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colour inside

Virtual power plants –
Part 1: Architecture and functional requirements

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FOREWORD

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IEC TS 63189-1 has been prepared by subcommittee SC 8B: Decentralized electrical energy systems, of IEC technical committee TC 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/124/DTS	8B/197/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- withdrawn,
- replaced by a revised edition, or
- amended.

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VIRTUAL POWER PLANTS –

Part 1: Architecture and functional requirements

1 Scope

This part of IEC 63189 covers the terms and definitions, system composition and control modes of virtual power plant (VPP). It defines the functional requirements for VPPs, including power generation forecasting, load forecasting, generation and consumption scheduling, control and management of energy storage devices and loads, coordinated optimization of distributed energy resources, status monitoring and communication, data collection and analysis, and market transactions.

Since a virtual power plant is a cluster of dispersed energy converting installations, which are aggregated, it uses additional systems to achieve its objectives (e.g. regional energy meteorology forecasting, site specific energy management systems, SCADA and other communication systems).

Local regulations, the electricity market model and the corresponding manner of organising the market related to the utilisation of controllable DER affect the management, control and operation of VPPs.

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 60870-5-101, *Telecontrol equipment and systems – Part 5-101: Transmission protocols – Companion standard for basic telecontrol tasks*

IEC 60870-5-104, *Telecontrol equipment and systems – Part 5-104: Transmission protocols – Network access for IEC 60870-5-101 using standard transport profiles*

IEC 61000 (all parts): *Electromagnetic compatibility EMC*

IEC 61850 (all parts), *Communication networks and systems for power utility automation*

IEC 62351-3, *Power systems management and associated information exchange – Data and communications security – Part 3: Communication network and system security – Profiles including TCP/IP*

IEC TS 62351-5, *Power systems management and associated information exchange – Data and communications security – Part 5: Security for IEC 60870-5 and derivatives*

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
controllable load
load of particular consumers which under contract must be increased or 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.

[SOURCE: IEC 60050-603:1986, 603-04-42, modified – "increased or" has been added to the definition.]

3.2
distributed energy resources
DER
generating units (with their auxiliaries, protection and connection equipment), as well as load units and those units having both characteristics (such as electrical energy storage systems), connected to a low-voltage or a medium-voltage network

[SOURCE: IEC 60050-617: 2009, 617-04-20, modified: adopted for the inclusion of controllable loads]

3.3
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]

3.4
demand response
DR
action resulting from management of the electricity demand in response to supply conditions

[SOURCE: IEC 60050-617:2009, 617-04-16]

3.5
demand side management
DSM
process that is intended to influence the quantity or patterns of use of electric energy consumed by end-use customers

[SOURCE: IEC 60050-617:2009, 617-04-15]

3.6
electrical energy storage system
EES system
EESS
grid-connected 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 electrical 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 (nonelectrical) 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).

Note 3 to entry: "Electric power system" is defined in IEC 60050-601:1985, 601-01-01.

[SOURCE: IEC 62933-1:2018, 3.1.2]

3.7
local control unit
LCU
device that interfaces field equipment to a control system by transmitting measurement and status data from the equipment to the control system and operating commands from the control system to the equipment

3.8
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 60050-617:2009, 617-04-22]

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.

3.10
virtual power plant management system
VMS
system which can realize the dispatch management and control of different VPP units such as generators, loads and energy storage units, with the VPP participating in market trading in an orderly manner

4 System components

4.1 General

A VPP may include distributed generators, storages and controllable loads spread over a wide geographical area, equivalent to a large power plant with the function of regulation and control. A core part of a VPP is the virtual power plant management system (VMS). In VPPs, the VMS can communicate with generators, controllable loads, energy storage units and microgrids with different reserved communication interfaces to provide operational data and realize unified scheduling management and control. The communication medium can be optical fibre, cable or wireless, with OPC (Object Linking and Embedding for Process Control), IEC or other protocols. The VMS provides external interfaces and can interact with system operator and energy management/trading platform to implement external information access release, scheduling management and market trading. Figure 1 shows the VPP system components.

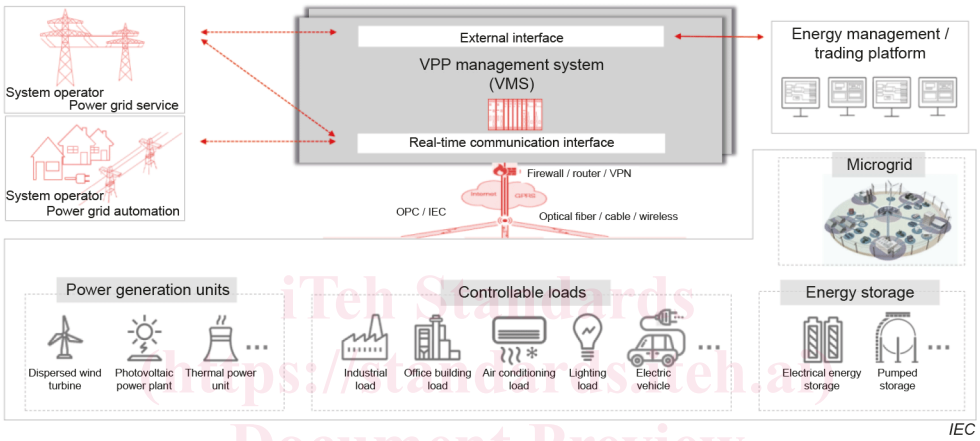

Figure 1 – VPP composition diagram

A typical virtual power plant possibly contains multiple levels, among which the subordinate level may be regarded as an integrated part for the upper level, and a VPP can also be formed by a certain amount of VPPs.

4.2 Power generation units

The power generation units of a VPP can include dispersed wind turbines, photovoltaic power plants, thermal power units and other units. The power generation unit can interact with VMS to upload the status information of the power generation unit and respond to the power generation control command of VMS. The power generation forecast function should be provided by upper layer VMS.

4.3 Controllable loads

The controllable loads of a VPP can include industrial loads, office building loads, air conditioning, lighting, electric vehicles, and other loads. The controllable loads exchange information with the VMS, upload the status information and respond to the power demand command of VMS. The controllable loads prediction function should be provided by the upper layer VMS.

4.4 Energy storage

The energy storage units of a VPP can include electric energy storage, pumped storage and other units, which have the ability to interact with the power grid in two directions, and can supply or consume power. The energy storage unit interacts with the VMS to upload the status information of the units and respond to the charge and discharge control commands of the VMS.