# D4.1

## Analysis of standards environment relevant for int:net

int:net

Interoperability Network for the Energy Transition

## DELIVERABLE INFORMATION

| | |
|---|---|
| **Project** | int:net |
| **Deliverable ID & title** | D4.1 Analysis of standards environment relevant for int:net |
| **Work package** | WP4 - Standardization, Coordination and Regulation |
| **Contractual delivery date** | Oct 31, 2024 (M30) |
| **Actual delivery date** | |
| **Lead organisation** | VDE Verband der Elektrotechnik Elektronik Informationstechnik e.V. (DKE) |
| **Security** | P |
| **Nature** | Report |
| **Version** | 1.0 |
| **Total number of pages** | 77 |

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The research leading to these results has received funding from the European Union's Horizon Europe Research and Innovation Programme, under Grant Agreement no 101070086.

## ABSTRACT

This deliverable contains the results of an analysis of the standards environment relevant to int:net. It examines current standardization projects and related activities and identifies and describes pertinent standardization expert groups. It provides easy-to-use tools for a structured overview and regular reports.

The document also explores how to facilitate networking with stakeholders and considers the dissemination of int:net developments related to standardization.

This analysis contributes to an overarching standardization strategy, identifying both project-specific and cross-project focal points. int:net partners are given easy access to standardization activities and the sustainable utilization of int:net project results in standardization is ensured.



## KEYWORD LIST

Standardization, IEC, CENELEC, Technical Committee, Working Groups, Energy Transition, Interoperability, System Integration, Communication, IT Security, Cybersecurity


## DISCLAIMER

## EXECUTIVE SUMMARY

This report analyzes standardization information and activities relevant for int:net which can be referred to in the course of the project.

Relevant standardization expert groups of the International Electrotechnical Commission (IEC) and the European Committee for Electrotechnical Standardization (CENELEC) have been identified and described.

A “Standardization Matrix” has been developed to illustrate the connections between int:net Work Packages (WP) and the pertinent Technical Committees (TC) of IEC and CENELEC at three levels of relevance. To facilitate usability and searchability, comprehensible key words have been included. The matrix is a sorted overview which has been copied in three variants: from the perspective of the int:net WPs, the int:net Interoperability Focus Groups (IFG) and the Energy Data Space Cluster Projects (EDSCP).

Since the matrix is a living document, a “Standardization Blog” has been launched. This blog serves as a platform for exchanging news about standardization, furthermore a regular newsletter provides updates on the progress of projects within the Working Groups (WG) of the committees, including links to current project documents.

The document also provides an in-depth analysis of the relevant standards applied across the work packages („Standardization Table“), alongside a review of the current state of the art. The standards are thoroughly described, listed, and categorized within the energy domain using the established Smart Grid Architecture Model (SGAM) framework. This categorization creates a comprehensive overview of the standards applicable to addressing interoperability challenges.

The Standardization Matrix, the Standardization Blog and the Standardization Table are accessible to all int:net partners and can be found in the annex. These tools create transparency, and each partner can get access to relevant WGs of IEC, CENELEC or other standardization groups via the partner VDE DKE.

int:net has been and will be involved in standardization, providing input and observing relevant standardization activities, e.g., in the areas Internet of Things (IoT), digital twin, reference architecture and data spaces, all with regard to interoperability efforts.

A connection has also been established with the Horizon Europe project InterSTORE, facilitating mutual benefits through the exchange of common topics.

Public relations efforts concerning standardization have been enhanced by presenting int:net at the fairs E-world 2023 in Essen, Germany and Hannover Messe 2024 in Hannover, Germany. Furthermore int:net is featured in both German and English language on the DKE website.

In conclusion, this document contributes to the development of an overarching standardization strategy, supporting the int:net partners in engaging with the relevant standardization groups to adapt existing standards, develop new standards, or adequately document their solutions, in order to ensure the sustainable utilization of the project results in standardization.

# CONTENTS

# 1 Introduction

## 1.1 Objectives of the work reported

Objective of this report is an analysis of standardization information, projects, and activities relevant for int:net that can be referred to in the course of the project.

Pertinent standardization expert groups, e.g., of the International Electrotechnical Commission (IEC) or the European Committee for Electrotechnical Standardization (CENELEC), are to be identified and described to facilitate easy access for the int:net partners to the appropriate groups and activities. These activities must be updated regularly.

Another objective is to enhance public relations efforts with standardization-specific initiatives, including organizing events and conferences, maintaining online presences, and engaging in bilateral networking with selected countries and relevant stakeholders.

Finally, this document contributes to the objective of developing an overarching standardization strategy that supports the int:net partners in adapting existing standards, developing new standards, or adequately documenting their solutions, in order to ensure the sustainable utilization of the project results in standardization.

## 1.2 How to read this document

This report provides an analysis of the standards environment relevant for int:net. The main section offers an overview and description of the pertinent standardization expert groups.

This document is intended to assist interested stakeholders in identifying appropriate standardization groups and staying informed about current standardization activities. A look is taken at all int:net work packages and their relation to standardization, e.g., testing standards, maturity models, and the use of IEC 61850 Communication Protocols and IEC 61970 Common Information Model (CIM). A matrix is included as a useful structured overview.

Overall, this deliverable supports int:net partners in working on standards and appropriately documenting their solutions to ensure the sustainable integration of project results into standardization.

## 1.3 Structure of the document

The report begins with a basic explanation of the importance of standardization, followed by a listing of the most important (electrotechnical) standardization organizations.

In the main section, all standardization expert groups relevant to int:net are listed and described. For a better overview and improved usability, a Standardization Matrix has been created, which is explained in the subsequent section and appended in the annex.

Additional accompanying topics, such as the Standardization Blog, the enhancement of public relations efforts with standardization-specific activities, networking with stakeholders and the Standardization Table are addressed in the following sections. Contributions to standardization and the observation of relevant standardization activities are listed in the next part. A conclusion, which also explains how this report contributes to an overarching standardization strategy, completes this document.

# 2 Standardization

## 2.1 Introduction to standardization

Standardization is the process of developing and implementing standard rules, guidelines, and requirements that ensure products, services, and processes meet a set of established specifications or criteria.

Using and creating European and global (electrotechnical) standards offer numerous advantages for industries, businesses, and consumers: [1] [2]

- Global and Regional Compatibility: These standards are widely recognized, ensuring that products and systems are compatible across borders and within Europe, facilitating smoother trade and cooperation.
- Quality and Safety: Adherence to these standards ensures high levels of quality and safety for products, protecting consumers and minimizing risks associated with malfunctions and hazards.
- Interoperability: Standards enable different systems and devices to work together seamlessly, enhancing user experience and overall functionality.
- Market Access: Compliance with these standards is often necessary for market entry, particularly in regulated markets. This compliance opens doors to global and European markets, respectively.
- Cost Efficiency: Standardization streamlines production processes, reduces redundancy, and lowers costs related to custom designs and testing.
- Innovation and Competitiveness: Standards provide a clear foundation for innovation by establishing clear guidelines, allowing companies to focus on advancing technology rather than reinventing existing solutions.
- Environmental and Social Responsibility: Many of these standards address environmental impact and sustainability, helping companies meet regulatory and consumer demands for responsible practices.
- Consumer Trust: Adherence to recognized standards enhances consumer confidence in the safety, reliability, and performance of products.

Overall, these standards support economic growth, international trade, and technological progress while ensuring safety, quality, and sustainability (see Figure 1).


*Figure 1: Why standards?*

## 2.2 Relevant standardization organizations

The most important electrotechnical standardization organizations covered in this report are:

1. **CENELEC** (European Committee for Electrotechnical Standardization) [2]
2. **IEC** (International Electrotechnical Commission) [1]

As there are relevant joint committees and working groups with IEC, this report also describes

3. **ISO** (International Organization for Standardization) [3]

For the sake of completeness and due to occasional mentions, this document also explains

4. **IEEE SA** (Institute of Electrical and Electronics Engineers Standards Association) [4] [5]

### 2.2.1 CENELEC

CENELEC, the European Committee for Electrotechnical Standardization, is a non-profit organization that develops and publishes harmonized standards for electrical and electronic products and systems across Europe. CENELEC's responsibility extends to the European Union (EU), European Free Trade Association (EFTA), and other European countries.

Founded in 1973, CENELEC works closely with industry stakeholders and national standardization bodies to ensure that its standards are safe, reliable, and compatible with international standards. The organization's work covers a wide range of areas, including energy, telecommunications, transportation, and medical devices. Compliance with CENELEC standards is often required by EU legislation and is necessary for manufacturers to sell their products in the European market.

CENELEC has 34 member countries, the head office is located in Brussels, Belgium.

### 2.2.2 IEC

IEC, the International Electrotechnical Commission, is a global organization that develops and publishes international standards for electrical and electronic technologies.

Founded in 1906, IEC works with industry experts and stakeholders from around the world to establish standards that ensure safety, interoperability, and efficiency of electrical and electronic products and systems. IEC also provides conformity assessment services to ensure that products and systems meet these standards. Its work covers a wide range of areas, including energy, telecommunications, medical devices, and renewable energy.

IEC has 170 member countries, the head office is located in Geneva, Switzerland.

### 2.2.3 ISO

ISO, the International Organization for Standardization, is an independent, non-governmental organization that develops and publishes international standards.

Founded in 1947, ISO brings together experts to create consensus-based standards across various industries and sectors. These standards aim to enhance quality, safety, and efficiency while facilitating global trade and supporting innovation. ISO standards cover diverse fields including technology, healthcare, environmental management, and more, providing frameworks for best practices and regulatory compliance worldwide.

Joint committees of ISO, IEC and IEEE develop international standards for electrotechnical and IT sectors collaboratively.

ISO has 167 member countries, the head office is located in Geneva, Switzerland.

### 2.2.4 IEEE SA

IEEE is a professional association of electrical, electronics, and computer engineers, as well as other technology professionals.

Established in 1884, IEEE is one of the world's largest technical professional organizations, with over 460,000 individual members in more than 160 countries. IEEE fosters innovation in technology by developing and promoting technical standards, organizing events, and publishing technical content. The IEEE's standards (managed by IEEE SA) cover a wide range of areas, including power and energy, communications, aerospace, and computing.

IEEE is a non-governmental organization that holds a liaison status with IEC and ISO. This status allows IEEE to collaborate with IEC and/or ISO on technical matters and standards development, particularly in areas where their expertise overlaps.

