

IEEE Guide for Distributed Energy Resources Management Systems (DERMS) Functional Specification

IEEE Power and Energy Society

Developed by the
Transmission and Distribution Committee

IEEE Std 2030.11™-2021

STANDARDS

IEEE Guide for Distributed Energy Resources Management Systems (DERMS) Functional Specification

Developed by the

Transmission and Distribution Committee
of the
IEEE Power and Energy Society

Approved 29 April 2021

IEEE SA Standards Board

Abstract: A key concept and requirement for an operational and effective deployment of a large number of distributed energy resources (DER), which include sources of power and demand response, to enable the provision of flexibility and grid services, is the aggregation of DER. This aggregation function, as well as the functions required to enable grid services, are provided by DER management systems (DERMS). A functional specification for a DERMS and a description of the grid services that aggregated DER can provide the distribution and transmission systems is provided by this guide. Implementation issues and the interoperability requirements of a DERMS with its environment, including the transmission and distribution systems, and the communication and information infrastructure of modern grids are addressed by this guide.

Keywords: advanced distribution management system, aggregation, ancillary services, demand response, DERMS, distributed energy resources, distributed energy storage system, distributed generation, distribution system, energy management system, grid and system services, IEEE 2030.11™, microgrid, transmission system, virtual power plant

The Institute of Electrical and Electronics Engineers, Inc.
3 Park Avenue, New York, NY 10016-5997, USA

Copyright © 2021 by The Institute of Electrical and Electronics Engineers, Inc.
All rights reserved. Published 9 June 2021. Printed in the United States of America.

IEEE is a registered trademark in the U.S. Patent & Trademark Office, owned by The Institute of Electrical and Electronics Engineers, Incorporated.

PDF: ISBN 978-1-5044-7593-8 STD24716
Print: ISBN 978-1-5044-7594-5 STDPD24716

IEEE prohibits discrimination, harassment, and bullying.

For more information, visit <https://www.ieee.org/about/corporate/governance/p9-26.html>.

No part of this publication may be reproduced in any form, in an electronic retrieval system or otherwise, without the prior written permission of the publisher.

Important Notices and Disclaimers Concerning IEEE Standards Documents

IEEE Standards documents are made available for use subject to important notices and legal disclaimers. These notices and disclaimers, or a reference to this page (<https://standards.ieee.org/ipr/disclaimers.html>), appear in all standards and may be found under the heading “Important Notices and Disclaimers Concerning IEEE Standards Documents.”

Notice and Disclaimer of Liability Concerning the Use of IEEE Standards Documents

IEEE Standards documents are developed within the IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association (IEEE SA) Standards Board. IEEE develops its standards through an accredited consensus development process, which brings together volunteers representing varied viewpoints and interests to achieve the final product. IEEE Standards are documents developed by volunteers with scientific, academic, and industry-based expertise in technical working groups. Volunteers are not necessarily members of IEEE or IEEE SA, and participate without compensation from IEEE. While IEEE administers the process and establishes rules to promote fairness in the consensus development process, IEEE does not independently evaluate, test, or verify the accuracy of any of the information or the soundness of any judgments contained in its standards.

IEEE does not warrant or represent the accuracy or completeness of the material contained in its standards, and expressly disclaims all warranties (express, implied and statutory) not included in this or any other document relating to the standard, including, but not limited to, the warranties of: merchantability; fitness for a particular purpose; non-infringement; and quality, accuracy, effectiveness, currency, or completeness of material. In addition, IEEE disclaims any and all conditions relating to results and workmanlike effort. In addition, IEEE does not warrant or represent that the use of the material contained in its standards is free from patent infringement. IEEE Standards documents are supplied “AS IS” and “WITH ALL FAULTS.”

Use of an IEEE standard is wholly voluntary. The existence of an IEEE Standard does not imply that there are no other ways to produce, test, measure, purchase, market, or provide other goods and services related to the scope of the IEEE standard. Furthermore, the viewpoint expressed at the time a standard is approved and issued is subject to change brought about through developments in the state of the art and comments received from users of the standard.

In publishing and making its standards available, IEEE is not suggesting or rendering professional or other services for, or on behalf of, any person or entity, nor is IEEE undertaking to perform any duty owed by any other person or entity to another. Any person utilizing any IEEE Standards document, should rely upon his or her own independent judgment in the exercise of reasonable care in any given circumstances or, as appropriate, seek the advice of a competent professional in determining the appropriateness of a given IEEE standard.

