

This document contains supplemental information referenced by the European Rolling Plan for ICT Standardisation.

IEEE Standards Activities in the Smart Grid Space (ICT Focus)

Overview

IEEE's standardization work not only covers information and communication technologies (ICT) but also aspects of electrical power generation and distribution, including demand response, renewable energy sources, security, reliability, and systems engineering. ICT standards work in Smart Grid includes:

- **Smart Grid Interoperability:** The [IEEE 2030](#) series is based on an interoperability reference model that defines data flows for reliable, secure, bi-directional flow of electric power, and identifies the necessary communication infrastructure, incl. for electric vehicles.
- **Networking and Communications:** The [IEEE 1901](#) series of standards addresses broadband/narrowband over powerline; the [IEEE 802](#) family of standards addresses many other aspects of networking.
- **Cyber Security for Smart Grid:** Multiple standards addressing cybersecurity for Intelligent Electronic Devices ([IEEE 1686](#)), Substation Automation ([IEEE C37.240](#), [IEEE 1711](#) series)
- **Smart Metering and Demand Response:** Multiple standards including [IEEE 170X](#) series and [IEEE 1377](#) for communication protocols, [IEEE 2030.5](#) for smart energy profiles, and [IEEE 1901](#) series for smart metering functionality
- **Substation Automation:** Standards include time protocol, synchronization work, and electric power system communication, such as [IEEE 1815 \(DNP3\)](#), [IEC/IEEE 61850-9-3](#), [IEEE C37.238](#), [IEEE C37.118](#) series, etc.
- **Electric Vehicle Charging:** Standards include [IEEE 2030.1.1](#), which specifies the design interface of electric vehicles as well as direct current and bi-directional chargers that utilize battery electric vehicles as power storage devices.

IEEE has established a wide range of relationships across many geographic and standards development organization (SDO) boundaries. Coordination and collaboration across the standards community are necessary to ensure that the smart grid can realize its full potential.

Vision projects

In addition to the standards projects that are a central activity, the IEEE Standards Association (IEEE-SA) has partnered with the respective IEEE Societies to develop long-term **smart grid visions** for each technology that has a great impact on the smart grid: Communications, Power, IT, Control Systems, and Vehicular Technologies.

These visions are looking beyond the year 2030 and are predicting how the smart grid will evolve for each of these technology-focused areas.

Smart grid data analytics

In the research area of furthering smart grid evolution, a data analytics group is looking to develop a data repository where real data could be used and leveraged to develop modeling and simulating tools, user interfaces, and other software predicting applications.

Relevant Standards Activities

Interoperability

IEEE Standards Series*

- [IEEE 1278](#) series on distributed interactive simulation
- [IEEE 1516](#) series on modeling and simulation standards
- [IEEE 1730](#) series, addressing a process for distributed simulation engineering and execution
- [IEEE 1815](#) series on electric power system communications
- [IEEE 2030](#) series on the Smart Grid, including electric vehicle infrastructure

Approved Standards and New or Revision Projects*

- [IEEE 1377-2012](#), IEEE Standard for Utility Industry Metering Communication Protocol Application Layer Standard (End Device Data Tables)
- [IEEE P1451.8](#), IEEE Draft Standard for Wind Turbine Health Monitoring System Wireless Communication Protocols and Transducer Electronic Data Sheet (TEDS) Format
- [IEEE P1547](#) (revision), IEEE Draft Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces
- [IEEE P1591.2-2017](#), IEEE Draft Standard for Testing and Performance of Hardware for All-Dielectric Self-Supporting (ADSS) Fiber Optic Cable
- [IEEE P1591.3](#), IEEE Draft Standard for Qualifying Hardware for Helically Applied Fiber Optic Cable Systems (WRAP Cable)
- [IEEE P1594](#), IEEE Draft Standard for Helically Applied Fiber Optic Cable Systems (WRAP Cable) for Use on Overhead Utility Lines
- [IEEE P1595](#), IEEE Draft Standard for Testing and Performance for Optical Phase Conductor (OPPC) for Use on Electrical Utility Power Lines
- [IEEE 1701-2011](#), IEEE Standard for Optical Port Communication Protocol to Complement the Utility Industry End Device Data Tables
- [IEEE 1702-2011](#), IEEE Standard for Telephone Modem Communication Protocol to Complement the Utility Industry End Device Data Tables
- [IEEE 1703-2012](#), IEEE Standard for Local Area Network/Wide Area Network (LAN/WAN) Node Communication Protocol to Complement the Utility Industry End Device Data Tables
- [IEEE 1711-2010](#), IEEE Trial Use Standard for a Cryptographic Protocol for Cyber Security of Substation Serial Links