The head office is located in Piscataway, New Jersey, USA.

## 2.3 Relevant standardization expert groups

The IEC and CENELEC Technical Committees (IEC/TC and CLC/TC) in the following subsections are evaluated as relevant for int:net.

Key factors for the transition to future energy grids are the interoperability of power systems, the integration of renewables, communication and IT security.

Criteria for identifying Technical Committees (TC) and projects in their Working Groups (WG) are relations to communication, systems integration, interoperable distributed energy resources (DER), cybersecurity, data spaces and electrical energy storage (EES) systems.

Tables with current projects of relevant WGs are appended in Annex A.

### 2.3.1 Power systems management and associated information exchange (IEC/TC 57)

IEC/TC 57 [1] is a technical committee within IEC, focused on developing standards for power systems management and associated information exchange. Established to address the growing complexity of power systems and the need for efficient information exchange, TC 57 (see Figure 2) plays a crucial role in ensuring the reliability, efficiency, and security of electrical grids.

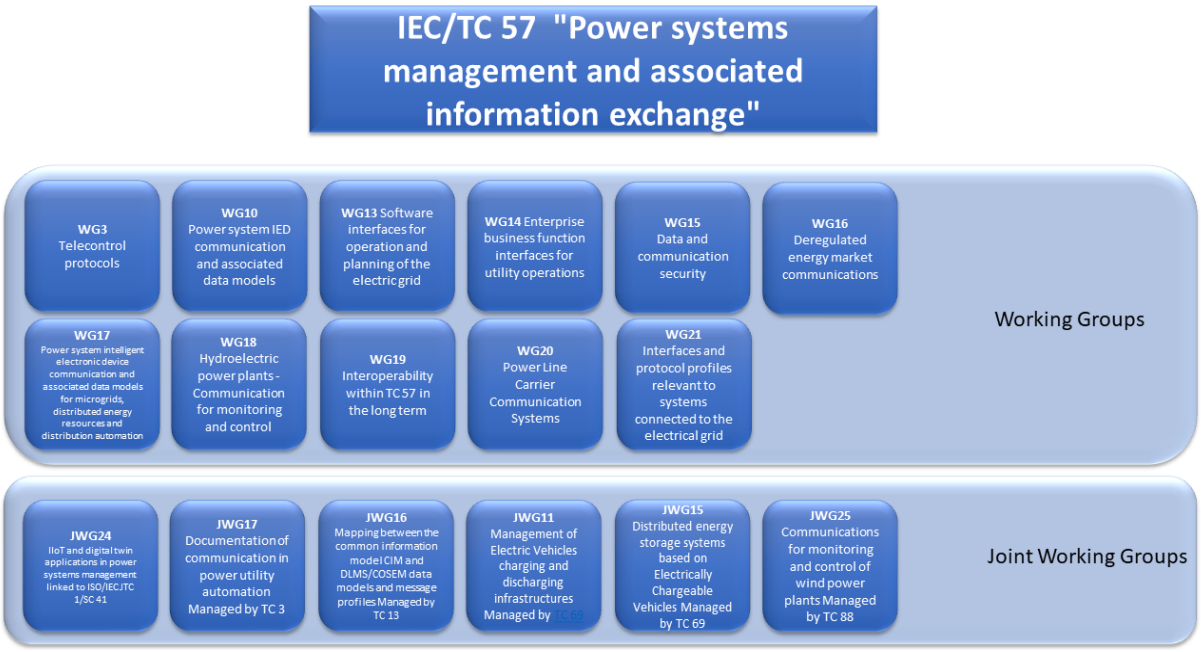



*Figure 2: Working Groups IEC/TC 57 [1]*

The scope of IEC/TC 57 includes a wide range of topics related to power system operations, such as real-time data exchange, system control, and protection. The committee's work encompasses the development of protocols, communication standards, and data models that facilitate the seamless exchange of information between various components of power systems. Key standards developed by TC 57 include the IEC 61850 series for substation automation, IEC 61970 (see Figure 3) for energy management system application programming interfaces (EMS-API), and IEC 61968 for distribution management system interfaces.

- IEC 61850: This standard focuses on communication networks and systems in substations. It defines the communication between intelligent electronic devices in substations and related system requirements. The standard is widely adopted for its role in enhancing interoperability and ensuring reliable data exchange in substation environments.
- IEC 61970: Known as the Common Information Model (CIM) for energy management, this standard provides a common framework for data exchange between different applications and systems within energy management systems. It supports interoperability by enabling seamless data integration and exchange.
- IEC 61968: This standard extends the CIM to distribution management systems, addressing the information exchange needs of utilities. It supports various functions such as outage management, asset management, and customer information systems, enhancing overall system interoperability and efficiency.

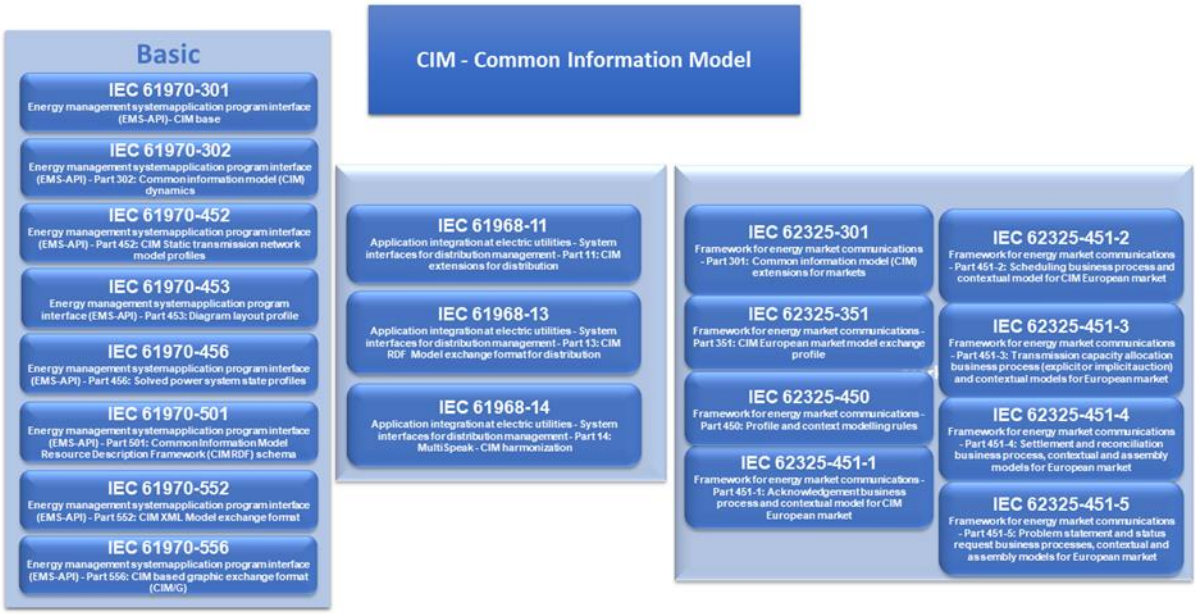



*Figure 3: IEC 61970 CIM structure [1]*

Interoperability is a key focus for IEC/TC 57 as it ensures that diverse systems and devices can work together harmoniously, regardless of the manufacturer. This is critical for the effective operation of smart grids, where numerous components must interact seamlessly to optimize performance, enhance resilience, and support the integration of renewable energy sources. The standards developed by IEC/TC 57 play a pivotal role in achieving this interoperability, thereby enabling utilities and other stakeholders to implement advanced power system solutions efficiently and cost-effectively.

In summary, IEC/TC 57 develops standards for efficient and secure communication in power systems, ensuring seamless data exchange and integration of advanced technologies. Its work facilitates interoperability and enhances grid management and sustainability through collaboration with stakeholders and alignment with technological advancements.

### 2.3.2 Information Technology (ISO/IEC JTC 1)

ISO/IEC JTC 1 (Joint Technical Committee 1) [1] [3] is a collaborative effort between ISO and IEC, established to address the rapidly evolving field of information technology (IT). The committee's primary mission is to develop, maintain, and promote a comprehensive portfolio of international standards that enable global interoperability and compatibility among IT systems. This collaboration is crucial in ensuring that IT products and services can function seamlessly across different markets and geographical regions.

JTC 1 covers a broad spectrum of IT topics, including but not limited to, Cloud Computing, Cybersecurity, Data Management, Software Engineering, Artificial Intelligence (AI), the Internet of Things (IoT), and Blockchain Technology. These standards provide a foundation for innovation, guiding the development of new technologies while ensuring they are secure, efficient, and interoperable. The committee's work helps to avoid technical trade barriers and facilitates the global exchange of information and technology.

The structure of JTC 1 includes multiple subcommittees (SC) and working groups (WG), each focused on specific aspects of IT (see Figure 4). These groups are composed of experts from various sectors, including industry, academia, and government, who bring diverse perspectives and expertise to the standardization process. The collaborative nature of JTC 1 ensures that the standards developed are comprehensive and widely accepted.