IN NO EVENT SHALL IEEE BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO: THE NEED TO PROCURE SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE PUBLICATION, USE OF, OR RELIANCE UPON ANY STANDARD, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE AND REGARDLESS OF WHETHER SUCH DAMAGE WAS FORESEEABLE.

Translations

The IEEE consensus development process involves the review of documents in English only. In the event that an IEEE standard is translated, only the English version published by IEEE is the approved IEEE standard.

Official statements

A statement, written or oral, that is not processed in accordance with the IEEE SA Standards Board Operations Manual shall not be considered or inferred to be the official position of IEEE or any of its committees and shall not be considered to be, nor be relied upon as, a formal position of IEEE. At lectures, symposia, seminars, or educational courses, an individual presenting information on IEEE standards shall make it clear that the presenter's views should be considered the personal views of that individual rather than the formal position of IEEE, IEEE SA, the Standards Committee, or the Working Group.

Comments on standards

Comments for revision of IEEE Standards documents are welcome from any interested party, regardless of membership affiliation with IEEE or IEEE SA. However, **IEEE does not provide interpretations, consulting information, or advice pertaining to IEEE Standards documents.**

Suggestions for changes in documents should be in the form of a proposed change of text, together with appropriate supporting comments. Since IEEE standards represent a consensus of concerned interests, it is important that any responses to comments and questions also receive the concurrence of a balance of interests. For this reason, IEEE and the members of its Societies and Standards Coordinating Committees are not able to provide an instant response to comments, or questions except in those cases where the matter has previously been addressed. For the same reason, IEEE does not respond to interpretation requests. Any person who would like to participate in evaluating comments or in revisions to an IEEE standard is welcome to join the relevant IEEE working group. You can indicate interest in a working group using the Interests tab in the Manage Profile and Interests area of the [IEEE SA myProject system](#). An IEEE Account is needed to access the application.

Comments on standards should be submitted using the [Contact Us](#) form.

Laws and regulations

Users of IEEE Standards documents should consult all applicable laws and regulations. Compliance with the provisions of any IEEE Standards document does not constitute compliance to any applicable regulatory requirements. Implementers of the standard are responsible for observing or referring to the applicable regulatory requirements. IEEE does not, by the publication of its standards, intend to urge action that is not in compliance with applicable laws, and these documents may not be construed as doing so.

Data privacy

Users of IEEE Standards documents should evaluate the standards for considerations of data privacy and data ownership in the context of assessing and using the standards in compliance with applicable laws and regulations.

Copyrights

IEEE draft and approved standards are copyrighted by IEEE under US and international copyright laws. They are made available by IEEE and are adopted for a wide variety of both public and private uses. These include

both use, by reference, in laws and regulations, and use in private self-regulation, standardization, and the promotion of engineering practices and methods. By making these documents available for use and adoption by public authorities and private users, IEEE does not waive any rights in copyright to the documents.

Photocopies

Subject to payment of the appropriate licensing fees, IEEE will grant users a limited, non-exclusive license to photocopy portions of any individual standard for company or organizational internal use or individual, non-commercial use only. To arrange for payment of licensing fees, please contact Copyright Clearance Center, Customer Service, 222 Rosewood Drive, Danvers, MA 01923 USA; +1 978 750 8400; <https://www.copyright.com/>. Permission to photocopy portions of any individual standard for educational classroom use can also be obtained through the Copyright Clearance Center.

Updating of IEEE Standards documents

Users of IEEE Standards documents should be aware that these documents may be superseded at any time by the issuance of new editions or may be amended from time to time through the issuance of amendments, corrigenda, or errata. An official IEEE document at any point in time consists of the current edition of the document together with any amendments, corrigenda, or errata then in effect.

Every IEEE standard is subjected to review at least every 10 years. When a document is more than 10 years old and has not undergone a revision process, it is reasonable to conclude that its contents, although still of some value, do not wholly reflect the present state of the art. Users are cautioned to check to determine that they have the latest edition of any IEEE standard.

In order to determine whether a given document is the current edition and whether it has been amended through the issuance of amendments, corrigenda, or errata, visit [IEEE Xplore](#) or [contact IEEE](#). For more information about the IEEE SA or IEEE's standards development process, visit the IEEE SA Website.

Errata

Errata, if any, for all IEEE standards can be accessed on the [IEEE SA Website](#). Search for standard number and year of approval to access the web page of the published standard. Errata links are located under the Additional Resources Details section. Errata are also available in [IEEE Xplore](#). Users are encouraged to periodically check for errata.

