

IEEE Guide for Monitoring, Information Exchange, and Control of Distributed Resources Interconnected with Electric Power Systems

Sponsor
**IEEE Standards Coordinating Committee 21 on
Fuel Cells, Photovoltaics, Dispersed Generation, and Energy Storage**

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Abstract: This guide is intended to facilitate the interoperability of distributed resources (DR) and help DR project stakeholders implement monitoring, information exchange, and control (MIC) to support the technical and business operations of DR and transactions among the stakeholders. The focus is on MIC between DR controllers and stakeholder entities with direct communication interactions. This guide incorporates information modeling, use case approaches, and a pro-forma information exchange template and introduces the concept of an information exchange interface. The concepts and approaches are compatible with historical approaches to establishing and satisfying MIC needs. The IEEE 1547™ series of standards is cited in the U.S. Federal Energy Policy Act of 2005, and this guide is one document in the IEEE 1547 series.

This guide is primarily concerned with MIC between the DR unit controller and the outside world. However, the concepts and methods should also prove helpful to manufacturers and implementers of communications systems for loads, energy management systems, SCADA, electric power system and equipment protection, and revenue metering. The guide does not address the economic or technical viability of specific types of DR. It provides use case methodology and examples (e.g., examples of DR unit dispatch, scheduling, maintenance, ancillary services, and reactive supply). Market drivers will determine which DR applications become viable. This document provides guidelines rather than mandatory requirements or prioritized preferences.

Keywords: communications; control; data acquisition; diesel generators; dispersed generation; distributed energy resources; distributed generation; distributed power; distributed resources; distribution system; electric power system; electrical network; energy management; energy storage; fuel cells; grid; IED; information exchange; intelligent electronic devices; interconnection requirements and specifications; meter; microturbines; monitoring; photovoltaic power systems; public utility commission; regulations; rulemaking, federal, national, regional, SCADA; standards; state; substations; supervisory; telemetry; utility grid

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Introduction

This introduction is not part of IEEE Std 1547.3, IEEE Guide for Monitoring, Information Exchange, and Control of Distributed Resources Interconnected with Electric Power Systems.

IEEE Std 1547.3 is one of a series of standards published by the IEEE or being developed by IEEE Standards Coordinating Committee 21 on Fuel Cells, Photovoltaics, Dispersed Generation, and Energy Storage concerning distributed resources interconnected with area electric power systems. IEEE Std 1547TM provides interconnection technical specifications and requirements as well as test specifications and requirements; IEEE Std 1547.1TM provides the test procedures for verifying conformance to IEEE Std 1547. The documents in the IEEE 1547 series are as follows:

- IEEE Std 1547TM, IEEE Standard for Distributed Resources Interconnected with Electric Power Systems.
- IEEE Std 1547.1TM, IEEE Standard for Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems.
- IEEE P1547.2TM, Draft Application Guide for IEEE Std 1547 Standard for Interconnecting Distributed Resources with Electric Power Systems.¹
- IEEE Std 1547.3TM, IEEE Guide for Monitoring, Information Exchange, and Control of Distributed Resources Interconnected with Electric Power Systems.
- IEEE P1547.4TM, Draft Guide for Design, Operation, and Integration of Distributed Resource Island Systems with Electric Power Systems.
- IEEE P1547.5TM, Draft Technical Guidelines for Interconnection of Electric Power Sources Greater Than 10 MVA to the Power Transmission Grid.
- IEEE P1547.6TM, Draft Recommended Practice for Interconnecting Distributed Resources with Electric Power Systems Distribution Secondary Networks.

The IEEE 1547 series of standards is an outgrowth of the changes in the environment for the production and delivery of electricity and builds on prior IEEE standards, recommended practices, and guides developed by the IEEE Standards Coordinating Committee 21 on Fuel Cells, Photovoltaics, Dispersed Generation, and Energy Storage. In 2005, the United States Federal Energy Policy Act cited and required the IEEE 1547 series of standards for interconnection.

IEEE Std 1547.3 is intended to facilitate interoperability of distributed resources interconnected with an area electric power system. It is intended to help stakeholders in distributed resource installations implement optional approaches for monitoring, information exchange, and control to support the operation of their distributed resources and transactions among the stakeholders associated with the distributed resources. This guide describes functionality, parameters, and methodologies for monitoring, information exchange, and control related to distributed resources interconnected with an area electric power system. The focus is on monitoring, information exchange, and control data exchanges between distributed resource controllers and stakeholder entities with direct communication interactions. This guide incorporates information modeling and use case approaches, but it is also compatible with historical approaches to establishing and satisfying monitoring, information exchange, and control needs for distributed resources interconnected with an area electric power system.

