PD IEC TR 62898-4:2023

BSI Standards Publication

Microgrids

Part 4: Use cases

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National foreword

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A list of organizations represented on this committee can be obtained on request to its committee manager.

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TECHNICAL REPORT

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Microgrids –
Part 4: Use cases

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

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MICROGRIDS –

Part 4: Use cases

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IEC TR 62898-4 has been prepared by subcommittee SC 8B: Decentralized electrical energy systems, of IEC technical committee 8: System aspects of electrical energy supply. It is a Technical Report.

The text of this Technical Report is based on the following documents:

Draft	Report on voting
8B/120/DTR	8B/142/RVDTR

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this Technical Report is English.

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This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

A list of all parts in the IEC 62898 series, published under the general title *Microgrids*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
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INTRODUCTION

This document provides a set of use cases related to microgrids, as a form of "decentralized energy system". Decentralized energy systems are small energy systems containing loads and distributed energy resources (generation, storage) with decentralized management for energy supply. This document completes the SC 8B roadmap for decentralized electrical energy systems. The goal is to explain the methodology retained on the microgrid sub-domain, which is a kind of decentralized system. This methodology, based on IEC 62913-1, describes high-level use cases (business use cases) covering the main typical usage of microgrids, and details some of them through system use cases. The proposed list of use cases is a first version, proposed for review; the goal is to cover all use cases with the same level of depth.

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MICROGRIDS –

Part 4: Use cases

1 Scope

In line with the methodology specified in IEC SRD 62913-1, this document describes business use cases (high-level use cases covering the main typical usage of microgrids) and details some of them. System use cases linked to those business use cases are listed and briefly described for contextualizing the main functions to be performed for managing microgrids. Ultimately, the goal of this document is to provide a consistent level of detail for all business use cases. The document details the methodology retained to develop system use cases from the business use cases.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC SRD 62913-1, *Generic smart grid requirements – Part 1: Specific application of the Use case methodology for defining generic smart grid requirements according to the IEC systems approach*

3 Terms, definitions, and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC SRD 62913-1 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1.1
black start
start-up of an electric power system from a blackout through internal energy resources

[SOURCE: IEC 60050-617:2017, 617-04-24]

3.1.2
distributed energy resources
DER
generators (with their auxiliaries, protection and connection equipment), including loads having a generating mode (such as electrical energy storage systems), connected to a low-voltage or a medium-voltage network

[SOURCE: IEC 60050-617:2017, 617-04-20]

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3.1.3
distributed energy resource management system
DERMS
system which, on behalf of other interested systems, manages the communications and control of individual distributed energy resources (DER), and can do this with a variety of field message protocols, and aggregates this information and communicates with other utility systems, such as a distribution management system (DMS)

3.1.4
distributed generation
DG
generation of electric energy by multiple sources which are connected to the power distribution system

[SOURCE: IEC 60050-617:2009, 617-04-09, modified – The preferred terms "embedded generation" and "dispersed generation" have been omitted.]

3.1.5
distribution management system
DMS
integration of business processes, hardware, software, and telecommunications equipment that provide effective tools to manage the operational business processes related to network management, outage management, power quality and other supporting operational practices

[SOURCE: IEC TS 61968-2:2011, 2.88]

3.1.6
electrical energy management system
EEMS
system monitoring, operating, controlling and managing energy resources and loads of the installations

Note 1 to entry: This equipment can be stand-alone or integrated in other larger equipment such as a home and building electronic system.

[SOURCE: IEC 60364-8-1:2019, 3.2.1, modified – Note 1 to entry has been added.]

3.1.7
electrical energy storage
EES
installation able to absorb electrical energy, to store it for a certain amount of time and to release electrical energy during which energy conversion processes can be included

EXAMPLE A device that absorbs AC electrical energy to produce hydrogen by electrolysis, stores the hydrogen, and uses that gas to produce AC electrical energy is an electrical energy storage.

Note 1 to entry: The term "electrical energy storage" may also be used to indicate the activity that an apparatus, described in the definition, carries out when performing its own functionality.

Note 2 to entry: The term "electrical energy storage" should not be used to designate a grid-connected installation; *electrical energy storage system* (3.1.8) is the appropriate term.