- [IEEE 1775-2010](#), IEEE Standard for Powerline Communication Equipment - Electromagnetic Compatibility (EMC) Requirements - Testing and Measurement Methods
- [IEEE 1808-2011](#), IEEE Guide for Collecting and Managing Transmission Line Inspection and Maintenance Data
- [IEEE 1905.1-2013](#), IEEE Standard for a Convergent Digital Home Network for Heterogeneous Technologies
- [IEEE 1909.1-2014](#), IEEE Recommended Practice for Smart Grid Communication Equipment - Test methods and installation requirements

Networking and Communications (including the home)

IEEE Standards Series*

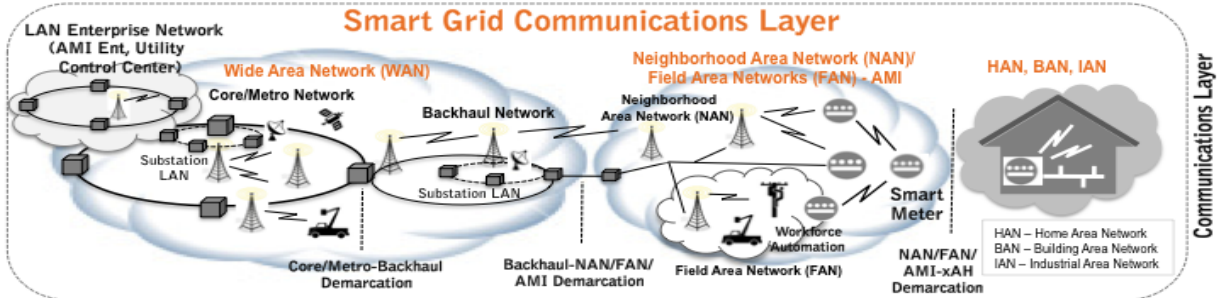
- [IEEE 802.1](#) series on bridging and architecture
- [IEEE 802.3](#) series on wired Ethernet
- [IEEE 802.11](#) series on wireless LAN
- [IEEE 802.15](#) series on wireless personal area networks
- [IEEE 802.16](#) series on broadband wireless access mobility enhancements
- [IEEE 802.19](#) series on wireless coexistence
- [IEEE 802.20](#) series on mobile broadband wireless access
- [IEEE 802.21](#) series on media independent handover across different types of wireless networks
- [IEEE 802.22](#) series on wireless regional area networks
- [IEEE 1888](#) series, addressing ubiquitous green community control networks
- [IEEE 1901](#) series on broadband and narrowband over powerline networks
- [IEEE 2030.5-2018](#), (revision) IEEE Standard for Smart Energy Profile Application Protocol

Approved Standards and New or Revision Projects*

- [IEEE P802c](#), IEEE Draft Standard for Local and Metropolitan Area Networks: Overview and Architecture - Amendment: Local Medium Access Control (MAC) Address Usage
- [IEEE 802.1AC-2016](#), IEEE Standard for Local and Metropolitan Area Networks - Media Access Control (MAC) Service Definition
- [IEEE 802.1AEcg-2017](#), IEEE Standard for Local and Metropolitan Area Networks - Media Access Control (MAC) Security - Amendment 3: Ethernet Data Encryption Devices
- [IEEE P802.1AR](#), IEEE Draft Standard for Local and Metropolitan Area Networks - Secure Device Identity
- [IEEE P802.1AX-2014/Cor1-2016](#), IEEE Draft Standard for Local and Metropolitan Area Networks - Link Aggregation - Corrigendum 1: Technical and Editorial Corrections
- [IEEE P802.1CS](#), IEEE Draft Standard for Local and Metropolitan Area Networks - Link-local Registration Protocol
- [IEEE 802.1Qch-2017](#), IEEE Standard for Local and Metropolitan Area Networks - Media Access Control (MAC) Bridges and Virtual Bridged Local Area Networks Amendment: Cyclic Queuing and Forwarding
- [IEEE P802.1Qci-2017](#), IEEE Draft Standard for Local and Metropolitan Area Networks - Bridges and Bridged Networks Amendment: Per-Stream Filtering and Policing
- [IEEE P802.3](#), IEEE Draft Standard for Ethernet
- [IEEE 802.3bu-2016](#), IEEE Standard for Ethernet Amendment: Physical Layer and Management Parameters for 1-Pair Power over Data Lines