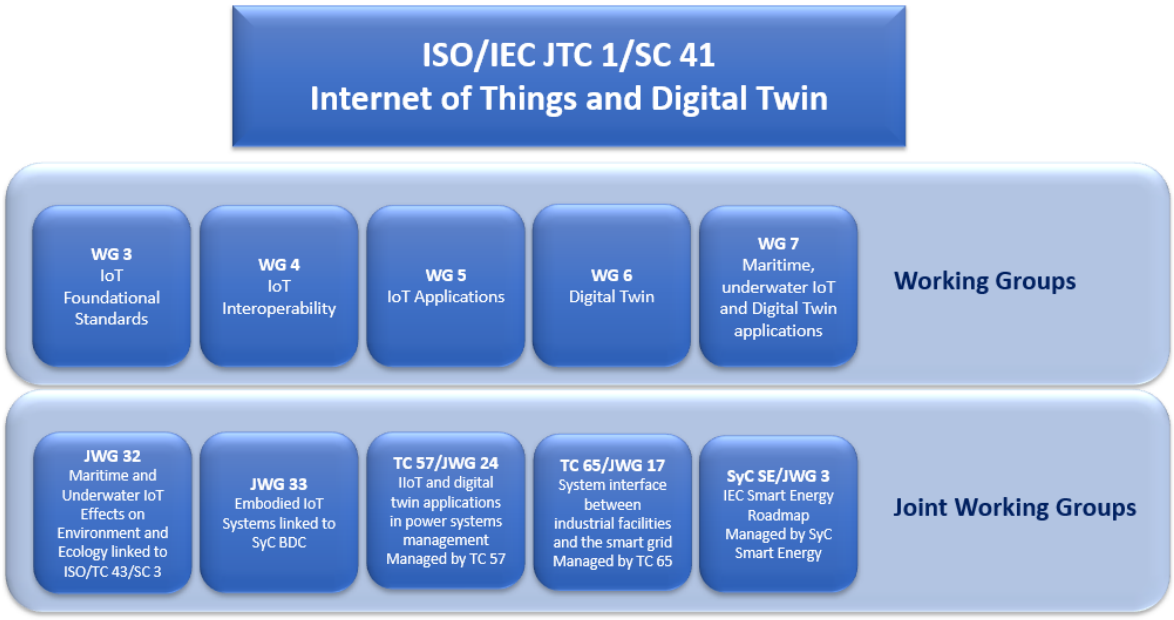



*Figure 4: Working Groups ISO/IEC JTC 1/SC 41 [1]*

One of the significant contributions of JTC 1 is its role in bridging the gap between emerging technologies and their practical implementation. By providing clear, consistent, and internationally recognized standards, JTC 1 helps stakeholders adopt new technologies with confidence, knowing that they meet global benchmarks for quality and interoperability. This support is vital for driving technological advancement, fostering innovation, and promoting economic growth on a global scale.

ISO/IEC JTC1 significantly enhances interoperability by creating standards that define common protocols, interfaces, and data formats. These standards ensure that IT systems and devices from different manufacturers can communicate and work together seamlessly, facilitating integration and interoperability across global IT infrastructures.

In summary, ISO/IEC JTC1 standardizes information technology, developing protocols and interfaces to ensure seamless communication and interoperability among IT systems and devices. The committee covers a broad range of technologies and regularly updates its standards to stay relevant with technological advancements, fostering innovation and global IT integration.

### 2.3.3 Industrial-process measurement, control and automation (IEC/TC 65)

IEC/TC 65 [1] is a TC within IEC, responsible for standardizing industrial-process measurement, control, and automation. Established to address the needs of the industrial automation sector, TC 65 develops international standards that ensure the interoperability, reliability, and safety of industrial systems and equipment.

The scope of TC 65 includes a wide range of topics related to industrial automation, such as sensors and instrumentation, control systems, and software used in the automation of manufacturing processes (see Figure 5). These standards cover the entire lifecycle of automation systems, from design and installation to operation and maintenance. By providing standardized guidelines, TC 65 helps manufacturers and end-users achieve consistency and quality in their automation processes, reducing downtime and improving productivity.

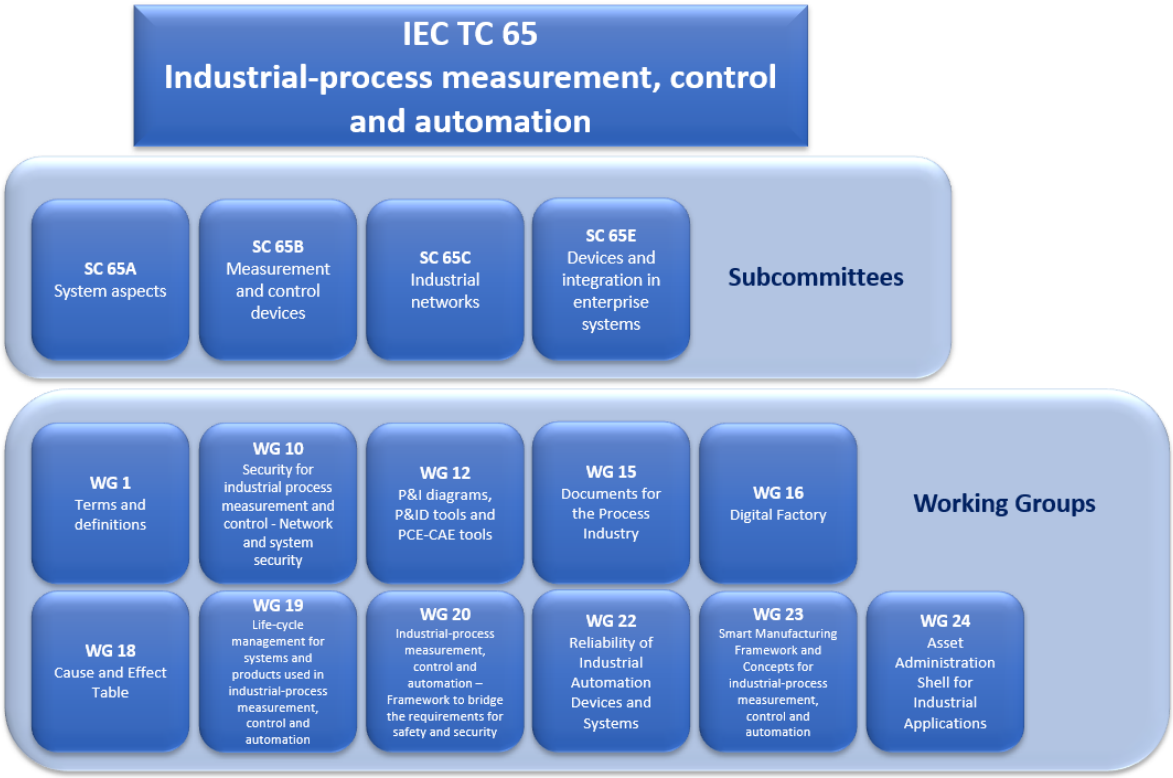



*Figure 5: Subcommittees and Working Groups IEC TC 65 [1]*

TC 65's work is crucial for industries that rely heavily on automation, such as manufacturing, chemical processing, and power generation. The committee addresses emerging technologies and trends, including Industry 4.0, the Industrial Internet of Things (IIoT), and smart manufacturing. By developing standards that incorporate these advancements, TC 65 ensures that industrial automation systems are equipped to meet the demands of modern production environments.

The committee consists of experts from various countries and industries, who collaborate to draft, review, and refine standards. This global participation ensures that the standards developed are comprehensive and applicable worldwide. TC 65 also works closely with other IEC committees and international organizations to align its standards with broader regulatory and technological frameworks.

One of the key benefits of TC 65's work is the enhancement of global trade in industrial automation equipment and systems. By adhering to internationally recognized standards, manufacturers can ensure that their products are compatible with those from other countries, facilitating smoother integration and reducing technical barriers to trade.

IEC/TC 65 enhances interoperability by developing standards that define common communication protocols, data models, and interfaces for industrial automation systems. This ensures that diverse devices and systems from different manufacturers can seamlessly communicate and operate together, improving efficiency and safety in industrial environments.

In summary, IEC/TC 65 focuses on standardizing industrial-process measurement, control, and automation to ensure efficiency, safety, and interoperability. The committee develops guidelines for sensors, control systems, and communication protocols, and collaborates with various stakeholders to align standards with technological advancements and regulatory requirements.

### 2.3.4 Smart Energy (IEC/SyC SE)

IEC/SyC Smart Energy [1] is a systems committee within IEC, focused on developing standards and frameworks to support the integration and management of smart energy systems (see Figure 6) . These systems encompass various components of the energy sector, including generation, distribution, storage, and consumption, all interconnected through advanced communication and information technologies. The goal of IEC/SyC Smart Energy is to create a cohesive and efficient energy ecosystem that leverages smart technologies to enhance energy efficiency, reliability, and sustainability.

The committee's work involves addressing the complexities of integrating renewable energy sources, such as solar and wind, with traditional power grids. This integration requires sophisticated control systems, real-time data analytics, and robust cybersecurity measures to ensure the stable and secure operation of the energy network. IEC/SyC Smart Energy collaborates with various stakeholders, including industry experts, utilities, and technology providers, to develop comprehensive guidelines and best practices that facilitate the deployment of smart energy solutions.

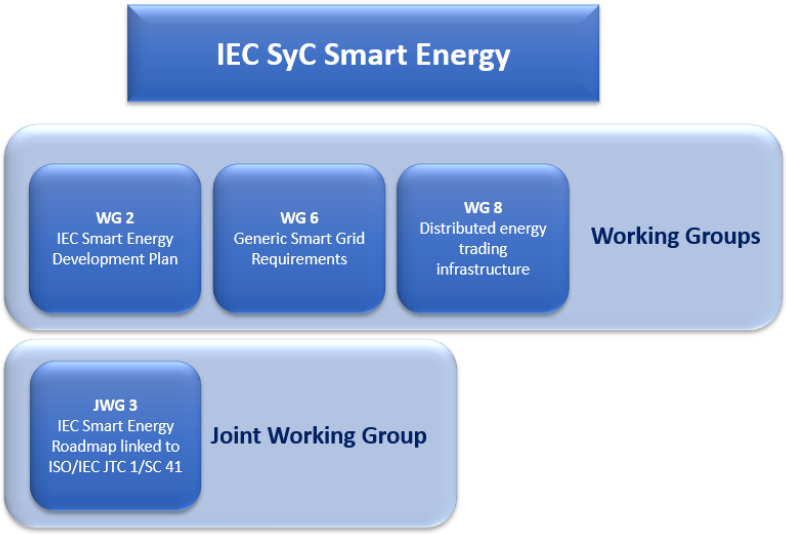



*Figure 6: Working Groups IEC/SyC Smart Energy [1]*

Examples of standardization work in which IEC/SyC Smart Energy has been involved include the Use Case methodology established in the energy sector according to IEC 62559 and the standardization of the SGAM framework via IEC 63200, which are used both for standardization work, but in particular also for requirements management for complex energy systems and to understand and address the interoperability challenges. The IEC TR 63097 standard also sets out a standardization roadmap for the development of the smart grid.

Interoperability is a key focus for IEC/SyC Smart Energy, as the success of smart energy systems relies on the seamless interaction of diverse technologies and components. The committee develops standards that ensure different devices, systems, and platforms can communicate and operate together efficiently. This interoperability enables the integration of new technologies without disrupting existing infrastructure, thereby optimizing performance and reducing costs.

Furthermore, IEC/SyC SEs emphasis on interoperability supports the creation of flexible and scalable energy systems. By ensuring that components from various manufacturers and different technological domains can work together, the committee promotes innovation and allows for the gradual evolution of energy systems in response to emerging needs and advancements.

