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TECHNICAL REPORT

colour inside

Decentralized electrical energy systems roadmap

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DECENTRALIZED ELECTRICAL ENERGY SYSTEMS ROADMAP

FOREWORD

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IEC TR 63410 has been prepared by subcommittee 8B: Decentralized Electrical Energy Systems, of IEC technical committee 8: System aspects for electrical supply. It is a Technical Report.

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

Draft	Report on voting
8B/139/DTR	8B/152/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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- withdrawn,
- replaced by a revised edition, or
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INTRODUCTION

Decentralized Electrical Energy Systems are intended to support the development of safe, secure and reliable systems with decentralized management for electrical energy supply, alternative/complement/precursor to traditional large interconnected and highly centralized systems.

Decentralized electrical energy systems have applications for developing countries (focusing on access to electricity) as well as for developed countries (focusing on higher reliability, black-out recovery and/or services). Interactions within Decentralized (Multi) Energy Systems are also considered.

- Microgrids

A microgrid is an independent system composed of distributed energy resources, which normally connected with main grid with tie-line. Due to the imbalance between supply and load, a microgrid can either connect with main grid or operate independently.

- Non-conventional distribution systems

Non-conventional distribution systems include grid-tied local system, multi-energy local system and DC distribution system.

A grid-tied local system means a group of interconnected loads and distributed energy resources with defined electrical boundaries forming a local electric power system at distribution voltage levels, that is not intended to be disconnected from a wider electric power system.

A multi-energy local system is composed of distributed power networks (such as electrical power supply, gas supply, and cooling/heat supply networks), energy exchange segments (such as CCHP unit, generator, boiler, air conditioner, and heat pump, etc.), distributed energy storage segments (such as electricity storage, heat storage, gas storage, cooling storage, etc.) and users.

One DC distribution system is an electrical power system formed by connecting the DC electrical power supply, DC lines, DC converter stations, DC loads and monitoring systems in the way of direct current, mainly completing DC electrical power distribution and consumption.

- Virtual Power Plants

A Virtual power plant achieves Distributed Energy Resources (DER) aggregation and coordination optimization (such as DG, energy storage systems, controllable load, and electric cars, etc.) through advanced ICT and software systems. It is considered as a special power plant participating in electricity market and power grid operation.

- Decentralized DC distribution system

The decentralized DC distribution system is mostly distributed in the strong demand DC power supply area or in the area of high DC load density, and in the areas where DC power supply and DC load exist simultaneously. The decentralized DC distribution systems are distributed in AC power supply areas. [Source: IEC SC 8B, WG5]

DECENTRALIZED ELECTRICAL ENERGY SYSTEMS ROADMAP

1 Scope

IEC TR 63410, which is a Technical Report, aims to prepare a road map for categorizing Decentralized Electrical Energy Systems and identifying gaps in the existing standards relevant to Decentralized Electrical Energy Systems. The task of IEC Subcommittee 8B is to develop IEC publications enabling the development of secure, reliable and cost-effective systems with decentralized management for electrical energy supply, which are alternative, complementary or precursors to traditional large interconnected and highly centralized systems. This includes but is not limited to AC, DC, AC/DC hybrid decentralized electrical energy system, such as distributed generation, distributed energy storage, dispatchable loads, virtual power plants and electrical energy systems having interaction with multiple types of distributed energy resources.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

For the purposes of this document, the following terms, definitions and abbreviated terms 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 Terms and definitions

3.1.1
microgrid
<in an electric power system>
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 grid-connected and/or island mode

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

[SOURCE: IEC 60050-617:2009, 617-04-22]

3.1.2
isolated microgrid
group of interconnected loads and distributed energy resources with defined electrical boundaries forming a local electric power system at distribution voltage levels, that cannot be connected to a wider electric power system

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

[SOURCE: IEC 60050-617:2009/AMD2:2017, 617-04-23]

3.1.3
black start
start-up of an electric power system from a blackout through internal energy resources

[SOURCE: IEC 60050-617:2009, 617-04-24]

3.1.4
virtual power plant
VPP
party or system that realizes aggregation, optimization and control of decentralized generations, energy storage devices and controllable loads, which are not necessarily within the same geographical area, and facilitate the activities in power system operations and electricity market

[SOURCE: IEC TS 63189-1:—[1]]

3.1.5
intentional island
island resulting from planned action(s) of automatic protections, or from deliberate action by the responsible network operator, or both, in order to keep supplying electrical energy to a section of an electric power system

[SOURCE: IEC 60050-617:2009/AMD2:2017, 617-04-17]

3.1.6
prosumer
network user that consumes and produces electrical energy

[SOURCE: IEC 60050-617:2009, 617-02-16]

3.1.7
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 for ancillary services

[SOURCE: IEC 60050-617:2009, 617-02-18]

3.1.8
microgrid operator
party responsible for the safe and reliable operation of a microgrid

[SOURCE: IEC 60050-617:2009, 617-02-19]

3.1.9
microgrid user
party who supplies electric energy or is supplied with electrical energy through a microgrid

[SOURCE: IEC 60050-617:2009, 617-02-20]

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1 Under preparation. Stage at the time of publication: IEC/PRVDTS 63189-1:2023.