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3.1.8
electrical energy storage system
EES system
EESS
installation with defined electrical boundaries, comprising at least one electrical energy storage, which extracts electrical energy from an electric power system, stores this energy internally in some manner and injects electrical energy into an electric power system and which includes civil engineering works, energy conversion equipment and related ancillary equipment

Note 1 to entry: The EES system is controlled and coordinated to provide services to the electric power system operators or to the electric power system users.

Note 2 to entry: In some cases, an EES system may require an additional energy source (non-electrical) during its discharge, providing more energy to the electric power system than the energy it stored. Compressed air energy storage is a typical example where additional thermal energy is required.

3.1.9
electric power system
EPS
composite, comprised of one or more generating sources, and connecting transmission and distribution facilities, operated to supply electric energy

Note 1 to entry: A specific electric power system includes all installations and plant, within defined bounds, provided for the purpose of generating, transmitting and distributing electric energy.

[SOURCE: IEC 60050-692:2017, 692-01-02]

3.1.10
isolated microgrid
group of interconnected loads and distributed energy resources forming a local electric power system at distribution voltage levels not currently capable of being connected to a wider electric power system

Note 1 to entry: Isolated microgrids are usually designed for geographical islands or for rural electrification.

Note 2 to entry: The definition includes a modification with respect to the IEV 617-04-23 to consider the fact that in the future, an isolated microgrid may be connected to an electric power system thanks to grid extension (this feature is explored further in this document).

[SOURCE: IEC 60050-617:2017, 617-04-23:2017, modified – In the definition, "with defined electrical boundaries" has been deleted, and "that cannot be connected" has been replaced with "not currently capable of being connected".]

3.1.11
microgrid
group of interconnected loads and distributed energy resources with defined electrical boundaries forming a local electric power system at distribution voltage levels, that acts as a single controllable entity and is able to operate in either grid-connected or island mode

Note 1 to entry: This definition covers both (utility) distribution microgrids and (customer owned) facility microgrids.

[SOURCE: IEC 60050-617:2017, 617-04-22]

3.1.12
prosumer's electrical installation
PEI
electrical installation connected to a public distribution network or not able to operate with one or both of local power supplies and local storage units, and that monitors and controls the energy from the connected sources delivering it to one or more of loads, local storage units, and public distribution network

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3.1.13
virtual power plant
VPP
group of distributed energy resources which combine to function as a dispatchable unit

Note 1 to entry: A virtual power plant can be used for the purpose of participating in the electricity market or aggregating ancillary services.

[SOURCE: IEC 60050-617:2017, 617-04-27]

3.2 Abbreviated terms

BUC	business use cases
CIM	common information model
DC	direct current
DER	distributed energy resource(s)
DERMS	distributed energy resources management system
DG	distributed generation
DMS	distribution management system
DSO	distribution system operator
EEMS	electrical energy management system
EES	energy storage system
EESS	electrical energy storage system
EMS	energy management system
EV	electric vehicle
EPS	electric power system
FACTS	flexible alternating current transmission system
HV	high voltage
HVDC	high voltage direct current
IEC	International Electrotechnical Commission
LV	low voltage
MV	medium voltage
POC	point of connection
PEI	prosumer's electrical installation
PQ	power quality
REP	retail energy provider
SCADA	supervisory control and data acquisition
SMU	system management unit
SUC	system use cases
SyC	system committee
TSO	transmission system operator
UML®[1]	Unified Modeling Language™
VPP	virtual power plant

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4 Overview of the document

In line with the methodology specified in IEC SRD 62913-1, this document describes business use cases (high-level use cases covering the main typical usage of microgrids) and details some of them.

Like any business use cases, these use cases attempt to be agnostic from any solutions or systems used for supporting the implementation of these use cases.

System use cases linked to those business use cases are listed for contextualizing the main functions to be performed for managing microgrids. For each of these, a short description and the involved system roles are listed with the intent to lay out technical requirements for further analysis. In the current document, not all the business use cases are covered in detail. Ultimately, the goal of the document is to provide a consistent level of detail for all business use cases. The document details the methodology selected to develop system use cases from the business use cases.