- [IEEE 802.3bv-2017](#), IEEE Standard for Ethernet Amendment 9: Physical Layer Specifications and Management Parameters for 1000 Mb/s Operation Over Plastic Optical Fiber
- [IEEE P802.3cg](#), IEEE Draft Standard for Ethernet Amendment: Physical Layer Specifications and Management Parameters for 10 Mb/s Operation over Single Balanced Twisted-pair Cabling and Associated Power Delivery
- [IEEE 802.11](#), IEEE Standard for Information Technology - Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks - Specific Requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications
- [IEEE P802.11ba](#), IEEE Draft Standard for Information Technology - Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks - Specific Requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment: Wake-up radio operation
- [IEEE 802.15.4-2015](#), IEEE Standard for Low-Rate Wireless Networks
- [IEEE 802.15.4t-2016](#), IEEE Standard for Local and Metropolitan Area Networks - Part 15.4: Low-Rate Wireless Personal Area Networks (LR-WPANs) Amendment for a Higher Rate (2 Mb/s) Physical (PHY) Layer
- [IEEE 802.15.4v-2017](#), IEEE Standard for Low-Rate Wireless Networks Amendment: Enabling/Updating the Use of Regional Sub-GHz Bands
- [IEEE P802.16](#), IEEE Draft Standard for Air Interface for Broadband Wireless Access Systems IEEE
- [IEEE P802.21-2017](#), IEEE Draft Standard for Local and Metropolitan Area Networks - Part 21: Media Independent Services Framework
- [IEEE P802.21-2017/Cor1](#), IEEE Draft Standard for Local and Metropolitan Area Networks - Part 21: Media Independent Services Framework - Corrigendum 1: Clarification of Parameter Definition in Group Session Key Derivation
- [IEEE P802.21.1-2017](#), IEEE Draft Standard for Local and Metropolitan Area Networks - Part 21.1: Media Independent Services
- [IEEE 802.11ai-2016](#), IEEE Standard for Information Technology- Telecommunications and Information Exchange Between Systems-Local and Metropolitan Area Networks-Specific requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications: Amendment to IEEE P802.11-REVmc(™)/D8.0: Fast Initial Link Setup
- [IEEE 802.11-2016](#), IEEE Standard for Information Technology- Telecommunications and Information Exchange Between Systems - Local and Metropolitan Area Networks - Specific Requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications
- [IEEE P802.15.4-2015/Cor1](#), IEEE Draft Standard for Low-Rate Wireless Networks - Corrigendum 1
- [IEEE P1613.1](#), (revision) IEEE Draft Standard Environmental and Testing Requirements for Communications Networking Devices Installed in Electric Power Substations
- [IEEE P1615](#), (revision) IEEE Draft Recommended Practice for Network Communication in Electric Power Substations
- [IEEE 1888.4-2016](#), IEEE Green Smart Home and Residential Quarter Control Network Protocol
- [IEEE 1901.1-2018](#), IEEE Standard for Medium Frequency (less than 15 MHz) Power Line Communications for Smart Grid Applications
- [IEEE P1901.1.1](#), IEEE Draft Standard Test Procedures for IEEE 1901.1 Standard for Medium Frequency (less than 15 MHz) Power Line Communications for Smart Grid Applications
- [IEEE P1904.1](#), (revision) IEEE Draft Standard for Service Interoperability in Ethernet Passive Optical Networks (SIEPON)