In summary, IEC/SyC Smart Energy aims to develop standards that support the integration and management of smart energy systems, focusing on efficiency, reliability, and sustainability. The committee's emphasis on interoperability ensures seamless interaction among diverse technologies, fostering innovation and optimizing system performance. This interoperability is crucial for creating flexible, scalable, and sustainable energy ecosystems.

### 2.3.5 System aspects of electrical energy supply (IEC/TC 8 and CLC/TC 8x)

IEC/TC 8 and CLC/TC 8x are technical committees within IEC and CENELEC, focusing on system aspects of electrical energy supply.

While both committees aim to improve the efficiency, reliability, and integration of electrical energy systems, their primary difference lies in their geographic and regulatory focus areas.

#### 2.3.5.1 IEC/TC 8

IEC/TC 8 [1] is the technical committee within IEC that focuses on standardizing system aspects of electrical energy supply. The committee's primary goal is to develop standards that ensure the reliable, efficient, and sustainable operation of electrical power systems. This includes addressing the needs of traditional power grids as well as modern smart grids, which incorporate advanced technologies for better management and distribution of electricity.

The work of IEC/TC 8 encompasses a broad range of areas including system design, operational practices, and integration of renewable energy sources. By establishing comprehensive guidelines and best practices, IEC/TC 8 helps utilities, manufacturers, and policymakers implement robust power systems that can meet the evolving demands of the energy sector. The committee collaborates with other IEC committees and external organizations to ensure that its standards are aligned with global needs and technological advancements.

Interoperability is a critical concern for IEC/TC 8, as it ensures that various components of the power grid, including generation, transmission, and distribution systems, can work together seamlessly. The standards developed by IEC/TC 8 facilitate the integration of different technologies and systems, enabling efficient communication and coordination across the entire power grid. This interoperability is essential for the effective operation of smart grids, which rely on the seamless interaction of diverse technologies to optimize performance and enhance grid stability.

IEC/TC 8 has established three subcommittees to cover grid integration of renewables, applications of renewables and grid stabilization (see Figure 7):

- **Grid Integration of Renewable Energy Generation (IEC/TC 8 SC 8A)**

  This subcommittee is responsible for developing international standards and other deliverables for the grid integration of variable power generation from renewable sources such as photovoltaic (PV) and wind energy. The emphasis is on the overall system aspects of electricity supply systems, specifically the grids, as defined in the scope of TC 8. It's important to note that SC 8A does not cover issues typically regulated, such as renewable energy policies like infeed tariff schemes.

- **Decentralized electrical energy systems (IEC/TC 8 SC 8B)**

  SC 8B's scope is to develop IEC publications enabling the development of secure, reliable and cost-effective systems with decentralized management for electrical energy supply, which are alternative, complement or precursor to traditional large interconnected and highly centralized systems. These new systems include but are not limited to AC, DC, AC/DC hybrid decentralized electrical energy systems and influence distributed generation, distributed energy storage, virtual power plants and electrical energy management systems.

A popular concept is currently the “microgrid” defined as a group of interconnected loads and distributed energy resources with defined electrical boundaries that acts as a single controllable entity and is able to operate in both grid-connected and island mode.

Decentralized electrical energy systems have applications for developing countries (focusing on access to electricity) as well as for developed countries (focusing on high reliability, black-out recovery and services). Interactions within decentralized multi-energy systems should also be considered.

- **Network management in Interconnected Electric Power Systems (IEC/TC 8 SC 8C)**

  The focus of this expert group is on network management in interconnected electric power systems, including functions with different time horizons, such as design, planning, operation, control, and market integration. SC 8C plans to address issues contributing to the resilience, reliability, security, and stability of interconnected electric power systems. The current focus is on ensuring stable grid operation; however, the current projects are still in the preliminary phase.

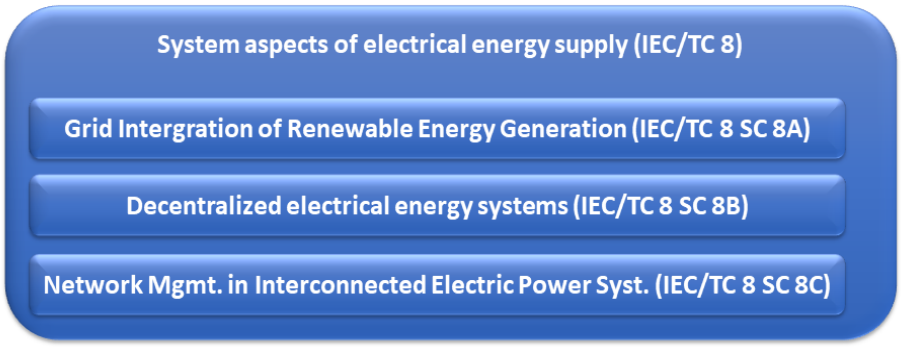



*Figure 7: Structure of IEC/TC 8 [1]*

In summary, IEC/TC 8 focuses on creating standards for the reliable, efficient, and sustainable operation of electrical power systems. By promoting interoperability among various components and technologies, these standards support the seamless integration and coordination necessary for modern and smart grids, enhancing overall grid performance and stability. This interoperability is vital for optimizing energy supply systems.

#### 2.3.5.2 CLC/TC 8x

CLC/TC 8x [2] is the technical committee within CENELEC that focuses on standardizing system aspects of electrical energy supply. Several working groups, denoted by the "x" in the designation, address specific topics within the broader scope of TC 8's activities, such as renewable energy integration, smart grids, energy efficiency, or technical standards for electrical equipment and systems.

The committee plays a crucial role in developing standards that ensure the efficiency, safety, and reliability of these systems, which are fundamental to modern electrical infrastructure.

The committee’s work includes establishing guidelines for the design, implementation, and management of electrical systems, covering aspects such as system performance, safety measures, and operational practices. By creating these standards, CLC/TC 8x supports the development of robust power systems

that can effectively integrate new technologies and adapt to evolving demands in the energy sector. The committee collaborates with various stakeholders, including industry experts and regulators, to ensure that its standards address current technological trends and industry needs.

Interoperability is a key aspect of CLC/TC 8x's mission. The standards developed by the committee are designed to facilitate the integration and seamless operation of diverse technologies within electrical power systems. This interoperability ensures that different components, such as generators, transformers, and control systems, can work together efficiently and reliably. By promoting interoperability, CLC/TC 8x helps enhance the overall performance and stability of power grids, enabling smoother communication and coordination among various system elements.

In summary, CLC/TC 8x, develops specialized European standards for efficient and sustainable electrical energy supply. Its focus on interoperability fosters seamless integration of diverse technologies, enhances grid performance, and aligns with European regulatory frameworks, ensuring reliable and adaptive energy management across Europe.

### 2.3.6 Electrical Energy Storage (EES) systems (IEC/TC 120)

IEC/TC 120 [1] is a technical committee within IEC dedicated to standardizing electrical energy storage (EES) systems. These systems are crucial for balancing supply and demand in power grids, integrating renewable energy sources, and enhancing the reliability and efficiency of electrical power systems. IEC/TC 120 focuses on various aspects of EES, including performance, safety, testing, and environmental impact, ensuring that these systems are reliable and can meet the demands of modern power grids.

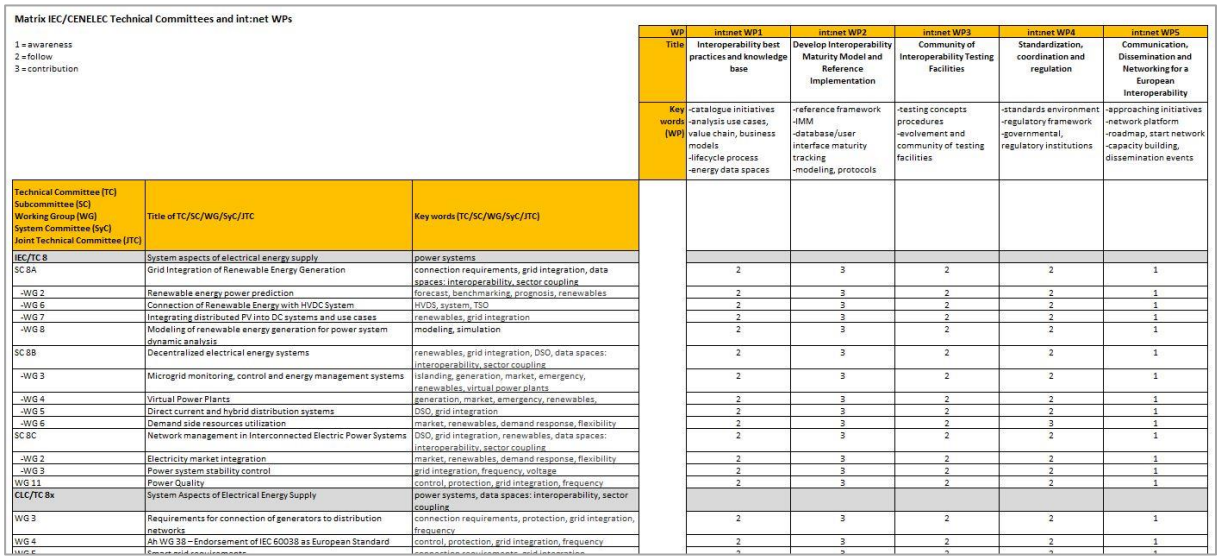
The committee's work involves creating guidelines for different types of energy storage technologies such as batteries, supercapacitors, and flywheels. This includes establishing criteria for performance evaluation, safety protocols, and methods for lifecycle assessment. By providing a comprehensive framework, IEC/TC 120 helps manufacturers, utilities, and regulators implement and manage energy storage solutions effectively. This is vital for the transition to more sustainable and resilient energy systems, which increasingly rely on the ability to store and release energy as needed.

Interoperability is a key focus for IEC/TC 120, as energy storage systems must integrate seamlessly with various components of the power grid, including generation sources, transmission networks, and distribution systems. The standards developed by IEC/TC 120 ensure that different energy storage technologies can operate together and with other grid components, facilitating the smooth exchange of information and energy. This interoperability is essential for optimizing the performance of the entire power system, enhancing grid stability, and supporting the integration of renewable energy sources.

