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

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Sponsored by the
IEEE Standards Coordinating Committee 21 on Fuel Cells, Photovoltaics, Dispersed Generation, and Energy Storage

IEEE
3 Park Avenue
New York, NY 10016-5997
USA

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Abstract: IEEE Std 2030® provides alternative approaches and best practices for achieving smart grid interoperability. It is the first all-encompassing IEEE standard on smart grid interoperability providing a roadmap directed at establishing the framework in developing an IEEE national and international body of standards based on cross-cutting technical disciplines in power applications and information exchange and control through communications.

IEEE Std 2030 establishes the smart grid interoperability reference model (SGIRM) and provides a knowledge base addressing terminology, characteristics, functional performance and evaluation criteria, and the application of engineering principles for smart grid interoperability of the electric power system with end-use applications and loads. A system of systems approach to smart grid interoperability lays the foundation on which IEEE Std 2030 establishes the SGIRM as a design tool that inherently allows for extensibility, scalability, and upgradeability. The IEEE 2030 SGIRM defines three integrated architectural perspectives: power systems, communications technology, and information technology. Additionally, it defines design tables and the classification of data flow characteristics necessary for interoperability. Guidelines for smart grid interoperability, design criteria, and reference model applications are addressed with emphasis on functional interface identification, logical connections and data flows, communications and linkages, digital information management, and power generation usage.

Keywords: communications technology, controls, cyber security, distributed resources, electric infrastructure and reliability, electric power system, electricity customers and loads, EPS, grid architecture, grid operations, IEEE 2030®, information technology, interconnection, interfaces, interoperability, power systems, SCADA, SGIRM, Smart Grid, smart grid reference model

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Introduction

This introduction is not part of 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.

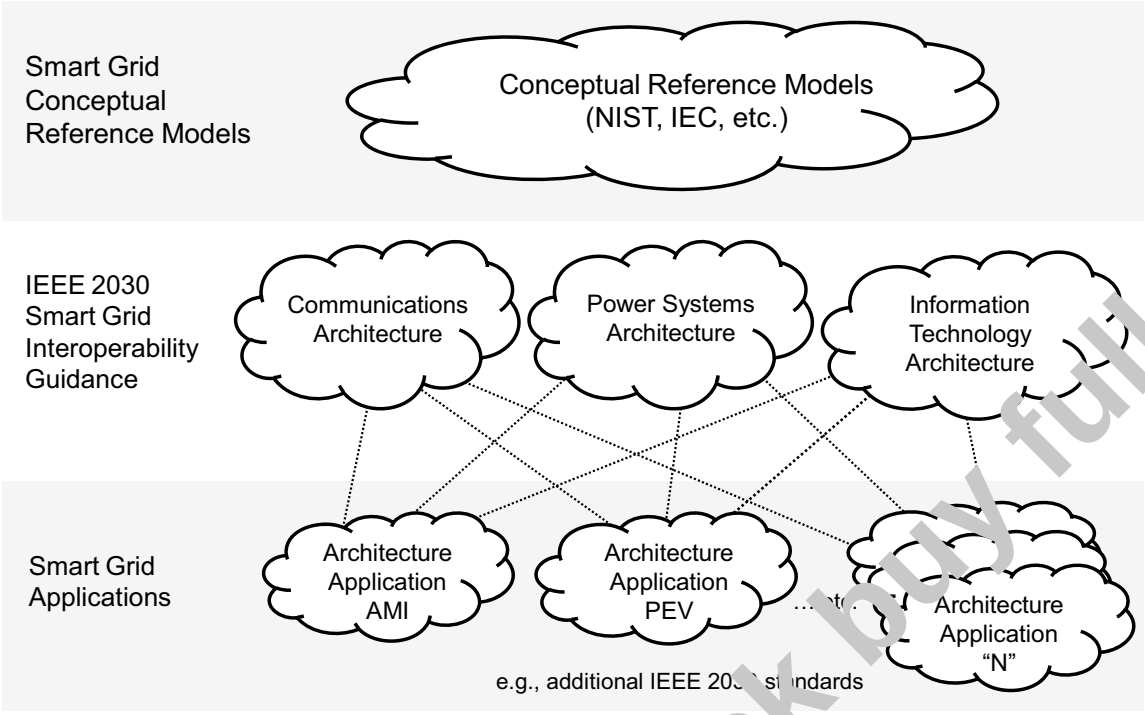
The sophistication and age of electrical power grids throughout the world vary significantly, and they may vary within a country from area to area or electrical service provider to electrical service provider. Additionally, there is an increasing worldwide demand for building an expansive electricity infrastructure. Satisfying the demands for expansion and for upgrading aging electrical power systems, coupled with the advances in communications and information technologies, has stimulated the concept of "Smart Grid"—a broad term used to include the application of secure, two-way communications and information technology to electrical power grids.