The data exchanges between the distributed resource controller and equipment or entities internal to the local electric power system are not addressed in this guide. The many potential paths of data exchanges among individual stakeholders are also beyond the focus of this document. This guide does not establish requirements for interconnection, protection, safety, or local and area electric power system operation functions. Further, it is beyond the scope of this guide to mandate the business or tariff requirements associated with distributed resources interconnected with an electric power system. However, monitoring,

¹ Numbers 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.

information exchange, and control related to such issues and requirements may be ameliorated or satisfied by judicious use of this guide. Finally, specific hardware and software equipment, products, and services are not the subject of this guide.

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IEEE Guide for Monitoring, Information Exchange, and Control of Distributed Resources Interconnected with Electric Power Systems

1. Overview

This overview is intended to provide a concise description of the scope, purpose, limitations, and application of this guide. Background information is provided in this clause, and detailed discussions of technical content are provided in the later clauses of this guide. The scope explains what is covered in the guide, the purpose explains why this guide's project is needed, and a subclause on limitations is presented that identifies certain monitoring, information exchange, and control (MIC) aspects not covered in this guide. In other words, the technical boundaries of the guide are discussed in these opening subclauses. Following that, background and introductory information are presented on understanding this guide's general application considerations.

1.1 Scope

This document provides guidelines for monitoring, information exchange, and control of distributed resources (DR) interconnected with electric power systems (EPSs).

1.2 Purpose

This document provides guidelines to facilitate the interoperability of one or more DR interconnected with EPSs. It describes functionality, parameters, and methodologies for MIC of DR interconnected with or associated with EPSs. DR technologies include fuel cells, photovoltaics, wind turbines, microturbines, and other distributed generators as well as distributed energy storage systems.

This guide documents alternatives for sound practice based on current practice and includes both legacy and new MIC systems.

1.3 Limitations

This guide is primarily concerned with MIC between DR units and the outside world. It is not intended for MIC within a device or among the components that make up a DR unit. The data exchanges between the distributed resource controller and equipment or entities internal to the local electric power system are not addressed in this guide. Refer to 1.7 for clarification. The many potential paths of data exchanges among individual stakeholders are also beyond the focus of this document. This guide does not establish requirements for interconnection, protection, safety, or local and area EPS operation functions.

This guide does not attempt to judge the economic or technical viability of specific types of DR, but rather presents guidelines for MIC for specific use cases of DR. Market drivers will determine which DR applications become viable in these use cases. Further, it is beyond the scope of this guide to mandate the business or tariff requirements associated with DR interconnected with an electric power system. However, monitoring, information exchange, and control related to such issues and requirements may be satisfied by judicious use of this guide.

The guide provides a description of the MIC characteristics that support DR installations. The guide is intended to aid DR-interested entities in the identification of MIC issues and solutions to support DR installations. This guide is not wholly comprehensive of the types of applications or the MIC desires of interested parties.

This guide does not address the MIC within the local EPS. (See Figure 1.) It does not address MIC for protection, and it does not address MIC requirements associated with revenue metering.

The guide is not part of any set of information exchange architecture standards for utility systems. Hence, conforming products to this guide does not guarantee they will be compatible with any utility system information exchange architecture.

Finally, specific hardware and software equipment, products, and services are not the subject of this guide.

1.4 Alternative approaches

This document provides guidelines rather than rigid requirements. This means alternative approaches to good practice are suggested but no clear-cut recommendations are made. This document states approaches relative to MIC for DR in EPSs. Example approaches are given, but there is more than one effective way to accomplish the desired results. One approach or another may be easier to implement in a specific user's DR installation, and it is recognized that the user has a choice.

1.5 Different levels of stakeholder needs

Stakeholder MIC needs vary with DR type, size, ownership, and location. In some situations, only minimal DR communications capabilities will be implemented. Additional capabilities may simply not be needed, or the functional benefit may not justify the expense. In other situations, a more comprehensive set of capabilities will be implemented to meet particular stakeholder needs or because the implementation cost is minimal. Although this document lists many potential MIC capabilities, it is important to remember that a wide range of stakeholder needs exists and that a corresponding range of MIC capabilities would be appropriate in these systems. In general, the size of the DR unit and the complexity of the application situation will help the user determine which MIC capabilities from the most relevant use case in this guide should be applied.