In summary, IEC/TC 120 develops standards for electrical energy storage systems, focusing on performance, safety, and environmental impact. These standards ensure interoperability among different energy storage technologies and other grid components, enhancing the reliability and efficiency of power systems and supporting the integration of renewable energy. This interoperability is crucial for optimizing grid performance and stability.

## 2.4 Standardization Matrix

Given the extensive number of technical expert groups within IEC and CENELEC, a structured approach was adopted to illustrate the requirements of the int:net Work Packages and the corresponding standardization expert groups within a matrix (see Figure 8).



Matrix IEC/CENELEC Technical Committees and int:net WPs

1 = awareness
2 = follow
3 = contribution

| | | | WP | intinet WP1 | intinet WP2 | intinet WP3 | intinet WP4 | intinet WP5 |
|---|---|---|---|---|---|---|---|---|
| | | | Title | Interoperability best practices and knowledge base | Develop Interoperability Maturity Model and Reference Implementation | Community of Interoperability Testing Facilities | Standardization, coordination and regulation | Communication, Dissemination and Networking for a European Interoperability |
| | | | Key words (WP) | -catalogue initiatives<br>-analysis use cases,<br>value chain, business models<br>-lifecycle process<br>-energy data spaces | -reference framework<br>-IMM<br>-database/user interface maturity tracking<br>-modeling, protocols | -testing concepts procedures<br>-evolvement and community of testing facilities | -standards environment<br>-regulatory framework<br>-governmental, regulatory institutions | -approaching initiatives<br>-network platform<br>-roadmap, start network<br>-capacity building, dissemination events |
| Technical Committee (TC)<br>Subcommittee (SC)<br>Working Group (WG)<br>System Committee (SyC)<br>Joint Technical Committee (JTC) | Title of TC/SC/WG/SyC/JTC | Key words (TC/SC/WG/SyC/JTC) | | | | | | |
| IEC/TC 8 | System aspects of electrical energy supply | power systems | | | | | | |
| SC 8A | Grid Integration of Renewable Energy Generation | connection requirements, grid integration, data spaces: interoperability, sector coupling | | 2 | 3 | 2 | 2 | 1 |
| -WG 2 | Renewable energy power prediction | forecast, benchmarking, prognosis, renewables | | 2 | 3 | 2 | 2 | 1 |
| -WG 6 | Connection of Renewable Energy with HVDC System | HVDS, system, TSO | | 2 | 3 | 2 | 2 | 1 |
| -WG 7 | Integrating distributed PV into DC systems and use cases | renewables, grid integration | | 2 | 3 | 2 | 2 | 1 |
| -WG 8 | Modeling of renewable energy generation for power system dynamic analysis | modeling, simulation | | 2 | 3 | 2 | 2 | 1 |
| SC 8B | Decentralized electrical energy systems | renewables, grid integration, DSO, data spaces: interoperability, sector coupling | | 2 | 3 | 2 | 2 | 1 |
| -WG 3 | Microgrid monitoring, control and energy management systems | islanding, generation, market, emergency, renewables, virtual power plants | | 2 | 3 | 2 | 2 | 1 |
| -WG 4 | Virtual Power Plants | generation, market, emergency, renewables, | | 2 | 3 | 2 | 2 | 1 |
| -WG 5 | Direct current and hybrid distribution systems | DSO, grid integration | | 2 | 3 | 2 | 2 | 1 |
| -WG 6 | Demand side resources utilization | market, renewables, demand response, flexibility | | 2 | 3 | 2 | 3 | 1 |
| SC 8C | Network management in Interconnected Electric Power Systems | DSO, grid integration, renewables, data spaces: interoperability, sector coupling | | 2 | 3 | 2 | 2 | 1 |
| -WG 2 | Electricity market integration | market, renewables, demand response, flexibility | | 2 | 3 | 2 | 2 | 1 |
| -WG 3 | Power system stability control | grid integration, frequency, voltage | | 2 | 3 | 2 | 2 | 1 |
| WG 11 | Power Quality | control, protection, grid integration, frequency | | 2 | 3 | 2 | 2 | 1 |
| CLC/TC 8x | System Aspects of Electrical Energy Supply | power systems, data spaces: interoperability, sector coupling | | | | | | |
| WG 3 | Requirements for connection of generators to distribution networks | connection requirements, protection, grid integration, frequency | | 2 | 3 | 2 | 2 | 1 |
| WG 4 | Ah WG 38 – Endorsement of IEC 60038 as European Standard | control, protection, grid integration, frequency | | 2 | 3 | 2 | 2 | 1 |
| WG 6 | Smart grid requirements | connection requirements, grid integration | | 2 | 3 | 2 | 2 | 1 |

*Figure 8: Layout of Standardization Matrix*

For improved readability see Annex B: Standardization Matrices.

The matrix shows IEC and CENELEC

- Technical Committees (TC)
- Subcommittees (SC)
- Working Groups (WG)
- System Committee (SyC)
- Joint Technical Committee (JTC)

and their relevance to the int:net work packages (WP)

- WP1: Interoperability best practices and knowledge base
- WP2: Develop Interoperability Maturity Model and Reference Implementation
- WP3: Community of Interoperability Testing Facilities
- WP4: Standardization, coordination and regulation
- WP5: Communication, Dissemination and Networking for a European Interoperability Ecosystem

The relevance is ranked in ascending importance:

- Level 1 - awareness: subject should be known, action is currently not necessary
- Level 2 - follow: activity which should be monitored (passive work)
- Level 3 - contribution: activity which requires action and submittance (active work)

Key words for the TC, SC, WG, SyC, JTC and key words for the int:net WP facilitate the search for int:net partners.

Illustration – the matrix can be utilized as follows:
For instance, WP2 focuses on the domain of “interoperability maturity model/reference implementation”, with key words including modelling and protocols. Similar key words are used in IEC/TC 57 WG 10. Consequently, WP2 is linked to IEC/TC 57 WG 10 at relevance level 3.

However, the matrix is a living document and may evolve as the project progresses.
Potential reasons for changes include:

- Modifications in int:net project activity or WP scope
  - Changes in project objectives
  - New technical developments
  - Regulatory changes
- Changes in standardization expert groups
  - New technical developments
  - New regulatory requirements

### Extension to additional variants

Due to the popularity of the Standardization Matrix, two additional variants have been developed.

Variant 2: The int:net WPs in the matrix are replaced with int:net Interoperability Focus Groups (IFG). IFGs are moderated groups on specific activities within the int:net community.
The relevant TCs in the matrix remain the same, but the assignment of relevance levels and key words are revised according to the perspective of the IFGs.

IFGs included in variant 2:

- IFG-1: Interoperability profiles in data spaces
- IFG-2: Increasing maturity in interoperability
- IFG-3: The interoperability regulatory landscape
- IFG-4: Interoperability testing approaches, test cases, and test facilities
- IFG-5: Smart grid-related use cases and SGAM

Variant 3: Analog approach, the int:net WPs in the matrix are replaced with Energy Data Space Cluster Projects (EDSCP). The relevant TCs in the matrix remain the same, but the assignment of relevance levels and key words are revised according to the perspective of the EDSCPs.

EDSCPs included in variant 3:

- omega-x
- SYNERGIES
- Enershare
- DATA CELLAR
- EDDIE (European Distributed Data Infrastructure for Energy)

To avoid confusion, the matrices are distinguished by color-coded headers (see Figure 9):

- orange - variant 1 (int:net WG)
- yellow - variant 2 (int:net IFG)
- green - variant 3 (EDSCP)

For improved readability, see Annex B: Standardization Matrices.

**Matrix IEC/CENELEC Technical Committees and int:net IFGs**

1 = awareness
2 = follow
3 = contribution

| | | | IFG | IFG-1 | IFG-2 | IFG-3 | IFG-4 | IFG-5 |
|---|---|---|---|---|---|---|---|---|
| | | | Title | Interoperability Profiles in Data Spaces | Increasing Maturity in Interoperability | The Interoperability Regulatory Landscape | Interoperability Testing Approaches, Test Cases, and Test Facilities | Smart Grid related Use Cases and SGAM |
| | | | Key words (IFG) | -interoperability profiles<br>-data spaces<br>-trusted data sharing | -organizational maturity<br>-collaboration in interoperability<br>-interoperable solutions | -policy and regulatory initiatives<br>-promote development of interoperable energy services<br>-stakeholders | -testing approaches, test cases, test facilities<br>-harmonisation of testing procedures<br>-integrated pan-European network of testing facilities | -smart grid related use cases<br>-SGAM<br>-IEC 62559-2<br>-interoperability |
| **Technical Committee (TC)<br>Subcommittee (SC)<br>Working Group (WG)<br>System Committee (SyC)<br>Joint Technical Committee (JTC)** | **Title of TC/SC/WG/SyC/JTC** | **Key words (TC/SC/WG/SyC/JTC)** | | | | | | |
| **IEC/TC 8** | System aspects of electrical energy supply | power systems | | | | | | |
| SC 8A | Grid Integration of Renewable Energy Generation | connection requirements, grid integration, data spaces: interoperability, sector coupling | | 3 | 2 | 2 | 3 | 3 |
| -WG 2 | Renewable energy power prediction | forecast, benchmarking, prognosis, renewables | | 3 | 2 | 1 | 3 | 3 |
| -WG 6 | Connection of Renewable Energy with HVDC System | HVDS, system, TSO | | 3 | 2 | 1 | 3 | 3 |
| -WG 7 | Integrating distributed PV into DC systems and use cases | renewables, grid integration | | 3 | 2 | 2 | 3 | 3 |
| -WG 8 | Modeling of renewable energy generation for power system dynamic analysis | modeling, simulation | | 3 | 2 | 1 | 3 | 3 |
| SC 8B | Decentralized electrical energy systems | renewables, grid integration, DSO, data spaces: interoperability, sector coupling | | 3 | 2 | 2 | 3 | 3 |
| -WG 3 | Microgrid monitoring, control and energy management systems | islanding, generation, market, emergency, renewables, virtual power plants | | 3 | 2 | 1 | 3 | 3 |
| -WG 4 | Virtual Power Plants | generation, market, emergency, renewables, | | 3 | 2 | 1 | 3 | 3 |
| -WG 5 | Direct current and hybrid distribution systems | DSO, grid integration | | 3 | 2 | 1 | 3 | 3 |
| -WG 6 | Demand side resources utilization | market, renewables, demand response, flexibility | | 3 | 2 | 2 | 3 | 3 |
| SC 8C | Network management in Interconnected Electric Power Systems | DSO, grid integration, renewables, data spaces: interoperability, sector coupling | | 3 | 2 | 2 | 3 | 3 |
| -WG 2 | Electricity market integration | market, renewables, demand response, flexibility | | 3 | 2 | 2 | 3 | 3 |
| -WG 3 | Power system stability control | grid integration, frequency, voltage | | 3 | 2 | 1 | 3 | 3 |
| WG 11 | Power Quality | control, protection, grid integration, frequency | | 3 | 2 | 1 | 3 | 3 |
| **CLC/TC 8x** | System Aspects of Electrical Energy Supply | power systems, data spaces: interoperability, sector coupling | | | | | | |
| WG 3 | Requirements for connection of generators to distribution networks | connection requirements, protection, grid integration, frequency | | 3 | 2 | 1 | 3 | 3 |
| WG 4 | Ah WG 38 – Endorsement of IEC 60038 as European Standard | control, protection, grid integration, frequency | | 3 | 2 | 1 | 3 | 3 |