Patents

IEEE Standards are developed in compliance with the [IEEE SA Patent Policy](#).

IMPORTANT NOTICE

IEEE Standards do not guarantee or ensure safety, security, health, or environmental protection, or ensure against interference with or from other devices or networks. IEEE Standards development activities consider research and information presented to the standards development group in developing any safety recommendations. Other information about safety practices, changes in technology or technology implementation, or impact by peripheral systems also may be pertinent to safety considerations during implementation of the standard. Implementers and users of IEEE Standards documents are responsible for determining and complying with all appropriate safety, security, environmental, health, and interference protection practices and all applicable laws and regulations.

Participants

At the time this IEEE guide was completed, the P2030.11 Working Group had the following membership:

Geza Joos, *Chair*
Anthony Johnson, *Vice Chair*
Robert Cummings, *Vice Chair*
James Reilly, *Secretary*

Chad Abbey	Andrew Ingram	Ajit Renjit
Shafiu Alam	Rosanna Kallio	Steven Rymsha
John Barnick	Hasan Kamal-Al-Deen	Amin Salmani
Craig Boice	Ning Kang	Nicole Segal
Anjan Bose	Peter Klauer	Mark Siira
Ron Chebra	Scott Koehler	Ravindra Singh
Robert Currie	Dave Konye	Greg Smith
Rustom Dessai	Rory Lewis	Michael Stadler
Fei Ding	Peter Maltbaek	Kay Stefferud
Kyle Garton	Prakash Menon	Clayton Stice
Vipul Gholap	Michelle Menvielle	James Taylor
Hugo Gil	Keith Mitchell	Nima Tehrani
Jon Grooters	Zack Pecanak	Damien Tholomier
Al Hefner	Ben Rankin	Tom Weaver
Paul Hines		Dean Weng

The following members of the individual Standards Association balloting group voted on this guide. Balloters may have voted for approval, disapproval, or abstention.

Chad Abbey	Brian Johnson	James Reilly
Mark Adamiak	Geza Joos	Charles Rogers
James Babcock	Rosanna Kallio	Daniel Sabin
Steven Bezner	Hasan Kamal-Al-Deen	Bartien Sayogo
William Byrd	Ning Kang	Ronald Shipman
Richard Carter	John Kay	Mark Siira
Diego Chiozzi	Yashar Kenarangui	Ravindra Singh
Terry Conrad	Yuri Khersonsky	P. Sivaraman
Robert Cummings	Boris Kogan	Jerry Smith
Rustom Dessai	Marc Lacroix	Gary Smullin
Mamadou Diong	Chung-Yiu Lam	Aaron Snyder
Neal Dowling	Chen-Ching Liu	Michael Stadler
Paul Duncan	Timothy McJunkin	Wayne Stec
Thomas Dunmore II	Anudeep Medam	Ryan Stone
George Gela	Ronald Mitchell	Damien Tholomier
Hugo Gil	Dennis Neitzel	Joseph Thomas
Jeffrey Helzer	Joe Nims	Eric Udren
Michael Higginson	Nayeem Ninad	James Van De Ligt
Paul Hines	Zachary Pecanak	John Vergis
Werner Hoelzl	Howard Penrose	Kenneth White
Yi Hu	Patty Polpattana	Vahraz Zamani
	Benito Ramos	

When the IEEE SA Standards Board approved this guide on 29 April 2021, it had the following membership:

Gary Hoffman, *Chair*
Jon Walter Rosdahl, *Vice Chair*
John D. Kulick, *Past Chair*
Konstantinos Karachalios, *Secretary*

Edward A. Addy
Doug Edwards
Ramy Ahmed Fathy
J. Travis Griffith
Thomas Koshy
Joseph L. Koepfinger*
David J. Law

Howard Li
Daozhuang Lin
Kevin Lu
Daleep C. Mohla
Chenhui Niu
Damir Novosel
Annette Reilly
Dorothy Stanley

Mehmet Ulema
Lei Wang
F. Keith Waters
Karl Weber
Sha Wei
Howard Wolfman
Daidi Zhong

*Member Emeritus

Introduction

This introduction is not part of IEEE Std 2030.11–2021, IEEE Guide for Distributed Energy Resources Management Systems (DERMS) Functional Specification.

The technologies and operational concepts to properly aggregate, integrate, and manage distributed energy resources, which include sources of power and demand response, deployed in distribution and transmission systems to enable the provision of grid services, are increasingly being developed and deployed. These systems are known as distributed energy resources management systems (DERMS).