This work feeds the setting up of the standardization roadmap for decentralized energy systems, in the specific case of microgrids.

This means that this work will be followed by three next steps.

- Derive from these use cases some high-level objects to be standardized to ensure the implementation of a standard based solution for microgrids.
- Identify standards or standardization initiatives relevant in the context of microgrids and engage in a collaboration for coordination.
- Conclude on possible standardization recommendations to SC 8B or other TCs/SCs in IEC. Standardization activities could proceed with cooperation of concerned TC/SCs and SyCs, including but not limited to IEC SyC Smart Energy, SyC LVDC, TC 22, TC 57, TC 64, TC 82, TC 88, TC 95, TC 120.

Some additional benefits are expected from the content of this document:

- harmonization of the vocabulary related to microgrids across IEC initiatives;
- harmonization of the roles and functions;
- harmonization of the context of standardization for features cross cutting the IEC organization.

By nature, such a document is expected to evolve in order to reflect in the closest way market needs related to microgrids usage.

The proposed list of system use cases is a first version, proposed for review; the ultimate goal is to cover all use cases with the same level of depth.

5 Role model associated to decentralized electrical energy systems

5.1 Role model based on SGAM

The grouping of roles and actors (systems, components, operators, etc.) is based on a commonly accepted breakdown model, the EU M490 smart grid conceptual model Smart Grid Architecture Model (SGAM) in order to apprehend its complexity and to help maintain a global vision. SGAM is described in detail in IEC TR 62357-1 and IEC SRD 63200. IEC established a link between the SGAM framework and the use case methodology through key concepts: roles, business processes, activities, systems and functions in IEC SRD 62913-1. The SGAM framework enables the design of new smart grid architecture components to be organized on a three-axis basis (see Figure 1).

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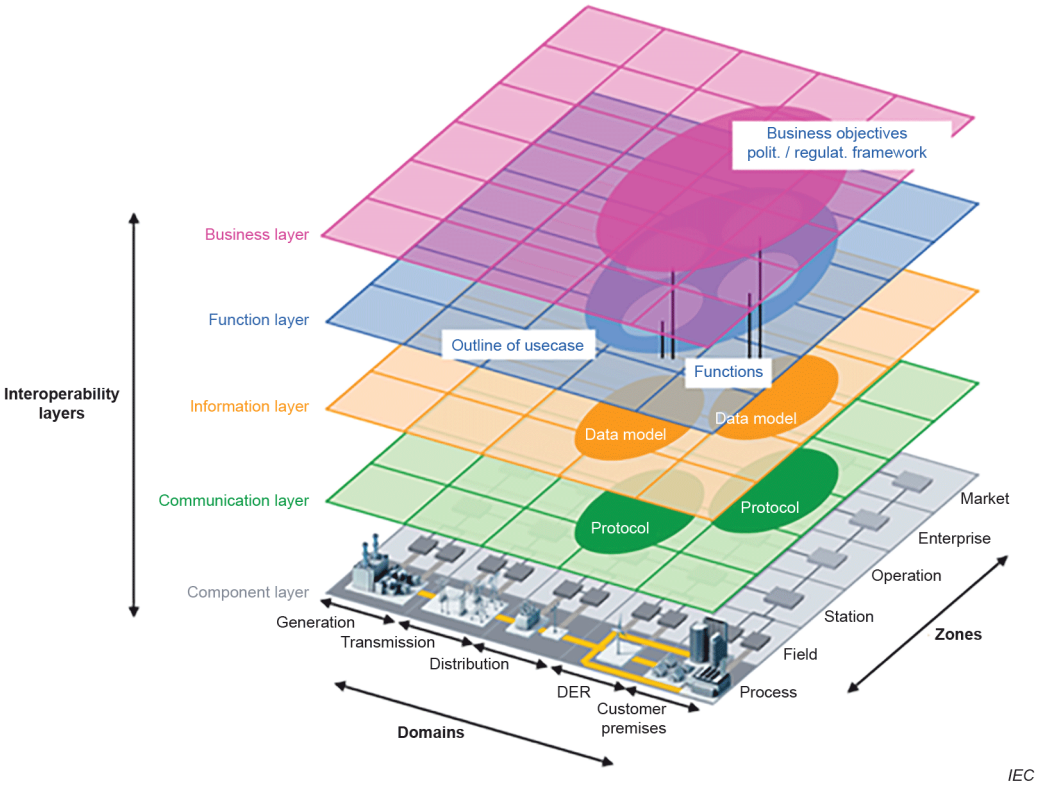

