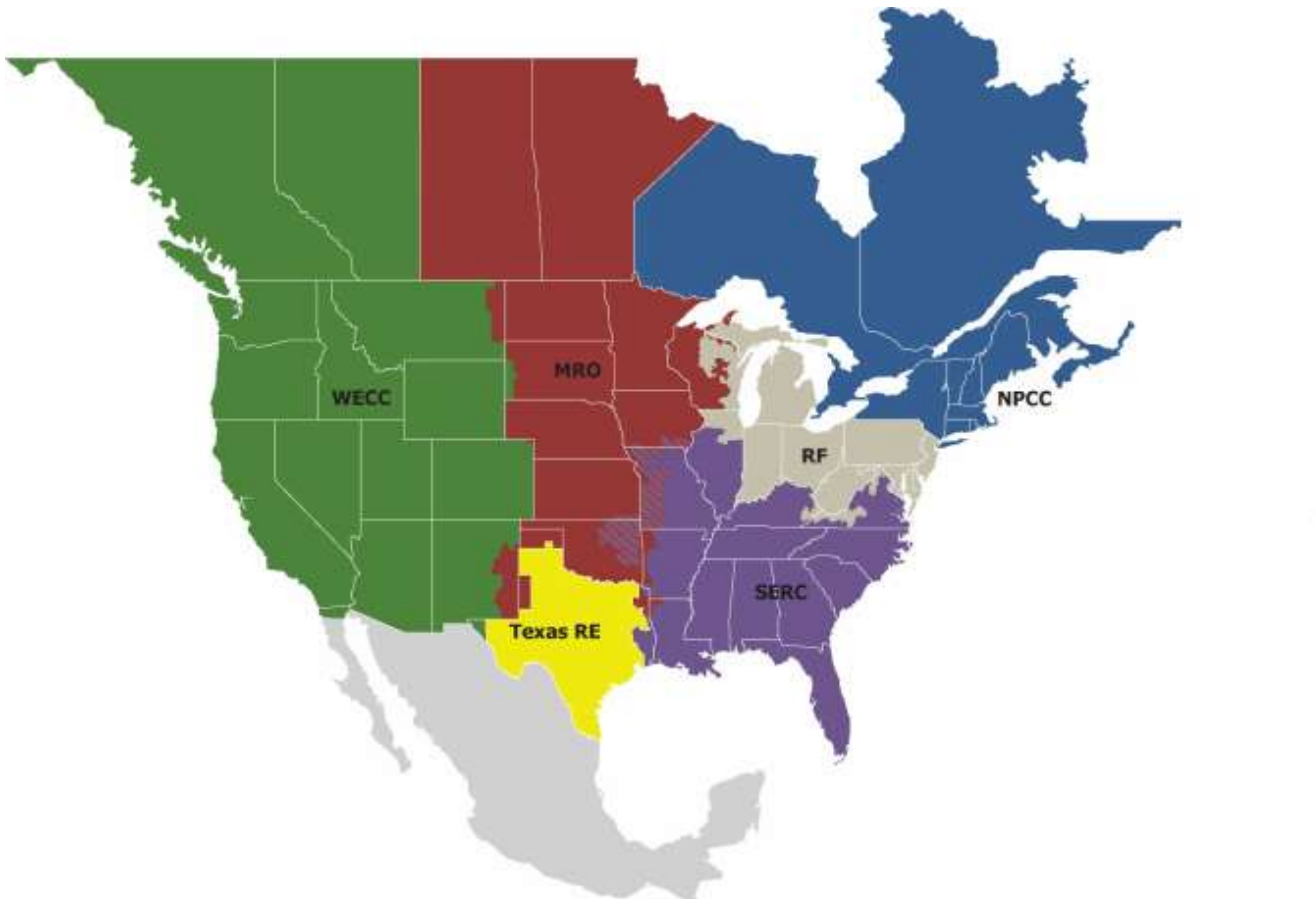
Board Approved changes to the GADS Section 1600 Data Request, Effective January 1, 2024: November 16, 2022

Preface

Electricity is a key component of the fabric of modern society and the Electric Reliability Organization (ERO) Enterprise serves to strengthen that fabric. The vision for the ERO Enterprise, which is comprised of NERC and the six Regional Entities, is a highly reliable, resilient, and secure North American bulk power system (BPS). Our mission is to ensure the effective and efficient reduction of risks to the reliability and security of the grid.

Reliability | Resilience | Security
Because nearly 400 million citizens in North America are counting on us

The North American BPS is made up of six Regional Entities as shown on the map and in the corresponding table below. The multicolored area denotes overlap as some load-serving entities participate in one Regional Entity while associated Transmission Owners/Operators participate in another.



MRO	Midwest Reliability Organization
NPCC	Northeast Power Coordinating Council
RF	ReliabilityFirst
SERC	SERC Reliability Corporation
Texas RE	Texas Reliability Entity
WECC	WECC

Introduction

The *GADS Solar Generation (GADS-S) – Data Reporting Instructions* were developed to assist plant personnel in reporting information to NERC's GADS Solar Reporting application. The instructions detail the procedures, schedule, and format to follow when reporting data. Throughout this document, the term "entity" will be used to refer to the principal organization that owns one or more plants.

Who Must Report

Reporting of solar performance data is required for all NERC registered entities with a Generator Owner function/scope that operate solar generating plants with a Plant Total Installed Capacity[1] of 20 MW or greater per plant with commercial operation that began on January 1, 2010, or later, regardless of interconnection. Plant Total Installed Capacity is the combined capacity of Inverter Group Installed Capacity, not including Energy Storage Capacity. These reporting instructions detail the data elements collected by the GADS Solar Reporting application and have been identified by the industry as being vital to the understanding and interpretation of solar generating plants' performance.

Data Release Guidelines

The GADS Solar Reporting Application Data Release Guidelines can be found in **Appendix A**.

What will be reported?

1. Configuration Data:
   a. Plant
   b. Subgroup
   c. Energy Storage
2. Monthly Performance Data
   a. Inverter Group
   b. Energy Storage
3. Event Data
   a. Plant

When will Required Reporting Begin?

Entities' data collection will begin January 1, 2024, to be submitted by August 15, 2024.

Phased-in Approach

- 2024 – Plants with a Plant Total Installed Capacity of 100 MW or more
- 2025 – Plants with a Plant Total Installed Capacity of 20 MW or more

Note: Solar plants that do not meet the required reporting criteria may report on a voluntary basis.

[1] Plant Total Installed Capacity is defined in **Appendix F.Appendix F**

Chapter 1: Data Record Types and Format

Data Record Types

Three types of data files will be reported:

1. Configuration
    a. Plant
    b. Inverter Group
    c. Energy Storage Group
2. Monthly Performance
    a. Inverter Group
    b. Energy Storage Group
3. Event
    a. Plant

Configuration data are required prior to reporting of the performance and event data to the GADS Solar reporting application. Configuration data are provided to establish the assets on which to report. This data provides foundational information regarding installed equipment, design, and operating characteristics that are used when completing special analyses. Configuration data may be updated as needed. Configuration data should be reviewed each quarter to ensure that the information is current.

Format

Data should be provided to NERC through the GADS Solar reporting application using the Excel-format XML templates available on NERC's website[2] or a XML formatted files that follows the column order of the data reporting templates. Column headers are required for all Excel and XML-formatted files[3]. Filenames and data in the fields of the import file must not include commas; however, decimal points, dashes, and slashes are permitted.

Multiple NERC entity, plant, inverter group and energy storage group IDs may be reported within the same file. Each data type and template have specific tab labels.

Reporting Deadline

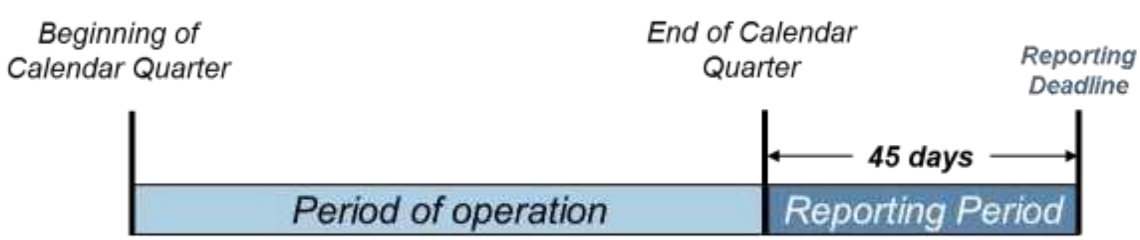


Figure 1.1: Timeline of Reporting Deadline

[2] (Link to be established by January 1, 2024)

[3] Some third-party vendors will have direct to XML capability.

Data shall be submitted quarterly to NERC through the GADS Solar reporting application within 45 days after the end of each calendar quarter, as specified in the following sections that detail the data to be reported. Reporting deadlines are posted on the NERC website on the GADS web page[4].

Late Reporting

An entity is required to notify their regional entity contact when they are unable to complete their data reports by the reporting deadline. The Regional Entity contacts for solar reporting are available on the GADS web page.

Questions and Comments

All questions regarding data transmittals and reporting procedures should be directed to gadssolar@nerc.net.

[4] https://www.nerc.com/pa/RAPA/gads/Pages/GeneratingAvailabilityDataSystem-(GADS).aspx

Chapter 2: Plants, Inverter Groups, and Energy Storage Groups

In **Figure 2.1**, the diagram represents a typical plant with the plant boundary at the revenue meter (point of interconnection). Inverter Groups may represent different phases of development or physical connections of solar panels to an inverter. Although **Figure 2.1** shows the groups as being electrically isolated, this need not be the case. A feeder may have multiple inverter types. The plant is responsible for allocating production and hourly distributions using feeder meters, inverter meters, SCADA systems, manual logs, or other means into the proper groups.

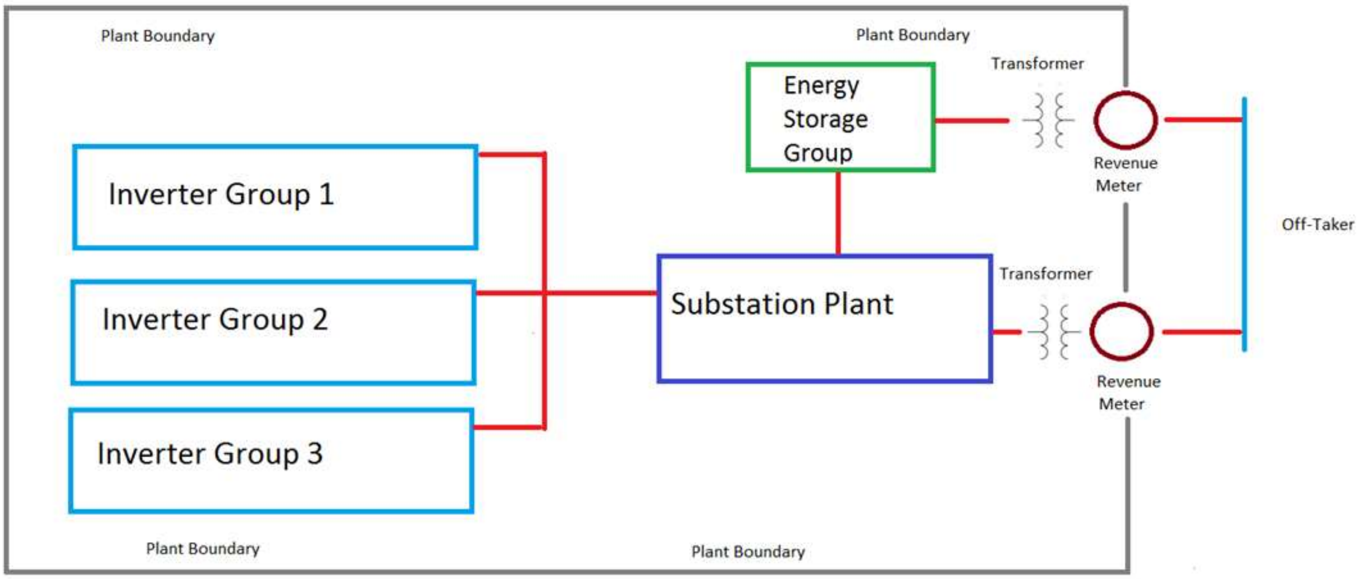


Figure 2.1: Example of Solar Plant Layout

Plant Boundaries

The following describes the plant boundary in preferred order:

1. The preferred plant boundary at the revenue meter is usually at the high-voltage terminals of the generator step-up (GSU) transformer and the station service transformers; or
2. In cases of multiple Inverter groups, the plant boundary would be at the metering of the low side of the substation transformer (load) side of the generator voltage circuit breakers; or
3. Any equipment boundary that is reasonable considering the design and configuration of the generating unit.

Plant boundaries may not cross the boundary of a NERC region, state, province, or country. Additional guidelines are provided under the Plant entry in the Glossary.

Plants

A plant is defined as a collection of inverter groups at a single physical location managed by a single manager and operating out of a common Operations and Management building. Generally, each separate plant is reported to EIA and is treated as a single plant within the parent entity. There may be any number of solar inverter groups at a solar plant and there may be connected energy storage within the plant boundary. See for an enhanced definition of a plant. Each plant will have a unique identifier assigned by NERC through the GADS Solar reporting application.

Inverter Groups

An Inverter Group is a collection of solar inverters with the same manufacturer, design, system capacity, model number, and phase of construction. Each inverter group will have a unique identifier assigned by NERC through the GADS Solar reporting application.

Energy Storage Groups

An Energy Storage Group is a collection of energy storage equipment of the same technology, manufacturer, design, system capacity, model number, and phase of construction that is electrically connected to a renewable energy generating plant and installed on-site connected as part of the plant. Each energy storage group will have a unique identifier assigned by NERC through the GADS Solar reporting application.

Chapter 3: Configuration Data

Configuration data contains location, environment, and other design data about the plant, inverter group, or on- site connected energy storage. Configuration data is required prior to reporting performance, event, and component outage data. During the initial import of configuration data, IDs will be assigned to the plant, inverter group(s), and on-site connected energy storage group(s), if applicable. The assigned IDs remain with the plant throughout its life cycle. Configuration data may be updated at any time and must be reviewed annually. Retirements and transfer of ownership are handled through configuration data updates.

NERC requests that values reported match the values reported to other governmental or regulatory agencies such as the EIA, EPA, etc.

When to Report Configuration Data

Equipment-related (configuration) data, such as plant, inverter group, or energy storage configuration data will be required in the first full month after the Commercial Operating Date (COD), acquisition, or repowering of an inverter group at the plant. Once established, configuration data may be updated as changes occur.

Plant Configuration

Plant data is required. Each Plant will be assigned a unique identifier through the GADS Solar Reporting application when the Plant Configuration template is imported. Outage Event data are reported at the Plant level.

Table 3.1: Plant Configuration Record Fields

Column	Field Name	Column Header Label	Entry Type	Required or Voluntary
1	Entity ID	EntityID	Alpha-Numeric-10	Required
2	Region	Region	Alpha-Numeric - 8	Required
3	Plant ID	PlantID	Numeric - 10	Required
4	Plant Name	PlantName	Alpha-Numeric - 45	Required
5	EIA Plant Code	EIACode	Numeric – 6	Required
6	ISO Resource ID	PlantISOID	Alpha-Numeric - 30	Voluntary
7	Country	Country	Alpha-Numeric - 2	Required
8	Nearest City	NearCity	Alpha-Numeric - 40	Required
9	State/Province	State	Alpha-Numeric - 2	Required
10	Time Zone	TimeZone	Alpha-Numeric - 3	Required
11	Plant Location Latitude	PlantLatitude	Numeric - 3 + 4 decimals	Required
12	Plant Location Longitude	PlantLongitude	Numeric - 3 + 4 decimals	Required
13	Elevation (m)	Elevation	Numeric - 5	Required
14	Solar Regime Environment	SRegime	Numeric - 3	Required
15	Global Horizontal Irradiance(kWh/m^2)	GHI	Numeric – 4 + 2 decimals	Required
16	Inter-Annual Variance of Irradiance (%)	IAVOR	Numeric – 3 + 2 decimals	Required
17	Plant Capacity at POI	CPOI	Numeric – 8_+ 2 decimals	Required
18	On-site connected Energy Storage	OnsiteStorage	Yes/No	Required
19	Plant Ownership Status	PlantOwnStatus	Alpha-Numeric-2	Required
20	Plant Effective Date	PlantEffDate	Date (mm/dd/yyyy)	Required
21	Plant Transfer to Entity ID	PlantTransferEntity	Alpha-Numeric – 10	Conditionally Required

Note: The ISO Resource ID is a voluntary field used to provide an identifier assigned by an ISO/RTO market in the event the ISO/RTO requires required GADS reporting for solar plants.

Table 3.2: Plant Configuration Record Field Descriptions		
Column	**Field Name**	**Description**
1	Entity ID	Enter the NERC Compliance Registry ID number (NCR ID) or voluntary reporting ID assigned by NERC of the organization that operates the Solar plant.
2	Region	Enter the region code for the NERC region where the Plant, Inverter Group or Energy Storage Group is located. Refer to **Appendix D** and identify the correct region abbreviation.
3	Plant ID	Enter the Plant ID assigned by the GADS Solar application.
4	Plant Name	Enter the Plant name. This will not be assigned by NERC or the GADS Solar application.
5	EIA Plant Code	Enter the EIA Plant Code of the facility as reported to EIA.
6	ISO Resource ID	If applicable, enter the unique plant identifier assigned by the ISO or RTO.
7	Country	Refer to **Appendix D** and enter the two-letter country abbreviation where the plant is located.
8	Nearest City	Enter the name of the major city closest in proximity to the plant.
9	State /Province	Refer to **Appendix D** and enter the two-letter State/Province abbreviation where the plant, group, or energy storage is located.
10	Time Zone	Refer to **Appendix D** and enter the Time Zone in which data are reported for the plant. This time zone will be used to convert Event Start and End Date/Times to UTC.
11	Plant Location Latitude	Enter the degrees of latitude of the physical location of the plant[5].
12	Plant Location Longitude	Enter the degrees of longitude of the physical location of the plant.
13	Elevation	Enter the elevation of the physical location of the plant, given in meters.
14	Solar Regime Environment	Refer to **Appendix D** and enter the solar regime.
15	Global Horizontal Irradiance (Insolation)	Enter the Annual Average Global Horizontal Irradiance based on local calculations. With new plants, use theoretical data from available design data (generally annual averages over at least five years). Report as kWh/m^2 over the course of a year. For older plants, use on-site connected data (generally annual averages over at least five years). See **Appendix C** for more details and guidelines.
16	Inter-Annual Variance of GHI	Enter the Inter-Annual Variance of GHI, use location-specific data. With new plants, use theoretical data from available design data; for older plants, use on-site connected data.[6]
17	Plant Capacity at POI	Plant Capacity at Point of Interconnection. This is the capacity of the Interconnection agreement or threshold. This capacity differs from installed capacity of equipment reported at the Inverter Group level.
18	On-site connected Energy Storage	Indicate whether the facility has any type of energy storage that is electrically connected to a renewable energy generating facility and installed on-site connected as part of the plant.

[5] The degrees of longitude, latitude, and elevation may be taken anywhere on the site that is meaningful to the reporting entity. This could be the revenue meter, main structure, or geographic center of the Inverter Inventory.

[6] Preferably, five years of data is needed for annual standard deviation of irradiance. GHI- Global Horizontal Irradiance – https://nsrdb.nrel.gov/

Table 3.2: Plant Configuration Record Field Descriptions		
Column	**Field Name**	**Description**
19	Plant Ownership Status	Enter the ownership status of the Plant. Refer to **Appendix D** for ownership status codes or **Appendix E** for more details on ownership status codes. Plant Ownership Status is required for updates to existing configuration data; leave blank for new plants.
20	Plant Effective Date	Enter the effective date of the Plant ownership status being reported. Effective Date is required for updates to existing configuration data; leave blank for new plants.
21	Plant Transfer to Entity ID	Enter the Entity ID of the Entity to which the Plant is being sold. This is a required field when the Plant Ownership Status being reported is "Transfer."

Inverter Group Configuration

An Inverter Group is a collection of solar inverters with the same manufacturer, design, system capacity, model number, and phase of construction. Each Inverter Group will have a unique identifier assigned by NERC through the GADS Solar Reporting application. At least one Inverter Group data is required for each plant.

Table 3.3: Inverter Group Configuration Record Fields				
Column	**Field Name**	**Column Header Label**	**Entry Type**	**Required or Voluntary**
1	Entity ID	EntityID	Alpha-Numeric-10	Required
2	Plant ID	PlantID	Numeric - 10	Required
3	Inverter Group ID	InvGroupID	Numeric - 10	Required
4	Inverter Group Name	InvGroupName	Alpha-Numeric - 45	Required
5	Commissioning Date	InvCommDate	Date (mm-dd-yyyy)	Required
6	Inverter Group Installed Capacity (Single Inverter System Capacity * Number of Inverters) MW	InvGrpInstCapacity	Calculated Field (Numeric - 8 + 2 decimals)	Required
7	Total Number of Inverters for Inverter Group	InverterCount	Numeric - 7	Required
8	Single Inverter System Capacity (MW)	InvSystemMW	Numeric - 3 + 3 decimals	Required
9	Single Inverter AC Nameplate (MW)	InvACCap	Numeric - 3 + 3 decimals	Required
10	Inverter Manufacturer	InvMfr	Alpha-Numeric - 5	Required
11	Inverter Model	InvMdl	Alpha-Numeric - 20	Required
12	SCADA Manufacturer	SCADAMfr	Alpha-Numeric - 5	Required
13	SCADA Model	SCADAMdl	Alpha Numeric - 10	Required
14	DC Input Type	InvDCInputType	Alpha-Numeric - 20	Required
15	Aggregate DC to AC Field Capacity Ratio	InvDCACRatio	Numeric - 2 + 3 decimals	Required
16	Panel Tracking Type	InvPanelTracking	Alpha-Numeric - 20	Required
17	Panel Tilt Angle (degrees)	InvPanelTilt	Numeric - 3	Required
18	Minimum Irradiance (W/m^2)	InvMinIrradiance	Numeric - 4	Required
19	Stowing Wind Speed (m/s)	InvStowingSpd	Numeric - 2	Conditionally Required
20	Minimal Operating Temperature (C)	InvMinOpTemp	Numeric - 3	Required
21	Maximum Operating Temperature (C)	InvMaxOpTemp	Numeric - 3	Required

Table 3.3: Inverter Group Configuration Record Fields				
Column	**Field Name**	**Column Header Label**	**Entry Type**	**Required or Voluntary**
22	Temperature Coefficent (%/degree C)	InvTempCoeff	Numeric - 1 + 3 decimals	Required
23	Nameplate Panel Efficiency (%)	InvPanelEff	Numeric – 2 + 2 decimals	Required
24	Inverter Ownership Status	InverterOwnStatus	Alpha-Numeric - 2	Required
25	Inverter Effective Date	InvStatusEffDate	Date (mm/dd/yyyy)	Required
26	Inverter Transfer to Entity ID	InvTransfertoEntity	Alpha-Numeric - 10	Conditionally Required

Table 3.4: Inverter Group Configuration Record Field Descriptions		
Column	**Field Name**	**Description**
1	Entity ID	Enter the NERC Compliance Registry ID number (NCR ID) or voluntary reporting ID assigned by NERC of the organization that operates the Solar plant.
2	Plant ID	Enter the Plant ID assigned by the GADS Solar application.
3	Inverter Group ID	Enter the Inverter Group ID assigned by the GADS Solar application.
4	Inverter Group Name	Enter the Inverter Group name. This will not be assigned by NERC or the GADS Solar application.
5	Commissioning Date	Enter the date (MM/DD/YYYY) that the Inverter Group was commissioned.
6	Inverter Group Installed Capacity (MW)	Enter the total capacity for the Inverter Group, in megawatts (MW). The Inverter Group Capacity is equal to the ***Number of Inverters*** multiplied by the applicable ***Single Inverter System Capacity*** MW.
7	Number of Inverters in the Inverter Group	Enter the number of physical inverters in the Inverter Group.
8	Single Inverter System Capacity (MW)	The System MW rating of the Inverter. This includes temperature set points and other internal inverter limits as the site is set up. All inverters in the inverter group are required to be the same manufacturer, model, design, version, and AC capacity.
9	Single Inverter AC Nameplate (MW)	The AC nameplate capacity assigned to a single inverter in the Inverter Group by the manufacturer.
10	Inverter Manufacturer	Refer to **Appendix D** and enter the abbreviation for the name of the manufacturer of the inverters in the Inverter Group.
11	Inverter Model	Enter the model of the inverters in the Inverter Group. Enter zero (0) if model version is not applicable.
12	SCADA Manufacturer	Refer to **Appendix D** and enter the abbreviation for the manufacturer of the SCADA system used for the Inverter Group. Values reported to NERC should match any values that are also reported to other agencies such as the EIA, EPA, etc.
13	SCADA Model	Enter the model of the SCADA system for the Inverter Group.
14	DC Input Type	This selection defines whether the inverters are powered by solar PV alone (PV), solar PV with Energy Storage system (battery) (PVES), or Energy Storage system (battery) alone (ES). Refer to **Appendix F** for more details.
15	DC to AC Field Capacity Ratio	Average ratio of DC to AC capacity for individual inverters in the inverter group.
16	Panel Tracking	Enter the Panel Tracking type from **Appendix D**.