**Matrix IEC/CENELEC Technical Committees and EDSCP (Energy Data Space Cluster Projects)**

1 = awareness
2 = follow
3 = contribution

| | | | Data Space Cluster Project | omega-x | SYNERGIES | Enershare | DATA CELLAR | EDDIE (European Distributed Data Infrastructure for Energy) |
|---|---|---|---|---|---|---|---|---|
| | | | Key words (Data Space Cluster Project) | -data spaces<br>-text | -data management<br>-smart grid<br>-interoperability<br>-AI, analytics<br>-IoT, smart metering<br>-energy/flexibility markets<br>-e-mobility, storage<br>-renewable energy | -data spaces<br>-text | -data spaces<br>-text | -data spaces<br>-text |
| **Technical Committee (TC)<br>Subcommittee (SC)<br>Working Group (WG)<br>System Committee (SyC)<br>Joint Technical Committee (JTC)** | **Title of TC/SC/WG/SyC/JTC** | **Key words (TC/SC/WG/SyC/JTC)** | | | | | | |
| **IEC/TC 8** | System aspects of electrical energy supply | power systems | | | | | | |
| SC 8A | Grid Integration of Renewable Energy Generation | connection requirements, grid integration, data spaces: interoperability, sector coupling | | | 2 | | | 1 |
| -WG 2 | Renewable energy power prediction | forecast, benchmarking, prognosis, renewables | | | 2 | | | 1 |
| -WG 6 | Connection of Renewable Energy with HVDC System | HVDS, system, TSO | | | 1 | | | 1 |
| -WG 7 | Integrating distributed PV into DC systems and use cases | renewables, grid integration | | | 1 | | | 1 |
| -WG 8 | Modeling of renewable energy generation for power system dynamic analysis | modeling, simulation | | | 2 | | | 1 |
| SC 8B | Decentralized electrical energy systems | renewables, grid integration, DSO, data spaces: interoperability, sector coupling | | | 2 | | | 2 |
| -WG 3 | Microgrid monitoring, control and energy management systems | islanding, generation, market, emergency, renewables, virtual power plants | | | 2 | | | 1 |
| -WG 4 | Virtual Power Plants | generation, market, emergency, renewables, | | | 2 | | | 1 |
| -WG 5 | Direct current and hybrid distribution systems | DSO, grid integration | | | 1 | | | 1 |
| -WG 6 | Demand side resources utilization | market, renewables, demand response, flexibility | | | 2 | | | 2 |
| SC 8C | Network management in Interconnected Electric Power Systems | DSO, grid integration, renewables, data spaces: interoperability, sector coupling | | | 2 | | | 1 |
| -WG 2 | Electricity market integration | market, renewables, demand response, flexibility | | | 2 | | | 2 |
| -WG 3 | Power system stability control | grid integration, frequency, voltage | | | 2 | | | 1 |
| WG 11 | Power Quality | control, protection, grid integration, frequency | | | 2 | | | 1 |
| **CLC/TC 8x** | System Aspects of Electrical Energy Supply | power systems, data spaces: interoperability, sector coupling | | | | | | |
| WG 3 | Requirements for connection of generators to distribution networks | connection requirements, protection, grid integration, frequency | | | 1 | | | 1 |
| WG 4 | Ah WG 38 – Endorsement of IEC 60038 as European Standard | control, protection, grid integration, frequency | | | 1 | | | 1 |

*Figure 9: Layout of variants 2 and 3*

Note: Variant 3 requires input from the EDSCPs. Feedback has only been received from two EDSCPs so far, which is included in this report for completeness.

In summary, the Standardization Matrix is a strategic tool that links the int:net project with relevant Technical Committees and associated Working Groups of IEC and CENELEC. As it is a living document, it requires ongoing contributions from all int:net project partners.

## 2.5 Standardization Blog, networking and other actions

Since the Standardization Matrix is a living document, a Standardization Blog has been launched to keep everybody up to date. This blog serves as a platform for exchanging news about standardization, furthermore, a regular newsletter provides updates on the progress of projects within the relevant WGs of the relevant TCs. Links to project documents on the IEC website [1] are also posted.

Tables with details of the current projects of the relevant WGs can be found in Annex A.

Both the Standardization Matrix and the Standardization Blog are accessible to all int:net partners on the int:net project SharePoint [6]. These tools create transparency, and each partner can get access to the pertinent WGs of IEC, CENELEC or other standardization groups via the partner VDE DKE.

The INTEC initiative of VDE DKE facilitates networking with stakeholders in selected countries. The biennial “US-German Standards Panel” and the annual dialogue with South Korean standardization organizations are highlighted here. The next events are scheduled for 2025.

A connection to the Horizon Europe project InterSTORE (**I**nteroperable ope**N**-source **T**ools to **E**nable hyb**R**idisation, utili**S**ation, and mone**T**isation of st**OR**age fl**E**xibility) [7] has been established, both projects benefit from the exchange of common topics.

Public relations work – regarding standardization – has been enhanced by the presentation of int:net at E-world 2023 [8] in Essen/Germany, Europe's top energy industry trade fair with 30,000 visitors, and Hannover Messe 2024 [9], one of the world’s largest trade fairs with 130,000 visitors, which also included streaming of the VDE DKE conference stage.

Short presentations on the progress of int:net were also given at several smaller VDE DKE events. Additionally, int:net is featured in both German and English language on the DKE website [10].

Two internal workshops (int:net milestones M1 and M2) were conducted in Frankfurt, Germany: “General Introduction to Standardization” (Nov 30/Dec 1, 2022) and “Smart Energy Grid Data Modelling” (June 22, 2023). These workshops facilitated a common understanding of standards and contributed to the identification and discussion of new perspectives on specific int:net topics.

From an academic perspective, a tool named *Smart Grid Assistive Artificial Intelligence for Requirements Engineering (SGAAIRE)* [11] was developed as part of the task. This AI tool aims to enhance the creation of IEC 62559 Use Case descriptions and SGAM models. In earlier years, these descriptions and models were primarily used in standardization efforts to identify gaps. Today, however, the focus has shifted more towards requirements management, to promote interoperability in system design and development.

In summary, a blog with a regular newsletter, cross-border networking with stakeholders and workshops with in-depth technical discussions support the dissemination and utilization of int:net results in standardization.

## 2.6 Standardization Table

Interoperability is closely linked to the topics of standardization. The int:net project actively engages with interoperability issues and works in alignment with relevant standards. The project structure is organized to categorize core topics into various work packages, which can be clustered around relevant standards:

- **WP1: "Interoperability Best Practices and Knowledge Base"** focuses on providing a knowledge base to enhance the understanding of interoperability within the energy sector. This includes considering standards that offer an overview of pertinent topics, outline standardization processes (e.g., IEC 63097 Smart Grid Roadmap), and support requirements management (e.g., IEC 62559 Use Case Methodology and IEC 63200 SGAM).
- **WP2: "Interoperability Maturity Model and Reference Implementation"** aims to develop a maturity model that tracks progress in interoperability and provides support in achieving higher maturity levels. By linking standardization and interoperability, the maturity model considers both the relevant processes and the contribution to or utilization of standardization efforts.
- **WP3: "Community of Interoperability Testing Facilities"** is dedicated to advancing testing procedures for energy systems, with a particular emphasis on interoperability testing.
- **WP4: "Standardization, Coordination, and Regulation"** addresses the themes of standardization, regulation, and the development of procedures to enhance interoperability efforts. Additionally, a concept for a Connectathon is being developed, with a broader focus on standards and standardization activities.

The objective of the Standardization Table is to document both past and current standardization activities relevant to the energy sector and to map these to the respective work packages, and vice versa. Additionally, the standards have been analyzed, adopting a technology-agnostic perspective on the Smart Grid as a system-of-systems. These standards have been categorized within the SGAM (Smart Grid Architecture Model) framework. The SGAM framework (see Figure 10) comprises three dimensions: interoperability layers, domains, and zones. This enables energy sector stakeholders to effectively utilize the relevant standards during system development to address specific interoperability challenges. The table can also be used to carry out more extensive contextual analyses.

The table was maintained and populated concurrently with other tasks. Members of the int:net project were able to contribute by adding relevant standards to the table. Additionally, all deliverables up to the date of this document were analyzed to extract and include additional standards.

The Standardization Table presented in Annex C provides a condensed overview.

