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TECHNICAL SPECIFICATION

colour inside

Virtual Power Plants-
Part 2: Use Cases

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VIRTUAL POWER PLANTS –

Part 2: Use cases

FOREWORD

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IEC TS 63189-2 has been prepared by subcommittee 8B: Decentralized electrical energy systems, of IEC technical committee 8: System aspects of electrical energy supply. It is a Technical Specification.

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

Draft	Report on voting
8B/136/DTS	8B/198/RVDTS

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 Specification is English.

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/publications.

A list of all parts in the IEC 63189 series, published under the general title *Virtual power plants*, 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 webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

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INTRODUCTION

The virtual power plants use cases are developed to facilitate the standardization in this area from a system perspective. The use cases capture the basic information, business roles, actors, scenarios, and processes from practical business applications, pilot projects, and academic researches of virtual power plants in different countries. This document is developed to capture the requirements in the form of use cases that contain the scenarios and steps in a logical sequence so that it cannot only be understood by interested parties to obtain their related requirements, develop a virtual power plant, or operate a virtual power plant, but also establish a nomenclature for the functions, roles, etc. Meanwhile, the use cases in the document apply to any types of DER aggregation (physical, virtual, small and large), and also to microgrids.

Interested parties for this document include, but are not limited to:

- virtual power plant operator
- distributed generation operator
- demand response service operator
- electrical energy storage operator
- electric vehicle operator
- electric vehicle charging station with storage
- power system operator
- electricity market operator
- transmission and/or distribution company
- energy service company
- energy information provider
- regulator

The major objectives of this document include:

- to build common understanding of the business, system and functional requirements and thus to facilitate further development of VPPs;
- to investigate future standardization needs, in order to ensure the easy implementation, performance and interoperability of VPPs;
- to serve as an input to the IEC Use Case management repository, the purpose of which is to collect, administer, maintain, and analyze generic use cases.

VIRTUAL POWER PLANTS –

Part 2: Use cases

1 Scope

This document is applicable to virtual power plants (VPPs) that consist of distributed generation, controllable loads, and electrical energy storages.

This part of IEC 63189 is to provide VPPs use cases that capture the basic information, business roles, actors, scenarios, and processes.

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 62913-1:2019[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 and definitions

For the purposes of this document, the following terms and definitions 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
aggregator
party who contracts with a number of other network users (e.g. energy consumers) in order to combine the effect of smaller loads or distributed energy resources for actions such as demand response or ancillary services

[SOURCE: IEC 60050-617:2017, 617-02-18]

3.2
controllable load
CL
load of particular consumers which under contract shall be reduced, for a limited period of time, at the request of the distribution supply undertaking

Note 1 to entry: Controllable load can be increased as well as reduced, according to the request of the distribution supply undertaking.

[1] This publication was withdrawn.

[SOURCE: IEC 60050-603:1986, 603-04-42, modified ─ Addition of a Note 1 to entry.]

3.3
demand response
DR
action resulting from management of the electricity demand in response to supply conditions

[SOURCE: IEC 60050-617:2011, 617-04-16]

3.4
distributed energy resources
DER
generators (with their auxiliaries, protection and connection equipment), including load 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]

3.5
distributed generation
DG
generation of electric energy by multiple resources which are connected to the power distribution system

Note 1 to entry: Distributed generation in VPPs are usually in the form of renewable energy generation, such as wind power, photovoltaic generation.

[SOURCE: IEC 60050-617:2009, 617-04-09, modified ─ Addition of a Note 1 to entry.]

3.6
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 may be included

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" is the appropriate term.

[SOURCE: IEC 62933-1:2018, 3.1, modified ─ The example was deleted.]

3.7
prosumer
network user that consumes and produces electrical energy

[SOURCE: IEC 60050-617:2017, 617-02-16]

3.8
use case
specification of a set of actions performed by a system, which yields an observable result that is, typically, of value for one or more actors or other stakeholders of the system

[SOURCE: ISO/IEC 19505-2:2012, 16.3.6]

3.9
virtual power plant
VPP
party or system that realizes aggregation, optimization and control of distributed generation, energy storage devices and controllable loads

Note 1 to entry: The aggregated distributed generation, energy storage devices and controllable loads are not necessarily within the same geographical area.

Note 2 to entry: The party or system is to facilitate the activities in power system operations and electricity market.

4 System requirements

4.1 General considerations

VPPs aim to effectively aggregate DG, EESs and CLs as one dispatchable and tradable unit by utilizing technologies in areas such as information, communication and control technologies. VPPs provide capacity and ancillary services to the power system operation and sell energy to electricity markets. VPPs enhance the overall system economics and reliability, promote efficient optimization in resources, and facilitate renewable energy consumption.

The general objective of this document is to collect actual business applications, pilot projects, and academic researches, and develop use cases that capture VPPs basic information, business requirements, actors and roles, scenarios, and processes. VPPs use cases help participants to understand an existing function or process, engineers to develop system and functional requirements, and stakeholders to reach common consensus on best practice processes.

Use cases in this document can also provide guidance to development teams on user's needs related to cyber security and data privacy.