3.2 Abbreviated terms

ADEMS	Aggregator DER Management System
AMI	Advanced Metering Infrastructure
BDEMS	Building DER EMS
BUC	Business Use Cases
CAGR	Compound Annual Growth Rate
CHP	Combined Heat and Power
CIM	Common Information Model
CIS	Customer Information System
CVPP	Commercial VPP
CVR	Conservative Voltage Reduction
DDEMS	DSO DER EMS
DER	Distributed Energy Resources
DERMS	DER Management Systems
DES	Distributed Energy Storage
DMS	Distribution Management System
DOMA	Distribution Operations Model and Analysis
DR	Demand Response
DSCADA	Distribution SCADA System
DSOs	Distribution System Operators
DSPF	Distribution System Power Flow
ECPs	Electrical Connection Points
EPS	Electric Power System
ESPs	Energy Service Providers
ESI	Energy Services Interface
EV	Electric Vehicle
EVEMS	Electric Vehicle EMS
EVSE	Electric Vehicle Supply Equipment
FDEMS	Facility DER Energy Management Systems
GIS	Geographical Information Systems
GOOSE	Generic Object Oriented Substation Event
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IEV	International Electrotechnical Vocabulary
ISO	International Organization for Standardization
ISOs	Independent System Operators
LAN	Local Area Network
MDEMS	Microgrid DER EMS
MDMS	Meter Data Management System
NEA	National Energy Administration
OMS	Outage Management Systems

PAS	Publicly Available Specifications
PCC	Point of Common Coupling
PDEMS	Power Plant DER EMS
PPA	Power Purchase Agreements
PV	Photovoltaic System
REP	Retail Energy Providers
RDEMS	Retail DER Energy Management System
RTOs	Regional Transmission Organizations
SGAM	Smart Grid Architecture Model
SyC SE	System Committee Smart Energy
TBLM	Transmission Bus Load Model
TCs	Technical Committees
TSOs	Transmission System Operators
TVPP	Technical VPP
VDEMS	Virtual Power Plant DER EMS
WAN	Wide Area Network

4 Methodology

A System Approach is a holistic, iterative process that helps to deal with complex situations. This document is developed as a means of exchange with the System Committee Smart Energy and other involved Technical Committees (TCs) in order to identify applicable standards and standardization work to be undertaken.

Figure 1 identifies links between TCs and System Committee Smart Energy (SyC SE). Figure 2 illustrates the fields that SC 8B covers and the relationship between work programmes.

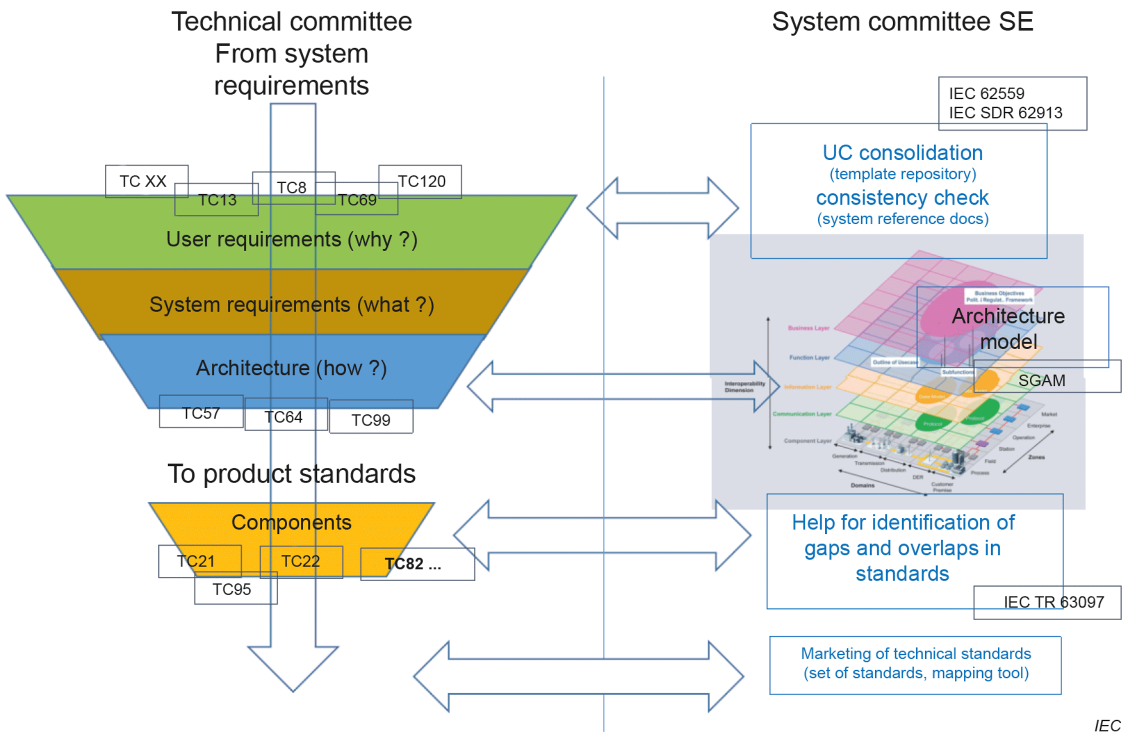

Figure 1 – From system requirements to product standards (TC8 Road map)