Network Technology Standards Mapping



Smart Grid Network Technology & Protocols Standards Mapping

Wide Area Network (WAN) (public/private)					(NAN/ FAN) AMI Networks (public/private)					Smart Meters	HAN, BAN, IAN																						
Substation	Core/Metro Network			Backhaul Network		Substation	(licensed/unlicensed)				wireless	wireline																					
LAN (several options)	wireline	wireless		wireless	wireline	LAN (several options)	wireless	wireline			wireless	wireline																					
DNP3/IEC 61850	IP/MPLS/T-MPLS	SONET-SDH/STS-Mesh/DWDM	PacketMetro-Ethernet	Wimax 802.16d/e	Trunked Radio	3G-3GPP/1XRTT/EVDO	GPRS/EDGE/HSDPA	Wimax 802.16d/e	Mesh RF/mim-Wave	RF Plo-to-Pro/MAS	802.16/LMDS	GPON/EPON	RFoG-DOCSIS	Metro-Ethernet	DSU/POTS/DPDH	LAN (several options)	DNP3/IEC 61850	RF Mesh/ 802.15.4g	Wimax 802.16d/e	3G-3GPP/1XRTT/EVDO	GPRS/EDGE/HSDPA	RF Radio Plo-Mtp/MAS	WLAN 802.11 n/g	802.2.15.4/ ZigBee	FTTP/FTTH/Ethernet	RFoG-DOCSIS	PLC/BPL P1901	ANSI C.1222	802.2.15.4/ ZigBee	6LowPAN	802.11	ITU-T SG15 G.hn	HomePlug



Wide Area Network (WAN)			NAN/FAN		Smart Meters	HAN, BAN, IAN		
Substation	Core/Metro Network/Backhaul Network		Substation			wireline	wireless	
LAN	Wireline	Wireless	LAN	Wireline	Wireless	Wireline	Wireless	
IEEE 1815/IEC 61850 Several Options	IEEE 802.1 IEEE 802.3	IEEE 802.16d/e IEEE 802.20 IEEE 802.22	LAN IEEE 1815/IEC 61850 Several Options	IEEE 802.1 IEEE 802.3 IEEE 1901	IEEE 802.11 IEEE 802.15.4 IEEE 802.16	IEEE SC31 (1377, 1701, 1703, P1704)	IEEE 802.1 IEEE 802.3 IEEE 1901 IEEE 1901.2 IEEE P1905.1	IEEE 802.11 IEEE 802.15.4

Cyber Security

Approved Standards*

- [IEEE 1686-2013](#), IEEE Standard for Intelligent Electronic Devices Cyber Security Capabilities
- [IEEE C37.240-2014](#), IEEE Standard Cybersecurity Requirements for Substation Automation, Protection, and Control Systems

Projects under Development*

- [IEEE P1402](#), (revision) IEEE Draft Guide for Electric Power Substation Physical and Electronic Security
- [IEEE P1711](#), IEEE Draft Standard for a Cryptographic Protocol for Cyber Security of Substation Serial Links
- [IEEE P1711.2](#), IEEE Draft Standard for Secure SCADA Communications Protocol (SSCP)
- [IEEE P2030.102.1](#), IEEE Draft Standard for Interoperability of Internet Protocol Security (IPsec) Utilized within Utility Control Systems
- [IEEE P2658](#), IEEE Draft Guide for Cybersecurity Testing in Electric Power Systems
- [IEEE PC37.249](#), IEEE Draft Guide for Cyber Security of Protection Related Data Files

Substations**Automation**

Approved Standards*

- [IEEE 1615-2007](#), IEEE Recommended Practice for Network Communication in Electric Power Substations
- [IEEE 1646-2004](#), IEEE Standard Communication Delivery Time Performance Requirements for Electric Power Substation Automation
- [IEEE 1815.1/cor1-2016](#), IEEE Standard for Exchanging Information between Networks Implementing IEC 61850 and IEEE Std 1815™ (Distributed Network Protocol - DNP3) - Corrigendum 1
- [IEEE 1815.1-2015](#), IEEE Standard for Exchanging Information Between Networks Implementing IEC 61850 and IEEE Std 1815 (Distributed Network Protocol--DNP3)
- [IEEE 1909.1-2014](#), IEEE Recommended Practice for Smart Grid Communications Equipment--Test Methods and Installation Requirements
- [IEEE 2030.100-2017](#), IEEE Recommended Practice for Implementing an IEC 61850 Based Substation Communications, Protection, Monitoring and Control System
- [IEEE 2030.101-2018](#), IEEE Guide for Designing a Time Synchronization System for Power Substations
- [IEC/IEEE 61850-9-3-2016](#), IEC/IEEE International Standard: Communication Networks and Systems for Power Utility Automation--Part 9-3: Precision Time Protocol Profile for Power Utility Automation
- [IEEE C37.1-2007](#), IEEE Standard for SCADA and Automation Systems
- [IEEE C37.111-2013](#), IEEE/IEC Measuring Relays and Protection Equipment-- Part 24: Common Format for Transient Data Exchange (COMTRADE) for Power Systems
- [IEEE C37.118.2-2011](#), IEEE Standard for Synchrophasor Data Transfer for Power Systems
- [IEEE C37.231-2006](#), IEEE Recommended Practice for Microprocessor-Based Protection Equipment Firmware Control
- [IEEE C37.232-2011](#), IEEE Standard for Common Format for Naming Time Sequence Data Files (COMNAME)
- [IEEE C37.236-2013](#), IEEE Guide for Power System Protective Relay Applications over Digital Communication Channels
- [IEEE C37.239-2010](#), IEEE Standard Common Format for Event Data Exchange (COMFEDE) for Power Systems
- [IEEE C37.240-2014](#), IEEE Standard Cybersecurity Requirements for Substation Automation, Protection, and Control Systems
- [IEEE C37.243-2015](#), IEEE Guide for Application of Digital Line Current Differential Relays Using Digital Communication