The purpose of this guide is to propose a structured approach to the development of a functional specification for DERMS. It provides the mandatory and optional functional requirements needed to assure a technically sound operation of DERMS in its interaction with distribution and transmission system operators and their management systems. It is not intended to be a design or application guideline for a DERMS.

The guide describes the function required for the operation of a DERMS, both the mandatory and optional functions. It details functionalities that can be designed into the DERMS to support grid services at the distribution and transmission system levels. It discusses implementation approaches that allow interaction of the DERMS with energy management and controls used in distribution and transmission systems. It provides examples of implementation. It addresses interoperability requirements with reference to a smart grid interoperability reference model (SGIRM). The model codifies the interaction of the DERMS with the different elements of its environment, power system hardware, software, and communication and information systems.

The guide is intended to provide a common language and define core functionalities for a DERMS to a wide range of stakeholders, including vendors, utilities, energy service providers, developers, codes and standards organizations, regulators and legislators, and governing bodies.

Contents

1. Overview	10
1.1 Scope	10
1.2 Purpose	10
1.3 Word usage	10
1.4 Limitations	11
1.5 Assumptions	11
2. Normative references	11
3. Definitions, acronyms, and abbreviations	12
3.1 Definitions	12
3.2 Acronyms and abbreviations	13
4. Background and context	14
4.1 Scope of DERMS	14
4.2 DERMS concept and application	15
4.3 DERMS expectations	16
5. DERMS functions	16
5.1 General function considerations	16
5.2 DERMS general functionality	16
5.3 Typically specified DERMS base functionalities	16
5.4 DERMS optional functionalities	26
6. DERMS functionality in support of grid services	29
6.1 General considerations	29
6.2 Approach and categories	30
6.3 Energy	31
6.4 Capacity	31
6.5 Constraint management	33
6.6 Frequency control and response	34
6.7 Black start	36
6.8 Resilience	36
6.9 Voltage support	36
7. Specific DERMS implementation and interoperability considerations	37
7.1 General considerations and approaches	37
7.2 Cybersecurity	37
7.3 Communications	37
7.4 DERMS deployment considerations	38
7.5 DERMS configuration examples	39
7.6 Architecture and interoperability considerations	43
7.7 Other considerations	52
Annex A (informative) Bibliography	53
Annex B (informative) Flexibility services	55

IEEE Guide for Distributed Energy Resources Management Systems (DERMS) Functional Specification

1. Overview

1.1 Scope

This document provides a guide for the development of a functional specification for distributed energy resources (DER) management systems (DERMS). It includes guiding principles for the application and deployment of DERMS and DERMS control systems, addresses the basic functional requirements, and proposes a set of core functions. These include: DER discovery, visualization, and monitoring of active and reactive power flows and voltage at specific nodes; DER production estimation and scheduling, and dispatch of active and reactive power; DER ancillary services provision, including voltage and frequency control/support. The approach is extended to virtual power plant (VPP) control systems.

1.2 Purpose

The purpose of the DERMS is to aggregate and dispatch multiple DER, coordinate their operation in the electric system, and optimize their output. With the increased deployment and penetration of DER, aggregation of DER can be an effective approach to integrate DER into the planning and operation of distribution systems and transmission systems.

1.3 Word usage

The word *shall* indicates mandatory requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted (*shall* equals *is required to*).^{1, 2}

The word *should* indicates that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required (*should* equals *is recommended that*).

The word *may* is used to indicate a course of action permissible within the limits of the standard (*may* equals *is permitted to*).

¹The use of the word *must* is deprecated and cannot be used when stating mandatory requirements, *must* is used only to describe unavoidable situations.

²The use of *will* is deprecated and cannot be used when stating mandatory requirements, *will* is only used in statements of fact.

The word *can* is used for statements of possibility and capability, whether material, physical, or causal (*can* equals *is able to*).

1.4 Limitations

The guide is limited to discussing and proposing approaches to aggregate DER to enable services to the distribution system or at sub-transmission or transmission, and/or market levels.

The guide does not address the following issues:

- The type of communication system between individual DER and the DERMS, either hardware or software
- The hardware and software implementation of the DER monitoring, control, and dispatch algorithms
- The individual DER interconnection requirements³
- The DER protection requirements⁴
- The impact of DER control and dispatch on power quality (flicker and voltage distortion) on the distribution, sub-transmission, or transmission system⁵
- The size of the individual DER or aggregated DER, and the interconnection voltage level
- The implementation and requirements of the communication and interface with the utility advanced distribution management system (ADMS)
- The way in which individual and aggregated DER are operated to enable the DERMS to offer grid services

1.5 Assumptions

The term *DER* used in the scope and purpose of this guide, refers collectively to both conventional distributed energy resources (defined as DER), that include both generators and energy storage technologies, and to demand response (DR). A DERMS can aggregate both DER and DR and a combination of these assets.