Table 3.4: Inverter Group Configuration Record Field Descriptions		
Column	**Field Name**	**Description**
17	Panel Tilt Angle	Enter the Panel Tilt Angle, given in whole degrees. (applies to fixed or single axis)
18	Minimum Irradiance (W/m^2)	Enter the minimum irradiance to cause a single inverter to start producing (W/m^2) (i.e., what is the Plane of Array minimum irradiance for the inverter group to be considered "on" at standard temperature?)
19	Stowing Wind Speed (m/s)	Wind speed at which the positioning mechanisms set the panels into a safety position. Not required if panels are fixed.
20	Minimal Operating Temperature (C)	Enter the manufacturer's minimum operating temperature in degrees Celsius.
21	Maximum Operating Temperature (C)	Enter the manufacturer's maximum operating temperature in degrees Celsius.
22	Temperature Coefficient	Average correction factor of all panels in the Inverter Group; the percent temperature output adjustment from manufacturer's Standard Test Condition (STC) panel output (%/degree C).
23	Nameplate Panel Efficiency (%)	Average of nameplate efficiency of all panels in the Inverter Group to convert light energy into electrical energy as defined on the nameplate of panel.
24	Inverter Ownership Status	Enter the ownership status of the Inverter Group. See **Appendix D** for ownership status codes or **Appendix E** for more details on ownership status codes.
25	Inverter Effective Date	Enter the effective date of the Inverter Group ownership status being reported.
26	Inverter Transfer to Entity ID	Enter the Entity ID of the Entity to which the Inverter Group is being sold. This is a required field when the Group Ownership Status being reported is "Transfer."

Energy Storage Group Configuration

An Energy Storage Group is a collection of energy storage equipment with the same manufacturer, design, system capacity, model number, and phase of construction. Each Energy Storage Group will have a unique identifier assigned by NERC through the GADS Solar Reporting application. Monthly performance data are reported for on-site connected Energy Storage.

Table 3.5: Energy Storage Group Configuration Record				
Column	**Field Name**	**Column Header Label**	**Entry Type**	**Required or Voluntary**
1	Entity ID	EntityID	Alpha-Numeric-10	Required
2	Plant ID	PlantID	Numeric - 10	Required
3	Energy Storage Group ID	StorageGroupID	Numeric - 10	Required
4	Energy Storage Group Name	StorageGroupName	Alpha-Numeric - 45	Required
5	Energy Storage Group EIA Code	StorageEIACode	Numeric – 6	Required
6	Energy Storage Group ISO ID	StorageISORID	Alpha-Numeric - 30	Voluntary
7	Energy Storage Type	StorageType	Alpha-Numeric - 20	Required
8	Energy Storage Capacity (MW) (Nameplate Capacity)	StorageCap	Numeric - 4 + 2 decimals	Required
9	Energy Storage (MWh) (Nameplate Energy Capacity)	StorageEnergy	Numeric - 5 + 2 decimals	Required
10	Energy Storage Connection (AC or DC)	StorageConnType	Alpha-Numeric - 2	Required

Table 3.5: Energy Storage Group Configuration Record				
Column	**Field Name**	**Column Header Label**	**Entry Type**	**Required or Voluntary**
11	Energy Storage Chargeable from Grid (Yes/No)	GridCharge	Yes/No	Required
12	Energy Storage Manufacturer	StorageManuf	Alpha-Numeric - 5	Required
13	Energy Storage Model	StorageModl	Alpha-Numeric - 20	Required
14	Storage Group Commissioning Date	StorageCommDate	Date (mm/dd/yyyy)	Required
15	Energy Storage Inverter Manufacturer	StorageInvManuf	Alpha-Numeric - 5	Required
16	Energy Storage Inverter Model	StorageInvModel	Alpha-Numeric - 20	Required
17	Storage Group Ownership Status	StorageOwnStatus	Alpha-Numeric - 2	Required
18	Storage Group Effective Date	StorageStatusEffDate	Date (mm/dd/yyyy)	Required
19	Storage Group Transfer to Entity ID	StorageTrfrtoEntity	Alpha-Numeric - 10	Conditionally Required

Table 3.6: Energy Storage Group Configuration Record Field Descriptions		
Column	**Field Name**	**Description**
1	Entity ID – NCR Number	Enter the NERC Compliance Registry ID number (NCR ID) or voluntary reporting ID assigned by NERC of the organization that operates the Solar plant and associated energy storage.
2	Plant ID	Enter the Plant ID assigned by the GADS Solar application.
3	Energy Storage Group ID	Enter the Energy Storage Group ID assigned by the GADS Solar application.
4	Energy Storage Group Name	Enter the Energy Storage Group name. This will not be assigned by NERC or the GADS Solar application.
5	Energy Storage Group EIA Code	Enter the EIA Plant Code for the Energy Storage Group as reported to EIA.
6	Energy Storage Group ISO ID	If applicable, enter the unique plant identifier assigned by the ISO or RTO.
7	Energy Storage Type	Enter the storage type from **Appendix D**.
8	Energy Storage Capacity (MW) (Nameplate Capacity)	Enter the energy storage capacity (MW) recorded at the inverter boundary (usually the revenue meter). This is the recorded nameplate capacity of the energy storage group.
9	Energy Storage MWh (Nameplate Energy Capacity)	Enter the actual generating capability (MWh) at the inverter boundary. This is equal to the installed capacity less any electrical losses such as transformation losses, line losses, and other losses due to transmission between the inverter and the revenue meter.
10	Energy Storage Connection	Refer to **Appendix D** and enter the Energy Storage Connection type that indicates whether the Energy Storage module is behind the inverter (DC) or between the inverter and grid connection (AC).
11	Energy Storage Chargeable from Grid	Indicate whether the Energy Storage Group may be charged from the grid.
12	Energy Storage Manufacturer	Refer to **Appendix D** and enter the abbreviation for the name of the manufacturer of the energy storage equipment in the Energy Storage Group; the company compiling the energy storage system.
13	Energy Storage Model	Enter the model of the energy storage equipment in the Energy Storage Group. Enter zero (0) if model version is not applicable.

Table 3.6: Energy Storage Group Configuration Record Field Descriptions		
Column	**Field Name**	**Description**
14	Storage Group Commissioning Date	Enter the date (MM/DD/YYYY) that the Energy Storage Group was commissioned.
15	Energy Storage Inverter Manufacturer	Refer to **Appendix D** and enter the abbreviation for the name of the manufacturer of the Inverter at the Energy Storage level.
16	Energy Storage Inverter Model	Enter the model of the energy storage Inverter in the Energy Storage Group. Enter zero (0) if model version is not applicable.
17	Storage Group Ownership Status	Enter the ownership status of the Energy Storage Group. See **Appendix D** for ownership status codes or **Appendix E** for more details on ownership status codes.
18	Storage Group Effective Date	Enter the effective date of the Energy Storage Group ownership status being reported.
19	Storage Group Transfer to Entity ID	Enter the Entity ID of the Entity to which the Energy Storage Group is being sold. This is a required field when the Group Ownership Status being reported is "Transfer."

Chapter 4: Performance Reporting

Performance data provides inverter group and energy storage group information pertaining to operations during a given month. These data are used to calculate performance, reliability, and availability statistics. Performance data are required.

For purposes of GADS Solar reporting, any IEEE 762 references to “group” in this section will be reported for the Inverter Group.

When to Report Performance Data

Performance data is summarized at the monthly level and required quarterly within 45 days of the end of the quarter.

Monthly performance data will be required beginning with the third full month after COD, acquisition, or repowering. If a reportable event occurs after the Commercial Operation date, it must be reported, regardless of whether monthly performance reporting has begun.

Inverter Group Performance Record

Table 4.1: Inverter Group Performance Record Fields

Column	Field Name	Column Header Label	Entry Type	Required or Voluntary
1	Entity ID	EntityID	Numeric - 10	Required
2	Plant ID	PlantID	Numeric – 10	Required
3	Inverter Group ID	GroupID	Numeric - 10	Required
4	Report Period (month)	ReptMonth	Numeric - 2	Required
5	Report Year	ReptYear	Numeric - 4	Required
6	Inverter Group Availability Status	InvAvailStatus	Alpha-Numeric - 2	Required
7	Gross Actual Generation (GAG) (MWh)	GAG	Numeric - 12 + 2 decimals	Required
8	Net Actual Generation (NAG) (MWh)	NAG	Numeric - 12 + 2 decimals	Required
9	Net Maximum Capacity (NMC) (MW)	NMC	Numeric - 5 + 3 decimals	Required
10	Monthly Plane of Array (MWh/m^2)	MPOA	Numeric - 3 + 3 decimals	Required
11	Performance Ratio	PerfRatio	Numeric - 1 + 3 decimals	Required
12	Expected Generation (MWh)	EG	Numeric - 12 + 2 decimals	Required
13	Active Solar Inverter Hours	ASIH	Numeric - 7 + 2 decimals	Required
14	Active Inverter Hours	AIH	Numeric - 7 + 2 decimals	Required
15	Inactive Reserve Inverter Hours	IRIH	Numeric - 7 + 2 decimals	Required
16	Mothballed Inverter Hours	MBIH	Numeric - 7 + 2 decimals	Required
17	Retired Unit Inverter Hours	RIH	Numeric - 7 + 2 decimals	Required
18	Service Inverter Hours Day	SIHD	Numeric - 7 + 2 decimals	Required
19	Reserve Shutdown Inverter Hours	RSIH	Numeric - 7 + 2 decimals	Required
20	Forced Outage Inverter Hours Day	FOIHD	Numeric - 7 + 2 decimals	Required
21	Maintenance Inverter Hours Day	MIHD	Numeric - 7 + 2 decimals	Required
22	Planned Inverter Hours Day	PIHD	Numeric - 7 + 2 decimals	Required
23	Resource Unavailable Inverter Hours - Day	RUIHD	Numeric - 7 + 2 decimals	Required
24	Service Inverter Hours Night	SIHN	Numeric - 7 + 2 decimals	Required
25	Forced Outage Inverter Hours Night	FOIHN	Numeric - 7 + 2 decimals	Required

Table 4.1: Inverter Group Performance Record Fields				
Column	**Field Name**	**Column Header Label**	**Entry Type**	**Required or Voluntary**
26	Maintenance Inverter Hours Night	MIHN	Numeric - 7 + 2 decimals	Required
27	Planned Inverter Hours Night	PIHN	Numeric - 7 + 2 decimals	Required
28	Resource Unavailable Inverter Hours - Night	RUIHN	Numeric - 7 + 2 decimals	Required

Table 4.2: Inverter Group Performance Record Field Descriptions		
Column	**Field Name**	**Description**
1	Entity ID	Enter the NERC Compliance Registry ID number (NCR ID) or voluntary reporting ID assigned by NERC of the organization that operates the Solar plant.
2	Plant ID	Enter the Plant ID assigned by the GADS Solar application. This is assigned in the Plant Configuration.
3	Inverter Group ID	Enter the Inverter Group ID assigned by the GADS Solar application.
4	Report Period (month)	Enter the two-digit month (MM) for which the performance data is being reported. See **Appendix D**.
5	Report Year	Enter the four-digit year (YYYY) for which the performance data is being reported.
6	Inverter Group Availability Status	Select the status of the entire group during the period for which the data is being reported. See **Appendix D**.
7	Gross Actual Generation (GAG) (MWh)	Enter the total energy generated at the Inverter Group level (MWh). This is the sum of the AC inverter outputs for the group.
8	Net Actual Generation (NAG) (MWh)	Enter the net generation (MWh) recorded at the inverter boundary (usually the revenue meter). It is possible to have a negative net actual generation value if the group's station service or auxiliary loads are greater than total generation.
9	Net Maximum Capacity (NMC) (MW)	Enter the Maximum AC generating capability at the inverter boundary. This is equal to the installed capacity less any electrical losses such as transformation losses, line losses, and other losses due to transmission between the inverter and the revenue meter.
10	Monthly Plane of Array (MWh/m^2) (MPOA)	Enter the Monthly Plane of Array (MWh/m^2) value of solar radiation
11	Performance Ratio	Enter the Performance Ratio for the month. This is calculated using DC Capacity (DC Nameplate rating) power capability and actual AC power delivered from the inverter, along with adjustments for measured Plane of Array Irradiance power degradation, Inverter efficiency, and module temperature corrections.[7]
12	Expected Generation (MWh)	Enter the expected generation (MWh) expected at the data point level and rolled up to the inverter group for the reporting period. This is based on solar-day hours[8] and daily energy produced per hour, summed up for the month.

[7] Performance Ratio is based on the NREL Weather Corrected Performance ratio and IEC 61724 [1]. While the NREL paper recommends Flash Point Data for DC Capacity, the DC Nameplate Rating is more commonly known.
[8] See Glossary for definition of solar-day hours.

Table 4.2: Inverter Group Performance Record Field Descriptions		
Column	**Field Name**	**Description**
13	Active Solar Inverter Hours (Day) (ASIH)	Enter the number of inverter hours (number of inverters times number of hours) from Sunrise to Sunset during the month being reported.[9] This sum is across all inverters in the Inverter Group.
14	Active Inverter Hours (AIH)	Enter the number of inverter hours (number of inverters times number of hours) that the inverter group is in the active state. AIH for GADS Solar reporting purposes refers to the number of inverter hours during the month being reported.
15	Inactive Reserve Inverter Hours (IRIH)	Total number of inverter hours (number of inverters times number of hours) that the inverter group is in the inactive reserve state during the month being reported. (Inactive)
16	Mothballed Inverter Hours (MBIH)	Total number of inverter hours (number of inverters times number of hours) that the inverter group is in the mothballed state during the month being reported. (Inactive)
17	Retired Unit Inverter Hours (RIH)	Total number of inverter hours (number of inverters times number of hours) that the inverter group is in a permanently retired state during the month being reported. (Inactive)
18	Service Inverter Hours Day (SIHD)	Enter the number of inverter hours (number of inverters times number of hours) the inverter group is synchronized to the grid (in service) during daytime hours for the month being reported.
19	Reserve Shutdown Inverter Hours (RSIH)	Enter the number of inverter hours (number of inverters times number of hours) that the inverter group is off-line for economic reasons but available for service during daytime hours for the month being reported. If the inverter group is not available due to an outage condition, it is not a reserve shutdown.
20	Forced Outage Inverter Hours Day (FOIHD)	Enter the number of inverter hours (number of inverters times number of hours) that the inverter group is off-line due to forced events during daytime hours for the month being reported. FIH are all forced events where the Inverter group must be removed from service for repairs before the next Sunday at 23:59 (just before Sunday becomes Monday).
21	Maintenance Inverter Hours Day (MIHD)	Enter the number of inverter hours (number of inverters times number of hours) that the inverter group is off-line due to a maintenance event during daytime hours for the month being reported. The inverter group must be capable of running until the following week. If the outage occurs on the weekend, the inverter must be capable of running through the following week.
22	Planned Inverter Hours Day (PIHD)	Enter the number of inverter hours (number of inverters times number of hours) that the inverter group is off-line due to a planned event during daytime hours for the month being reported. A PIHD event is scheduled well in advance and is of a predetermined duration and can occur several times a year.

[9] Sunrise and sunset as defined for plant location by the National Oceanic and Atmospheric Administration: www.noaa.gov

Table 4.2: Inverter Group Performance Record Field Descriptions		
Column	**Field Name**	**Description**
23	Resource Unavailable Inverter Hours – Day (RUIHD)	The number of inverter hours (number of inverters times number of hours) that the inverters are available but not producing electricity for environmental conditions that are outside the operating specifications of the Solar inverter, during daytime hours for the month being reported (i.e., low / high Solar and includes normal systems checks and calibrations). The system is delivering no electricity.
24	Service Inverter Hours Night (SIHN)	Enter the total number of inverter hours (number of inverters times number of hours) the inverter group is synchronized to the system (in service) between sunset of the current day and sunrise of the next day for the month being reported. It is the inverter hours that the main breaker is closed, and generation is provided to the grid.
25	Forced Outage Inverter Hours Night (FOIHN)	Enter the total number of inverter hours (number of inverters times number of hours) that the inverter group is off-line due to forced events between sunset of the current day and sunrise of the next day for the month being reported. FOIHN are all forced events where the Inverters must be removed from service for repairs before the next Sunday at 23:59 (just before Sunday becomes Monday).
26	Maintenance Inverter Hours Night (MIHN)	Enter the total number of inverter hours (number of inverters times number of hours) that the inverter group is off-line due to a maintenance event between sunset of the current day and sunrise of the next day for the month being reported. The inverters must be capable of running until the following week. If the outage occurs on the weekend, the inverter must be capable of running through the following week.
27	Planned Inverter Hours Night (PIHN)	Enter the number of inverter hours (number of inverters times number of hours) that the inverter group is off-line due to a planned event between sunset of the current day and sunrise of the next day for the month being reported. A PIHN event is scheduled well in advance and is of a predetermined duration and can occur several times a year.
28	Resource Unavailable Inverter Hours – Night (RUIHN)	The total number of Inverter hours (number of inverters times number of hours) between sunset of the current day and sunrise of the next day for the month being reported, that the inverters are available, but not producing electricity for environmental conditions that are outside the operating specifications of the Solar inverter.

Energy Storage Performance Record

Energy Storage Group performance data provides information pertaining to Energy Storage Group operations during a given month. Performance data are required for all energy storage groups.

Table 4.3: Energy Storage Performance Record				
Column	**Field Name**	**Column Header Label**	**Entry Type**	**Required or Voluntary**
1	Entity ID	EntityID	Alpha-Numeric-10	Required
2	Plant ID	PlantID	Numeric - 10	Required
3	Energy Storage Group ID	GroupID	Numeric - 10	Required
4	Report Period (month)	ReptMonth	Numeric - 2	Required
5	Report Year	ReptYear	Numeric - 4	Required
6	Storage Group Availability Status	SGAvailStatus	Alpha-Numeric - 2	Required
7	Charge Generation (MWh)	ChgMWh	Numeric - 10	Required
8	Discharge Generation (MWh)	DischgMWh	Numeric - 10	Required
9	Charging Hours	ChgHrs	Numeric - 3 + 2 decimals	Required
10	Discharging Hours	DisChgHrs	Numeric - 3 + 2 decimals	Required
11	Forced Outage Hours	StorageFOH	Numeric - 3 + 2 decimals	Required
12	Maintenance Outage Hours	StorageMOH	Numeric - 3 + 2 decimals	Required
13	Planned Outage Hours	StoragePOH	Numeric - 3 + 2 decimals	Required

Table 4.4: Energy Storage Performance Record Field Descriptions		
Column	**Field Name**	**Description**
1	Entity ID	Enter the NERC Compliance Registry ID number (NCR ID) or voluntary reporting ID assigned by NERC of the organization that operates the Solar plant.
2	Plant ID	Enter the Plant ID assigned by the GADS Solar application. This is assigned in the Plant Configuration.
3	Energy Storage Group ID	Enter the Energy Storage Group ID assigned by the GADS Solar application.
4	Report Month (month)	Enter the two-digit month (MM) for which the performance data is being reported. See **Appendix D**.
5	Report Year	Enter the four-digit year (YYYY) for which the performance data is being reported.
6	Storage Availability Status	Select the status of the entire group for the month being reported. See **Appendix D.**
7	Charge Generation (MWh)	Enter the MWh of charge to the Energy Storage Group for the month being reported.
8	Discharge Generation (MWh)	Enter the MWh of discharge from the Energy Storage Group for the month being reported.
9	Charging Hours	Enter the number of charging hours to the Energy Storage Group for the month being reported.
10	Discharging Hours	Enter the number of discharge hours from the Energy Storage Group for the month being reported.
11	Forced Outage Hours	Enter the number of hours that the Energy Storage Group is in a Forced Outage State.
12	Maintenance Outage Hours	Enter the number of hours that the Energy Storage Group is in a Maintenance Outage State
13	Planned Outage Hours	Enter the number of hours that the Energy Storage Group is in a Planned Outage State.

Chapter 5: Event Reporting

Event Detail Reporting

Event Detail reporting is used to identify outages that are impactful to the grid. Events are reported at the Plant level. Event Detail reporting is required for all plants.

Outages start when they are known to start and end when they are known to end. If equipment goes out overnight, but do not know it until sunrise because power is not being delivered, then report the event start at sunrise. If there is an indication that equipment went out at a certain time overnight, then report that time as the event start.

When to Report Event Data

Event data is reported on the same schedule as performance data: within 45 days of the end of each quarter.

For newly commissioned, acquired, or repowered plants: if an event that meets the Event Criteria below occurs after the Commercial Operation or acquisition date of the plant or portion of the plant, it must be reported within 45 days of the end of the quarter in which it occurred, regardless of whether monthly performance reporting has begun.

Event Criteria

Event Start:

An event starts when there is a loss of at least 20 MW of Plant Total Installed Capacity due to a forced outage. [10,11]

Event End:

95% of the Plant Total Installed Capacity that was unavailable due to the forced outage event has been returned to service.

AND

Less than 20 MW of Plant Total Installed Capacity is unavailable due to a forced outage.

Plant Event Record

Table 5.1: Plant Event Record Fields

Column	Field Name	Column Header Label	Entry Type	Required or Voluntary
1	Entity ID	EntityID	Alpha-Numeric-10	Required
2	Plant ID	PlantID	Numeric - 10	Required
3	Event ID	EventID	Alpha-Numeric-20	Required
4	Time Zone	TimeZone	Alpha-3	Required
5	Event Start Date/Time	StartDT	mm/dd/yyyy HH:MM	Required
6	Event End date/Time	EndDT	mm/dd/yyyy HH:MM	Required
7	Event Type	EventType	Alpha-Numeric-10	Required
8	Cause Code	CauseCode	Numeric - 5	Required
9	Contributing Operating Condition	Condition	AlphaNumeric – 1	Required

[10] Reduction in Plant Total Installed Capacity due to reserve shutdown, planned outages, and maintenance outages are not considered part of forced outages.