- [IEEE C37.244-2013](#), IEEE Guide for Phasor Data Concentrator Requirements for Power System Protection, Control, and Monitoring
- [IEEE C37.248-2017](#), IEEE Guide for Common Format for Naming Intelligent Electronic Devices (COMDEV)

Projects under Development*

- [IEEE P1127](#), IEEE Draft Guide for the Design, Construction, and Operation of Electric Power Substations for Community Acceptance and Environmental Compatibility
- [IEEE P1250](#), IEEE Draft Guide for Identifying and Improving Voltage Quality in Power Systems
- [IEEE P1613.1](#), (revision) IEEE Draft Standard Environmental and Testing Requirements for Communications Networking Devices Installed in Electric Power Substations
- [IEEE P1615](#), (revision) IEEE Draft Recommended Practice for Network Communication in Electric Power Substations
- [IEEE P1646](#), IEEE Draft Standard Communication Delivery Time Performance Requirements for Electric Power Substation Automation
- [IEEE P1815](#), (revision) IEEE Draft Standard for Electric Power Systems Communications--Distributed Network Protocol (DNP3)
- [IEEE P2030.4](#), IEEE Draft Guide for Control and Automation Installations Applied to the Electric power infrastructure
- [IEEE P2030.101](#), IEEE Draft Guide for Designing a Time Synchronization System for Power Substations
- [IEEE P2408](#), IEEE Draft Guide for Communications-Based Protection of Industrial and Commercial Power Systems
- [IEEE P2775](#), IEEE Draft Technical Guide for Smart Hydroelectric Power Plant
- [IEEE PC37.94](#), (revision) IEEE Draft Standard for N Times 64 Kilobit Per Second Optical Fiber Interfaces Between Teleprotection and Multiplexer Equipment
- [IEEE PC37.118.2](#), IEEE Draft Standard for Synchrophasor Data Transfer for Power Systems
- [IEEE PC37.237](#), IEEE Draft Recommended Practice for Time Tagging of Power System Protection Events
- [IEEE PC37.238](#), (revision) IEEE Draft Standard Profile for Use of IEEE Std 1588 Precision Time Protocol in Power System Applications
- [IEEE PC37.247](#), IEEE Draft Standard for Phasor Data Concentrators for Power Systems
- [IEEE PC37.249](#), IEEE Draft Guide for Categorizing Security Needs for Protection and Automation Related Data Files
- [IEEE PC37.251](#), IEEE Draft Standard for Common Protection and Control Settings or Configuration Data Format (COMSET)
- [IEEE P37.300](#), IEEE Draft Guide for Centralized Protection and Control (CPC) Systems within a Substation

Electric Power Infrastructure

Approved Standards*

- [IEEE 2030.100-2017](#), IEEE Recommended Practice for Implementing an IEC-61850 Based Substation Communications, Protection, Monitoring and Control System

Projects under Development*

- [IEEE P825](#), IEEE Draft Guide for Interoperability of Transactive Energy Systems with Electric Power Infrastructure (Building the Enabling Network for Distributed Energy Resources)

- [IEEE P2030.100.1](#), IEEE Draft Monitoring and Diagnostics of IEC 61850 Generic Object Oriented Status Event (GOOSE) and Sampled Values Based Systems