It is assumed that all rules applying to a given jurisdiction and imposed by the distribution system operator (DSO) and/or transmission system operator (TSO) are followed:

- It is assumed that the DSO or TSO with which the DERMS communicates has a service agreement with the DERMS owner and operator (unless it is the DSO or TSO itself) for the provision of power and ancillary services (including reactive power), these being provided by the aggregation of DER.
- It is assumed that the balancing authority (BA) or market operator receiving capacity and energy services from an independent DERMS owner and operator has a service agreement in place detailing those services.

2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is

³For distribution-connected DER, refer to IEEE Std 1547™-2018 or relevant grid code in the relevant jurisdiction. For sub-transmission- or transmission-connected DER, refer to IEEE Std P2800-2021 currently under development for inverter-based resources connected above distribution voltages.

⁴See relevant standards and guides.

⁵See relevant standards and guides.

explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

IEEE P2800 (Draft 6, March 2021), Draft Standard for Interconnection and Interoperability of Inverter-Based Resources (IBR) Interconnecting with Associated Transmission Electric Power Systems.⁶

IEEE Std 1547™-2018, IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces.^{7,8}

IEEE Std 1815™-2012, IEEE Standard for Electric Power Systems Communications-Distributed Network Protocol (DNP3).

IEEE Std 2030™-2011, IEEE Guide for Smart Grid Interoperability of Energy Technology and Information Technology Operation with the Electric Power System (EPS), End-Use Applications, and Loads.

IEEE Std 2030.5™-2018, IEEE Standard for Smart Energy Profile Application Protocol.

IEEE Std 2030.7™-2017, IEEE Standard for the Specification of Microgrid Controllers.

IEEE Std C37.240™-2014, Standard Cybersecurity Requirements for Substation Automation, Protection, and Control Systems.

3. Definitions, acronyms, and abbreviations

3.1 Definitions

For the purposes of this document, the following terms and definitions apply. The *IEEE Standards Dictionary Online* should be consulted for terms not defined in this clause.⁹

advanced distribution management system (ADMS): A collection of applications that may include applications typically associated with an outage management system (OMS), a distribution management system (DMS), and supervisory control and data acquisition (SCADA), designed to monitor, control, and manage operations and outages of a distribution network efficiently and reliably.

aggregator: Manages distributed energy resources (DER) and demand response (DR) resources that consist of more than one source for the purpose of marketing energy and ancillary services to clients via the electric power system.

demand response (DR): The modification of electricity consumption by consumers for a limited time period in response to signals, incentives, and/or prices. This can include the shifting, shaping, or shedding of load.

distributed energy resources management system (DERMS): An application platform designed to manage device information, monitor and enable optimization and control of distributed energy resources (DER) and demand response (DR). A DERMS must be able to aggregate, simplify, optimize, and translate DER and DR functionalities. The DERMS enables the implementation of system services to the grid.

⁶Numbers preceded by P are IEEE authorized standards projects that were not approved by the IEEE-SA Standards Board at the time this publication went to press. For information about obtaining drafts, contact the IEEE.

⁷The IEEE standards or products referred to in Clause 2 are trademarks owned by The Institute of Electrical and Electronics Engineers, Incorporated.

⁸IEEE publications are available from The Institute of Electrical and Electronics Engineers (<https://standards.ieee.org/>).

⁹*IEEE Standards Dictionary Online* is available at: <http://dictionary.ieee.org>. An IEEE Account is required for access to the dictionary, and one can be created at no charge on the dictionary sign-in page.

distributed energy resources (DER): Sources and groups of sources of electric power that are connected to the electric power system. DER includes both generators and energy storage technologies capable of exporting active power to an electric power system (EPS). An individual DER device inside a group of DER that form a system is a DER unit (DERU). An interconnection system or a supplemental DER device that is necessary for compliance with this guide is part of a DER.

virtual power plant (VPP): A distributed energy resources management system (DERMS) that has the purpose of aggregating and controlling distributed energy resource assets in blocks of resources (generation, renewables, energy storage, or controllable demand) that can be remotely and automatically dispatched using meters, a software system, and a communications network.