Figure 1 – The Smart Grid Architecture Model (CEN-CENELEC-ETSI, 2014)

5.2 Business roles

Table 1 lists the business roles that have been identified so far by IEC SyC Smart Energy following the guidelines for role modelling of IEC SRD 62913-1. This list is not exhaustive and will be updated as the use cases are drafted.

Table 1 – Business roles of the domain

Business roles	Definition
Generation and DER roles	
DER owner	Responsible party for overall market and financial decisions and contracts related to DER including microgrid design and operations
DER operator	Responsible party for operational aspects of the facilities and their DER systems including real time microgrid operations
Flexibility aggregator	A party which aggregates flexibilities for its customers. Can activate flexibility sites. Equivalent to retail energy provider (REP) in this document.
DER equipment manufacturer	Entity that produces, tests, sells, and implements DER systems
Producer	Party generating electric energy. Additional information: This is a type of grid user. [SOURCE: IEC 60050-617:2009, 617-02-01]
Prosumer	Network user that consumes and produces electrical energy [SOURCE: IEC 60050-617:2017, 617-02-16]
Decentralized electricity producer	Electricity producer with generator(s) connected to the distribution grid. Production can be dispatchable or non-dispatchable. This is a type of producer.
Power plant operator	Responsible party for operational aspects of a power plant

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Business roles	Definition
Power plant owner	Responsible party for market and financial decisions and contracts related to a power plant
Client / customer / consumer (of electricity supplier)	A party connected to the EPS that contracts for the ability to consume electricity at a metering point.
Grid user	A party connected to the EPS and consuming or producing electricity or both. Grid users include consumers, producers, and prosumers. Equivalent to party connected to the grid.
Microgrid operator	Party responsible for the safe and reliable operation of a microgrid [SOURCE: IEC 60050-617:2017, 617-02-19]
Microgrid owner	Third party managing DER systems based on market information, financial decisions and contracts related to a microgrid
Transmission and distribution domain	
Microgrid manager	Entity responsible for the planning, operation, maintenance, and the development in given areas of the electricity network (LV, MV, and potentially HV), the quality of electricity supply (power delivery, voltage etc.), to arrange for grid connections to DERs and prosumers. The microgrid manager is responsible for the management of DER within the microgrid premises to match consumption.
Retail energy provider (REP)	Third party managing DER systems based on market information
System operator	Party responsible for safe and reliable operation of a part of the electric power system (EPS) in a certain area and for connection to other parts of the electric power system [SOURCE: IEC 60050-617:2009, 617-02-09]
Distribution system operator (DSO)	Party operating a distribution system [SOURCE: IEC 60050-617:2009, 617-02-10] The DSO is responsible for the planning, operation, maintenance, and the development in given areas of the electricity distribution network (LV, MV, and potentially HV), the quality of electricity supply (power delivery, voltage etc.), grid connection of DERs and prosumers for customer access to energy supply retail market through the DSO's system under regulated conditions. According to Article 2.6 of the Electricity Directive 2009/72/EC (Directive): "a natural or legal person responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area and, where applicable, its interconnections with other systems and for ensuring the long-term ability of the system to meet reasonable demands for the distribution of electricity"
Transmission system operator (TSO)	Party operating a transmission system [SOURCE: IEC 60050-617:2009, 617-02-11] The TSO is responsible for the planning, operation, maintenance, and the development in given areas of the electricity transmission network (HV), the quality of electricity supply (frequency and voltage), and access to the bulk market system for DER systems capable of participating. According to Article 2.4 of the Electricity Directive 2009/72/EC (Directive): "a natural or legal person responsible for operating, ensuring the maintenance of and, if necessary, developing the transmission system in a given area and, where applicable, its interconnections with other systems, and for ensuring the long-term ability of the system to meet reasonable demands for the transmission of electricity". Moreover, the TSO is responsible for connection of all grid users at the transmission level and connection of the DSOs within the TSO control area. [SOURCE: EU Commission Task Force for Smart Grids, EG3]
Balancing responsible arty	Party contractually responsible for the observed differences between electricity supplied and electricity consumed, within a defined area
Market services roles	
Service provider or energy service provider	Entity providing electricity-related services (such as energy efficiency or communication services)
Bulk power market or transmission market	Entity providing a market for buying and selling energy and ancillary services to the bulk power system