[11] Changes in generating efficiency, such as those due to dust accumulation, are not considered outages. This does not include equipment loss due to similar factors. For example, if a group of panels is only able to produce at 80% efficiency due to dust accumulation, that would not be reportable. If an inverter must shut down due to overheating because of dust accumulation, it would be reportable.

Table 5.1: Plant Event Record Fields				
Column	**Field Name**	**Column Header Label**	**Entry Type**	**Required or Voluntary**
10	Description	Description	Alpha-Numeric-500	Voluntary
11	Potential MWh Production loss	MWHLoss	Numeric - 10	Required

Table 5.2: Plant Event Record Field Descriptions		
Column	**Field Name**	**Description**
1	Entity ID	Enter the NERC Compliance Registry ID number (NCR ID) or voluntary reporting ID assigned by NERC of the organization that operates the Solar plant.
2	Plant ID	Enter the Plant ID assigned by the GADS Solar application. This is assigned in the Plant Configuration.
3	Event ID	Enter a unique identification for the event
4	Time Zone	Refer to **Appendix D** and enter the Time Zone in which data are reported for the plant. This time zone will be used to convert Event Start and End Date/Times to UTC.
5	Event Start Date/Time	Identify the time of the Event Start (mm/dd/yyyy HH:MM) (24-hour clock used)
6	Event End Date/Time	Identify the time of the end of the Event (mm/dd/yyyy HH:MM) (24-hour clock used)
7	Event Type	Enter the type of Event (Forced, Maintenance, Planned)
8	Cause Code	Enter the cause for the outage. See **Appendix K** for a complete list of the cause codes and descriptions. Generally, this is the equipment that went out during the event. If equipment was pre-emptively shut down in preparation for a storm to protect the equipment, enter the storm cause code and Contributing Operating Condition. If a storm damaged equipment, enter the equipment damaged in the Cause Code and enter Storm in Contributing Operating Condition.
9	Contributing Operating Condition	Enter the underlying environment. See **Table 5.3** for a complete list of Contributing Operating Conditions. Such as Storm, Flood, Cold Weather.
10	Description	Describe the Event in more detail to allow comparison to similar events.
11	Potential MWh Production Loss	Enter the number of Potential MWh loss during the duration of the event. This is the sum of the capacity lost due to forced outage(s) in all intervals during the event period. See the Potential Production MWH Loss section below for a description of this field.

Guidelines for Determining Event Start and End Times

Events start when they are known to start and end when they are known to end. For example, if a plant is not generating energy after sunrise, the event is known to start when the operator becomes aware that the plant is not producing, since equipment may have been out overnight at an undetermined time. However, if equipment shows a fault time when the equipment went out, then that is when the event is known to start. Similarly, if equipment is fixed overnight, then the event ends at the time the equipment is fixed.

Event Cause Codes

Cause codes indicate the equipment that has caused the outage. This could be equipment related or personnel related.

For events with multiple causes the most impactful code should be identified as the primary cause, with any other causes reported as secondary.

A list of Cause Codes can be found in **Appendix K.**

Contributing Operating Condition

The Contributing Operating Condition is a required field for event reporting. It provides context for the conditions that led to the event or outage. The Contributing Operating Condition field will be used in analysis of events to distinguish the failure mode ("what failed") from the failure mechanism ("conditions under which it failed"). The Contributing Operating Condition does not take the place of the Cause Code but complements the overall detail and cause of the event.

Table 5.3: Contributing Operating Condition (Required)

Contributing Operating Condition	Code	Description
No Contributing Condition*	0	Outage or damage that occurred during normal operating ("blue-sky") conditions without external influence.
Flood or High Water	1	Outage or damage occurred that is determined to be outside of design considerations due to flooding or high-water that occurs due to a natural or man-made event. This includes pre-emptive actions as well.
Drought or Low Water	2	Outage or damage occurred due to drought or low-water conditions that are determined to be outside of design considerations and that occurs due to a natural or man-made event.
Fire, including wildfires	3	Outage or damage occurred due to fire that occurs due to a natural or man-made event or equipment that gets involved from a fire initiated from another system in the plant. This includes pre-emptive actions as well.
Lightning	4	Outage or damage occurred due to lightning striking the equipment during a thunder and lightning storm.
Geomagnetic Disturbance	5	Outage or damage occurred due to a geomagnetic disturbance. This includes pre-emptive actions as well.
Earthquake	6	Outage or damage occurred due to an earthquake.
Tornado	7	Outage or damage occurred due to a tornado. This includes pre-emptive actions as well.
Hurricane	8	Outage or damage occurred due to a hurricane. This includes pre-emptive actions as well.
Cold Weather Conditions	9	Outage or damage occurred due to cold.
Hot Weather Conditions	A	Outage or damage occurred due to heat.
Ice, Hail, and/or Snow	B	Outage or damage occurred due to hail, ice and/or snow accumulation.
Turbulent Wind	C	Outage or damage occurred due to abnormally turbulent winds.
Avalanche or Landslide	D	Outage or damage occurred due to an avalanche or landslide.
State of Emergency declared by applicable authority or Other External Disturbance	Z	Outage or damage occurred due to state of emergency declared by applicable authority or other external disturbance.

When more than one Contributing Operating Condition can be assigned for a single cause, report the most impactful Contributing Operating Condition. If multiple causes are reported, the most impactful Contributing Operating Condition for each cause should be selected.

Examples of the application of the Contributing Operating Condition Code field

No Contributing Condition (Code 0)

- During normal operations on a fair-weather day, the generator experiences a spontaneous failure due to excessive wear and tear.

Flood or High Water (Code 1)

- Due to flood or extreme rain conditions, a settling pond at a power plant is threatening to spill over and the plant must be derated (or shut down) to prevent a pond failure.
- A system delivers excessive rain that causes containment systems (such as transformer oil containment basins, plant drain systems, emission management chemical, etc.) to exceed their capacity and the output of a unit is impacted until the containment system can be safely managed again.

Drought or Low Water (Code 2)

- Dust storm causes panel contamination decreasing plant output by 60%

Fire, including wildfires (Code 3)

- A solar site experiences an electrical fault that sparks a grass fire at the facility. The solar site is removed from service to address the spreading grass fire.
- Ash panel contamination from a forest fire decreases solar plant output by 20%
- A plant shut down due to fire prevention during high wind / low humidity conditions in forested areas.
- During a thunder and lightning storm in the area, dispatch directs that the plant be removed from service so a transmission line can be de-energized to proactively address possible fire ignition from the transmission lines. (The root cause of the shutdown is to prevent fire.)

Lightning (Code 4)

- Preemptive shutdown to prevent damage from large hail. Panels positioned vertically.
- During a thunder and lightning storm, a unit tripped offline due to a relay operation. The unit is cleared for return to service relatively quickly as no damage to the unit or to other plant equipment has occurred.
- During a thunder and lightning storm, a pole fire is started on a structure within the plant switchyard. The pole fire caused the plant to be taken offline.

Geomagnetic Disturbance (Code 5)

- Preemptive shutdown of generating units due to a large X-class earth directed solar flare. These types of flares can cause large current excursions on transmission lines, burning out connected equipment.

Earthquake (Code 6)

- Substation and pad mount transformers moved off their concrete pads. Some high voltage connections were damaged.
- After an earthquake, the batteries for the DC system have moved causing a partial loss of DC power that requires a shutdown to correct.

Tornado (Code 7)

- Tornado cuts through a solar plant, destroying panels.
- Equipment at a plant is damaged by the tornado or by debris from the tornado.

Hurricane (Code 8)

- Heavy rains from a hurricane residual cause flooding or other damage that floods the area and damages plant equipment and requires a derate or shutdown.

Cold Weather Conditions (Code 9)

- Freezing rain at a solar plant prevents the panels from tracking properly.

Hot Weather Conditions (Code A)

- The ambient temperatures at a solar plant exceed the panel design limits resulting in unit shutdowns.
- High ambient temperatures and high generation result in derated output to prevent GSU overheating.

Ice, Hail, or Snow (Code B)

- Freezing rain causes overhead gen tie lines to gallop causing line slaps. Due to a large amount of snow, it took several weeks to manually reset all the units.
- An outage occurs and due to road conditions, the workers are unable to arrive for two days to perform corrective actions and return the unit to service.

Turbulent Wind (Code C)

- A solar plant stows panels to prevent damage from blowing sand and debris.
- During severe winds, a trampoline from a nearby house is picked up, and blown onto the plant switchyard bus, causing a fault, and prohibiting a unit from connecting to the grid.

Avalanche or Landslide (Code D)

- An avalanche from a nearby hill or mountain damages the GSU, forcing the plant offline until the debris is cleared and repairs are made.

State of Emergency declared by applicable authority or Other External Disturbance (Code Z)

- Any event where a governing authority intervenes with orders that require a unit or a plant to be shutdown.
- A multiple vehicle accident occurs on a highway where transmission lines are involved. Governmental authorities require the transmission lines be de-energized, and that requires the plant to be shut down as well.
- During an epidemic, plant staffing is impacted such that a minimal staff can no longer be maintained, and a plant must be shutdown.
- A transportation labor strike occurs, impacting the company’s ability to acquire fuel.

Potential Production MWH Loss

The sum of the capacity lost due to forced outage(s) in all intervals during the event period - the MW loss during an interval multiplied by the duration of an interval, shown as the green-shaded area in the figure below. The duration of the interval used to calculate Potential Production MWH Loss should be at the finest granularity available, the maximum observation interval should not exceed 5 minutes.

Examples

In **Figure 5.1** below, the Plant Total Installed Capacity is 100 MW. The event starts when there is a 20 MW difference between Plant Total Installed Capacity (100 MW) and Plant Available Installed Capacity (80 MW). The event reaches its Nadir (Minimum Plant Available Installed Capacity for event) at a loss of 25 MW. The event ends when 95% of the Plant Total Installed Capacity that was unavailable at time of the Nadir (25 MW) has been returned to service, which in this example is 98.75 MW.

The calculations for this event are as follows.

Event start: Plant Total Installed Capacity (100 MW) – Start Plant Available Installed Capacity (80 MW) = 20 MW

Event Nadir: Minimum Plant Available Installed Capacity for event = 25 MW

Event End: End Plant Available Installed Capacity = Plant Total Installed Capacity (100 MW) - (Minimum Plant Available Installed Capacity (25 MW * (1 – 0.95)) = 98.75 MW

End Plant Available Installed Capacity = 100 – (25 * 0.05) = 98.75

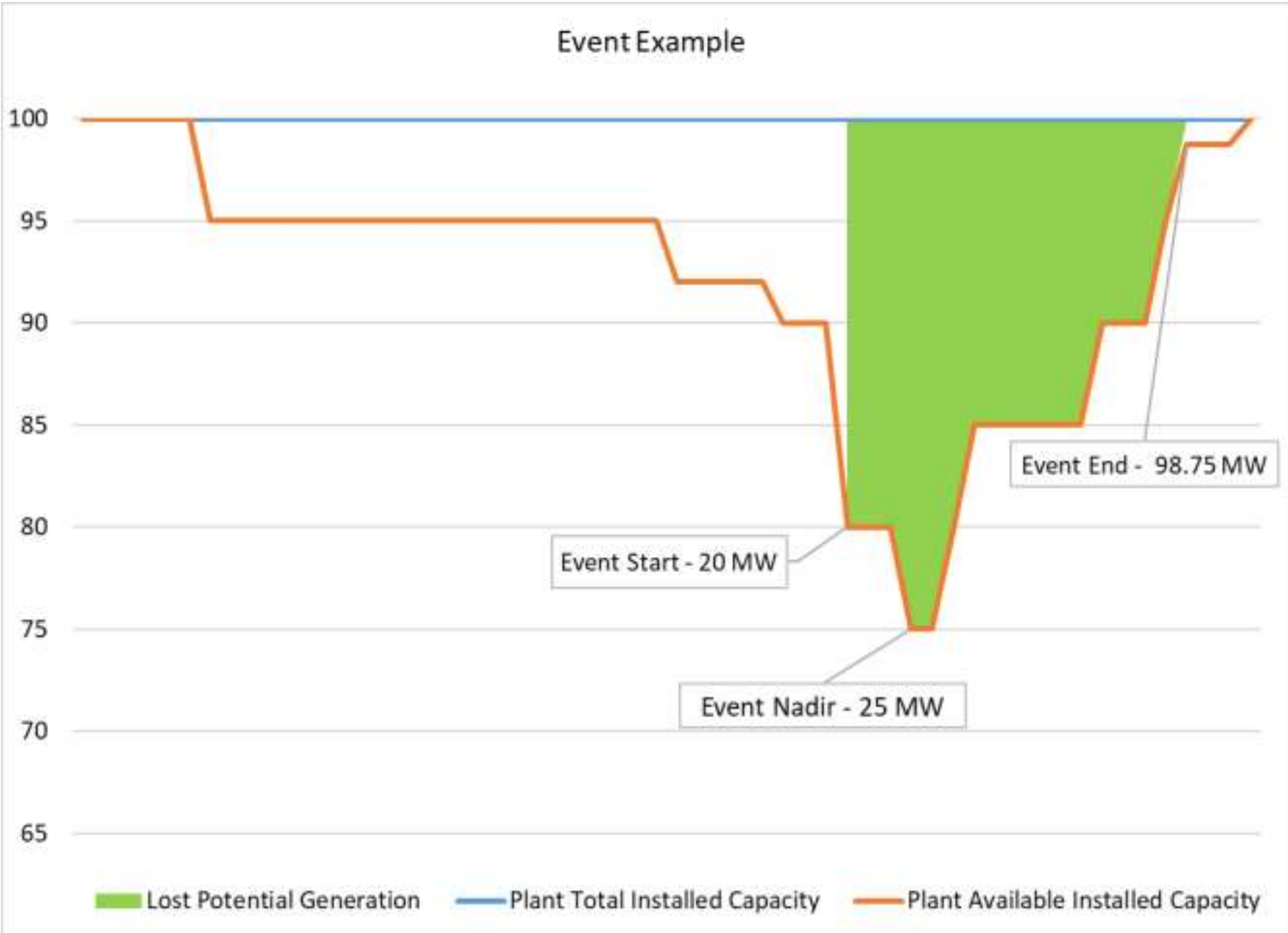


Figure 5.1: Event Example

Appendix A: GADS Solar Reporting Application Data Release Guidelines

Data reported to NERC via a Section 1600 Data Request of the NERC Rules of Procedure will be treated as confidential in accordance with Section 1500 of the NERC Rules of Procedure. Data may be reported publicly in aggregate or otherwise anonymized form to preserve confidentiality.

Appendix B: Entity and Inverter Group Identification

Entity Identification

Each entity that reports data into the GADS Solar application will be required to use its NERC Compliance Registry number (NCR #), regardless of whether it is reporting into the GADS Solar Reporting application on a required or voluntary basis. Entities that wish to voluntarily provide Solar data must ID request a voluntary reporting ID from NERC.

Getting an Entity Registration ID

NERC Compliance Registry – required for all entities with NERC compliance obligations.
The process for requesting a NERC Compliance Registry number is available on NERC's website at: http://www.nerc.com/pa/comp/Pages/Registration.aspx (Refer to *Registration Process Documents*)

Entities without a NERC compliance obligation
Entities that do not have a NERC Compliance obligation and wish to provide Solar data on a voluntary basis must request a voluntary reporting ID through the automated request ID process at:
https://gadsSolar.nerc.net/VRRequest.aspx

Note: An entity that has an NCR number may not use a voluntary reporting ID to report into the GADS Solar application. When an entity that has a voluntary reporting ID registers for a NERC Compliance Registry number, it must notify NERC of its NCR number at gadsSolar@nerc.net and discontinue reporting under the voluntary reporting ID.

Plant ID

Plant IDs are assigned by NERC, and requested through the GADS Solar application, using information provided in the Plant configuration import file.

Inverter Group ID

Inverter Group IDs are assigned by NERC, and requested through the GADS Solar application, using information provided in the Group configuration import file.

Energy Storage Group ID

Energy Storage IDs are assigned by NERC, and requested through the GADS Solar reporting application, using information provided in the Energy Storage Group configuration import file.

Entity Reporter Identification

- The access forms for the NERC Solar reporting program will be posted once the Solar application is available.
- The NERC Compliance or Voluntary primary contact is responsible for registering individuals requiring access to the GADS Solar Program.

Appendix C: Solar Considerations

These Data Reporting Instructions have been set up to record statistics based on the Solar Day to measure solar site-specific information, as well as select statistics based on a 24-hour day, to allow for the comparison to conventional generators regarding reliability.

Solar Day

A Solar Day is defined as the period from sunrise to sunset, based on the local time of the plant. Over the course of the month, these Solar Day hours add up to Active Solar Hours. When multiplied by the number of Inverters in an Inverter Group, these hours are recorded as *Active Solar Inverter Hours* in the monthly Performance Report.

Guidelines for Determining Solar Day Hours

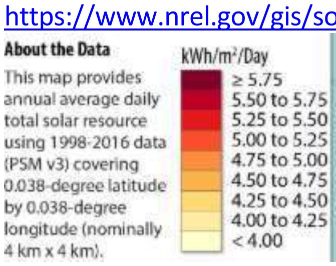
There are several different resources that can be used at a particular location (Latitude and Longitude) that show when sunrise and sunset occur, such as NOAA[12]. Most solar sites have a small difference between the sunrise time and the stable voltage in the inverter that would begin solar generation, as well as the end of the day's end of stable voltage as the sun goes down and the time of sunset. These moments are assigned to *Resource Unavailable Inverter Hours–Day* in the Performance Report. For other hours during the day when the inverters are producing and sending energy to the grid, these are assigned as *Service Inverter Hours – Day* in the Performance Report. Planned, Maintenance, and Forced Outage Hours during the day are recorded as appropriate. If there are outages during Resource Unavailable times, the outages take precedence in reporting.

At night, the time between sunset and sunrise can be recorded as *Resource Unavailable Inverter Hours – Night,* unless there is some other state in affect. *Service Inverter Hours- Night* can be used when the plant is providing grid support.

Resources for Global Horizontal Irradiance Information

Some Solar entities use an averaged *per day* version of Global Horizontal Irradiance, and some use a *per year* version. For GADS Solar reporting, Global Horizontal Irradiance will be in kWh/m2 ***per year***. Please be careful when researching or calculating a plant's Global Horizontal Irradiance and note how it is referenced, since it can vary from one source to another. Some list the annual as an Average Annual Sum of Global Horizontal Irradiance. (In many cases Irradiance is an instantaneous measurement in KW/m2; however, the value for GHI used here is in kWh/m2/year i.e. Insolation.) A comparison of locations that use one or the other is below.

NREL lists potential solar sites with Global Horizontal Irradiance figures in kWh/m2/day.
https://www.nrel.gov/gis/solar.html.



This is also referenced by the National Solar Radiation Database[13].

[12] https://www.esrl.noaa.gov/gmd/grad/solcalc/sunrise.html
[13] https://nsrdb.nrel.gov/

Multi Year PSM Global Horizontal Irradiance

This data provides monthly average and annual average daily total solar resource

Global Solar Atlas[14] lists Global Horizontal Irradiance in kWh/m2 per year.

PVOUT	1650 kWh/kWp per year
GHI	1825 kWh/m² per year
DNI	2086 kWh/m² per year
DIF	580 kWh/m² per year
GTI	2092 kWh/m² per year

Solargis[15] lists Global Horizontal Irradiance in kWh/m2 per year.

PV Performance Modeling (Sandia National Labs)

If using your own company's reference material, please be sure to make sure proper (day vs year) numbers are reported for GADS Solar reporting.

Expected Generation

Expected Generation (MWh) is the calculated optimal generation that a Solar Plant can produce under measured conditions with all equipment working as expected. "Measured Conditions" means **actual measured** solar radiation for the reporting period. Expected Generation is the best possible generation under available conditions without any equipment issues. The IEC Weather Corrected Expected Generation is a good reference.[16] This is different than Predicted Generation (such as used by PVWatts[17]) that uses historical measurements of solar radiation to predict Maximum Generation in a reporting period that can also be used as to compare actual generation. NERC does not use Predicted Generation. In conventional plants, the Maximum Generation a plant can deliver is constant during the whole reporting period. Since Solar is variable throughout any given day, this conventional method cannot be used as an accurate measure of performance.

In general, we can say which terms go into Expected Generation (but not limited to):

Expected Generation = Plane of Array (POA) Irradiance x time of reporting period x Temperature correction x Panel Efficiency Factor x Inverter Efficiency Factor x Internal loss factor

Figure C.1 below shows the variability in generation, as the expected capacity (MW) at any moment will be different than the Maximum Capacity that the plant can provide. The area in green is the *Actual Generation* of the plant. The area in green plus the area in orange is the *Expected Generation* of the plant.

[14] https://globalsolaratlas.info/
[15] https://solargis.com/maps-and-gis-data/download/usa
[16] Reference IEC 61724 standard
[17] https://pvwatts.nrel.gov/

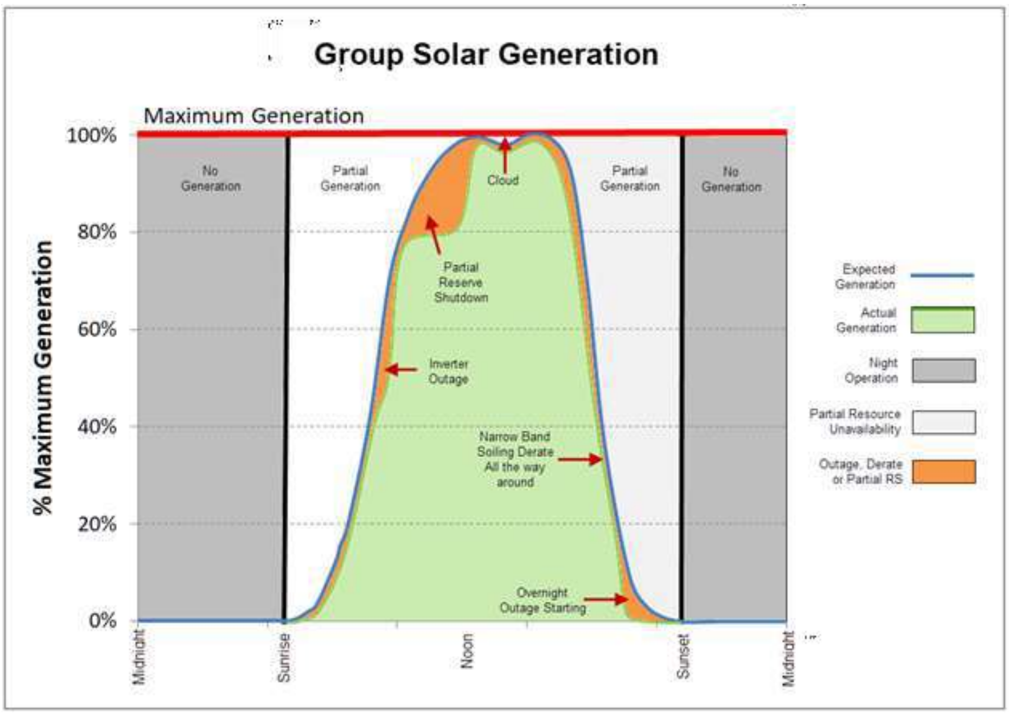


Figure C.1: Expected Generation

Methods to record *Expected Generation* can depend on the location's method of measuring irradiance (instantaneous measure of solar power). Since *Expected Generation* is reported monthly, a location would measure irradiance at certain intervals, then add up those intervals for a month. A location that measures irradiance every 1 minute will have a more accurate *Expected Generation* than a location that measures irradiance every 5 or 10 minutes. As Expected Generation is reported at the AC side of each inverter, this should include internal losses at the inverter level, temperature adjustments, and internal line losses as well. NERC does not define the interval or method of collecting *Expected Generation* but does expect it to be accurate enough that *Net Actual Generation* (MWh delivered to the grid) does not exceed *Expected Generation* over the course of a reported month.