1.6 How to use this document

This guide is intended to help stakeholders in DR installations implement alternative approaches for MIC to support the operation of DR and transactions among stakeholders associated with DR. The reader should become familiar with the overall structure and intent of this guide, especially as discussed in Clause 1 and Clause 4.

Clause 1 provides an overview of the guide. Clause 2 presents references that are indispensable for the application of this guide. Clause 3 presents definitions and acronyms. Clause 4 introduces general technical content and application considerations of MIC of DR. Clause 5 contains basic MIC guidelines that focus on 4.16 of IEEE Std 1547TM.¹ Clause 6 and Clause 7 present an in-depth treatment of MIC based on forward-looking approaches. In these clauses, guidelines are given for information modeling of DR interconnection applications. Clause 8 identifies example information technology protocol options and guidelines for protocols for MIC. Clause 9 provides guidelines for security issues for MIC in DR applications.

¹ Information on references can be found in Clause 2.

After these clauses, Annex A provides a bibliography. Annex B supports Clause 4 by presenting an annotated list of communications protocols, and Annex C supports this clause by providing additional information about open systems. Annex D is an introduction to business process concepts that supplements Clause 6 and Clause 8. Clause 6 is also supported by Annex E, which provides a use case template, and Annex F, which provides sample use cases. Annex G supplements Clause 7 with sample information exchange agreements (IEAs). Finally, Annex H supports Clause 9 by providing additional information security information.

1.7 IEEE 1547.3 reference diagram for information exchange

Figure 1 provides a reference overview of IEEE 1547.3 guidelines. Its emphasis is conceptual to focus the guidelines on the MIC that are relevant to DR interconnection. The diagram identifies the components that participate in processes of interest. These components are the subjects, or actors, of the process descriptions included in these guidelines. The components in this diagram are consistent with IEEE Std 1547. The new components of the diagram not defined in IEEE Std 1547 are defined in 1.7.1.