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Business roles	Definition
Distribution market	Entity providing a market for buying and selling energy and ancillary services to the distribution power system In general, this entity does not exist as a "market", but many energy service providers can provide related capabilities.
Demand response market	Entity providing energy prices to consumers and prosumers so that they can change their energy demand based on those prices
Third party roles	
Meter operator	A party responsible for installing, maintaining, testing, certifying and decommissioning physical meters in compliance with the regulated conditions for contract between ESR and their customers [SOURCE: ENTSO-E, EFET, and ebIX, 2010]
Metering point administrator	A party responsible for registering the parties linked to the metering points in a Metering Grid Area. The metering point administrator is also responsible for maintaining the Metering Point technical specifications. The metering point administrator is responsible for creating and terminating metering points. [SOURCE: ENTSO-E, EFET, and ebIX, 2014]
Telecommunications operator	Entity that offers telecommunications services
Electricity installer	Entity that installs and maintains smart electric systems for industrial, commercial, and residential purposes
Equipment manufacturer	Entity that produces and sells electrical devices and electricity management devices

In addition, analysis has highlighted the need to extend business roles listed above with the following role:

Third party roles	
Weather service provider	A party responsible for providing weather forecast suitable for asset power forecast that can affect DER dispatchability

5.3 System roles

Table 2 lists the system roles identified by the IEC SyC Smart Energy and SC8B AhG2 relevant for this document along with some necessary additions.

To sort the system roles, the distinction was made between general and specific system roles. A specific system role is always attached to a general system role. A specific system role inherits the properties of the general system role and can also be referred to by the general system role. A system role can both be a general and a specific system role.

Note that this list is not intended to be exhaustive, nor does it intend to show all the relationships between different roles. Its intent is to serve the purpose of this document to provide details on the system roles to better describe the system use case.

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Table 2 – System roles of the domain

System roles		Definition
General system role	**Specific system role**	
Level 0 Electric Power System		
Electric power system (EPS)		Composite, comprised of one or more generating sources, and connecting transmission and distribution facilities, operated to supply electric energy Note 1 to entry: A specific electric power system includes all installations and plant, within defined bounds, provided for the purpose of generating, transmitting and distributing electric energy. [SOURCE: IEC 60050-692:2017, 692-01-02]
	Local EPS	An EPS contained entirely within a single premises or group of premises
	Area EPS	An EPS that serves local EPSs
	Microgrid EPS	A local EPS that can operate as an island and can be operated as a virtual resource to the area EPS
	DC EPS	A local EPS that operates direct current
EPS measurement system		The overall measurement system of an EPS, consisting of all the sensors and relays that measure, record and deliver the electrical state variables of the EPS
	Frequency measurement system	A set of equipment that can measure frequency, record and provide the data for other systems to use.
	Voltages measurement system	A set of equipment that can measure voltage, record and provide the data for other systems to use.
Point of connection (POC)		Reference point on the electric power system where the user's electrical facility is connected. Note 1 to entry: In this document, point of connection indicates a point where an area EPS is connected to another local, DER or microgrid EPS. [[SOURCE: IEC 60050-617:2009, 617-04-01, modified – Note 1 to entry added.] NOTE For those POC between a utility EPS and a plant or site EPS, this point is identical to the point of common coupling (PCC) in IEEE Std 1547 "Standard for Interconnecting Distributed Resources with Electric Power Systems".
	POC switch	Switch plus its controller at the POC
	EPS switch	Switch plus its controller within an EPS
Synchronizing equipment		Equipment that synchronizes the frequency, voltage magnitude and angle between two EPSs
Weather system		Meteorological service providing weather system that can affect DER capabilities