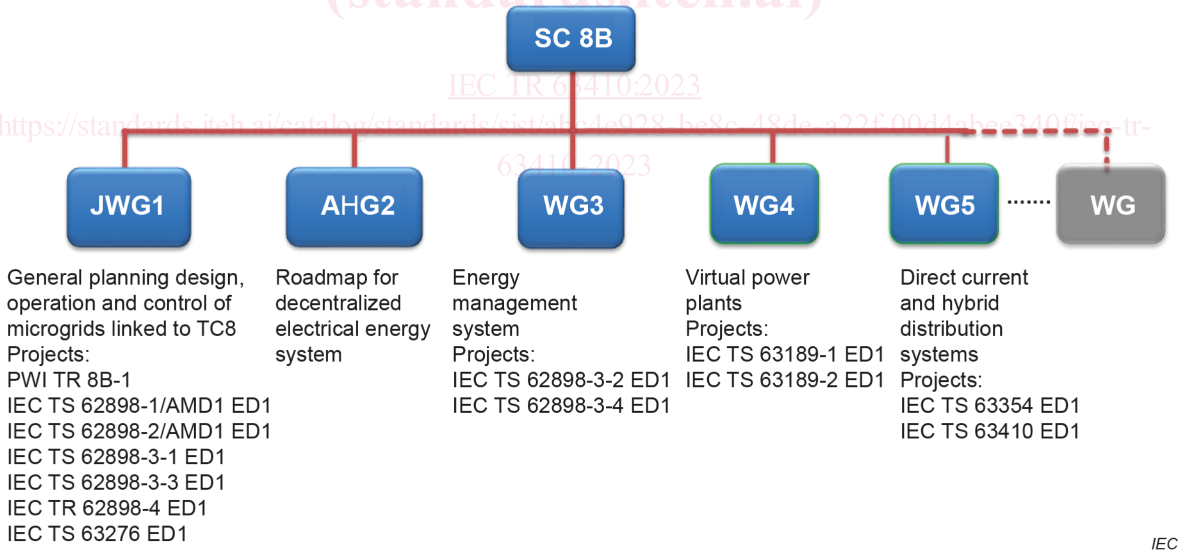

Figure 2 – SC 8B work groups, fields and work programmes

5 Market analysis, market segmentation and business models

5.1 Online survey

5.1.1 General

To support the decentralized electrical energy system standardization strategy development, the IEC SC 8B AHG2 prepared a survey on decentralized electrical energy systems in 2018 and a survey on microgrids in 2020. The survey outcomes are given in 5.1.2 and 5.1.3.

5.1.2 Outcomes from the 2018 survey on decentralized electrical energy systems

1) Participation of government in the non-conventional distribution system development

   Non-conventional distribution systems include grid-tied local systems, multi-energy local systems and DC distribution systems. According to the online survey, it can be seen that governments are very supportive. Three of the five non-conventional distribution system projects identified in the survey are government-sponsored and the remaining two projects do not receive any sponsorship fund.

   Government support contributes a lot to the non-conventional distribution system's development, and it has a big impact on the near future of the market. Standards are important to guarantee the confidence of investing in new market and technologies; therefore, government may be not willing to support if the standardization work is not sufficient.

2) Drivers and types of non-conventional distribution system projects

   According to the survey results, five primary drivers to launch non-conventional distribution system are summarized, which are shown below.

   Non-conventional distribution systems play an important part in achieving emission reduction and energy conservation, improving comprehensive utilization efficiency of energy, and cost efficiency in investments and operational cost, etc.

   - Improving the acceptance and local consumption of renewable energy generation
   - Improving comprehensive utilization efficiency of electricity, heat, gas and other forms of energy
   - Solving the problem of electricity use in areas with weak connections to the power grid or geographically isolated islands
   - (In some cases) providing higher cost efficiency in investments and operational cost (life cycle assessment) compared to traditional grid solutions
   - Saving energy and reducing emissions.

3) Application of decentralized electrical energy systems

   Despite of the low response, the information received about five responses covers all common types of projects. Two projects are DER projects, two are DC distribution projects, and the remaining one is a multi-energy local system project.

   At present, the specifically designed technologies and equipment for non-conventional distribution systems are not available in this analysis because none of the results received from the five surveys responded to this question.

4) Standards needs for non-conventional distribution systems

   The survey is beneficial to identify the satisfaction degree in the current standardization level of non-conventional distribution systems. The collected results are still valuable although the number of responses is limited.