Appendix D: Reference Tables

If you would like to add an item to any of the tables, please e-mail your request to GADS at gadsSolar@nerc.net

Table D.1: Country	
Name	**Abbreviation**
Canada	CA
Mexico	MX
United States	US
Other	OT

Table D.2: States – United States					
Name	**Abb.**	**Name**	**Abb.**	**Name**	**Abb.**
Alabama	AL	Kentucky	KY	Oklahoma	OK
Alaska	AK	Louisiana	LA	Oregon	OR
American Samoa	AS	Maine	ME	Pennsylvania	PA
Arizona	AZ	Maryland	MD	Puerto Rico	PR
Arkansas	AR	Massachusetts	MA	Rhode Island	RI
California	CA	Michigan	MI	South Carolina	SC
Colorado	CO	Minnesota	MN	South Dakota	SD
Connecticut	CT	Mississippi	MS	Tennessee	TN
Delaware	DE	Missouri	MO	Texas	TX
District of Columbia	DC	Montana	MT	Utah	UT
Florida	FL	Nebraska	NE	Vermont	VT
Georgia	GA	Nevada	NV	Virgin Islands	VI
Guam	GU	New Hampshire	NH	Virginia	VA
Hawaii	HI	New Jersey	NJ	Washington	WA
Idaho	ID	New Mexico	NM	West Virginia	WV
Illinois	IL	New York	NY	Wisconsin	WI
Indiana	IN	North Carolina	NC	Wyoming	WY
Iowa	IA	North Dakota	ND		
Kansas	KS	Ohio	OH		

Table D.3: Provinces – Canada			
Name	**Abb.**	**Name**	**Abb.**
Alberta	AB	Nova Scotia	NS
British Columbia	BC	Ontario	ON
Manitoba	MB	Prince Edward Island	PE
New Brunswick	NB	Quebec	QC
Newfoundland and Labrador	NF	Saskatchewan	SK

Table D.4: States – Mexico					
Name	**Abb.**	**Name**	**Abb.**	**Name**	**Abb.**
Aguascalientes	AG	Guerrero	GR	Quintana Room	QR
Baja California	BJ	Hidalgo	HG	San Luis Potosi	SL
Baja California Sur	BS	Jalisco	JA	Sinaloa	SI
Campeche	CP	Mexico	EM	Sonora	SO

Table D.4: States – Mexico					
Name	**Abb.**	**Name**	**Abb.**	**Name**	**Abb.**
Chiapas	CH	Michoacán	MH	Tabasco	TA
Chihuahua	CI	Morelos	MR	Tamaulipas	TM
Coahuila	CU	Nayarit	NA	Tlaxcala	TL
Colima	CL	Nuevo Leon	NL	Veracruz	VZ
Distrito Federal	DF	Oaxaca	OA	Yucatan	YC
Durango	DG	Puebla	PU	Zacatecas	ZT
Guanajuato	GJ	Queretaro	QA		

Table D.5: Solar Regimes	
Solar Regime	**Entry**
Standard large field	1
Virtual Power Plant – aggregate location/ rooftop	2
Water / Floating *	3

*Installations located on the water, not the coast.

Table D.6: Inverter Group SCADA Manufacturers	
SCADA Manufacturer	**Entry**
First Solar	FS
General Electric	GE
In-house SCADA	IH
OSI - Soft	OSI
Other	OTH
Schweitzer Engineering Laboratory	SEL
Siemens	SIE
Solar Edge	SEDG
Trimark	TR

Table D.7: Inverter Manufacturers	
Inverter Manufacturer	**Entry**
ABB	ABB
Canadian Solar	CANSO
Chint Power Systems	CHINT
Delta Energy Systems	DELT
Fronius International	FRON
General Electric	GE
Ginlong - Solis	GSOL
Huawei Technologies	HUAW
Kaco New Energy	KACO
Other	OTHIM
Power Electronics	PWR
PowerOne	PONE
SATCON	SATC
Schneider Electric	SCHN
Selectria	SELT
SMA	SMA
SolarEdge	SEDG

Table D.7: Inverter Manufacturers	
Inverter Manufacturer	**Entry**
SunGrow PowerSupply	SGROW
TMEIC	TMEIC
Yaskawa	YASK

Table D.8: Energy Storage Manufacturer	
Energy Storage Manufacturer	**Entry**
Beacon	BEAC
Build Your Dreams	BYD
EOS	EOS
Lockheed Martin	LKM
Other	OTHM
Samsung SDI	SDI
SolarEdge	SEDG
Sun Catalyx	SCAT
Tesla	TES

Table D.9: Energy Storage Inverter Manufacturer	
Energy Storage Inverter Manufacturer	**Entry**
ABB	ABB
Canadian Solar	CANSO
Chint Power systems	CHINT
Delta Energy Systems	DELT
Fronius International	FRON
General Electric	GE
Ginlong-Solis	GSOL
Huawei Technologies	HUAW
Kaco New Energy	KACO
Other	OTHESM
Selectria	SELT

Table D.10: Energy Storage Type	
Energy Storage Type	**Entry**
Battery – Flow	FLB
Battery – Lithium Ion	LIB
Battery – Other	OTHB
Capacitor	CAP
Compressed Gas	CE
Flywheel	FW
Gravity Weight	GW
Hydrogen Fuel Cell	FC
Other	OTHS
Thermal / Heat	TH

Table D.11: Tracking Type	
Panel Tracking Type	**Entry**
Fixed – no tracking	FIXED
Single Axis	SINGLE
Dual Axis	DUAL

Table D.12: Energy Storage Connection Type	
Energy Storage Connection Type	**Entry**
AC – Connection between Inverters and grid connection	AC
DC – Connection behind the Inverters	DC

Table D.13: Month Reference	
Monthly Summaries	
01 – January	07 – July
02 - February	08 – August
03 – March	09 – September
04 – April	10 – October
05 – May	11 – November
06 - June	12 - December

Table D.14: Availability Status	
Status	**Entry**
Active	AC
Inactive Reserve	IR
Mothballed	MB
Retired	RU

Table D.15: Ownership Status	
Plant, Inverter Group, or Energy Storage Ownership Status	**Abbreviation**
Active	AV
Deactivated	DV
Delete	DL
ID Request	ID
Pending*	PE
Reactivate	RV
Retired	RT
Retired-Repowered	RP
Transfer	TR
*Pending is a system-assigned status, not a reportable status (See Appendix E)	

Table D.16: NERC Regional Entity Abbreviations	
NERC Region	**Abbreviation**
Midwest Reliability Organization	MRO
Northeast Power Coordinating Council	NPCC
ReliabilityFirst	RF

Table D.16: NERC Regional Entity Abbreviations	
NERC Region	**Abbreviation**
SERC Reliability Corporation	SERC
Texas Reliability Entity	TRE
WECC	WECC

Table D.17: DC Input Type	
DC Input Type	**Entry**
Solar PV only	PV
Solar with Energy Storage	PVES
Energy Storage only	ES

Table D.18: Time Zones	
Time Zone	**Entry**
Alaska Daylight Time	AKDT
Alaska Standard Time	AKST
Aleutian Daylight Time	HADT
Atlantic Standard Time	AST
Arizona Mountain Standard Time	MST
Central Daylight Time	CDT
Central Standard Time	CST
Chamorro Standard Time	CHST
Eastern Daylight Time	EDT
Eastern Standard Time	EST
Hawaii Standard Time	HST
Mountain Standard Time	MST
Pacific Daylight Time	PDT
Pacific Standard Time	PDT
Samoa Standard Time	SST

Table D.19: Event Type	
Event Type	**Entry**
Forced Outage	FO
Maintenance Outage	MO
Planned Outage	PO

Appendix E: Ownership Status

Plant, Inverter Group, and Energy Storage ("reporting group") Ownership Status allows the entity to manage the state of each reporting group through the GADS Solar Reporting application. Reporting group Ownership Status is part of the reporting group configuration data record, which is separate from the reporting of the *operational* status reported in the Performance record.

Users will have the ability to view and export a report from the GADS Solar Reporting application that includes the ownership and monthly reporting status of each reporting group.

The GADS Solar Reporting application will require an effective date for each status change except ID Request. There are nine states of Ownership that may be assigned to a reporting group:

Status	Abbreviation	Assigned by
Active	AV	User or System
Deactivated	DV	User
Delete	DL	User
ID Request	ID	User
Pending*	PE	System
Reactivate	RV	User
Retired	RT	User
Retired Repowered	RP	User
Transfer	TR	User

*Pending is a system-assigned status, not a reportable status

Active (AV)

Identifies that the reporting group is an active ownership state, even when the Performance Status defines an inactive state of operation.

A user enters **AV** on the reporting group record any time configuration data for the reporting group is updated, including to Reactivate a reporting group or to associate the purchasing entity with the reporting group after a Transfer.

The System assigns the Active reporting group Ownership Status when:

- A reporting group ID is assigned as the result of an ID Request status from the user, or
- When a reporting group ID in a Pending state has been updated with reporting group configuration data.

Performance records are expected for each month that a reporting group has an **Active** reporting group Ownership Status for any portion of the month (applies to inverter groups and energy storage groups).

Deactivated (DV)

Identifies that a reporting group is being put into a dormant state.

A user enters **DV** when all panels in the reporting group have been in an Inactive state for more than sixty (60) days. The effective date of the deactivation may not be in the future.

Performance records indicating the operational reason for the inactive state are required for each month for which a reporting group has a **Deactivated** Ownership status. Event reporting is also required for a reporting group with a **Deactivated** Ownership status.

Delete (DL)
Identifies a reporting group created in error and is no longer required.

A user enters **DL** when the reporting group was created in error or otherwise identified as a duplicate.

An error will occur if a reporting group marked with the DL ownership status has performance or event data reported for the reporting group.

ID Request (ID)
Identifies request for a new reporting group ID.

A user enters **ID** when a new reporting group ID is required. This is the only reporting group Ownership Status where the reporting group ID is left blank.

An ID Request should <u>not</u> be used by an entity to begin reporting a reporting group that it purchased from another reporting entity.

Upon successful validation of the reporting group configuration record, the GADS Solar Reporting application will assign the reporting group ID and set the reporting group Ownership Status to **Active**.

Pending* (PE)
Identifies on the Configuration Report that a reporting group ownership transfer is awaiting configuration data from the purchasing entity. Pending is a system-assigned status, not a user-reportable status.

Reactivate (RV)
Identifies a request to reactivate a reporting group in a Deactivated state of ownership.

A user enters **RV** when a reporting group becomes operational after a Deactivated state. Updated reporting group configuration data is required. The effective date of the reactivation may be in the future.

The GADS Solar Reporting application updates the reporting group configuration data and sets the reporting group Ownership Status to **Active**.

Retired (RT)
Identifies the effective date for which a reporting group is no longer operational due to permanent retirement.

A user enters **RT** when a reporting group has been permanently retired. The effective date of retirement may not be in the future.

Performance data records covering the month of operation through the last day of the month for which the reporting group operated are required. If the reporting group was retired mid-month, the remaining hours of the month are reported as retired on the performance record.

Retired - Repowered (RP)
Identifies the effective date for which a reporting group is no longer operational due to repowering.

A user enters **RP** when a reporting group has been retired as part of a repowering activity. The effective date of repower date may not be in the future.

Performance data records covering the period of operation through the last day of the month for which the reporting group operated are required. If the reporting group was retired mid-month, the remaining hours of the month are reported as retired on the performance record.

Transfer (TR)

Identifies a request to transfer ownership of a reporting group.

The selling entity enters **TR** when it sells a reporting group to another entity. The selling entity is required to enter the date of sale and entity ID of the purchasing entity in the reporting group record.

Performance data covering the month of operation through the last day of the month for which the reporting group was owned by the selling entity are required to be reported by the selling entity.

Appendix F: Glossary

Aggregate AC Inverter Clipping (MW)
The difference between Aggregate AC Nameplate and Summed Individual Inverter Capacity of the group is Aggregate AC Clipping. The difference between the point which the inverter can no longer convert DC power and the point of AC power below nameplate capacity summed for all inverters in the group.

For example, a system with a 1 MW Aggregate AC Nameplate, but an Individual Inverter Capacity (summed over the group) of 800 KW, the Aggregate AC Inverter clipping is .2 MW.

Aggregate DC to AC Ratio – Inverter Group Reporting
For the inverter group. Represents the ratio of DC capacity of the solar panels to the AC capacity of the inverters. (If you get a software upgrade on the AC inverters, then you can re-calculate, but generally this is fixed for the inverter group.)

Sample calculation: (sum of solar panel DC capacity) / (sum of inverter AC capacity)
With a group of 5 inverters rated at 2 MW, you would have 10 MW AC
With the 5 inverters linked to 2.1 MW solar panels per inverter, that would be 10.5 MW DC to AC Ratio = 10.5/10 = 1.05

Cause Code - Event Reporting
The Cause code describes what happened during an event. See **Appendix K** for a list of Cause Codes. This can be related to the Contributing Operating Condition, depending on the environment when the Event Start Date/Time occurs.

Commercial Operation Date – Inverter Group Configuration Reporting
The date after which all testing and commissioning is completed and is the initiation date to which the seller can start producing electricity for sale (i.e. when the project has been substantially completed).

Equipment-related (configuration) data, such as plant, inverter, or energy storage configuration data will be required in the first full month after the Commercial Operating Date (COD), acquisition, or repowering.

Monthly performance data will be required beginning with the third full month after COD, acquisition, or repowering. If a reportable event occurs after the Commercial Operating date, it must be reported, regardless of whether monthly performance reporting has begun.

Example: Jan 15 COD: First full month of commercial operation is February. Inventory (plant, inverter group and/or energy storage group) configuration data is required to be reported for February. The first full month of performance data reporting would begin in May. If a reportable event occurred on March 8, the event would be reported, even though performance data is not required to be tracked until the month of May.

Commissioning Date
The time when the plant, inverter group or energy storage group is first declared commercially active.

- The inverter group is capable of reaching 50% of its generator nameplate MW Capacity (Solar conditions not part of requirement) and
- Dispatch is notified that the inverter group is capable of providing power (Solar conditions not part of requirement).
- Power Purchase Agreement (PPA) or other distribution agreements satisfied.

Contributing Operating Condition - Event Reporting
The Contributing Operating Condition is the underlying reason for an event. When an Event caused by the environment damages equipment, the Cause Code describes the equipment and Contributing Operating Condition describes the environment.

Curtailment
Curtailment is a general term used by the wind and solar industry for the involuntary reduction of plant maximum generation called for by the off-taker or transmission operator for a limited period of time.

DC Input Type – Inverter Group Reporting
This selection defines whether the inverters in the inverter group are powered by solar PV alone, solar PV with Energy Storage system (battery), or Energy Storage system (battery) alone. The selections are: Photovoltaic, Photovoltaic plus Energy Storage system (battery), and Energy Storage system. This is *not* the start of (stand-alone) Energy Storage-only reporting for NERC, as that is a separate effort. This field is a guide in determining where Inverter Groups are placed with respect to PV and Energy Storage.

Description - Event Reporting
Verbal text expanding on Cause Code and Contributing Operating Condition to describe the event more fully. This can help NERC investigate common reasons that can be used to improve reliability.

Energy Information Administration (EIA)
EIA information can be found at: www.eia.gov

Energy Storage System Capacity (MW) – Energy Storage Configuration Reporting
This is the rated Capacity of energy storage group. (MW)

Energy Storage System Energy (MWh) – Energy Storage Configuration Reporting
This is how much rated energy can be delivered over time. (MWh)

Entity – Plant, Inverter Group, and Energy Storage Configuration Reporting
The principal organization that owns one or more plants. The entity is registered as a GOP (Generator Operator) with NERC and has an NCR number (NERC Compliance Registry), or if voluntarily reporting, a VR number (Voluntary Reporting).

Entity ID - Configuration Reporting
The identifier of the Entity (NERC NCR number) used in Performance and Event reporting to reference owners of the plant.

Event End Date/Time – Event Reporting
The end time and date of an event in the Time Zone that is reported. A 24-hour clock is used for reporting.

Event Start Date/Time – Event Reporting
The start time and date of an event in the Time Zone that is reported. A 24-hour clock is used for reporting.

Event Type – Event Reporting
The type of event. Events are broken down into Forced, Maintenance, and Planned Events. Only Forced events are required to be reported.

Expected Generation (EG) – Performance Reporting
This is based on solar hours and solar radiation measured during intervals summed up for the month. *Generally, this can be calculated using the Monthly Plane of Array x panel area x internal losses.* Expected Generation is reported at

the AC side of each inverter. This should include internal losses at the inverter level, temperature adjustments, and internal line losses as well. Expected Generation for Inverter groups or event records should be rolled up from each inverter. If referencing IEC 61724, this would be equivalent to the weather corrected expected generation.

Global Horizontal Irradiance – Plant Reporting
This is the total solar radiation coming into the panels. With new plants, use theoretical data from available data, for older plants, use on-site data[18]. This can be calculated using the sum of Direct Normal Irradiance (DNI), Diffuse Horizontal Irradiance (DHI), and ground-reflected radiation; however, because ground reflected radiation is usually insignificant compared to direct and diffuse, for all practical purposes global radiation is said to be the sum of direct and diffuse radiation only:

$$GHI = DHI + DNI * \cos(Z)$$

where

Z is the solar zenith angle.

Use NREL reference (or other reference) and use the average annual global horizontal irradiance. If you have real data for the past few years, that can be used.

Gross Actual Generation (GAG) (MWh) – Performance Reporting
This is the total energy generated at the group level - in MWh. The Gross Actual Generation is the sum of all individual inverters at the AC side of the inverter.

Individual Inverter Capacity (MW) – Inverter Group Reporting (not reported)
The Individual Inverter Capacity is the limited capacity of the inverter below its Inverter AC Nameplate. This is associated with set point changes in software that limits the output of the inverter. This is used to calculate Aggregate AC Inverter Clipping.

Interannual Variance of GHI – Plant Reporting
With new plants, use theoretical data from available data, for older plants, use on-site data[19]. (Generally, 5 years of data is needed for annual standard deviation of irradiance.)

With some knowledge about the inter-annual irradiance variability at a specific site, users can in principle select a particular experimental month to adequately characterize the solar resource. Although, ideally, such on-site measurement campaigns should last many years, practical reasons limit them to 1 year or less in most cases, which increases the uncertainty in the long-term estimates. Likewise, with knowledge of the spatial variability over the area around a measurement station, users can evaluate the applicability of those measurements to a location some distance away.

Inverter AC Nameplate (MW) – Inverter Group Reporting
This is the MW nameplate for a single inverter system in the group.

Inverter Group – Inverter Group, Performance, and Component Outage Reporting
An inverter Group is a collection of inverters with the same manufacturer, designs, model number, capacity rating, and phase of construction. All inverters in the inverter group are required to be the same manufacturer, model, design, version, and Nameplate capacity.

Inverter Group ID – Inverter Group, Performance, and Component Outage Reporting
An identifier to track individual inverter groups in Component Outage and Performance reporting.

[18] http://rredc.nrel.gov/solar/glossary/gloss_g.html
[19] https://nsrdb.nrel.gov/ https://www.nrel.gov/docs/fy18osti/68886.pdf

Inverter Group Installed Capacity – Inverter Group Reporting
Enter the total capacity for the Inverter Group, in megawatts (MW). The Inverter Group Capacity is equal to the ***Number of Inverters*** multiplied by the applicable ***Single Inverter System Capacity*** MW.

For example, one hundred, 1 MW Type A inverters, would have a system capacity of 100 MW. This field will automatically be calculated based on the inverter system capacity and the number of inverters. Validation: Inverter Group Capacity = Inverter Count x Single Inverter System Capacity.

Inverter Net Maximum Capacity (INMC) (MW)
NMC is the average Net Maximum Capacity of each inverter in the inverter group. It is calculated by dividing the NMC of the inverter group by the number of inverters in the inverter group. This value is used in equations so that inverter hours and inverter capacity may be used to arrive at a theoretical net max generation.

When multiple inverter groups are being pooled together, this value for the pooled set of inverters is equal to the sum of the capacities divided by the sum number of inverters.

Maximum Operating Temperature – Inverter Group Reporting
This is the Maximum operating temperature (Celsius) that the inverter will stop producing energy.

Minimal Operating Temperature – Inverter Group Reporting
This is the minimal operating temperature (Celsius) that the inverter will stop producing energy.

Minimum Irradiance – Inverter Group Reporting
This is the minimum amount of irradiance needed for the inverter to provide stable panel and inverter performance. (W/m^2) As an example, a typical value is 85 W/m^2. This is also used to show what irradiance is needed to *start performance reporting*. Also, this will show differentiation between changing technologies at the panel level.

Minimum Voltage – Inverter Group Reporting
This is the minimum amount of voltage needed for the inverter to provide energy. (Volts) Since the 85 W/m^2 is usually enough to provide enough voltage for the inverter, this shows how much voltage is needed to energize the inverters themselves. This should be the minimum cut-in voltage of the inverter.

Monthly Plane of Array – Performance Reporting
Monthly Plane of Array (MWh/m^2) value as measured at the inverter group. This is the amount of solar radiation in a set amount of time. This is the major measurement to begin calculating Expected Generation.

Net Actual Generation (NAG) (MWh) – Performance Reporting
The Net Actual Generation is the energy delivered at the revenue meter or Point of Interconnection. It is possible to have a negative net actual generation if the group's station service or auxiliary loads are greater than the total generation from the inverters.

Net Dependable Capacity (NDC) (MW) (equivalent to NMC x Capacity Factor) – Calculated Field
NDC is the actual generating capability at the revenue meter minus capacity losses. These losses may include, but are not limited to, losses from no solar, low solar, high solar, derated solar (less than rated capacity), or losses that occur outside the manufacturer's operating specifications (temperature, electrical & etc.). Another way of looking at NDC is the Capacity of the Inverter at 100% availability while running within the manufacturer's specification with the fuel source available (Solar).

For example, if the NMC is 100 MW and the losses from all Solar problems is 40%, then the NDC can be calculated as 100 MW x (1 - 0.40). Our NDC would be 60 MW.

When using the Capacity Factor, you can use the Standard Capacity Factor or the Resource Capacity Factor
NDC may also be calculated as follows: [(Actual Generation) + (Inverter specific losses) + (reserve shutdown) + (Site outages such as off-taker problems + balance of plant, not Solar related)] / (PH).

Net Maximum Capacity (NMC) (MW) – Performance Reporting
NMC is the actual maximum generating capability at the revenue meter and is equal to the Aggregate AC Nameplate (Inverter Group Installed Capacity) less any electrical losses. These losses may include, but are not limited to, transformation losses, line losses, and other auxiliary losses between the Inverter and revenue meter (usually equivalent to the point of interconnect).

For example, if the Aggregate AC Nameplate (Inverter Group Installed Capacity) is 410 MW and the loss is 2%, then the NMC can be calculated as 410 MW x (1 - 0.02). The NMC is 402 MW.