These demands have also driven policy, legislation, and regulation of power systems throughout the world.

The U.S. Energy Independence and Security Act (EISA) of 2007 addresses the coordination of the development of a smart grid interoperability framework. Under EISA Section 1305, the Director of the National Institute of Standards and Technology (NIST) shall have the primary responsibility of coordinating the development of that framework, including soliciting input from private organizations, including the National Electrical Manufacturers Association and IEEE. Further, the scope of the interoperable framework "shall be flexible, uniform, and technology neutral" and "align policy, business, and technology approaches in a manner that would enable all electric resources, including demand-side resources, to contribute to an efficient, reliable electricity network." The International Electrotechnical Commission (IEC) has similar interests in evolving their smart grid concepts and established the IEC Standardization Management Board (SMB) Strategic Group 3 (SG 3) on Smart Grid. It was established to advise the board concerning the technologies associated with the Smart Grid and to identify the needs for new international standards. Currently there are many (national and international) standardization activities related to the development of smart grid concepts. A smart grid standardization roadmap was developed in 2010 by the IEC that is similar to the framework and roadmap developed by NIST. Standards developing organizations (e.g., IEEE)—using an open and balanced consensus process—are establishing standards for the Smart Grid building off of the conceptual reference models produced by NIST [B17] and others.[a]

IEEE Std 2030-2011 supports EISA to the NIST framework coordination efforts, IEC interests, and additional smart grid applications. It focuses on a systems-level approach to understanding and guidance for *interoperability* components of communications, power systems, and information technology platforms (see Figure a). This guide views the Smart Grid as a large, complex "system of systems" and provides guidance to navigate the numerous smart grid design pathways throughout the EPS, loads, and end-use applications. This interoperability standard lays the foundation for the expanding smart grid applications level shown in Figure a**,** which provides a platform for any number of smart grid applications, i.e., advanced metering infrastructure, plug-in electric vehicles, and other smart grid applications ("N"). These applications may be supported by additional IEEE 2030 standards.

[a] The numbers in brackets correspond to those of the bibliography in Annex A.



AMI = advanced metering infrastructure
PEV = plug-in electric vehicle
N = other smart grid applications

Figure a—Evolution of smart grid interoperability

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John Bzura
James Daley
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Frank Goodman
Kelvin Hecht
Yiming Hou
Gerald Johnson
Joseph L. Koepfinger
Benjamin Kroposki
Peter McNutt
Thomas Prevost
Mary Reidy
Charles Rogers
Robert Saint
Mark Siira
Timothy Zgonena

At the time this guide was submitted to the IEEE-SA Standards Board for approval, the IEEE 2030 Smart Grid Interoperability Working Group had the following membership:

Richard DeBlasio, *Chair*
Thomas Prevost, *Vice Chair, Task Force 1 Co-Chair*
Thomas S. Basso, *Secretary, Task Force 1 Recorder*
Samuel Sciacca, *Task Force 1 Co-Chair*
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Jeffrey Katz, *Task Force 2 Co-Chair*
Michael Coddington, *Task Force 2 Recorder*
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Robert Heile, *Task Force 3 Co-Chair*
Connie Komomua, *Task Force 3 Recorder*

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Robert Saint
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Wayne Stec
Gary Stuebing
Alex Takahashi
William Tamae
Osamu Tomobe
Steve Turner
Randy West

The following list identifies individuals in addition to the working group members who participated in the development of this guide:

Dhice Achkir
Dhiraj Adya
Paul Ainslie
Wole Akpose
Farrokh Albuyeh
James Allen
Tom Anderson
Alexander Apostolov
Takashi Aramaki
Haukur Asgeirsson
Thao Attard
Papiya Bagchi
Xiaomin Bai
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Waldemar Ziomek

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Contents

1. Overview 1

1.1 Scope 1
1.2 Purpose 1
1.3 What this guide provides 2

2. Normative references 2

3. Definitions, acronyms, and abbreviations 3

3.1 Definitions 3
3.2 Acronyms and abbreviations 4

4. The IEEE 2030 smart grid approach 6

4.1 General 6
4.2 The Smart Grid—A complex system of systems 6
4.3 Smart grid architecture 6
4.4 Smart grid interoperability 8
4.5 Privacy and security 9
4.6 Reliability 19

5. The IEEE 2030 smart grid interoperability reference model (SGIRM) 21

5.1 General 21
5.2 The interoperability architectural perspective (IAP) concept 22
5.3 Classification of data flow characteristics 23
5.4 IEEE 2030 SGIRM methodology 27