4.2 Basic requirements

4.2.1 General

The system should be capable of aggregating, forecasting, optimizing, coordinating, and controlling distributed generation, energy storage systems, and controllable loads, as one dispatchable unit in power system operations and one tradable unit in electricity markets. Meanwhile, it should be capable of providing ancillary services, such as reserve to guarantee promised delivery, and communicating with the power system operator directly to provide the support in operators' tasks.

4.2.2 Privacy

The system should comply with applicable laws and regulations to ensure the integrity, security and privacy of related data acquired during the VPPs operation process.

4.2.3 Cyber security

VPPs' operation depends on cyber security to a large extent. The system should consider preventive measures to ensure cyber security and minimize risks that could cause network communication breakdowns in system failures.

4.2.4 Adaptability, flexibility and interoperability

The system should be adaptable to various software and hardware conditions, as well as flexible to incorporate customer needs, and interoperable among related equipment to realize coordinated operation.

4.2.5 Communication and information

The system should utilize the information and communication technologies to ensure the secure, reliable and effective communication to satisfy the technical and commercial needs.

4.2.6 Reliability

The reliability and security of the system should be ensured.

4.3 Operational risks of VPPs

4.3.1 General

Potential operational risks caused by the failure of a VPP equipment or system are classified into three levels, depending on the severity of potential damages to grid operations and electricity market.

4.3.2 Major

A failure in a VPP equipment or system is considered as major, if it could result in serious impacts or damages to grid operations and/or the market, including but not limited to:

– blackout;
– complete or large-scale loss of data acquisition and transmission;
– complete or large-scale failure of communication network;
– database crashes;
– application program outage;
– unable to cover the reserves.

4.3.3 Moderate

Abnormal operation of DER dispatch and control could result in moderate impacts or damages to grid operations and/or the market, including but not limited to:

– brownout or frequency drift;
– partial loss of stored data;
– failure of system upgrade;
– abnormal of software and/or hardware operation environment.

4.3.4 Minor

Abnormal operation of DER dispatch and control could result in minor impacts or damages to operations or the market, including but not limited to:

– redistribution of load or short-term unavailability of backup systems;
– terminal data collection deviation;
– failure of database backup;
– failure of data processing and calculation;
– interruption of access to network.

5 Business roles

5.1 VPP participant

A VPP participant can be an aggregator or VPP operator to group distinct agents in a power system (i.e. consumers, producers, prosumers, etc.) to act as a single entity when interacting with various market operator or providing services to system operator.

5.2 DER owner

A DER owner is a party who owns physical assets of the distributed resources to participate in VPP, including DG, EES, CL and electric vehicle (EV) charging station.

5.3 System operator

The system operator is responsible for the safe and reliable operation of a part of the power system in certain area and for connection to other parts of the power system.

5.4 Electricity market operator

The electricity market operator is responsible for operation of the electricity market through managing the selling and buying prices with the objective of maximizing profit while ensuring satisfaction of customers' needs.

6 Actors

An actor can be a person, an equipment, or an organization that plays a role in use cases developed in this document.

Common actors derived from stakeholders are listed as follows.

– VPP service provider
– DG operator
– demand response service operator
– EES operator
– electric vehicle operator
– EV charging station with storage
– system operator
– electricity market operator
– transmission and/or distribution company
– energy service company
– energy information provider
– regulator

7 Application scenarios and functions

7.1 Overview

Primary application scenarios and functions of VPP are categorized into five types:

1) aggregation and optimization;
2) analysis and forecast;
3) energy system management;

4) trading and settlements;

5) communication.

7.2 Functions

– Aggregation and optimization

Aggregation refers to the function that multiple distributed resources, such as DG, electrical energy storage and CLs are grouped together to act as one operating unit that is dispatchable and tradable.

Optimization refers to the function that improves the VPP system's operational and economic performance through maximizing or minimizing certain parameters.

– Analysis and forecast

Analysis refers to the functions conducted via quantitative calculations. The results can be provided to VPP stakeholders for investigation, inspection and survey purposes.

Forecast refers to the function that predicts DG's output, CL's consumption, etc.

– Energy system management

Energy system management refers to the function that VPP decomposes power system's dispatchments and send controls to individual DER based on interaction with power system operator.

– Trading and settlements

Trading refers to the function that realizes VPP buys or sells in electricity market.

Settlements refer to the function that performs financial settlements between VPP and the market, as well as financial settlements between a VPP service provider and an individual VPP component.

– Communication

Communication refers to the function that realizes information transfers and data exchanges (such as dispatch order, schedules, bids and offers, etc.) between VPP and system operator, VPP and electricity market, a VPP service provider and an individual VPP component.

8 VPP use case

8.1 Overview

This clause is to present the use case template and use case matrix applied in the development process of VPP use cases.

8.2 Use case template

The use case template provided in IEC SRD 62913-1 shall be adopted to facilitate the collection of relevant information and ensure the consistency of all use cases.

8.3 Use case matrix

A use case matrix is developed to fully cover the application scenarios, functions, business roles, as illustrated in Figure 1.