Off-Taker
The entity that receives the power produced by the plant. This is not necessarily the purchaser of the power, but the entity that takes control of the power when it leaves the plant boundary, such as a transmission operator. The Off-Taker could also be called the transmission provider or balancing authority.

Panel Tracking – Inverter Group Reporting
Panel Tracking shows what kind of panel tracking is used. The selections are: Fixed Panels, Single Axis (Azimuth) tracking, or Dual Axis tracking.

Performance ratio - Performance Reporting
As performance on a month-by-month basis to track degradation of panels, as well as temperature and ambient conditions. This is the ratio of actual generation to the capacity of the inverter. Reference document: NREL Weather Corrected Performance Ratio[20]

Plant
A plant is defined as a collection of Solar inverter groups and associated energy storage groups at a single physical location. See Chapter 2 for example of a Plant boundary. A plant is managed by a single plant manager who has responsibilities for KPIs, safety, OSHA, hiring, terminations, etc. The plant has a common O&M building, reported to FERC as a single plant (EIA), common trucks, crews, inventory, and safety plan. OSHA injury statistics and hazardous waste are handled as a single entity. Multiple plants will have separate budgets, crews, equipment, inventories, insurance policies, managers, etc. Plants may have multiple revenue meters. (Used in the inverter group, energy storage group, performance, and event reports. Also, helps define plant structure)

Plant ID - Configuration
The identifier of the Plant used in performance and Event reporting to reference owners of the plant.

Plant Manager
The plant manager is responsible for the plant key performance indicators, the safety plan, OSHA inspections, hiring, terminations, discipline, etc., for the site.

Potential MWH production Loss (MWh) – Event Reporting
The amount of Megawatt Hours of production that was lost during an event. This is the Plant Total Installed Capacity minus the Installed Capacity Loss during the duration of the outage.

[20] https://www.nrel.gov/docs/fy13osti/57991.pdf

Refurbish
After some inverters are offline, bringing them back to service with the same original condition (i.e. same inverter group)

Repower
After some inverters are offline, bringing them back or adding new inverters to meet Federal Energy criteria for energy credit or change to interconnection (retire inverter group and create a new inverter group.)

Reserve Capacity (MW)
Reserve Capacity is the Aggregate AC Nameplate minus the Inverter System Capacity. It is the capacity of the Inverters within a group that are available but not under contract. These Inverters must be available and connected to a group, not in an inactive state, and their output can be temporarily added to the inverter group at a moment's notice if another Inverter becomes unavailable.

The purpose of reserve capacity is to allow producers to use inverters that may have been phased out but are still in good working condition to improve their availability when Inverters in the main generating group are in an unavailable state due to an outage or to maximize output within contract limits.

For example: Total Inverters = 205, Inverter AC Nameplate = 2MW
Aggregate AC Nameplate = 410 MW (205 * 2MW)
Inverter System Capacity = Contracted PPA capacity = 400 MW
Reserve Capacity = 10 MW (410 MW – 400 MW).

Reserve Shutdown
For economic purposes, Reserve Shutdown is defined as negative energy pricing, lack of demand or curtailments. It does not apply to financial decisions required to run the plant.

Resource Capacity Factor
For a plant, calculated by sum of inverter group Net Actual Generation / (sum of Inverter Group Capacity x Active Solar Inverter hours). This can be used to compare solar generators with each other since generation only happens during solar hours.

Revenue Meter
The revenue meter is a device used to measure the electricity generated from a plant, group, depending on the plant configuration. The revenue meter accounts for the energy delivered to the transmission or distribution system and is normally owned by the off taker. This defines the Net Energy delivered to the grid, by a transmission agreement. You can have multiple revenue meters at a single Plant.

Single Inverter System Capacity (MW) -Inverter Group Reporting
The System MW rating of the Inverter. This includes temperature set points and other internal inverter limits as the site is set up. All inverters in the inverter group are required to be the same manufacturer, model, design, version, and AC capacity.

Solar Regime Environment– Inverter Group Reporting
The Solar Regime Environment describes the general environment in which the solar array is located.
See **Appendix D**, Table 5 for the Solar Regime list.

Standard Capacity Factor – calculated.
For a plant, calculated by sum of inverter group Net Actual Generation / (sum of Inverter Group Capacity * month hours (24 hour basis)). With this factor, a 24-hour comparison can be made to other non-solar generators.

Stowing Wind Speed (if tracking) – Inverter Group Reporting
If panels are tracking, this is the wind speed that tracking is stopped, and panels are adjusted for the wind to prevent damage. (meters/second)

Time Zone – Configuration and Event Reporting
The Time Zone where the reporting is tracked. If a plant is in one time zone, but the event times are reported in another time zone, use the time zone that is used in reporting.

Total Installed Capacity (TIC) (MW)
TIC is the sum of all the inverters' capacity within the inverter group, plant, or otherwise specified grouping. Includes reserve inverters. The TIC of related inverter groups may be summed to determine the TIC of a plant.

Appendix G: Abbreviations

Below is a list of the commonly used abbreviations in this document. They are sorted by common use, reporting and equations. There are additional abbreviations used in the inverter group report listed in **Appendix D**.

Abbreviation	Definition	Category
AC	Alternating Current	General
AIH	Active Inverter Hours	Reporting and Equation Attributes
ASIH	Active Solar Inverter Hours	Reporting and Equation Attributes
AV	Active	Ownership Status
BOP	Balance of Plant	General
BPS	Bulk Power System	General
C	Celsius	General
CalH	Calendar Hours	Reporting and Equation Attributes
CPOI	Plant Capacity at Point of Interconnection	Reporting and Equation Attributes
COD	Commercial Operating Date	Reporting and Equation Attributes
CSV	Comma Separated Value	General
CT	Current Transformer	General
DC	Direct Current	General
DCS	Distributive Control System	Reporting and Equation Attributes
DL	Delete	Ownership Status
DRI	Data Reporting Instructions	General
DV	Deactivated	Ownership Status
E-AIH	Equipment Available Inverter Hours	Reporting and Equation Attributes
E-AF	Equipment Availability Factor	Equation 1.B.1
E-FOF	Equipment Forced Outage Factor	Equation 1.B.5
E-FOR	Equipment Forced Outage Rate	Equation 1.B.12
E-MOF	Equipment Maintenance Outage Factor	Equation 1.B.4
E-MOR	Equipment Maintenance Outage Rate	Equation 1.B.11
E-POF	Equipment Planned Outage Factor	Equation 1.B.3
E-POR	Equipment Planned Outage Rate	Equation 1.B.10
E-SOF	Equipment Scheduled Outage Factor	Equation 1.B.7
E-SOR	Equipment Scheduled Outage Rate	Equation 1.B.14
E-UF	Equipment Unavailability Factor	Equation 1.B.2
E-UOF	Equipment Unplanned Outage Factor	Equation 1.B.6
E-UOR	Equipment Unplanned Outage Rate	Equation 1.B.13
EG	Expected Generation	General
E-GF	Equipment Generating Factor	Equation 1.B.8
EIA	Energy Information Administrator	Organization
E-NCF	Equipment Net Capacity Factor	Equation 1.B.9
EPA	Environmental Pollution Agency	Organization
ERO	Electric Reliability Organization	Organization
ES	Energy Storage	Reporting and Equation Attributes

Abbreviation	Definition	Category
E-UIH	Equipment Unavailable Inverter Hours	Reporting and Equation Attributes
FERC	Federal Energy Regulatory Commission	Organization
FO	Forced Outage	General
FOIHD	Forced Outage Inverter Hours Day	Reporting and Equation Attributes
FOIHN	Forced Outage Inverter Hours Night	Reporting and Equation Attributes
FIH	Forced Outage Inverter Hours	Reporting and Equation Attributes
FXDIH	Forced Delay Inverter Hours	Reporting and Equation Attributes
GADS	Generator Availability Data System	General
GADS-S	GADS Solar	General
GADSWG	GADS Working Group	General
GAG	Gross Actual Generation	Reporting and Equation Attributes
GHI	Global Horizontal Irradiance (kWh/m^2)	Reporting and Equation Attributes
GMC	Gross Maximum Capacity	Reporting and Equation Attributes
GMG	Gross Maximum Generation	Reporting and Equation Attributes
GO	Generator Owner	General
GSU	Generator Step Up transformer	General
HV	High Voltage	General
IA	Inactive State	General
IAVOR	Inter-Annual Variance Irradiance	Reporting and Equation Attributes
ID	Identification	General
ID	Identification Request	Ownership Status
IEC	International Electrotechnical Commission	Organization
IEEE	Institute of Electrical and Electronic Engineers	Organization
IH	Inverter Hours	Reporting and Equation Attributes
IIH	Inactive Inverter Hours	Reporting and Equation Attributes
INMC	Inverter Net Maximum Capacity	Reporting and Equation Attributes
IPP	Independent Power Producer	General
IR	Inactive Reserve	General
IRIH	Inactive Reserve Inverter Hours	Reporting and Equation Attributes
ISO	Independent System Operator	General
KPI	Key Performance Indicators	General
m	Meter	General
m/s	Meters per Second	General
MB	Mothball	General
MBIH	Mothballed Inverter Hours	Reporting and Equation Attributes
MIH	Maintenance Inverter Hours	Reporting and Equation Attributes
MIHD	Maintenance Inverter Hours Day	Reporting and Equation Attributes
MIHN	Maintenance Inverter Hours Night	Reporting and Equation Attributes
MO	Maintenance Outage	General
MPOA	Monthly Plane of Array (MWh/m^2)	Reporting and Equation Attributes
MRO	Midwest Reliability Organization	Organization

Abbreviation	Definition	Category
MW	Megawatt	General
MWh	Megawatt Hours	General
NAC	Net Available Capacity	Reporting and Equation Attributes
NAG	Net Actual Generation	Reporting and Equation Attributes
NCF	Net Capacity Factor	Equation – 2.A.3
NCR#	NERC Compliance Registry Number	General
NDC	Net Dependable Capacity	Reporting and Equation Attributes
NERC	North American Electric Reliability Corporation	Organization
NMC	Net Maximum Capacity	Reporting and Equation Attributes
NOF	Net Output Factor	Equation – 1.A.10
NPCC	Northeast Power Coordinating Council	Organization
NREL	National Renewable Energy Laboratory	Organization
O&M	Operations and Maintenance	General
OMC	Outside Management Control	General
OSHA	Occupation Safety and Health Administration	Organization
PE	Pending	Ownership Status
PLC	Programmable Logic Controller	Reporting and Equation Attributes
PO	Planned Outage	General
POA	Plane of Array	General
PPA	Power Purchase Agreement	General
PT	Potential Transformer	General
PI	Unit Performance Index	Equation – 2.A.1
PIH	Planned Inverter Hours	Reporting and Equation Attributes
PIHD	Planned Inverter Hours Day	Reporting and Equation Attributes
PIHN	Planned Inverter Hours Night	Reporting and Equation Attributes
PXDIH	Planned Delay Inverter Hours	Reporting and Equation Attributes
PV	Photovoltaic	Reporting and Equation Attributes
PVES	Photovoltaic with Energy Storage System	Reporting and Equation Attributes
QC	Quality Control	General
RAGF	System Resource Available Generation Factor	Equation 2.A.2.b
RE	Regional Entity	General
R-AF	Resource Availability Factor	Equation 1.A.1
R-FOF	Resource Forced Outage Factor	Equation 1.A.5
R-FOR	Resource Forced Outage Rate	Equation 1.A.13
R-MOF	Resource Maintenance Outage Factor	Equation 1.A.4
R-MOR	Resource Maintenance Outage Rate	Equation 1.A.12
R-POF	Resource Planned Outage Factor	Equation 1.A.3
R-POR	Resource Planned Outage Rate	Equation 1.A.11
R-SOF	Resource Scheduled Outage Factor	Equation 1.A.7
R-SOR	Resource Scheduled Outage Rate	Equation 1.A.16
R-UF	Resource Unavailability Factor	Equation 1.A.2

Abbreviation	Definition	Category
R-UFOR	Resource Unavailable Forced Outage Rate	Equation 1.A.14
R-UOF	Resource Unplanned Outage Factor	Equation 1.A.6
R-UOR	Resource Unplanned Outage Rate	Equation 1.A.15
RF	ReliabilityFirst	Organization
R-GF	Resource Generating Factor	Equation 1.A.8
RIH	Retired Inverter Hours	Reporting and Equation Attributes
R-NCF	Resource Net Capacity Factor	Equation 1.A.9
RP	Retired - Repowered	Ownership Status
RS	Reserve Shutdown	General
RSIH	Reserve Shutdown Inverter Hours	Reporting and Equation Attributes
RT	Retired	Ownership Status
RTS	Returned to Service	General
RU	Retired Unit	General
R-UF	Resource Unavailability Factor	Equation 1.A.17
RUGF	System Resource Unavailable Generation Factor	Equation 2.A.2
RUIH	Resource Unavailable Inverter Hours	Reporting and Equation Attributes
RUIHD	Resource Unavailable Inverter Hours Day	Reporting and Equation Attributes
RUIHN	Resource Unavailable Inverter Hours Night	Reporting and Equation Attributes
RV	Reactivate	Ownership Status
SAIH	Site (Resource) Available Inverter Hours	Reporting and Equation Attributes
SCADA	Supervisory Control and Data Acquisition	General
SERC	SERC Reliability Corporation	Organization
SIH	Service Inverter Hours	Reporting and Equation Attributes
SIHD	Service Inverter Hours Day	Reporting and Equation Attributes
SIHN	Service Inverter Hours Night	Reporting and Equation Attributes
SPI	System Performance Index	Equation – 2.A.1.b
STC	Standard Test Condition	Reporting and Equation Attributes
SUIH	Site (Resource) Unavailable Inverter Hours	Reporting and Equation Attributes
Texas RE	Texas Reliability Entity	Organization
TIC	Total Installed Capacity	Reporting and Equation Attributes
TR	Transfer	Ownership Status
WECC	WECC	Organization

Appendix H: Inverter Group States and Hours

Given the nature of solar generation, it would be a very rare occurrence for every inverter in a plant to be in the same state. Therefore, due to the hours that inverters spend in various conditions, NERC GADS collects hours as "inverter hours" to enable NERC to calculate meaningful statistics. Using Inverter-hours allows the operator to report hours simply by adding up the hours reported by each inverter.

Inverter Hours (IH)

IH are equal to the number of inverters in the group, times the number of Calendar Hours in the period. IH for any given condition for a given inverter group is equal to the total number of Calendar Hours that each inverter in the inverter group spent in the given condition.

All the following time/condition classifications are considered to be in inverter hours. For example, the number of IH for a group of 12 inverters in January (with 744 hours in January) would be 12 x 744 or 8,928 IH. If one of those inverters were mothballed for the entire month, the Active Inverter Hours (AIH) would be 11 x 744 or 8,184 AIH with 744 Inactive Inverter Hours.

Outage Reporting Priority

In some instances, there may be more than one event starting at the same time. When events start at the same time, the below list identifies how to select the correct outage type. Once an outage begins, outage types are not changed until the current outage is finished.

Service Inverter-Hours

Forced Inverter-Hours

Maintenance Inverter-Hours

Resource Unavailable Inverter-Hours Day

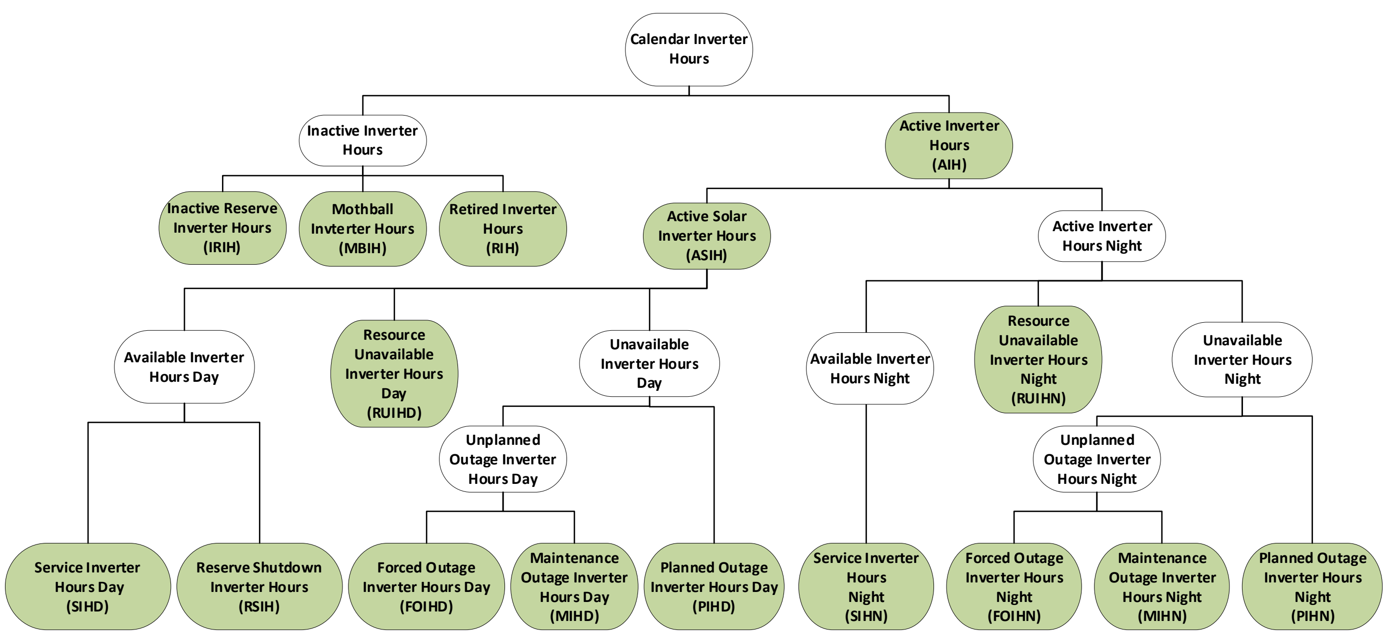


Figure H.1: Solar Hours Broken Out by Event Type

Inverter Group Availability States

Active or Commercial State (Active) – Configuration Reporting

Active state is the time from when the inverter group is first declared commercially active until the entire group moves to the inactive state.

If an inverter group is commissioned after the first of the month, the inverter group reporting obligation begins with the first full calendar month after the inverter group was commissioned.

Inactive State

Inactive State, or "Deactivated Shutdown" in IEEE 762, is defined as "The state in which a plant or unit is unavailable for service for an extended amount of time for reasons not related to the equipment." The purpose of these states is to remove plants or units from system availability when it is no longer financially viable to run the plant or unit for an extended month of time. For GADS, an extended amount of time is defined as greater than 60 days. Some examples are:

- Energy pricing drops below O&M cost
- O&M cost rise above income
- Fuel cost increases or the fuel becomes unavailable.
- Environmental or regulatory constraints or cost
- Major equipment failure where time is needed to determine the feasibility of making repairs.

Inactive Reserve (IR)

IR is defined by IEEE 762 and GADS as "The State in which a group is unavailable for service but can be brought back into service after some maintenance in a relatively short duration of time, typically measured in days."

In the Inactive Reserve definition above, GADS added "after some maintenance" and defines this statement to mean that some action may be needed to prepare the plant or unit for service because it had been sitting idle for an amount of time and some equipment parts have deteriorated or need replacing before the group can be operated.

The plant or unit should be <u>operable</u> at the time the IR begins. *This does not include plants or units that may be idle because of a failure and dispatch did not call for operation*. A plant or unit that is not operable or is not capable of operation at a moment's notice should be on a forced, maintenance, or planned outage and remain on that outage until the proper repairs are completed and the plant or group is able to operate. The plant or unit *must be* on RS (Reserve Shutdown) a minimum of 60 days before it can move to IR status.

Mothballed (MB)

MB is defined by IEEE 762 and GADS as "The State in which a plant or unit or individual inverter group is unavailable for service but can be brought back into service after some repairs with appropriate amount of notification, typically <u>weeks or months</u>."

In the Mothballed definition above, GADS replaced "WTG" with "inverter group" to apply to solar. GADS also added "after some repairs" and defines this statement to mean that some action may be necessary to prepare the plant or unit for service because it had been sitting idle for a month of time and some equipment parts may have deteriorated or need replacing before the group is operable. The plant or unit may have also experienced a series of serious mechanical problems for which management may wish to wait for a <u>month of time to determine whether the plant or unit should be repaired or retired.</u>

A plant or unit that is not operable or is not capable of operation at a moment's notice *must* be on a forced maintenance, or planned outage and remain on that outage for at least 60 days before it can be moved to the MB state.

If repairs are being made on the plant or unit to restore the plant or unit to operating status before the 60-day month expires, then the outage must remain a forced, maintenance, or planned outage and not changed to MB. Ordering equipment, parts or prepping the plant or unit is an indication that the unit is intended to return to service. Times to inspect, secure, dismantle and review are not considered repairs.

Anytime the decision to repair the plant or unit is made and the plant or unit is in MB, the plant or unit immediately reverts back to its original pre-60-day outage status.

Retired Unit (RU)

RU is defined by IEEE 762 and GADS as "the State in which a plant or unit is unavailable for service and not expected to return to service in the future." A plant or unit may go directly into the RU state. There is no waiting month.

Inverter Hours

Active Inverter Hours (AIH)

Active Inverter Hours (AIH) is the number of Inverter-Hours being reported that the inverter group is in the active state. AIH can vary in output reports (month, year, etc.) but for GADS reporting purposes, data is collected on the number of Inverter-Hours in a month.

In two instances, the AIH may be smaller than the normal month hours for the given month:

- When the inverter group becomes commercially active, or
- When one or more inverters go into the Inactive Reserve, Mothballed, or Retired State.

The sum of Available Inverter-Hours and Unavailable Inverter-Hours must equal inverter group Active Inverter-Hours.

Active Solar Inverter Hours (ASIH)

Active Solar Inverter Hours are equal to the number of inverters in the group, times the number of Active Hours during Daylight in the month. Daylight Hours are defined as being from the times between sunrise and sunset that produce energy in the inverter.

Calendar Hours

Calendar Hours are the total number of hours within a given range of dates. These are typically shown as the number of hours in a month, quarter, or year. (Used for calculating the total inverter group Inverter-Hours)

Calendar Inverter Hours (CalIH)

The CalIH is equal to the Calendar Hours for the period times the number of inverters. CalIH is the sum of Active Inverter Hours (AIH) and Inactive Inverter Hours. In most cases, AIH and CalIH will be the same number. Data is collected on the number of CalIH in a reporting period. The sum of AIH and Inactive Inverter Hours must equal CalIH or an error is generated during data submission. (Used as a quality check that all hours are accounted for)

Forced Outage Inverter Hours (FOIH)

FOIH is the sum of all inverter-hours that the group is off-line due to forced events. FOIH are all forced events where the group must be removed from service for repairs *before* the next Sunday at 23:59 (just before Sunday becomes Monday). Examples can be found in **Appendix J**.

Forced Outage Inverter Hours should be separated by day (FOIHD) and night (FOIHN).

Maintenance Inverter Hours (MIH)

MIH is the sum of all inverter-hours that the inverter group is off-line due to a Maintenance Event.

A maintenance event is an event that can be deferred beyond the end of the next weekend (Sunday at 2400), but requires that an inverter be removed from service, another outage state, or Reserve Shutdown state before the next Planned event. Characteristically, a maintenance event can occur at any time during the year, has a flexible start date, may or may not have a predetermined duration, and is usually much shorter than a Planned Event.