Distribution Automation

Approved Standards*

- [IEEE 1909.1-2014](#), IEEE Recommended Practice for Smart Grid Communications Equipment--Test Methods and Installation Requirements
- [IEEE C37.111-2013](#), IEEE/IEC Measuring Relays and Protection Equipment --Part 24: Common Format for Transient Data Exchange (COMTRADE) for Power Systems
- [IEEE C37.118.2-2011](#), IEEE Standard for Synchrophasor Data Transfer for Power Systems
- [IEEE C37.231-2006](#), IEEE Recommended Practice for Microprocessor-Based Protection Equipment Firmware Control
- [IEEE C37.232-2011](#), IEEE Standard for Common Format for Naming Time Sequence Data Files (COMNAME)
- [IEEE C37.236-2013](#), IEEE Guide for Power System Protective Relay Applications over Digital Communication Channels
- [IEEE C37.238-2017](#), IEEE Standard Profile for Use of IEEE Std. 1588 Precision Time Protocol in Power System Applications
- [IEEE C37.239-2010](#), IEEE Standard Common Format for Event Data Exchange (COMFEDE) for Power Systems
- [IEEE C37.244-2013](#), IEEE Guide for Phasor Data Concentrator Requirements for Power System Protection, Control, and Monitoring
- [IEEE C62.43.0-2017](#), IEEE Guide for Surge Protectors and Protective Circuits Used in Information and Communications Technology (ICT) Circuits, Including Smart Grid Data Networks - an Overview

Current New or Revision Projects*

- [IEEE PC37.94](#), (revision) IEEE Draft Standard for N Times 64 Kilobit Per Second Optical Fiber Interfaces Between Teleprotection and Multiplexer Equipment
- [IEEE PC62.220](#), IEEE Draft Guide for the Application of Surge Protective Devices for the Smart Grid

Renewables

Approved Standards*

- [IEEE 1547.3-2007](#), IEEE Guide for Monitoring, Information Exchange, and Control of Distributed Resources Interconnected with Electric Power Systems

AMI

Approved Standards*

- [IEEE 1377-2012](#), IEEE Standard for Utility Industry Metering Communication Protocol Application Layer Standard (End Device Data Tables)

- [IEEE 1701-2011](#), IEEE Standard for Optical Port Communication Protocol to Complement the Utility Industry End Device Data Tables
- [IEEE 1702-2011](#), IEEE Standard for Telephone Modem Communication Protocol to Complement the Utility Industry End Device Data Tables
- [IEEE 1703-2012](#), IEEE Standard for Local Area Network/Wide Area Network (LAN/WAN) Node Communication Protocol to Complement the Utility Industry End

Power quality and energy efficiency

Approved Standards and New or Revision Projects*

- [IEEE P1159.3](#), (revision) IEEE Draft Recommended Practice for the Transfer of Power Quality Data
- [IEEE 1894-2015](#), IEEE Guide for Online Monitoring and Recording Systems for Transient Overvoltages in Electric Power Systems

Intelligent Transportation

IEEE Standards Series*

- [IEEE 1609](#) series
- [IEEE 1901](#) series

Approved Standards and New or Revision Projects*

- [IEEE 802.15.4p-2014](#), Amendment: IEEE Standard for Local and Metropolitan Area Networks-Part 15.4: Low-Rate Wireless Personal Area Networks (LR-WPANS)-Amendment 7: Physical Layer for Rail Communications and Control (RCC)
- [IEEE 1512-2006](#), IEEE Standard for Common Incident Management Message Sets for Use by Emergency Management Centers
- [IEEE 1512.1-2006](#), IEEE Standard for Common Traffic Incident Management Message Sets for Use by Emergency Management Centers
- [IEEE 1512.3-2006](#), IEEE Standard for Hazardous Material Incident Management Message Sets for Use by Emergency Management Centers
- [IEEE 2030.1.1-2015](#), IEEE Standard Technical Specifications of a DC Quick Charger for Use with Electric Vehicles
- [IEEE P2030.1.1](#), (Revision) IEEE Draft Standard Technical Specifications of a DC Quick and Bi-directional Charger for Use with Electric Vehicles
- [IEEE P2690](#), IEEE Draft Standard for Charging Network Management Protocol for Electric Vehicle Charging Systems

**Draft standards projects, once approved, are often revised and/or used as the base for new projects. The status of these projects is updated periodically. For the most up-to-date status, please see the following link: <https://standards.ieee.org/project/index.html>*