3.2 Acronyms and abbreviations

ADMS	advanced distribution management system
AGC	automatic generation control
BA	balancing authority
BESS	Battery Energy Storage System
BTM	behind the meter
CT	communication technology
CVR	conservation voltage reduction
D-Model	distribution system model
DER	distributed energy resources
DERMS	distributed energy resources management system
DG	distributed generation
DMS	distribution management system
DR	demand response
DSO	distribution system operator
ESS	energy storage system
EMS	energy management system
EPS	electric power system
EV	electric vehicle
FFR	fast frequency response
FLISR	fault location, isolation, and service restoration
FM	fleet management
FTM	in front of the meter
GDER	generation distributed energy resources
IAP	interoperability architectural perspective
IBR	inverter-based resources
ID	identification
ISO	independent system operator

IT	information technology
LL	Line-Line
MPPT	maximum power point tracking
OPF	optimal power flow
OSB	operational service bus
P	active power
PCC	point of common coupling
PF	power factor
PS	power system
PV	photovoltaic
Q	reactive power
RC	reliability coordinator
RTO	regional transmission operator
SCADA	supervisory control and data acquisition system
SGIRM	smart grid interoperability reference model
SLA	service level agreement
STFE	short-term forecasting engine
TSO	transmission system operator
UFLS	under-frequency load shedding
VPP	virtual power plant

4. Background and context

4.1 Scope of DERMS

DERMS allows aggregation of both sources of power, known as *distributed energy resources (DER)*, and *demand response (DR) resources*. In general, and unless specified otherwise in this guide, the term *DER* may collectively refer to DER and DR. Virtual power plants (VPP) and microgrids also aggregate DER and DR, as discussed in this guide.

DERMS grid services may become necessary with the higher penetrations of DER and increased complexity of the power grid to support the transmission and distribution of electricity from the provider of energy to the consumer of energy (Denholm, Sun, and Mai [B6]¹⁰; NERC 2016 [B22]; NERC 2020 [B23]). The DERMS can also enable DER and DR to provide aggregated ancillary services to the grid. These services help ensure that objectives, such as grid reliability, power quality, availability, and resiliency, are maintained.

Individual distribution-connected DER typically meet the requirements of IEEE Std 1547™-2018. Transmission-connected inverter based resources (IBR) would meet IEEE P2800–2021. Both could be aggregated utilizing this guide.

¹⁰The numbers in brackets correspond to those of the bibliography in Annex A.

4.2 DERMS concept and application

A DERMS can be defined by its functions and the services it enables, regardless of ownership and complexity. Its basic functions are:

- Aggregate: DERMS should take the services of many individual DER and DR and present them as a more manageable, smaller number of aggregated virtual resources for the appropriate location.
- Simplify: DERMS should handle the granular details of DER and DR settings and present simple grid-related services.
- Optimize: DERMS should optimize the utilization of DER and DR and the existing infrastructure within various physical locations to get the desired outcome in terms of the role and functions of the DERMS at minimal cost, required performance, and best possible power quality.
- Translate: Individual DER may speak different languages, depending on their type and scale. DERMS should handle these diverse languages, and present to the upstream calling entity in a cohesive manner.

A DERMS should be operated to observe and respect all distribution and transmission operating constraints. Working with a market entity, the DERMS will support a reliability-constrained economic dispatch in order to contribute to the reliability and security of the power supply to the load. It is the function of the DERMS to coordinate DER operations with grid operations, protection systems, and controls.

This guide addresses functions and potential services enabled by a DERMS and how these are expected to behave and perform. Any specific DERMS can incorporate any or all those functions and services, depending on how it is integrated into the operation of the system, or if it is a pure stand-alone application performing these functions.

A DERMS can be integrated into distribution and transmission applications, such as supervisory control and data acquisition (SCADA), advanced distribution management systems (ADMS), or energy management systems (EMS).

Several types of DERMS may exist:

- Aggregator (service provider) versus DERMS operator (DERMS is the software solution or platform) can be separate entities (or one entity)
- Utility (power system) DERMS versus non-utility (industry, energy community) energy provider DERMS

Some independent functions may be performed without knowledge of the local electrical system. In this case, it is important that local electrical utility and non-utility DERMS coordinate to share adequate information based on mutual agreement to allow DERMS to successfully participate in the identified market.

The DERMS will consider generation capabilities¹¹ in the aggregation process to ensure consistent operation of the DER.

Performance metrics include the evaluation of effectiveness of the response to service provision requests.