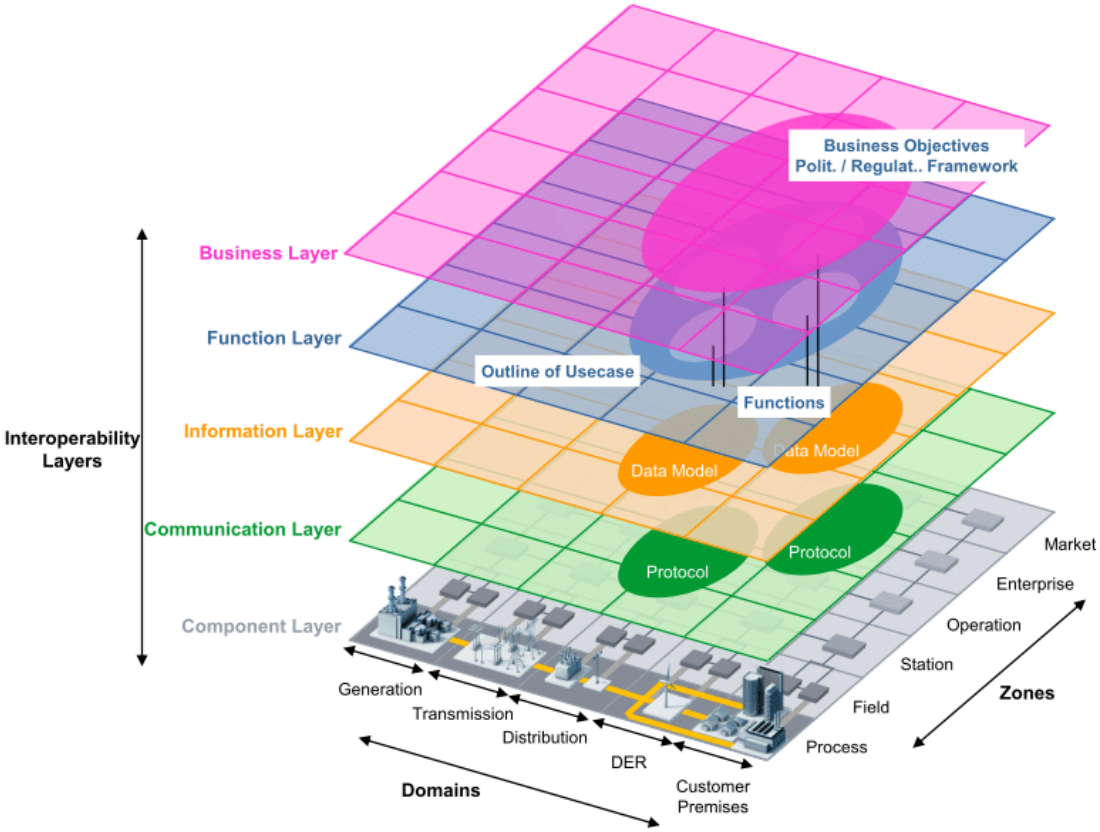



*Figure 10: Smart Grid Architecture Model (SGAM) Framework [12]*

## 2.7 Standardization Activities

Specific standardization activities were carried out or monitored by int:net:

- Contributions and interactions with associations (e.g., AIOTI [13], IDSA [14], ECLIPSE [15]) or other initiatives and projects (e.g., BRIDGE [16], DSSC [17], Common European Data Spaces [18], Enershare [19], Omega-X [20])
- Monitoring standardization committees (e.g., ISO/IEC JTC1 (SC7, SC27, SC32, SC38, SC41, SC42), IEC (SEG 15, SMB/SEG12, SyC Smart Energy), ETSI (SAREF), CEN-CENELEC JTC 13, JTC 21, JTC 25)

### 2.7.1 Contributions to standardization

This section covers work carried out in int:net that was subsequently used at standardization level (see **Fehler! Verweisquelle konnte nicht gefunden werden.**).

*Table 1: Contributions to the development of standards*

| Topic | Work done in int:net | Standardization outcome |
|---|---|---|
| Interoperability maturity model | Work done in WP2 for a maturity model and its application | Preparation of a global paper in the evolution of interoperability standards. The paper will be completed in 2024, contributed to AIOTI, and submitted to ISO/IEC JTC1/SC41 in 2025 with a request to promote it as a global standardization paper.<br>The content of the paper was presented during the IEC SyC Smart Energy workshop that took place on Sept 19th and 20th, 2024. |
| Interoperability testing | Work done in WP3<br>Description on constraint-based interoperability, reported in D3.1 Testing concepts and procedures harmonisation report | |
| Interoperability analysis | Work done in WP1<br>Survey done on data spaces analysis, reported in D1.2 Annex B (Report on identified interoperability use cases, requirements in the value chain and business models) | Input provided to ISO/IEC 21823-5 [21] IoT behavioural and policy interoperability, under development |
| Interoperability at energy domain level | Work done in WP5 and through liaison with BRIDGE and Enershare and IDSA (white paper on energy interoperability) | Discussion on an additional layer for SGAM and the concept of tube in the SGAM cube to take into account subdomains |
| Architecture and integration of digital twin and data spaces | Liaison with other projects, Enershare, Omega-X on digital twin and data spaces and within the CEEDS (Common European Energy Data Space) | Input provided to ISO/IEC 30188 [22] Digital twin reference architecture, under development<br>Input provided to ISO/IEC 30151 [23] Extraction and transactions of data products<br>Input provided to ISO/IEC 30152 [24] IoT and digital twins – Guidance on the connection to data spaces |
| Trustworthiness and privacy | Liaison with Enershare and liaison with ECLIPSE on the creation of the models4privacy [25] interest group | Input provided to ISO/IEC 27564 [26] Privacy protection - Guidance on the use of models for privacy engineering and ISO/IEC 27568 [27] Security and privacy of digital twins, under development |

### 2.7.2 Monitoring standardization

This section covers committees that have been monitored within int:net (see Table 2).

*Table 2: Relationship between standards under development and int:net*

| Committee | Standards under development | Relationship with int:net |
|---|---|---|
| ISO/IEC JTC 1/SC 7 [28] software and systems engineering | ISO/IEC/IEEE 42024 [29] Architecture fundamentals<br>ISO/IEC/IEEE 42042 [30] Reference architecture | Monitoring work to ensure alignment of CEEDS blueprint |
| ISO/IEC JTC 1/SC 27 [31] Information security, cybersecurity and privacy protection | ISO/IEC 27115 [32] Cybersecurity evaluation of complex systems - Introduction and framework overview<br>ISO/IEC 27564 [26] Privacy protection - Guidance on the use of models for privacy engineering<br>ISO/IEC 27568 [27] Security and privacy of digital twins | Monitoring work to ensure alignment of cybersecurity of smart grid architecture, privacy standards, and digital twin security and privacy related to energy data spaces<br>Monitoring ENISA SCCG [33] on cyber security certification |
| ISO/IEC JTC 1/SC 32 [34] Data management and interchange | Metadata and data usage standards | Monitoring work to ensure common concepts on data and on ontology and information model registries |
| ISO/IEC JTC 1/SC 38 [35] Cloud computing and distributed platforms | ISO/IEC 20151 [36] Cloud computing and distributed platforms - Dataspace concepts and characteristics | Monitoring work to ensure alignment on concept of data spaces |
| ISO/IEC JTC 1/SC 41 [37] Internet of Things and Digital Twin | ISO/IEC 30188 [22] Digital twin reference architecture<br>ISO/IEC 40141 [38] IoT reference architecture guidance<br>ISO/IEC 21823-5 [21] Interoperability for IoT systems - Part 5: Behavioural and policy interoperability<br>ISO/IEC 30151 [23] Extraction and transactions of data products<br>ISO/IEC 30152 [24] IoT and digital twins - Guidance on the connection to data spaces | Monitoring work to ensure alignment on architecture, interoperability and data space standards |
| IEC SyC Smart Energy [39] | IEC 63417 [40] Guidance and plan to develop smart energy ontologies | Monitoring work to ensure alignment on ontologies |
| IEC SEG 15 Joint SEG with ISO - Metaverse [41] | Explore needs for standardization on metaverse (virtual worlds) | Monitoring work to ensure alignment of energy standards needs on virtual worlds |
| IEC SMB/SG 12 [42] Digital Transformation and Systems Approach | IEC Guide 125 [43] Use case methodology guide | Monitoring work to ensure alignment in use case specifications |

| | | |
|---|---|---|
| ETSI SAREF [44] The Smart applications reference ontology | Publication of multi domain ontologies, e.g.,<br>SAREF for Energy Flexibility [45] | Monitoring work to ensure alignment on ontology work and standardisation |
| CEN-CENELEC JTC 13 [46] Cybersecurity and data protection | CEN/CLC JTC 13 WG 9 [47] Special working group on cyber resilience act | Monitoring work to assess impact on energy data and service interoperability |
| CEN-CENELEC JTC 21 [48] Artificial intelligence | AI trustworthiness framework [49] | Monitoring work to ensure alignment on at energy data space level, energy data level and energy service level |
| CEN-CENELEC JTC 25 [50] Data management, Dataspaces, Cloud and Edge | Creation of this JTC in September 2024. This JTC will address standardization requests concerning data exchange, including on the use of ontologies. | Participation to the work of this JTC in order to provide the energy domain viewpoint |

### 2.7.3 The way forward

The described activities are carried out within int:net:

- Alignment on architecture beyond the energy domain: coordination on data space in terms of architecture standards, in order to avoid fragmentations. For instance, defining an energy data space architecture that is not consistent with architectures in other domains and creating a silo needs to be avoided. Monitoring and coordination efforts consequently have the following objectives:
    - Agree on a common reference at standardization level, e.g., based on ISO/IEC 20151 [36] Cloud computing and distributed platforms - Data space concepts and characteristics
    - Agree on architecture patterns and associated implementations, e.g., based on IDSA [14] specifications
    - Ensure that proposed architecture blueprints, DSSC [51] and CEEDS [52] are aligned
- Alignment on interoperability beyond the energy domain: coordination in terms of information models, in order to enable integration of cross-cutting topics (e.g. integration of horizontal technologies such as AI, IoT, Digital twins) and cross-cutting characteristics (e.g., security, safety, resilience…), and cross-domain interoperability. Monitoring and coordination efforts consequently have the following objectives:
    - Agree on a consensus and governance practice for interoperability of concepts
    - Reusing common ontologies on cross-cutting topics and technologies
    - Reusing, adapting ontology subsets that need to be shared across domains
- Alignment on architecture and interoperability within the energy domain: coordination in terms of architecture and interoperability within sub-domains, e.g., based in the tube in the cube approach (see D4.3) defined by int:net. Monitoring and coordination efforts consequently have

the following objectives:

- Agree on a consensus and governance practice for interoperability of concepts at the tube level
- Reusing common ontologies on cross-cutting topics and technologies
- Reusing, adapting ontology subsets that need to be shared across subdomains and domains

int:net makes the recommendations for a continuation of these activities beyond the project.

# 3 Conclusion

This report analyzes standardization information and activities relevant for int:net which can be referred to throughout the project.

As a result, this document provides a listing and description of relevant standardization expert groups of IEC and CENELEC, and as an overview, a “Standardization Matrix” that links int:net work packages (WP) to the pertinent TCs of IEC and CENELEC. To facilitate usability and searchability, comprehensible key words have been included. The matrix has become very popular, so it has been copied in three variants: from the perspective of the int:net WPs, the int:net Interoperability Focus Groups (IFG), and the Energy Data Space Cluster Projects (EDSCP).