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System roles		Definition
General system role	**Specific system role**	
Level 1 Energy Resources		
Virtual resource (high level)		A set of one or more energy service resources, including generators, energy storage, controllable load, and ancillary services
Distributed energy resource (DER)		A distributed set of one or more energy service resources, including generators, energy storage, and ancillary services
	Renewable DER	DER system whose prime energy mover comes from renewable sources, including water, solar, wind, and biofuels
	Wind turbine	A rotating machinery in which the kinetic wind energy is transformed into another form of energy [SOURCE: IEC 60050-415:1999, 415-01-01]
	Hydroelectric power station	A power station in which the gravitational energy of water is converted into electricity [SOURCE: IEC 60050-602:1983, 602-01-04]
	Solar power station	A power station producing electrical energy from solar radiation directly by photovoltaic effect, or indirectly by thermal transformation [SOURCE: IEC 60050-602:1983, 602-01-29]
	Biomass power plant	A thermal power station in which the thermal energy is obtained by a combustion of biomass
	Geothermal power station	A thermal power station in which thermal energy is extracted from suitable parts of the Earth's crust [SOURCE: IEC 60050-602:1983, 602-01-28]
	Combined heat and power (CHP)	The production of heat which is used for non-electrical purposes and also for electricity. [SOURCE: IEC 60050-602:1983, 602-01-24] In some circumstances, electrical energy is the primary purpose with heat as a secondary purpose.
	Electric vehicle (EV) and electric vehicle supply equipment (EVSE)	Automobile which is powered completely or in part by electricity and whose battery can be charged from an EPS Combination of EV and EVSE is identified as a DER by IEC 63110-1.
	Fuel cell	A generator of electricity using chemical energy directly by ionisation and oxidation of the fuel [SOURCE: IEC 60050-602:1983, 602-01-33]
	Gas turbine set	A thermal generating set in which the prime mover consists of a gas turbine [SOURCE: IEC 60050-602:1983, 602-02-23]
	Heat pump	An electrical device that can heat a building (or part of a building) by transferring thermal energy from the outside using the refrigeration cycle
	Electrical energy storage system	A system that can store and deliver electrical energy by conversion into another form (chemical, potential, kinetic, thermal …) Electrical energy storage system includes battery, flywheel, compressed air, and pumped hydro storage
DER unit		Prime mover and converter to or from electrical energy or both, including generators, energy storage, and controllable load
	DER storage unit	DER unit that includes energy storage that can be converted to electrical energy
	DER generating unit	DER unit that includes generation of electrical energy

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System roles		Definition
General system role	**Specific system role**	
Load		Power demanded by a group of consumers
	Controllable load (high level)	Load allowed to be modified based on operating conditions, tariffs, contracts, or other criteria
	Non-controllable load	Load that is not allowed to be modified
	Critical load	Load within a local EPS having the highest priority of service These loads are served at the expense of all other loads.
	Non-critical load	Load within a local EPS having the lowest priority of service These loads can be left unserved in favour of critical loads.
DER controller		Controller of DER unit
DER system		Combined DER controller and DER unit, including generators, energy storage, and controllable load
	Regulating DER system	DER system responsible for frequency or voltage regulation or both The regulating DER system could be a generator, an energy storage system, or controllable load.
	Non-regulating DER system	DER system not participating in frequency or voltage regulation
Time synchronization source		Source of an accurate time signal
DER protection function		Safety-related function to prevent harm to personnel, the DER system and possibly other electrical equipment
	Protection	Provisions for detecting faults or other abnormal conditions in a power system, for enabling fault clearance, for terminating abnormal conditions, and for initiating signals or indications [SOURCE: IEC 60050-448:1995, 448-11-01]
	Firefighting	Function to prevent fire ignition
DER log		Log of significant events and alarms for use in market settlements, operational analysis, and other audit purposes
DER meter		Meter that records the energy produced within specified time periods, energy used within specified time periods for DER charging of storage, and demand curves of DER generation and storage over time Depending on the agreement between the system operator and the microgrid owner, the meter can perform recording of active and reactive power.
DER switch		Switch and its controller that connects a DER or a DER system to an upper-level EPS

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