If an event occurs before Friday at 2400, the above definition applies. If the event occurs after Friday at 2400 and before Sunday at 2400, the Maintenance event will only apply if the event can be delayed past the next weekend, not the current one. If the event cannot be deferred, it is a Forced Event. Examples can be found in **Appendix J.**

Maintenance Inverter Hours should be separated by day (MIHD) and night (MIHN).

Planned Inverter hours (PIH)

PIH is the sum of all Inverter-Hours that the inverter group is off-line due to a planned event. A Planned Event is scheduled well in advance, is of a predetermined duration, and can occur several times a year. Examples are in **Appendix J**.

Planned Inverter Hours should be separated by day (PIHD) and night (PIHN).

Reserve Shutdown Inverter Hours (RSIH)

RSIH is the sum of all inverter-hours that the group is not available to the system for economic reasons. Do not include RSIH with the same equations as SIH (this would result in double counting total inverter-hours). IEEE 762 and the NERC GADS DRI for Thermal/Hydro generators define RSIH as an inverter shutdown due to economic reasons. Economic is defined as negative energy pricing or lack of demand. Curtailment hours should be included in RSIH.

To qualify the following must be true:

1. The inverter must be in an active state.
2. The inverter must be available not in an outage state.
3. The inverter must not be in eminent danger of failure.

Note: Disabling an inverter (such as removing a processor card) immediately puts the inverter in an outage state and makes it no longer available.

Resource Unavailable Inverter Hours Day (RUIHD)

RUIHD is the number of inverter-hours the group is not producing electricity during daylight hours due to sunlight levels being too low to produce startup voltage. This includes normal system startup, calibrations, system checks and ramp-up, such as cable untwisting, battery checks, etc. RUIHD is classified as Available Inverter-Hours for equipment calculations and Unavailable Inverter-Hours for site calculations.

Resource Unavailable Inverter-Hours Night (RUIHN)

RUIHN is the number of inverter-hours the group is not producing electricity due to the sun being below the horizon or too low to produce startup voltage. This includes normal system startup, calibrations, system checks and ramp-up, such as cable untwisting, battery checks, etc. RUIHN is classified as Available Inverter-Hours for equipment calculations and Unavailable Inverter-Hours for site calculations.

Service Inverter Hours (SIH)

Service Inverter Hours is the number of inverter hours that inverters within the inverter group are synchronized to the system. It is the number of hours that the contactors are closed, and generation is connected to the grid providing power. The term is similar to Service Hours used in conventional generation.

Service Inverter Hours should be separated by day (SIHD) and night (SIHN). Not all inverters can produce generation at night.

Additional Inverter Hour Calculations – Useful for Data Quality of Performance Hours

Equipment Available Inverter hours (EAIH) (Calculated) – Informational only, not reported.

EAIH is the sum of the Service Inverter-Hours (SIH), Resource Unavailable Inverter-Hours Night (RUIHN) and Resource Unavailable Inverter-Hours Day (RUIHD) –Reserve Shutdown Inverter Hours (RSIH).

Equipment Unavailable Inverter hours (EUIH) (Calculated) – Informational only, not reported.

EUIH is the sum of Planned Inverter Hours (PIH), Forced Inverter Hours (FIH), and Maintenance Inverter Hours (MIH).

Appendix I: Outage Classification Guidelines

General Considerations

1. Segregating maintenance outages (MO) from forced outages (FO) is the single largest area for misunderstanding and abuse. MO's are defined as outages that can be deferred until the following week or, if they occur on the weekend, they can be deferred through the next (not current) weekend. When equipment breaks, it cannot be deferred and is a FO, so the problem comes when equipment is close to breaking. For example, during an annual inspection, a cooling system was found to have a slow coolant leak. The cooling system was running fine before inspection. If it is turned off for repair, is it an MO or a FO? This is where good judgment and engineering support helps. What is the risk of failure if the equipment is allowed to run for another week? If the risk is high, then the event is an FO.
2. Weather downtime is another area for abuse. The tendency is to attribute every event that occurs during Weather to the storm. There should be a clear predefined linkage between the event and the storm. For example, if a lightning strike causes low voltage grid events, then that is attributed to the storm. However, if rain gets into a poorly designed inverter, then that is attributed to the design of the inverter.
3. Equipment Failure or Weather can also be tricky. For example, an inverter shuts down when due to overheating. If the unit is in a desert and needs cooling equipment, then the equipment fails (E-FOR). If there is no cooling fan (inverter is in a cool area), then the event would be classified as Weather.
4. Recovering from a site wide event like an outage or a Plant substation breaker trip can be challenging to classify. Not all Inverters will automatically restart when power is restored. The assumption here is that an inverter should be able to handle an unplanned outage without a component failure. Electrical conditions during an outage are complex and inverters may fault due to out of spec electrical parameters. The event ends when one of the following three conditions occur:
    a. The inverter automatically restarts.
    b. The inverter is reset from SCADA and restarts.
    c. The inverter is visited and restarted locally. If the inverter fails to restart after a local reset, a FO event begins at that point.
5. At times events will overlap. When this occurs, the outage reporting prioritization list in the Inverter Group States appendix should be referenced. An example of this would be a string of failed inverters (FO). Several days later, the Off-Taker takes a 2-week maintenance outage (MO). The inverters remain in FO until the repair is completed and then become part of the MO.

Forced Outage – FO

An unplanned outage that usually results from a mechanical, electrical, control system trip or an operator- initiated trip in response to a unit alarm. The inverter is not capable of running under the FO rules.

1. **Component failures**: Most FOs will be component failures that require replacement and or repair. Examples are inverters, controllers, loose wire, etc.
2. **Trips or faults:** These remove the inverter from availability until corrected. Examples are overvoltage, undervoltage, over or underfrequency, etc.
3. **Condition Assessment**: Sometimes failing components are identified through condition assessment. If the component fails before the repair or replacement occurs, it is FO. For example, a inverter module is overheating and is scheduled for replacement. If the module fails before the scheduled replacement time, the outage is FO.

4. **Balance of Plant (BOP)**: components like underground cabling failure can cause FO. BOP failures often have parallel and undamaged components that need to be de-energized to complete the repairs safely. BOP failures usually impact many inverters, and their repairs are usually not delayed. Under this condition, the parallel circuits are part of the FO. If the primary repair is delayed for a week or two, the parallel circuit outage could be considered a MO.
5. **No Sun**: Inverter repairs often occur during no or low light conditions. Although there are no production losses, the inverter's FO hours still accumulate. For example, if an inverter fails but there is no sunlight, it is still a FO.
6. **Repeating Faults**: Occasionally, inverters fault multiple times from the same problem over a short period of time. For example, imagine that crews are dispatched to repair an inverter, but the inverter is running when the crew arrives. One might think to call this MO because the inverter is running, but due to the repetitive nature of the fault, it is FO. Here's another example: An inverter has been repeatedly faulting on unstable voltage. The previous day, it faulted six times. The inverter is later shut down to determine the root cause of the problem and repair it. Therefore, the inverter cannot be restarted until repaired, so it is FO.
7. **Outside Contractors:** Sometimes non-related contractors have access to the plant to service non- inverter equipment. (Oil equipment, gas lines, telephone) When digging or work occurs around high voltage (HV) or communication lines, it is the responsibility of the plant to be aware of and coordinate these events. Consider this example; a local phone company is installing a new fiber optic line that crosses the plant, and the contractor hits an underground HV cable. The site trips off and the cable requires repair. Were the crossings marked and flagged? Was the digging monitored? The event is FO even if all the proper safeguards are in place (human error).
8. **Human Error:** Human error falls under plant management control. For example, if a technician leaves a tool causing a short that spontaneously catches fire and burns it up, the event is FO.
9. **Weather:** Weather events are often difficult to categorize. When labelling an outage as FO, determine what equipment caused the failure. For example, if an inverter with a cooler to prevent overheating, but it overheats anyway, then the cooler failed, and the outage would be FO-Control System. If lightning were to strike a substation with lightning protection and cause damage, then the protection system failed, and the outage would be FO-Inverter. Consideration must be given for circumstances that exceed the protection system design limit.
10. **Safety Shutdown**: Safety shutdowns usually occur when neighboring equipment is in danger of harm. As an example, when an inverter overheats, neighboring inverters may be in danger of damage from overheating. If they are shut down, they are part of the event and are FO.

Maintenance Events – MO

These are components or systems that are close to failure or in need of modification. The inverter should be capable of running until the following week. For example, if identified on Tuesday, it should be capable of running until the following Monday. If identified on the weekend it should be capable of running through the following week. If the inverter requires maintenance and will not be able to run until the following week, then the outage is FO, not MO. Repairs can take place anytime as long as the inverter can run as stated above.

1. **Condition Assessment:** The condition of the inverter is evaluated using historical trends, inspection, non-destructive testing, etc. When an issue is found, the repair is scheduled.
2. **Inspections:** Inspections by their nature are MO. If the inverter is down prior to the inspection, then it is FO.
3. **Safety Shutdowns:** Sometimes neighboring inverters or parallel circuits need to be shut down for safety. If the safety shutdown is of an immediate nature or less than the MO definition, then it is FO. Examples:

a. A pad mount transformer failed several weeks ago and was bypassed until a replacement could be acquired. (The original event, including parallel circuits was FO). The original transformer failure remains FO, but when the rest of the circuit is de-energized to replace the transformer, the balance of the inverters are MO. All the inverters would have the same system classification, which in this case is Electrical / Individual Transformer.

b. An inverter failed several weeks ago (FO). To safely replace the inverter, two neighboring inverters were shut down. The two neighboring inverters are MO. The system classification for all inverters is the same in this case.

4. **Retrofits and Upgrades:** Most of these types of events will fall into the MO category. They could include anything from upgrading the inverter software to installing upgraded converters. If the items involve long term planning (specifically in the budget), then consider PO.

5. **Economic Repair:** Sometimes it is advantageous to shut down an inverter to minimize costly repairs. In this case, the inverter must clearly meet the MO standards and be able to run for another week. If used inappropriately, an FO event could be disguised as an MO. For example, if an inverter is continuously faulting multiple times a day, then the outage is FO, not MO. It is recommended to have an independent engineering team (not directly associated with the plant) make these decisions. If the engineer says don't run it, it is FO. If the engineer says run at reduced load or replace in six months, it is MO. The following are examples:

a. An inverter with coolant pump errors and can clearly run, but the issue can propagate over time, eventually leading to a pump failure. Turning the pump off now will minimize the repair cost and prevent further damage. Plant management could decide to keep the pump in service for another week, so the outage is MO, not FO. Repairs are completed when labor and equipment are available. Code as Coolant pump MO.

b. The inverter temperature has been rising, and inspection indicates that the coolant line should be replaced. Experience has shown that the inverter will run for several months in this condition, but there is a chance that the line could leak all coolant, significantly increasing the cost of repair. The inverter is shut down under MO and repairs completed when personnel and equipment are available. Code as Coolant line MO.

Planned Events - PO

Planned events are events that are scheduled well in advance and are usually specifically listed in the plant budget.

1. **Substation / HV Maintenance**: HV maintenance schedules are usually determined well in advance by NERC regulations. This is coded as Balance of Plant / Substation PO.
2. **Inverter Preventative Maintenance**: Most inverters have a regular maintenance schedule. This happens every year and is planned well in advance. This is coded as Inverter / Preventative Maintenance PO.
3. **Retrofit**: Some retrofit projects require long term planning. An example could be replacing the coolant at a plant. That would be coded as Coolant PO.

Reserve Shutdown – RS

RS is a decision by plant management to shut down inverter groups that are in an active state and not in outage or in danger of failure. IEEE 762 defines the condition as an economic[21] shutdown. Inverters in this state must remain available. Curtailments are also considered RS for GADS. If they are disabled in any way, like removing the controller, they move into an outage state (PO, MO, or FO). It can be difficult to discern between Outages due to off-site conditions and RS at times. The following are examples:

[21] Economic shutdown is an outage due to market or demand issue

1. Solar plant A is actively participating in the energy market. During certain times of the day, pricing goes negative (Negative energy pricing), so the revenue from the energy cannot cover the cost of operating the plant. The plant shuts down the inverters during these months, which is an RS.
2. During an RS due to negative energy pricing, a technician needs a controller board to repair another inverter. As soon as the technician removes the board the inverter is no longer RS and is in an outage state (no longer available).

Appendix J: Examples

Example: Determining Net Actual Generation at the Inverter Group level when there are multiple Inverter Groups

Multiple Inverter Groups can make up a plant. Since the *Net Actual Generation* is measured at Interconnection, there is no direct way to measure the *Net Actual Generation* for each Inverter Group. As an exercise, we will go through measuring *Gross Actual Generation* for each Inverter Group, the *Net Actual Generation* for the Plant, and calculate the *Net Actual Generation* for each Inverter Group. This can also give us a sample way to get Inverter Group Capacity Factors. Since this is an example, it is one way to make these calculations. Companies can use their own calculations based on their own data.

We will choose a sample month with 30 days. The sample month has an average of 10 hours of Solar Hours. For the Month, a 24-hour day will have 720 Monthly hours. A Solar Month with 10 hours a day will have 300 Monthly Hours. The sample plant has three Inverter Groups.

Inverter Group A		**Total MW**
System Inverter MW Capacity	1	10
# Inverters	10	
MWh Generated (Gross)	1800	
Inverter Group B		
System Inverter MW Capacity	0.75	12
# Inverters	16	
MWh Generated (Gross)	1600	
Inverter Group C		
System Inverter MW Capacity	1	8
# Inverters	8	
MWh Generated (Gross)	1200	

Inverter Group A:

- System Inverter MW Capacity = 1 MW (InvA_Cap)
- Number of Inverters = 10 (#A_Inv)
- Measured Gross Actual Generation = 1800 MWh (A_MWh_Gen)

Inverter Group B:

- System Inverter MW Capacity = .75 MW (InvB_Cap)
- Number of Inverters = 16 (#B_Inv)
- Measured Gross Actual Generation = 1600 MWh (B_MWh_Gen)

Inverter Group C:

- System Inverter MW Capacity = 1 MW (InvC_Cap)
- Number of Inverters = 8 (#C_Inv)

- Measured Gross Actual Generation = 1200 MWh (C_MWh_Gen)

Total Gross Generation for the Plant for the month sums up each measured *Gross Actual Generation* for each Inverter Group

(A_MWh_Gen + B_MWh_Gen + C_MWh_Gen) = 1800+1600+1200 = 4600 MWh (G_MWh_Gen)

Prorate the percentage of applicable *Gross Actual Generation* for each Inverter Group based on its contribution to the Plant *Gross Actual Generation*.

- **Inverter Group A** percentage is the calculation of 1800 / 4600 (A_MWh_Gen / G_MWh_Gen) = 39.1% (A%)
- **Inverter Group B** percentage is the calculation of 1600 / 4600 (B_MWh_Gen / G_MWh_Gen) = 34.8% (B%)
- **Inverter Group C** percentage is the calculation of 1200 / 4600 (C_MWh_Gen / G_MWh_Gen) = 26.1% (C%)

In the example, the *Net Actual Generation* is measured at the point of Interconnection. It is measured to be 4500 MWh (N_Gen). To get each Inverter Group's contribution to *Net Actual Generation*, multiply the *Net Actual Generation* by its percentage.
Out of 4500 MWh:

- Inverter Group A Net Actual Generation = 4500 x 39.1% (N_Gen x A%) = 1760.87 MWh (A_Net_Gen)
- Inverter Group B Net Actual Generation = 4500 x 34.8% (N_Gen x B%) = 2565.22 MWh (B_Net_Gen)
- Inverter Group C Net Actual Generation = 4500 x 26.1% (N_Gen x C%) = 1173.91 MWh (C_Net_Gen)

Capacity Factor
To get to the Capacity Factor, determine the potential Generation (theoretical maximum) for each Inverter Group. To compare between regular plants and other solar plants, Solar Day Capacity and Standard Factors are needed.

Inverter Group A's potential generation is the *System Inverter MW Capacity* times the number of Inverters times the number of hours. The Capacity Factor is the *Net Actual Generation* of that Inverter Group divided by the potential generation.

"Day" Hours			**Month Hours**
Standard	24	*X 30 =*	720
Day	10	*X 30 =*	300

Inverter Group A:

- Solar Capacity Factor A: = 1760.87 MWh / (10 x 1MW x 300 Hours) = 57.7%
- Standard Capacity Factor A = 1760.87 MWh / (10 x 1 MW x 720 Hours) = 24.5%

Inverter Group B:

- Solar Capacity Factor B = 1565.22 MWh / (16 x .75 MW x 300 Hours) = 43.5%
- Standard Capacity Factor B = 1565.22 MWh / (16 x .75 MW x 720 Hours) = 18.1%

Inverter Group C:

- Solar Capacity Factor C = 1173.91 MWh / (8 x 1 MW x 300 Hours) = 48.9%
- Standard Capacity Factor C = 1173.91 MWh / (8 x 1 MW x 720 Hours) = 20.4%

Inv A		Inv B		Inv C	
39.1%		34.8%		26.1%	
1760.87		1565.22		1173.91	
Standard	Day	Standard	Day	Standard	Day
7200	3000	8640	3600	5760	2400
Standard	Day	Standard	Day	Standard	Day
24.5%	58.7%	18.1%	43.5%	20.4%	48.9%

Step 1 Prorate Calculation
Gross Ratio
=X_MWh Gen/(A_Mwh_Gen+B_MWh_Gen+C_MWh_Gen)

Group Prorated Net Gen (MWh)
*= POI_MWh*X_G_Ratio*

Step 2 Capacity Factor Calculation
Potential Generation (MWh)
=Inv_Cap #_Inv* Hours*

Group Capacity Factor
=X_Grp_Net/Pot_Gen

Weighted Hours / Generation - continuation of example
If we have Expected Generation of 2000 MWh but the Gross Actual Generation of 1800 MWh, we have 200 MWh that applies to when the Inverter A is not generating.

These outage hours are recorded for Inverter Group A:
- Partial Reserve Shutdown Hours – Day: 20
- Forced Outage Hours – Day: 20
- Maintenance Outage Hours – Day: 15
- Planned Hours – Day: 2
- Other (Undefined) – Day: 3

If we allocate all 60 hours equally to the 200 MWh, that would be 3.33 MWh averaged. However, we know that some outages occur during peak Capacity times and other outages occur at times when the Inverter Group is at less than full Capacity. It makes sense to weight the hours to show the impact of outages. Increase the weight for outages that occur during high capacity hours and decrease the weight for outages that occur during low capacity hours.

Partial Reserve Shutdown Hours-Day	125%	20	83
Forced Outage Hours-Day	125%	20	83
Maintenance Hours-Day	25%	15	13

Planned Hours-Day	25%	2	2
Other (Undefined) - Day		3	19

Event Examples

During a summer heat wave, some inverters shut off for protection. At 08:15, the accumulated shutoffs cause a loss of 20 MW of Plant Total Installed Capacity. As the day goes on, the number of shutoffs varies, however at 09:40, the Plant Available Installed Capacity reaches its minimum for the event at a loss of 60 MW. At 12:15, 95% of the Plant Total Installed Capacity that was unavailable due to the forced outage, has been returned to service, at which point the event ends.

Event start: Plant Total Installed Capacity (300 MW) – Start Plant Available Installed Capacity (280 MW) = 20 MW

Event Nadir: Minimum value for Plant Available Installed Capacity for event = 60 MW

Event End: End Plant Total Installed Capacity = Plant Total Installed Capacity (300 MW) – (Minimum Plant Available Installed Capacity (60 MW * (1 – 0.095)) = 297 MW

End Plant Available Installed Capacity = 300 – (60 * 0.05) = 297 MW

A snapshot of the lost potential generation from the day of the event is shown in **Figure J.1.**

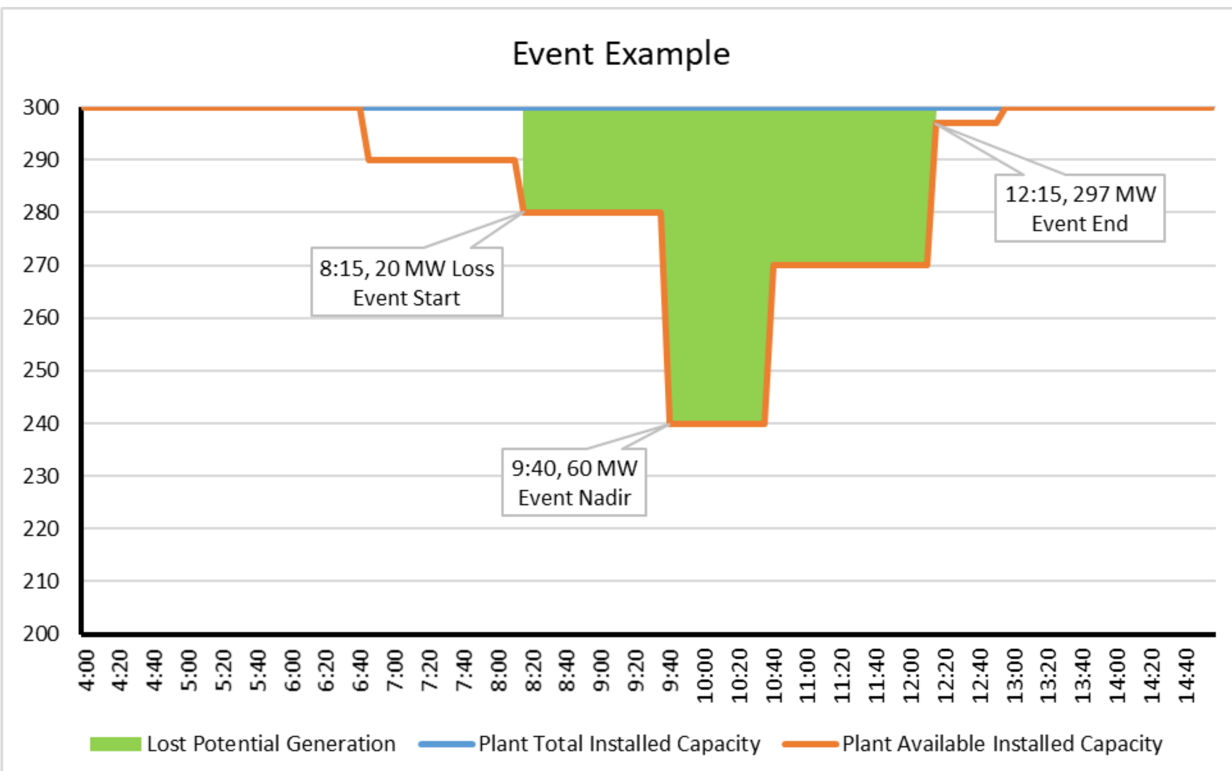


Figure J.1: Event Example

We will go on to show several examples that show how each field is reported, and the flexibility that reporting allows.

Simple Event

The example in **Figure J.2** uses a plant with **100 MW** Of Total Installed Capacity. All inverters are in service, which means that Available Capacity is also 100 MW. In this example, the whole plant is in an outage state. This simple Forced Outage starts at 11 AM and is resolved at 3 PM. The event lasted **Four hours** in duration.