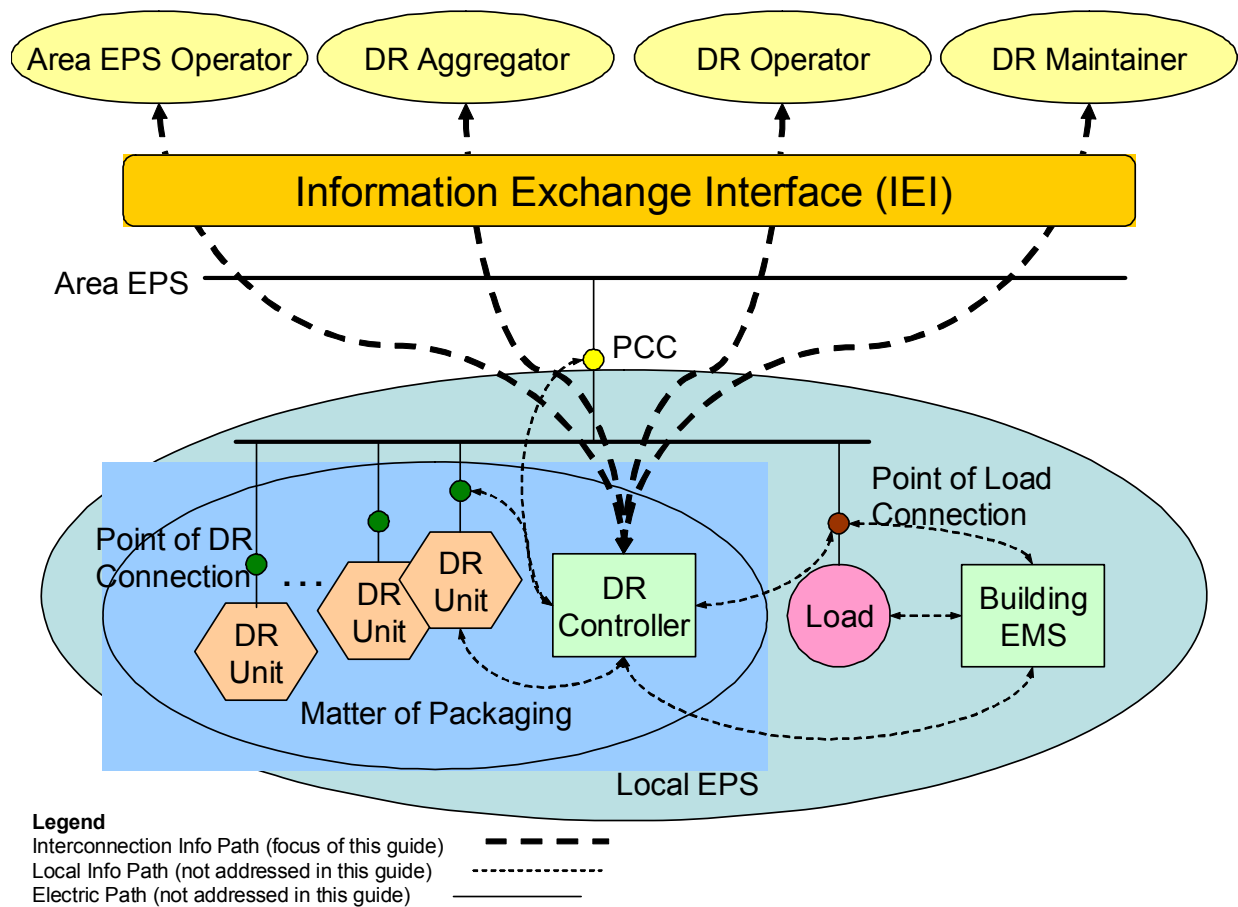


Figure 1— Reference diagram for information exchange

The upper ovals represent the roles of stakeholders who may need to exchange information with the DR system about its interconnection with the area EPS. Other stakeholders are acknowledged as important in the integration of these resources; however, those shown are the subject of the IEEE 1547.3 guidelines (see 1.7.1.2).

The DR units are represented by the hexagons. There may be one or many DR units at a site, but there will be at least one DR controller that performs a monitoring and control function. The DR controller has the intelligence with which to collaborate with stakeholders and site equipment. Note that the DR controller may communicate with these other entities through a communication gateway component; however, for the purposes of the reference diagram, the DR controller subsumes this function. The DR units and controllers can be installed in a variety of configurations. DR units and DR controllers may be packaged together or separately, depending on the business strategy of the manufacturers and the requirements of the clients.

The large circle represents a load. Some loads may be facilities with facility energy management system (EMS) controllers to optimize their operations. A building facility controller is represented as a rectangle and labeled building EMS. Because the focus of the guidelines is on the DR interconnection, coordination of the DR with specific loads on the local EPS may be needed. The building EMS represents the intelligent component for collaboration with the DR controller to enable such interactions as may be needed for combined heat and power applications. The building EMS operator and the DR operator would need to collaborate to ensure appropriate interaction between the DR controller and building EMS for this purpose.

Connections of interest are presented as lines in Figure 1. Solid lines represent electrical connections, and dashed lines represent communication paths. The communication paths are further sub-divided into those that are relevant to the guidelines and those that are acknowledged as important in an installation but are not the focus of this work. Note that communications exist among the stakeholders; however, these are not the subject of these guidelines and, for simplicity, are not shown in the diagram. The heavy dashed lines between stakeholders and the DR controller indicate the focus of these guidelines. The lighter dashed lines are generally required for local monitoring and control of internal device parameters or connection points in the local EPS. They are addressed through various mechanisms (such as standards, de facto standards, and custom implementations) that are generally within the control of the DR site integrator and, therefore, are less relevant to the interconnection with the area EPS and interaction with the DR stakeholders. As noted in 1.3, limitations, local sensing, and control are not the concern of this guide. In addition, the light dashed line between the DR controller and building EMS is included in the diagram to acknowledge that these systems may be integrated at a site to coordinate capabilities such as combined heat and power, but the details of this interaction are not the concern of this guide.

This guide can be thought of in terms of an information exchange interface for the DR device to communicate with remote parties. The information exchange interface could be an actual single point of interface for all remote information flows to and from the device, or it could be an abstraction that represents information flows by multiple, but coordinated, physical media. In either case, this document provides guidance for the information content (e.g., parameters, data, and data rates) that needs to be available at the information exchange interface. The information exchange interface is the information exchange counterpart of the point of common coupling (PCC) in the electrical system.

1.7.1 Diagram terminology

To clarify the terms and concepts in the reference diagram, definitions of the equipment and stakeholder roles follow. The term “role” represents that component of an organization that performs a certain job and interacts with other components in its duties. Organizations can be structured to contain different mixes of roles (e.g., a distribution system company may include area EPS operator (AEP SO), DR operator, and DR maintainer roles). By distinguishing among roles, the information exchange described by these guidelines can be applied to organizations with different combinations of roles. The same holds true for the combinations of equipment components in an installation and the roles they assume.