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TECHNICAL REPORT

Decentralized Multiple Energy Systems -
Part 1: General

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Decentralized Multiple Energy Systems - Part 1: General

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IEC TR 63631-1 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 Report.

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

Draft	Report on voting
8B/284/DTR	8B/296/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.

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.

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– revised.

INTRODUCTION

A Decentralized Multiple Energy System (DMES) integrates various forms of energy, such as electricity, water, heat or cold energy, gas, and hydrogen. By optimizing energy production, storage, distribution, and utilization, the DMES achieves efficient complementarity and collaborative management, enhancing the system's flexibility, reliability, and sustainability. Compared to centralized energy systems, the DMES is more suitable for the integration of distributed energy sources, offering significant advantages in addressing energy supply fluctuations and improving energy utilization. Furthermore, by providing customized energy solutions, the DMES can better satisfy the user demand in various application scenarios, such as industrial parks, urban communities, and remote areas.

Although a number of standards have been intensively established for different energy systems, there are still gaps in existing standards to guide the synergy and coordination of multiple energy systems due to the standard barrier between various industries. To address this issue, this report aims to analyse the applicability of existing standards in supporting the DMES development and identifying gaps and future standard needs.

1 Scope

This document presents general features, typical cases, and key technologies related to DMES. It analyses the existing standards and identifies the gaps and needs for DMES development from the perspectives of the equipment layer, the communication layer, the information layer, the management system layer, and the application layer. This document also provides information on future standardization needs in the area.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

No terms and definitions are listed in this document.

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

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

3.2 Abbreviated terms

AD	anaerobic digester
AMI	advanced metering infrastructure
CCHP	combined cooling, heating, and power unit
CHP	combined heat and power
CIM	common information model
DMES	decentralized multiple energy system
EES	electrical energy storage
EMS	energy management system
EMS-API	energy management system application program interface
ESMS	energy storage management systems
HES	home electronic system
IIoT	industrial internet of things
LCA	life cycle analysis
P2G	power to gas
PV	photovoltaic
UPS	uninterruptible power systems
WWTP	wastewater treatment plant

4 General

The DMES described in this report refers to a comprehensive energy system in a certain area. It takes electricity as the core and integrates decentralized energy sources such as electricity, heat/cold energy, gas, and hydrogen. The system deeply integrates energy flow, information flow, and business flow. It coordinates the supply, conversion, distribution, storage, consumption, and transaction of various types of energy. The system features a decentralized structure, multi-energy integration, diversified energy-use scenarios, a multi-source heterogeneous information flow, and complex operation and management.

(1) Decentralized structure: energy production, conversion, distribution, storage, and consumption equipment is located at the user's end. These systems can connect to the centralized energy network or operate independently, not relying on energy supply from the connected network to maintain energy balance.

(2) Multi-energy integration: the DMES involves the integration and coupling of multiple energy sources, including electricity, water, gas, cooling, heat, and hydrogen. This integration is aimed at enhancing energy reliability, flexibility and utilization efficiency. The energy flow schematic is shown in Figure 1.

(3) Diversified energy use scenarios: the DMES has a wide range of application scenarios across various market segments. The energy demand and energy use characteristics vary significantly among these scenarios.

(4) Multi-source heterogeneous information flow: the information flow of DMES involves data acquisition, transmission, processing, analysis, decision, and feedback, where the data formats and communication protocols are significantly different.

(5) Complex operation and management: the DMES involves many types of energy and subjects of interest. The characteristics of these energy types vary significantly and can be combined to enhance efficiency. The business flow of a DMES is a multi-level, multi-link collaborative process, covering the whole chain management from energy production to consumption, and is a "perception-decision-execution-feedback" closed-loop system. As a result, the planning, design, testing, commissioning, operation, maintenance, acceptance, evaluation, and market transactions of a DMES are complex.

The typical architecture of the DMES is shown in Figure 2, which includes the equipment layer, the communication layer, the information layer, the management system layer, and the application layer.

The equipment layer mainly includes energy equipment such as CCHPs, heat pumps, energy storage, P2G, and monitoring equipment such as collection terminals. The communication layer mainly includes the physical communication interfaces, the business flow, the communication protocol, the communication security, and the communication network device management. The information layer mainly includes the ontology, data model, data format, information flow, application security, and devices or user commissioning and decommissioning. The management system layer mainly includes platforms for energy management and market trading. The application layer mainly includes business aspects such as planning and design, testing and commissioning, acceptance and evaluation, operation, and maintenance.

Since relevant TCs/SCs, such as TC57, TC13, SC23K, etc., have already carried out standardization work on the communication layer and the information layer, this document will not discuss in detail the key technologies, standard gaps, or other related aspects of these communication and information layers.