¹¹For distribution-connected DER, the reference would be IEEE Std 1547™-2018, limit functions and parameters, go-to requests. For transmission- or sub-transmission-connected DER, IEEE P2800-2021 would be the reference. It should also be noted that not all DER are inverter based. This may be particularly true as the connection voltage rises.

4.3 DERMS expectations

All DERMS will have some of the functionalities identified in this guide. It is not expected that a DERMS implement all functionalities identified, but if a functionality is implemented, it should meet the guidelines established herein.

A DERMS is a system that will be utilized by an organization to interact with and/or model DER and DR. This interaction can range from simple monitoring to detailed configuration and control management of these resources, and grid analysis and planning.

5. DERMS functions

5.1 General function considerations

Many issues should be considered when evaluating the general functions that a DERMS should address. The functions required for a DERMS will vary based on a range of factors including, but not limited to, specific use cases, DER capability, system capability, DER and DR market participation, regulatory considerations, etc. (EPRI 2018 [B1]).

It is also important to consider the interaction between these various functions when designing or evaluating a DERMS. Figure 1 is one example of the relations and interactions of the functions among each other, but is not intended to be the only possible interactions of functions. Certain functions of a DERMS may be shared with other systems integrating DER and DR, such as microgrid controllers, ADMS, SCADA, and EMS, designating which system is responsible for what functions. Careful consideration needs to be given to how the various systems will be integrated with DER management, especially when they have similar functions. Subclause 7.6 provides a more detailed overview of architecture and interoperability considerations between these various systems involved with DER and DR integration.

Figure 1 illustrates some of the core functions of a DERMS, such as DER device information, DER monitoring/status, and DER operation/control. Dotted lines indicate connections to optional functions. Specific capabilities within each of these core functions are detailed in the next sections. Additional guidance is provided on what functionality of a DERMS should be considered mandatory and what functions are considered optional within this guide.

5.2 DERMS general functionality

Generally, a DERMS can be divided into three general functional areas with a few auxiliary areas: DER device information, monitoring/status, and operation/control. Aggregation is a cross-cutting function across all those general functional areas. Cross-cutting auxiliary functions are visualization and historization of the information provided by the DERMS. Both auxiliary functions are important, but they may not be part of the core functionality of the DERMS.

5.3 Typically specified DERMS base functionalities

5.3.1 DER device pedigree information

Device pedigree information is divided into registration information, grouping information, and device capability. Configuration settings are intended to be used as a configuration option to nameplate alternatives and are not intended for continuous dynamic adjustment.