The 20 MW outage threshold is hit at 11 AM, and the 95% return to service threshold is hit at 3 PM. The **Potential MWh Production Loss** for the event must be reported and is calculated as follows. More detail can be found in **Table J.1.**

Potential MWh Production Loss = 4 hours x **100 MW** loss = **400 MWh**

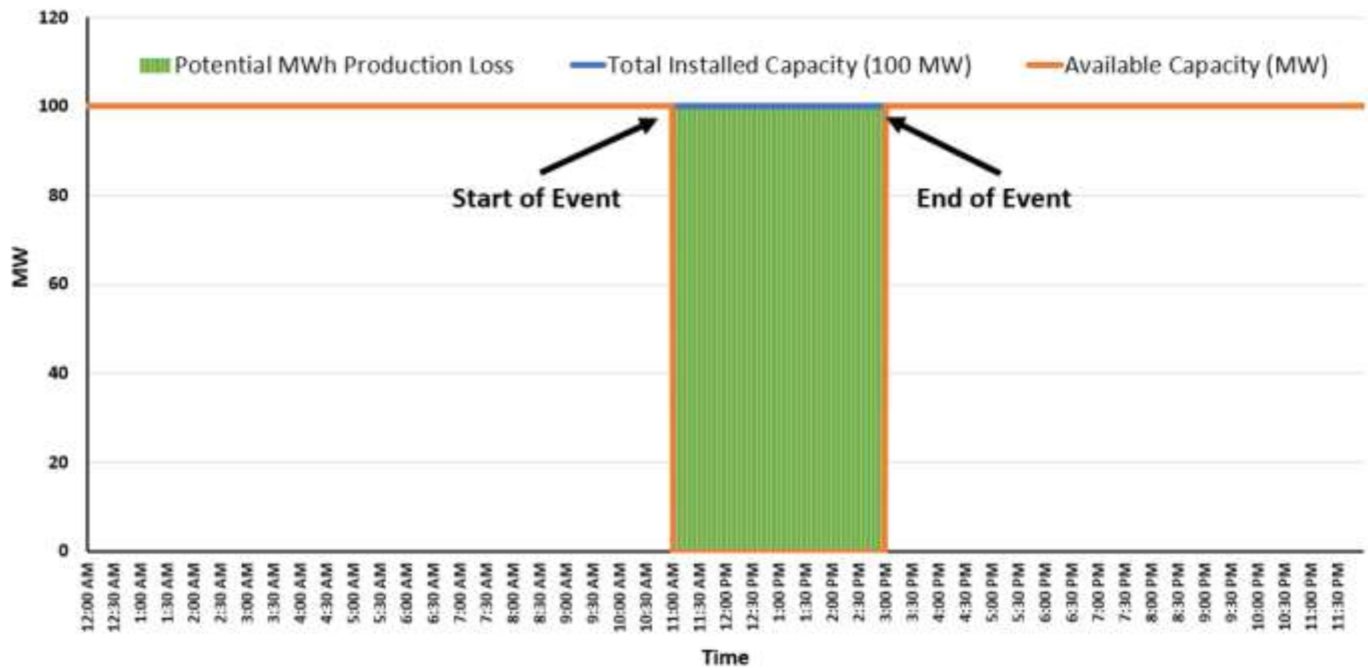


Figure J.2: Simple Event

Table J.1: Simple Event Detail

Entity ID	Plant ID	Event ID	Time Zone	Event Start Date / Time	Event End Date / Time	Event Type	Cause Code	Contributing Operating Condition	Description	Potential MWh Production Loss
1234	5678	18	CPT	10/23/2023 11:00	10/23/2023 15:00	FO	23612	0	Remote power plant went out, resulting in 100 MW outage, causing grid disturbance and protection devices to trip.	400

Progressive Repairs

Most events will likely have a different number of inverters out throughout the course of the event. This example demonstrates a more complex outage of a plant with **100 MW** of Total Installed Capacity. Some inverters are lost, but do not reach the threshold of starting an event as shown in **Figure J.3** Then, the loss threshold reaches **20 MW,** and the event starts at 11 AM.

As repairs are completed, the event ends when **95%** of the equipment comes back online, *even though there are still some inverters in an outage state.* This occurs at 3:00 PM, as shown in **Figure J.3**.

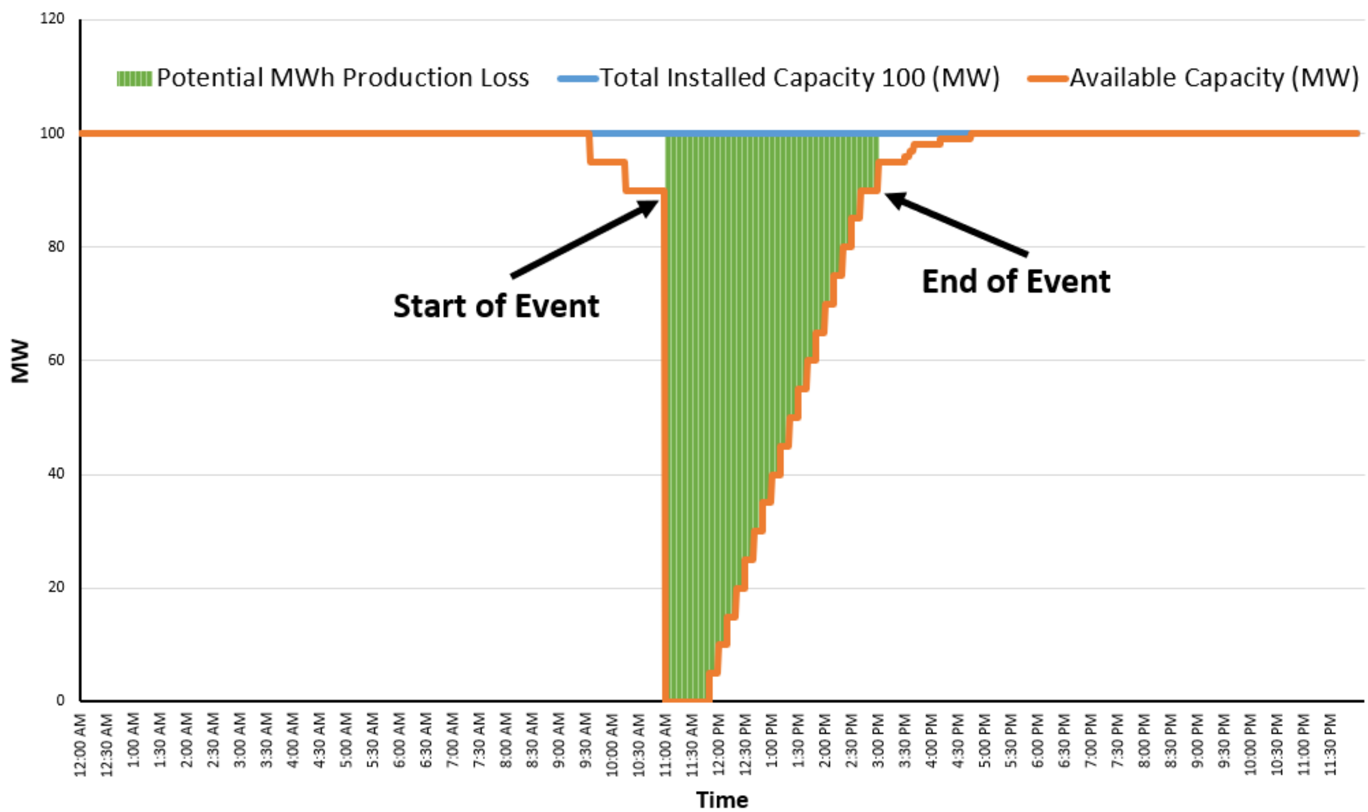


Figure J.3: Progressive Repairs

The event start date/time for this example is the same as in the previous example. However, in this case, the event occurs due to cold weather conditions, as shown in **Table J.2** under Contributing Operating Condition ("9" for cold weather).

Table J.2: Progressive Repairs Event Detail										
Entity ID	Plant ID	Event ID	Time Zone	Event Start Date / Time	Event End Date / Time	Event Type	Cause Code	Contributing Operating Condition	Description	Potential MWh Production Loss
1234	5678	22	CPT	10/23/2023 11:00	10/23/2023 15:00	FO	25050	9	Inverters shut down due to cold weather. However, inverter settings were out of date. Updates allow inverters to run in colder weather. Installed updated settings on each inverter one at a time.	242.50

When summing the intervals of inverters in an outage state over the course of the event, the Potential MWh Production Loss is calculated to be 242. 5 MWh. The calculation is as follows:

Potential MWh Production Loss: $MWh\ Loss = Event\ MW\ Loss\ \times\ Event\ Duration$
MWh Loss = (100 * .83333) + (95 * .16667) + (90 * .16667) + (85 * .16667) + (80 * .16667) + (75 * .16667) + (70 * .16667) + (65 * .16667) + (60 * .16667) + (55 * .16667) + (50 * .16667) + (45 * .16667) + (40 * .16667) + (35 * .16667) + (30 * .16667) + (25 * .16667) + (20 * .16667) + (15 * .16667) + (10 * .33333)
MWh Loss = 242.50

Multiple Inverter Outages as a Single Event

What happens when you have a forced outage during a planned outage event? This example is a continuation of the plant with **100 MW** Of Total Installed Capacity and represents a plant taking 20 MW of installed capacity offline. Several other forced outages occur around the same time.

While the first forced outage is being repaired, more installed capacity goes out. And while that is being worked on, another section of the plant goes out. As recovery proceeds, the forced event ends. The Potential MWh production loss pertains only to the forced outage, not the planned outage. This event is depicted in **Figure J.4**. In addition, there is the capability to use more than one cause code for each event.

As is shown in **Table J.3**, ALL fields must match in this event – especially Event ID. The only field with a different value is the Cause Code. Each event must have a Primary Cause Code. The Primary Cause Code is the main cause of the event that has the most impact to Potential MWh Production Loss. *Any inverters already out for the Planned Outage are not counted in the Forced Outage Event's Potential MWh Production Loss.*

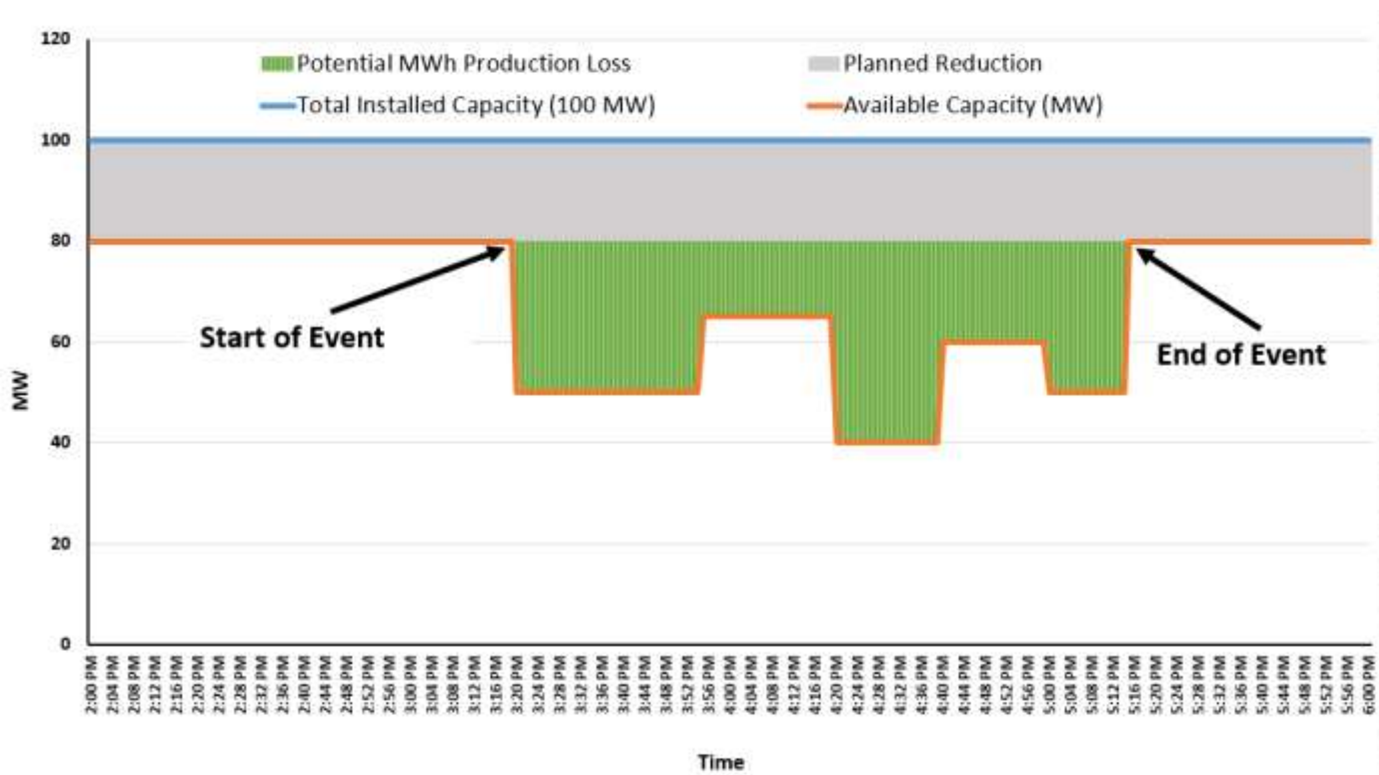


Figure J.4: Multiple Outages as a Single Event

As **Figure J.4** shows, the event starts when the plant has 20 MW of installed capacity go out and ends when 95% of the equipment that was in an outage state returns to service.

Table J.3: Multiple Outages – Single Event Detail

Entity ID	Plant ID	Event ID	Time Zone	Event Start Date / Time	Event End Date / Time	Event Type	Cause Code	Contributing Operating Condition	Description	Potential MWh Production Loss
1234	5678	45	CPT	10/23/2023 06:20	10/23/2023 08:10	FO	**Primary** 25050	0	Section 1 had several inverter rows overheat. During repairs, Section 2 had a cooling failure. While those were being repaired, Section 3 had a short circuit in a cabinet which quickly resolved.	51.25
1234	5678	45	CPT	10/23/2023 06:20	10/23/2023 08:10	FO	Secondary 25080	0	Section 1 had several inverter rows overheat. During repairs, Section 2 had a cooling failure. While those were being repaired, Section 3 had a short circuit in a cabinet which quickly resolved.	51.25
1234	5678	45	CPT	10/23/2023 06:20	10/23/2023 08:10	FO	Tertiary 25110	0	Section 1 had several inverter rows overheat. During repairs, Section 2 had a cooling failure. While those were being repaired, Section 3 had a short circuit in a cabinet which quickly resolved.	51.25

In **Table J.3**, all rows are the same except for the Cause Code Field. This is to explicitly show that there can be different cause codes for a single event. The Reporting interface may show a different format.

The calculation for the Potential MWh Production Loss is as follows:

Potential MWh Production Loss: $MWh\ Loss = Event\ MW\ Loss \times\ Event\ Duration$
MWh Loss = (30 * .5833) + (15 * .4167) + (40 * .3333) + (20 * .3333) + (30 * .25)
MWh Loss = 51.25

Overlapping Outages as Multiple Events

The previous example can pose a dilemma for some larger plants, as they may find that some of these events never actually reach the event end threshold (95% of equipment returns to service), due to the sheer volume of equipment they operate. To help resolve this issue, large outage events may be broken up into several single-cause events as shown in **Figure J.5**.

In this scenario, the outage circumstances in **Figure J.5**are the same as in **Figure J.4**. However, the larger event is broken down into smaller sub-events, which are then reported individually. This can only happen if the plant can ascertain how individual inverters are affected by the outages and can assign different cause codes to each smaller sub-event. In **Figure J.5**, the Plant Available Capacity that is unavailable for Event 45 overlaps the unavailable capacity for Event 46. When calculating the Potential MWh Production loss, only count the inverters that are out for each individual cause code as shown in **Table J.4.**

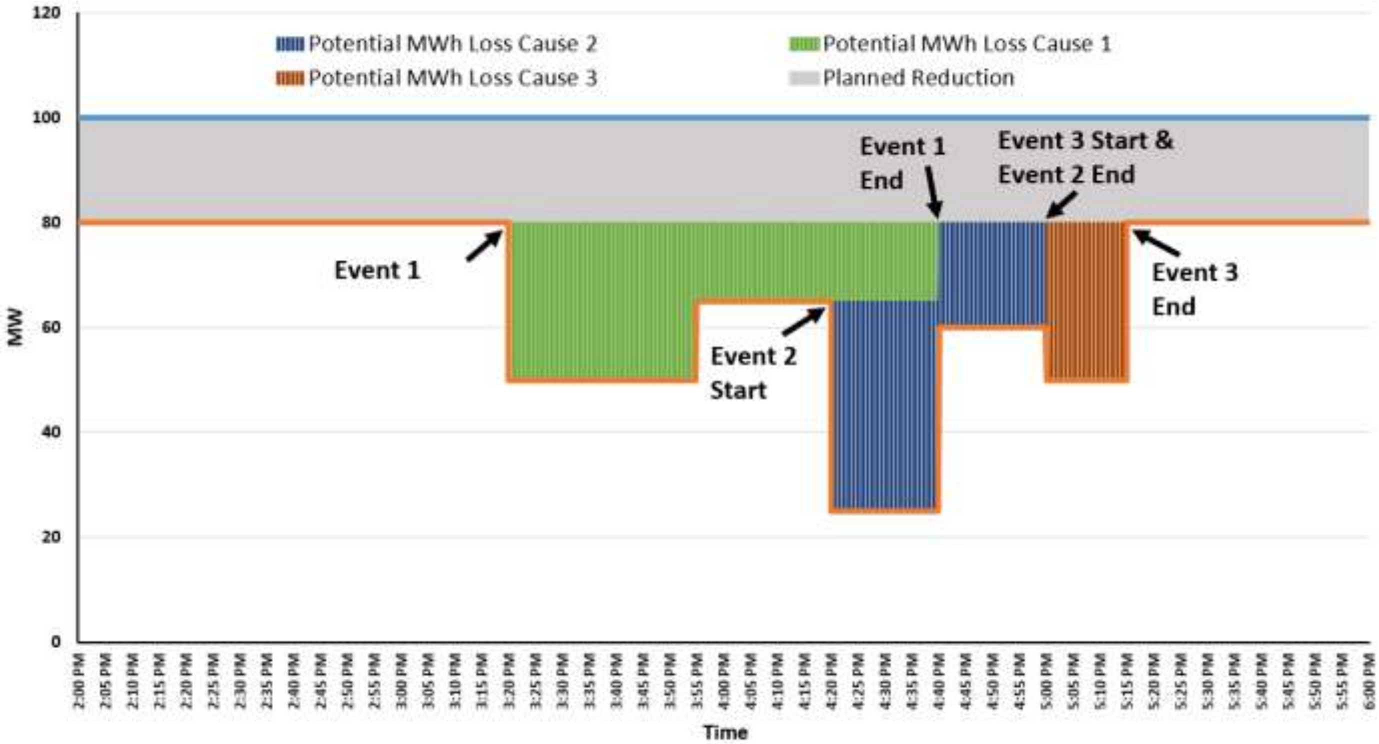


Figure J.5: Overlapping Outages as Multiple Events

We see different shadings for each separate set of inverters that are out. This results in separate values for Potential MWh Production Loss (Table J.4). If you add up each of the separate losses, they will equal the total loss as shown in the previous example (51.25 MWh Loss).

Table J.4: Overlapping Outages – Multiple Event Detail

Entity ID	Plant ID	Event ID	Time Zone	Event Start Date / Time	Event End Date / Time	Event Type	Cause Code	Contributing Operating Condition	Description	Potential MWh Production Loss
1234	5678	45	CPT	10/23/2023 15:20	10/23/2023 16:40	FO	25050	0	Section 1 had several inverter rows overheat.	28.75
1234	5678	46	CPT	10/23/2023 16:20	10/23/2023 17:00	FO	25080	0	Section 2 had a Cooling failure.	15.0
1234	5678	47	CPT	10/23/2023 17:00	10/23/2023 17:15	FO	25110	0	Section 3 had a short circuit in a cabinet which quickly resolved itself.	7.5

Note that all the separate cause codes occur on different sets of inverters. The calculation for the Potential MWh Production Loss is as follows:

Potential MWh Production Loss: $MWh\ Loss = Event\ MW\ Loss \times Event\ Duration$
Event 45 MWh Loss = (30 * .5833) + (15 * .75)
Event 45 MWh Loss = 28.75

Event 46 MWh Loss = (25 * .3333) + (20 * .3333)
Event 46 MWh Loss = 15

Event 47 MWh Loss = (30 * .25)
Event 47 MWh Loss = 7.5

Overlapping Outages for the Same Inverters

What if some of the same inverters were out for different reasons? In this example, shown in Figure J.6, we still have the same 100 MW plant with 20 MW out for a Planned Outage event. However, two events happen at nearly the same time. The first event takes out part of the plant, removing several inverters from service. The second event takes out many of the *same* inverters, as well as others.

There is an important GADS rule that covers this situation: "If equipment is already out of service for a particular outage, it stays in that outage until the outage is fixed." This rule can also apply when tallying inverter-hours in the performance reporting of an inverter group. This means the blue and green overlap should apply to the first outage, and the Potential MWh Production Loss of those inverters applies to that first event.

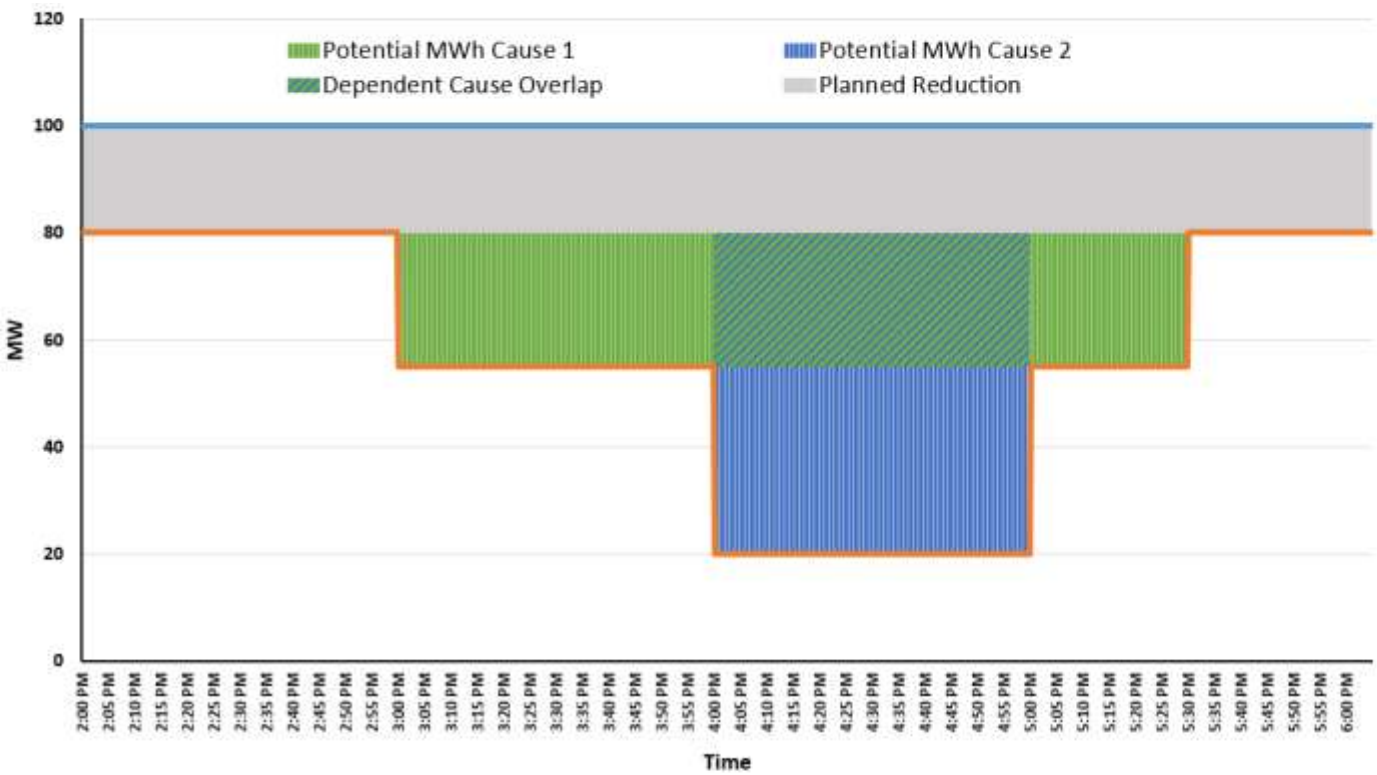


Figure J.6: Overlapping Outages for the Same Inverters

In this example, the summation of Potential MWh Production Loss is higher in the first event than the second event. See Table J.5 for more detail. The calculation for the Potential MWh Production Loss is as follows:

Potential MWh Production Loss: $MWh\ Loss = Event\ MW\ Loss\ \times\ Event\ Duration$
Event 45 MWh Loss = (25 * .25)
Event 45 MWh Loss = 62.5

Event 46 MWh Loss = (35 * 1)
Event 46 MWh Loss = 35

Table J.5: Overlapping Outages - Same Inverters Detail										
Entity ID	Plant ID	Event ID	Time Zone	Event Start Date / Time	Event End Date / Time	Event Type	Cause Code	Contributing Operating Condition	Description	Potential MWh Production Loss
1234	5678	45	CPT	10/23/2023 15:00	10/23/2023 17:30	FO	25050	0	Section 1 had several inverter rows overheat.	62.5
1234	5678	46	CPT	10/23/2023 16:00	10/23/2023 17:00	FO	23600	0	Transformer 2 failed, causing an outage over a large part of plant, overlapping some inverters already out due to event 45.	35.0

Appendix K: Cause Codes

The following tables list available equipment/component for each system and the code to enter for each piece of equipment.