6. Power systems interoperability 28

6.1 General 28
6.2 IEEE 2030 SGIRM power systems IAP (PS-IAP) 29
6.3 Typical data characteristics in EPS interfaces 41

7. Communications technology interoperability 42

7.1 General 42
7.2 IEEE 2030 SGIRM communication technology IAP (CT-IAP) 42
7.3 Uses of the CT-IAP 56
7.4 Characteristics of smart grid communications network connectivity 56
7.5 Security categorization applied to communications 58
7.6 Key management framework 63

8. Information technology interoperability 65

8.1 General 65
8.2 IEEE 2030 SGIRM information technology IAP (IT-IAP) 65
8.3 Logical description of information technology systems 71
8.4 Information exchange reference interoperability model for IT-IAP 73
8.5 Design framework methodologies and tools 76
8.6 Information security principles for the Smart Grid 79

9. Legacy electric power systems and the Smart Grid 81

Annex A (informative) Bibliography 82

Annex B (informative) Guidance for implementing security 84

B.1 General 84
B.2 Data classification 85

Annex C (informative) Using IEEE 2030 SGIRM PS-IAP 88

C.1 General 88
C.2 Examples of how to apply the SGIRM methodology to smart grid implementations 88

Annex D (informative) Using IEEE 2030 SGIRM CT-IAP 97

D.1 Interface description template 97
D.2 Examples 97

Annex E (informative) Smart grid interoperability in Object Process Methodology (OPM) notation 106

E.1 Introduction to OPM 106
E.2 View of interoperability within IT-IAP 108
E.3 View of integration within IT-IAP 108
E.4 Application interoperability framework within IT-IAP 108

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

1. Overview

The overview of this guide provides a concise description of the scope, purpose, and application. The scope explains what is covered in the guide and the purpose explains why the guide is needed. Following the scope and purpose, introductory information in 1.3 is presented on understanding this guide's general application considerations and how to use it. Detailed discussions of technical content are provided in the later clauses of this guide.

1.1 Scope

This document provides guidelines for smart grid interoperability. It also provides a knowledge base addressing terminology, characteristics, functional performance and evaluation criteria, and the application of engineering principles for smart grid interoperability of the electric power system (EPS) with end-use applications and loads. The guide discusses alternate approaches to good practices for the Smart Grid.

1.2 Purpose

This document provides guidelines in understanding and defining smart grid interoperability of the EPS with end-use applications and loads. Integration of energy technology and information and communications

technology (ICT) is necessary to achieve seamless operation for electric generation, delivery, and end-use benefits to permit two-way power flow with communication and control. Interconnection and intra-facing frameworks and strategies with design definitions are addressed in this guide, providing guidance in expanding the current knowledge base. This expanded knowledge base is needed as a key element in grid architectural designs and operation to promote a more reliable and flexible EPS.

1.3 What this guide provides

1.3.1 General

This guide provides understanding, definitions, and guidance for design and implementation of smart grid components and end-use applications for both legacy and future infrastructures. This document allows for additional functionality beyond what is stated and is meant to accommodate innovation. Because interoperability is achieved through extensive collaboration among many diverse members of the smart grid community, this guide provides the reader with a heightened awareness of the challenges and opportunities of the many different stakeholder roles of a smart grid implementation and a common understanding of the technology drivers of smart grid interoperability. The knowledge base of this guide contributes to a basis for future certification and testing of smart grid components and subsystems.

1.3.2 Intended audience

This guide is intended for the many diverse members of the smart grid community who participate in extensive collaboration for successful smart grid application implementation. This guide should be read in its entirety as it provides the reader with challenges and opportunities, and describes stakeholder roles pertinent to smart grid implementation.

1.3.3 Smart grid interoperability reference model

The IEEE 2030® smart grid interoperability reference model (SGIRM) is a reference tool to provide stakeholders with a common understanding of interoperability criteria from the power system, communications, and information technology perspectives. The IEEE 2030 SGIRM identifies and defines the interfaces between functional domains of the power grid from each of the perspectives and describes the relationships among the domains, including the characteristics of the data that flow between them. The constraints, issues, and impacts on interoperability at these interfaces are considered for each domain. With this information, optimal design criteria for the interoperability of smart grid implementations can be planned. The concept of the SGIRM reference tool is to allow for extensibility, scalability, and upgradeability.

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 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.

NISTIR 7628, Guidelines for Smart Grid Cyber Security: Vol. 1, Smart Grid Cyber Security Strategy, Architecture, and High-Level Requirements (Aug. 2010).[1]

[1] This document is available on the NIST website at: http://csrc.nist.gov/publications/nistir/ir7628/nistir-7628_vol1.pdf.