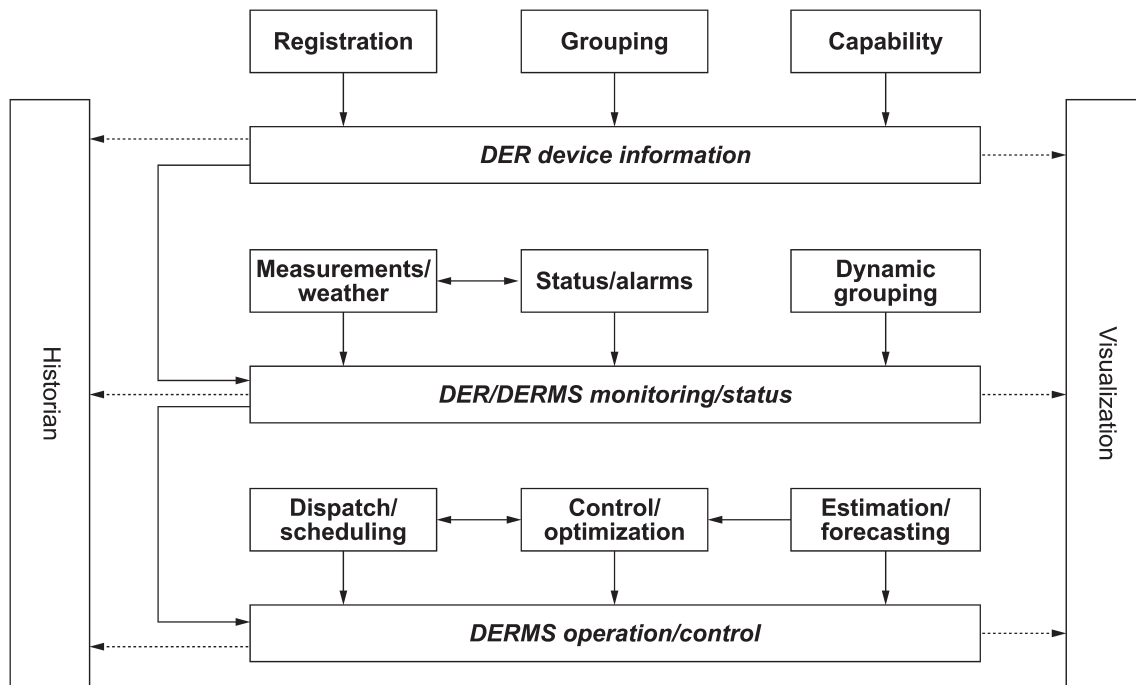


Figure 1—Examples DERMS functions and their relationships

5.3.2 Registration

Registration information for individual DER and DR can typically include the information listed below. It can also be provided for downstream DERMS, solar/wind plant controller, and other aggregated systems that an upstream DERMS will interface with.

a) Nameplate information

The nameplate information provides the information required for situational awareness, modeling, monitoring, and operational control. This could include:

- DER type: Example DER types can include microturbine, solar photovoltaic (PV), diesel, battery, wind turbines, fuel cell, etc. It should also include model, serial number, and manufacturer.
- Rating: Applicable information could include nominal ac voltage, kVA, charging and other ramp rates, kWhr, thermal limits, short-circuit current capability, standard test conditions (STC), photovoltaics for utility scale applications test conditions (PV test conditions), maximum continuous output power at unity power, maximum apparent power output, maximum continuous output current, weighted efficiency, dc voltage min/nominal/max. [Table 1](#) provides a list of useful parameters.

Table 1—Nameplate information (adapted from IEEE Std 1547-2018, Table 28)

Parameter	Description
Active power rating at unity power factor (nameplate active power rating)	Active power rating in watts at unity power factor
Active power rating at specified over-excited power factor	Active power rating in watts at specified over-excited power factor
Specified over-excited power factor	Over-excited power factor as described in IEEE Std 1547-2018

Table continues

Table 1—Nameplate information (adapted from IEEE Std 1547-2018, Table 28) (continued)

Parameter	Description
Active power rating at specified under-excited power factor	Active power rating in watts at specified under-excited power factor
Specified under-excited power factor	Under-excited power factor as described in IEEE Std 1547-2018
Apparent power maximum rating	Maximum apparent power rating in voltamperes
Normal operating performance category	Indication of reactive power and voltage/power control capability (Category A/B as described IEEE Std 1547-2018)
Abnormal operating performance category	Indication of voltage and frequency ride-through capability (Category I, II, or III, as described in IEEE Std 1547-2018)
Reactive power injected maximum rating	Maximum injected reactive power rating in vars
Reactive power absorbed maximum rating	Maximum absorbed reactive power rating in vars
Active power charge maximum rating	Maximum active power charge rating in watts
Apparent power charge maximum rating	Maximum apparent power charge rating in voltamperes; may differ from the apparent power maximum rating
AC voltage nominal rating	Nominal ac voltage rating in root mean square (rms) volts
AC voltage maximum rating	Maximum ac voltage rating in rms volts
AC voltage minimum rating	Minimum ac voltage rating in rms volts
Supported control mode functions	Indication of support for each control mode function
Reactive susceptance that remains connected to the area electric power system (EPS) in the cease to energize and trip state	Reactive susceptance that remains connected to the area EPS in the cease to energize and trip state
Manufacturer	Manufacturer
Model	Model
Serial number	Serial number
Version	Version

b) Communication information

The DER should support at least one of the protocols specified in 7.3.

c) Installation information

The installation information could include the physical location either in geographical coordinates (latitude, longitude), street address, or tied to a utility customer ID account number. It can also include the last inspection or repair date if necessary. The installation information can be structured per the IEC Common Information Model (CIM), defined in IEC 61968 and IEC 61970 (IEC 61968-5:2020 [B10]; IEC 61970-301:2020 [B12]).

d) Electrical location

The electrical location information may include the service delivery point, meter ID, customer ID, as built feeder segment ID, a connection point identifier for distribution, sub-transmission- or transmission-connected DER, and number of DER units within the total capacity. It can also include the phasing information indicating whether it is single or three phase DER. If the device is single phase, the phase to which it is connected should be specified. There are other options for supplying the location information: an ADMS can have a record the electrical location and pass that on to the DERMS. Interconnection details are addressed in IEEE Std 1547-2018. The IEC Common Information Model standards should be used to describe the electrical information (IEC 61968-5:2020 [B10]; IEC 61970-301:2020 [B12]).