Table K.1: Cause Codes			
System	**Subsystem**	**Cause Code**	**Description**
Electrical	Switchyard	23600	Switchyard transformers (not GSU) and associated cooling systems - external (not OMC)
Electrical	Switchyard	23601	Switchyard transformers (not GSU) and associated cooling systems - external (OMC)
Electrical	Switchyard	23610	Switchyard circuit breakers - external (not OMC)
Electrical	Switchyard	23611	Switchyard circuit breakers - external (OMC)
Electrical	Switchyard	23612	Switchyard system protection devices - external (not OMC)
Electrical	Switchyard	23613	Switchyard system protection devices - external (not OMC)
Electrical	Switchyard	23618	Other switchyard equipment - external (not OMC)
Electrical	Switchyard	23619	Other switchyard equipment - external (OMC)
Electrical	Switchyard	23620	Main transformer (GSU)
Electrical	Switchyard	23640	Revenue meter or Power meter
Electrical	Switchyard	23650	Site Reactive Power Compensation
Electrical	Switchyard	23660	Transmission cables/Buss Work
Solar Generating Equipment		24000	Photovoltaic Panels
Solar Generating Equipment		24010	Support Structure including Tracker
Solar Generating Equipment		24020	Electrical cables
Solar Generating Equipment		24030	Combiner Box
Solar Generating Equipment		24040	Recombiner Box
Solar Generating Equipment		24050	Inverter
Solar Generating Equipment		24060	AC breakers
Solar Generating Equipment		24070	Vegetation around Photovoltaic Panels
Solar Generating Equipment		24090	General
Control System / Communication		25040	Sensors
Control System / Communication		25050	Software

Table K.1: Cause Codes			
System	**Subsystem**	**Cause Code**	**Description**
Control System / Communication		25070	Processor
Control System / Communication		25080	Processor Cooling
Control System / Communication		25090	Hardware
Control System / Communication		25100	Power Supply
Control System / Communication		25110	Control Cabinet Filtration
Control System / Communication		25120	Cabinet Cooling/Heating
Control System / Communication		25130	SCADA
Control System / Communication		25140	Solar Plant Control System
Control System / Communication		25190	General
Control System / Communication		25300	Wave Trap (HV Communications)
Control System / Communication		25310	Site Communication
Energy Storage		26010	Lithium Battery
Energy Storage		26020	Flywheel
Energy Storage		26030	Molten Salt
Energy Storage		26040	Compressed Air
Energy Storage		26090	Other
External	Acts of Nature	29000	Flood (OMC)
External	Acts of Nature	29001	Drought (OMC)
External	Acts of Nature	29010	Fire including wildfires, not related to a specific component (OMC)
External	Acts of Nature	29015	Pandemic (OMC)
External	Acts of Nature	29020	Lightning (OMC)
External	Acts of Nature	29025	Geomagnetic Disturbance (OMC)
External	Acts of Nature	29030	Earthquake (OMC)
External	Acts of Nature	29031	Tornado (OMC)
External	Acts of Nature	29035	Hurricane (OMC)
External	Acts of Nature	29036	Weather - Ice (OMC)
External	Acts of Nature	29037	Weather - Temperature (OMC)
External	Acts of Nature	29038	Weather - Turbulence (OMC)
External	Acts of Nature	29040	Other Catastrophe (OMC)

Table K.1: Cause Codes			
System	**Subsystem**	**Cause Code**	**Description**
External	Acts of Man	29050	Off-Taker Transmission & Distribution (OMC)
External	Acts of Man	29060	External Communication (OMC)
External	Acts of Man	29070	Legal, Contractual or Environmental (OMC)
External	Acts of Man	29080	Execution Delays (OMC) * Special Requirements
External	Acts of Man	29090	Physical Security Incident
External	Acts of Man	29091	Physical Security Incident (OMC)
External	Acts of Man	29092	Cyber Security Incident
External	Acts of Man	29093	Cyber Security Incident (OMC)
External	Acts of Man	29100	External Labor Strikes (OMC)
External	Acts of Man	29110	Regulatory-Environmental
Transmission		29300	Transmission (Gen Tie)
Human Performance		29900	Operator Error
		29910	Maintenance Error
		29920	Contractor Error
		29940	Procedure Error

Appendix L: Equations

Two types of performance equations are provided:

1. **Resource and Equipment Calculations** – These equations calculate the individual resource and equipment performance by inverter group(s) that have similar inverter capacities.
2. **Generation Equations** – These equations calculate the performance statistics based on Generation measures instead of time measures.

In most cases, "resource" performance factors and rates take all outages and hours into consideration. These include, but are not limited to, outages from resource (Solar) unavailability, equipment failures, off-taker events, weather, and any other non-equipment outages. Resource equations are primarily used by resource planners integrating Solar energy into the bulk power supply.

Equipment performance factors and rates take into consideration Calendar Hours, Active Hours, and all outages pertaining to equipment that fall within and outside of management control for a given study. Equipment performance equations are used by plant managers to monitor performance behind the plant boundary.

Section 1: Resource and Equipment Calculations (for inverter groups)

1.A. Resource Performance Factors

These are performance rates and factors that highlight the effect of the resource and are primarily used by planners or from a system view. To do that, Resource Unavailable Inverter Hours Day (RUIHD) and Resource Unavailable Inverter Hours Night (RUIHN) are treated as forced outage hours. This defines the ability of the technology to deliver power to the bulk power system.

Time-based Metrics:
Reported hours are split into Daytime and Nighttime hours. The Resource equations can be calculated for Daytime Hours, Nighttime Hours, or Total Hours, a combination of day and night hours, *Total Hours = Daytime Hours + Nighttime Hours.*

These are the underlying hours for our System and Unit Equations below.

- Active Inverter Hours (AIH)
- Service Inverter Hours (SIH)
- Forced Outage Inverter Hours (FIH)
- Maintenance Outage Inverter Hours (MIH)
- Planned Outage Inverter Hours (PIH)
- Resource Unavailable Inverter Hours (RUIH)

1.A.1 Resource Availability Factor (R-AF)
% of the period in which the plant was available.

$$R\text{-}AF = \frac{[AIH - (FIH + MIH + PIH + RUIH)]}{AIH} \, x \, 100$$

≈ (100 – R-UF)

1.A.2 Resource Unavailability Factor (R-UF)
% of the period in which the plant was unavailable.

$$R\text{-}UF = \frac{(FIH\ +\ MIH\ +\ PIH\ +\ RUIH)}{AIH}\ x\ 100$$

≈ (100 – R-AF)

1.A.3 Resource Planned Outage Factor (R-POF)
% of the period in which the plant was in planned downtime.

$$R\text{-}POF = \frac{(PIH)}{AIH} \times 100$$

1.A.4 Resource Maintenance Outage Factor (R-MOF)
% of the period in which the plant was in maintenance downtime.

$$R\text{-}MOF = \frac{(MIH)}{AIH} \times 100$$

1.A.5 Resource Forced Outage Factor (R-FOF)
% of the period in which the plant was forced offline.

$$R\text{-}FOF = \frac{(FIH\ +\ RUIH)}{AIH}\ x\ 100$$

1.A.6 Resource Unplanned Outage Factor (R-UOF)
% of the period in which the plant was unavailable due to forced and maintenance downtime. For generation resource planning.

$$R\text{-}UOF = \frac{(FIH + MIH + RUIH)}{AIH} \times 100$$

1.A.7 Resource E Scheduled Outage Factor (R-SOF)
% of period in which the plant was unavailable due to maintenance and planned downtime.

$$R\text{-}SOF = \frac{(MIH + PIH)}{AIH} \times 100$$

1.A.8. Resource Generating Factor (R-GF)
% of the period in which the plant was online and in a generating state.

$$R\text{-}GF = \frac{(SIH)}{AIH} \times 100$$

1.A.9. Resource Net Capacity Factor (R-NCF)
% of actual plant generation.

$$R\text{-}NCF = \frac{NAG}{(AIH \times INMC)} \times 100$$

1.A.10. Net Output Factor (NOF)
% of actual plant loading when on-line.

$$NOF = \frac{NAG}{[(SIH) \times INMC]} \times 100$$

1.A.11. Resource Planned Outage Rate (R-POR)
Probability of planned plant downtime when needed for load.

$$R\text{-}POR = \frac{(PIH)}{[(SIH) + PIH]} \times 100$$

1.A.12. Resource Maintenance Outage Rate (R-MOR)
Probability of maintenance plant downtime when needed for load.

$$R\text{-}MOR = \frac{(MIH)}{[SIH + MIH]} \times 100$$

1.A.13 Resource Forced Outage Rate (R-FOR)
Probability of forced plant downtime when needed for load.

$$R\text{-}FOR = \frac{(FIH\ +\ RUIH)}{FIH\ +\ SIH\ +\ RUIH}\ x\ 100$$

1.A.14 Resource Unavailable Forced Outage Rate (R-UFOR)

$$R\text{-}UFOR = \frac{(RUIH)}{FIH + RUIH + SIH}\ x\ 100$$

1.A.15. Resource Unplanned Outage Rate (R-UOR)
Probability of forced or maintenance plant downtime when needed for load.

$$R\text{-}UOR = \frac{(FIH + MIH + RUIH)}{[SIH + FIH + MIH + RUIH]} \times 100$$

1.A.16. Resource Scheduled Outage Rate (R-SOR)
Probability of maintenance or planned plant downtime when needed for load.

$$R\text{-}SOR = \frac{(MIH + PIH)}{[SIH + MIH + PIH]} \times 100$$

1.A.17 Resource Unavailability Factor (R-UF)
The fraction of Active hours in which a unit was not available due to full Resource unavailability.

$$R\text{-}UF = \frac{(RUIH)}{AIH}\ x\ 100$$

1.B. Equipment Performance Factors

These are performance rates and factors that highlight the effect of the equipment and reduce the effect of the resource availability, from the plant view. To do that, Resource Unavailable Inverter-Hours (RUIH) are considered available non-generating hours rather than forced outage hours. This provides for the maximum number of hours the equipment would have operated under normal conditions.

1.B.1 Equipment Availability Factor (E-AF)
% of the period in which the plant was available.

$$E\text{-}AF = \frac{[AIH - (FIH + MIH + PIH)]}{AIH} \; x \; 100$$

≈ (100 – $E\text{-}UF$)

1.B.2 Equipment Unavailability Factor (E-UF)
% of the period in which the plant was unavailable.

$$E\text{-}UF = \frac{(FIH + MIH + PIH)}{AIH} \; x \; 100$$

≈ (100 – E-AF)

1.B.3. Equipment Planned Outage Factor (E-POF)
% of the period in which the equipment was in planned downtime.

$$E\text{-}POF = \frac{(PIH)}{AIH} \times 100$$

1.B.4. Equipment Maintenance Outage Factor (E-MOF)
% of the period in which the equipment was in maintenance downtime.

$$E\text{-}MOF = \frac{(MIH)}{AIH} \times 100$$

1.B.5 Equipment Forced Outage Factor (E-FOF)
% of the period in which the equipment was forced offline.

$$E\text{-}FOF = \frac{(FIH)}{AIH} \; x \; 100$$

1.B.6. Equipment Unplanned Outage Factor (E-UOF)
% of the period in which the equipment was unavailable due to forced and maintenance downtime. For generation resource planning.

$$E\text{-}UOF = \frac{(FIH + MIH)}{AIH} \times 100$$

1.B.7. Equipment Scheduled Outage Factor (E-SOF)
% of the period in which the equipment was unavailable due to maintenance and planned downtime.

$$E\text{-}SOF = \frac{(MIH + PIH)}{AIH} \times 100$$

1.B.8. Equipment Generating Factor (E-GF)
% of the period in which the equipment was online and in a generating state.

$$E\text{-}GF = \frac{(SIH)}{(AIH - RUIH)} \times 100$$

1.B.9. Equipment Net Capacity Factor (E-NCF)
% of actual equipment generation while online.

$$E\text{-}NCF = \frac{NAG}{[(AIH - RUIH) \times INMC]} \times 100$$

1.B.10. Equipment Planned Outage Rate (E-POR)
Probability of planned equipment downtime when needed for load.

$$E\text{-}POR = \frac{(PIH)}{[SIH + PIH + RUIH]} \times 100$$

1.B.11. Equipment Maintenance Outage Rate (E-MOR)
Probability of maintenance equipment downtime when needed for load.

$$E\text{-}MOR = \frac{(MIH)}{[SIH + MIH + RUIH]} \times 100$$

1.B.12. Equipment Forced Outage Rate (E-FOR)
Probability of forced equipment downtime when needed for load.

$$E\text{-}FOR = \frac{(FIH)}{[SIH + FIH + RUIH]} \times 100$$

1.B.13. Equipment Unplanned Outage Rate (E-UOR)
Probability of forced or maintenance equipment downtime when needed for load.

$$E\text{-}UOR = \frac{(FIH + MIH)}{[SIH + FIH + MIH + RUIH]} \times 100$$

1.B.14. Equipment Scheduled Outage Rate (E-SOR)
Probability of maintenance or planned equipment downtime when needed for load.

$$E\text{-}SOR = \frac{(MIH + PIH)}{[SIH + MIH + PIH + RUIH]} \times 100$$

Section 2 Generation Metrics

Generation metrics are based on Energy Generation terms in megawatt-hours instead of time. Since variable generators change capacity continuously, these metrics give better indications of performance than raw hours do. Calculations are based on these data items that are currently collected:

- Expected Generation: EG (Reported in Monthly Performance)

- Gross Maximum Generation: GMG = Active Inverter Hours (reported in Monthly Performance) x Inverter Group Installed Capacity
- Gross Maximum Capacity: GMC = Inverter Group Installed Capacity (Reported in Group Configuration)
- Gross Actual Generation: GAG (Reported in Monthly Performance) (measured at Inverter)
- Net Actual Generation: NAG (Reported in Monthly Performance) (measured at Revenue Meter)
- Net Maximum Capacity: NMC (Reported in Monthly Performance)

2.A.1 Unit Performance Index (PI)
The fraction of generation that was produced compared to the expected generation.

$$PI = \frac{GAG}{EG}\ x\ 100$$

2.A.1.b System Performance Index (SPI)

$$SPI = \frac{GAG}{GMG}\ x\ 100$$

2.A.2.a System Resource Unavailable Generation Factor (RUGF)

$$RUGF = 1 - \frac{EG}{GMG}\ x\ 100$$

2.A.2.b System Resource Available Generation Factor (RAGF)
For resource calculations, Gross Maximum Generation must be in the denominator.

$$RAGF = \frac{EG}{GMG}\ x\ 100$$

2.A.3 Net Capacity Factor (NCF)
The Net Energy that was produced in a given period as a fraction of the Net Maximum Generation.

$$NCF = \frac{NAG}{NMG}\ x\ 100 = NAG\ \frac{NAG}{AIH\ x\ GMC}\ x\ 100$$

Appendix M: Data Quality Validations

GADS data should be reviewed for the following potential discrepancies before submission. This list is by no means comprehensive, but data not meeting these minimum requirements will be rejected. Reporting is done monthly, submitted no later than 45 days after the end of the quarter.

1. **Inverter Group States** – Inverters are either in an Active state (AIH) or an Inactive state. The sum of the two equals the Calendar Hours: Calendar Hours = Active Hours (AIH) + Inactive Hours (IRIH + MBIH + RIH)
2. **Active State** – The sum of all active states should equal AIH.
   a. ASIH – Active Solar Hours (Day)
   b. SIHN – Service Hours Night
   c. RUIHN – Resource Unavailable Night
   d. FOIHN – Forced Outage Night
   e. MIHN – Maintenance Outage Night
   f. PIHN – Planned Outage Night
   g. AIH = ASIH + SIHN + RUIHN + FOIHN + MIHN + PIHN
3. **Inactive State** – Inactive State is the sum of all Inactive Reserve Hours (IRIH), Mothball Hours (MBIH) and Retired Hours (RIH).
4. **Active Solar Hours (Day) (ASIH)** – Active Solar Inverter Hours is the sum of all Available Hours (Day), Resource Unavailable Inverter Hours (Day) and Unavailable Hours (Day)
   a. ASIH = ASIH = RUIHD + SIHD + RSIH + FOIHD + MIHD + PIHD
5. **Resource Unavailable Inverter Hours - Day** – RUIHD is calculated by subtracting the known values from AIH.
   a. RUIHD = AIH – (SIHD + RSIH + FOIHD + MIHD + PIHD + SIHN + RUIHN + FOIHN + MIHN + PIHN)
6. **Resource Unavailable Inverter Hours - Night** – RUIHN is calculated by subtracting the known values from AIH.
   a. RUIHN = AIH – (ASIH + SIHN+ FOIHN + MIHN + PIHN)
7. **Generation** – Generation at the inverter (GAG) >= Net Actual Generation (NAG). GAG is the generation measured at the inverter.
   a. NAG is GAG minus line losses, transformer losses and auxiliary load losses.
   b. GAG < (Period Hours in Month) x (Number of Inverters) x (Max Inverter System Capacity)
   c. Difference between GAG and NAG <= 15%
8. **Capacity** – Inverter Group Installed Capacity >= Net Maximum Capacity (NMC)
   a. Inverter Group Installed Capacity is the Single Inverter System Capacity (MW) times the number of inverters. NMC is Inverter Group Installed Capacity minus line losses, transformer losses and auxiliary load losses.
9. **ID Missing** – An error will be generated if the Entity ID or Inverter Group ID is missing.
10. **ID Not Found** – The Entity ID or Inverter Group ID has not been registered with the GADS Solar Reporting application.
11. **Single Inverter System Capacity (MW) – The** System Capacity – MW rating of a single inverter in the inverter group. The correct value should be the MW capacity of a single inverter.

12. **Total Number of Inverters –** The actual number of physical inverters that exist in the inverter group. The number of inverters must be greater than zero.
13. **Gross Maximum Potential Production (GMPP) –** Gross maximum inverter generation at continuous full-power operation during performance reporting month.
    a. GMPP = (Hours in Month) X (Number of Inverters) X (Max Inverter System Capacity)
14. **Gross Maximum Potential Production against (GAG)** – Gross Actual Generation (GAG) must be less than or equal to Gross Max Potential Production (GMPP)
15. **Net Maximum Capacity (NMC)** - This is equal to the installed capacity less any electrical losses such as transformation losses, line losses, and other losses due to transmission between the inverter and the revenue meter. Net Maximum Capacity (NMC) must be less than or equal to Inverter Group Installed Capacity and may not equal zero when Inverter Group Installed Capacity, Gross Actual Generation (GAG) or Net Actual Generation (NAG) are greater than zero.
16. **Service Inverter Hours Day (SIHD) –** The number of inverter hours the inverter group is synchronized to the system (in service) between sunset of the current day and sunrise of the next day for the month being reported. If reported Service Inverter Hours Day (SIHD) are equal to zero, then Gross Actual Generation (GAG) and Net Actual Generation (NAG) must be equal to zero.
17. **Service Inverter Hours Night (SIHN) –** The number of inverter hours the inverter group is synchronized to the system. It is the inverter hours during which the main breaker is closed, and generation is provided to the grid. If reported Service Inverter Hours Night (SIHN) are equal to zero, then Gross Actual Generation (GAG) and Net Actual Generation (NAG) must be equal to zero.
18. **Gross Actual Generation against Net Actual Generation –** GAG is the sum of all individual inverter meters before removing station service or auxiliary loads. GAG should be measured as close to the inverter's generator as possible so that generation is measured before any auxiliary use by the inverter. NAG is the portion of generation delivered by the inverter group to the revenue meter. It is possible to have a negative NAG value if the group's station service or auxiliary loads are greater than total generation.
19. **Gross Actual Generation should not equal Net Actual Generation due to line losses**. The percentage difference between Gross Actual Generation (GAG) and Net Actual Generation (NAG) should not become greater than 15%.
20. **Service Inverter Hours Day (SIHD) Calculations –** The Service Inverter Hours Day (SIHD) multiplied by Inverter Group Installed Capacity must be greater than or equal to the Gross Actual Generation.
21. **Service Inverter Hours Night (SIHN) Calculations –** The Service Inverter Hours Night (SIHN) multiplied by Inverter Group Installed Capacity must be greater than or equal to the Gross Actual Generation.
22. **Panel Tilt Angle** – Panel Tilt Angle is the number of degrees from the horizontal plane. The Panel Tilt Angle must range from 5° to 45°.
23. **Minimum Irradiance (W/m^2)** – Minimum Irradiance is the minimum irradiance needed to cause a single inverter to start producing (W/m^2). Minimum Irradiance must be greater than 25.
24. **Stowing Wind Speed** – Stowing Wind Speed is the wind speed at which the positioning mechanisms set the panels into a safety position. Not required if panels are fixed. Stowing Wind Speed must range from 0 and 25.
25. **Minimal Operating Temperature** – Minimal Operating Temperature is the manufacturer's minimum operating temperature in degrees Celsius. Minimal Operating Temperature must range from -1 and -50 Celsius.

26. **Maximum Operating Temperature** – Maximum Operating Temperature is the manufacturer's maximum operating temperature in degrees Celsius. Maximum Operating Temperature must range from 40 to 60 degrees Celsius.
27. **Temperature Coefficient** – Temperature Coefficient is the average correction factor of all panels in the Inverter Group; the percent temperature output adjustment from manufacturer's Standard Test Condition (STC) panel output (%/degree C). Temperature Coefficient must range from -.2% and -.6% Celsius.
28. **Nameplate Panel Efficiency** – Nameplate Panel Efficiency is the average nameplate efficiency of all panels in the Inverter Group to convert light energy into electrical energy, as defined on the nameplate of panel. Nameplate Panel Efficiency must range from 10% to 25%.