Since the matrix is a living document, a “Standardization Blog” with a regular newsletter has been established to keep all participants informed. It includes updates on the progress of projects within the working groups of the committees and provides links to current project documents on the IEC website [1].

The Standardization Table serves as a tool for a detailed analysis of individual standards considered within the project. This table provides an overview of the standards and maps them to the SGAM framework. This approach enhances the selection of standards to address interoperability challenges in the development of the system of interest.

int:net has been involved in standardization and will continue to contribute by providing input and observing pertinent standardization activities, e.g., in the domains of the IoT, digital twins, reference architecture, and data spaces, all concerning interoperability efforts.

The compilation of information at hand ensures that all int:net partners are aware of their appropriate standardization expert groups and can get access to relevant working groups of IEC, CENELEC, or other standardization groups via the partner VDE DKE. Networking with stakeholders is facilitated and supported by presentations of int:net at various events. A connection to the Horizon Europe project InterSTORE has been established, facilitating mutual benefits through the exchange of common topics.

In summary, this document contributes to the development of an overarching standardization strategy, supporting the int:net partners in engaging with the relevant standardization groups to update existing standards, develop new standards, or adequately document their solutions, to ensure the sustainable utilization of the project results in standardization.

# 4 List of Tables

# 5 List of Figures

# 6 List of Abbreviations

| | |
|---|---|
| AC | Alternating Current |
| AG | Advisory Group |
| CEEDS | Common European Energy Data Space |
| CEN | European Committee for Standardization |
| CENELEC | European Committee for Electrotechnical Standardization |
| CIM | Common Information Model |
| CLC | CENELEC |
| DC | Direct Current |
| DER | Distributed Energy Resources |
| DKE | Deutsche Kommission Elektrotechnik Elektronik Informationstechnik |
| DSSC | Data Spaces Support Centre |
| EDSCP | Energy Data Space Cluster Project |
| EES | Electrical Energy Storage |
| EFTA | European Free Trade Association |
| EMS-API | Energy Management System - Application Programming Interface |
| ETSI | European Telecommunications Standards Institute |
| EU | European Union |
| IDSA | International Data Spaces Association |
| IEC | International Electrotechnical Commission |
| IEEE SA | Institute of Electrical and Electronics Engineers Standards Association |
| IFG | Interoperability Focus Group |
| IIoT | Industrial Internet of Things |
| int:net | Interoperability Network for the Energy Transition |
| IoT | Internet of Things |
| ISO | International Organization for Standardization |
| JTC | Joint Technical Committee |
| JWG | Joint Working Group |
| MT | Maintenance Team |
| PAS | Publicly Available Specification |
| PNW | New work item proposal |
| PR | Public Relations |
| PV | Photovoltaic |
| PWI | Preliminary work item |
| SAREF | Smart Applications REFerence Ontology |
| SC | Subcommittee |
| SEG | Standardization Evaluation Group |
| SGAAIRE | Smart Grid Assistive Artificial Intelligence for Requirements Engineering |
| SGAM | Smart Grid Architecture Model |
| SMB | Standardization Management Board |

| | |
|---|---|
| SRD | Systems Reference Deliverable |
| SyC | Systems Committee |
| TC | Technical Committee |
| TR | Technical Report |
| TS | Technical Specification |
| VDE | Verband der Elektrotechnik Elektronik Informationstechnik e.V. |
| WG | Working Group |
| WP | Work Package |

# A. Annex A: Projects in Working Groups (WG) of relevant Technical Committees (TC)

The tables below list projects which are related to communication, systems integration, interoperable distributed energy resources (DER), cybersecurity, data spaces and electrical energy storage (EES) systems.

In addition to the project no. (Project Reference) and title, the tables also list the current status of the project document (Document Reference) and the forecasted publication date.

(As of: July 2024)

### 1) IEC/TC 57 [1]

*Table 3: Projects in WGs of IEC/TC 57 [1]*

| Project Reference | Title | Document Reference | Working Group | Fcst. Publ. Date |
|---|---|---|---|---|
| IEC TS 60870-5-7 ED2 | Telecontrol equipment and systems - Part 5-7: Transmission protocols - Security extensions to IEC 60870-5-101 and IEC 60870-5-104 protocols (applying IEC 62351) | 57/2652/CD | WG 3 | 2025-07 |
| IEC TS 61334-5-6 ED1 | Distribution automation using distribution line carrier systems - Part 5-6: Medium-voltage High Speed Power Line Communication systems | 57/2589/NP | WG 3 | 2025-08 |
| IEC 62488-1 ED2 | Power line communication systems for power utility applications - Part 1: Planning of analogue and digital power line carrier systems operating over HV electricity grids | 57/2631/CD | WG 3 | 2025-09 |
| PNW 57-2668 ED1 | Power systems management and associated information exchange - Communication networks and systems for power utility automation - Part 6-2: Configuration description languages for human-machine interfaces | 57/2668/NP | WG 10 | 2027-04 |
| IEC 61850-6/AMD2 ED2 | Amendment 2 - Communication networks and systems for power utility automation - Part 6: Configuration description language for communication in electrical substations related to IEDs | 57/2602/CDV | WG 10 | 2024-10 |
| IEC TS 61850-6-3 ED1 | Format of machine-processable rules for validation of IEC 61850 XML-based files | 57/2557/NP | WG 10 | 2025-07 |
| IEC TR 61850-7-6 ED2 | Communication networks and systems for power utility automation - Part 7-6: Guideline for definition of Basic Application Profiles (BAPs) using IEC 61850 | 57/2710/DTR | WG 10 | 2024-11 |
| IEC 61850-10/AMD1 ED2 | Amendment 1 - Communication networks and systems for power utility automation - Part 10: Conformance testing | 57/2628/CDV | WG 10 | 2024-12 |
| IEC TS 61850-80-6 ED1 | Communication networks and systems for power utility automation - Part 80-6: Using IEC 61850 for communication between substations and control centres | 57/2632/CD | WG 10 | 2025-07 |
| IEC TS 61850-80-7 ED1 | Communication networks and systems for power utility automation - Part 80-7: Communication services and data model to support IEC 61850 system management | 57/2612/CD | WG 10 | 2025-12 |
| IEC PAS 61850-90-19 ED1 | Communication networks and systems for power utility automation - Part 90-19: Power system IED communication and associated data models for interoperability - Role Based Access Control (RBAC) with IEC 61850 | 57/2637/NP | WG 10 | 2025-05 |
| IEC TR 61850-90-19 ED1 | Communication networks and systems for power utility automation - Part 90-19: Using Role Based Access Control (RBAC) and IEC 61850 | | WG 10 | |
| PWI TR 61850-90-20 | Communication networks and systems for power utility automation - Part 90-20: Guideline to redundancy systems | | WG 10 | |

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|---|---|---|---|---|
| IEC 61968-8 ED2 | Application integration at electric utilities - System interfaces for distribution management - Part 8: Interfaces for customer operations | 57/2318A/RR | WG 14 | 2025-08 |
| PNW 57-2665 ED1 | Power systems management and associated information exchange - Data and communications security - Part 16: Profiles for Ethernet security, MACsec (IEC 62351-16) | 57/2665/NP | WG 15 | 2026-12 |
| IEC 62351-7 ED2 | Power systems management and associated information exchange - Data and communications security - Part 7: Network and System Management (NSM) data object models | 57/2639/CDV | WG 15 | 2025-06 |
| IEC 62351-8 ED2 | Power systems management and associated information exchange - Data and communications security - Part 8: Role-based access control for power system management | 57/2663/CD | WG 15 | 2025-08 |
| IEC TS 62351-15 ED1 | Power systems management and associated information exchange - Data and communications security - Part 15: Deep Packet Inspection (DPI) of encrypted communications | 57/2586/NP | WG 15 | 2026-07 |
| PWI 62325-452-1 | Day Ahead Market | | WG 16 | |
| PWI 62325-452-4 | Weather data to support market operations | | WG 16 | |
| PWI 62325-452-5 | Communications with Demand Response Systems | | WG 16 | |
| PWI 62325-550-2 | Common Dynamic Data Structures for DAM, RT, FTR | | WG 16 | |
| PWI 62325-552-1 | Dynamic Data Structures for DAM | | WG 16 | |
| IEC TR 61850-90-23 ED1 | Communication networks and systems for power utility automation - Part 90-23: Use of IEC 61850 for microgrid systems | 57/2488/CD | WG 17 | 2025-04 |
| IEC TS 63389 ED1 | Developing a profile composed of a set of Basic Application Profiles (BAPs) of IEC 61850 for DER compliant to IEEE 1547 | 57/2264/NP | WG 17 | 2025-07 |
| IEC 61850-7-410 ED3 | Communication networks and systems for power utility automation - Part 7-410: Basic communication structure - Hydroelectric power plants - Communication for monitoring and control | 57/2640/CD | WG 18 | 2025-09 |
| IEC TS 61850-90-31 ED1 | Communication networks and systems for power utility automation - Part 90-31: Use Cases for Dynamic Data model | 57/2582/NP | WG 18 | 2025-11 |
| IEC 62361-104 ED1 | Power systems management and associated information exchange - Interoperability in the long term - Part 104: CIM Profiles to JSON Schema Mapping | 57/2606/NP | WG 19 | 2026-01 |
| PWI 62488-4 | Broadband systems operating over EHV/HV/MV/LV electricity grids | | WG 20 | |
| IEC TR 62746-2 ED2 | Systems interface between customer energy management system and the power management system - Part 2: Use cases and requirements | 57/2643/CD | WG 21 | 2025-09 |
| IEC 62746-4 ED1 | Systems interface between customer energy management system and the power management system - Part 4: Demand Side Resource Interface | 57/2625/CDV | WG 21 | 2025-02 |
| IEC TR 63353 ED1 | IIoT applications in power distribution systems management: Architecture and functional requirements | 57/2616/CD | JWG 24 | 2025-04 |
| PWI TR 57-1001 | Development of IEC TR 61850-6-100, SCL Function Modelling for Substation Automation | | | |
| PWI TR 57-1002 | IEC TR 61850-90-28: Specification for subscriber IED to validate GOOSE and SV messages | | | |
| IEC TR 61850-90-21 ED1 | Communication networks and systems for power utility automation - Part 90-21: Travelling wave fault location | 57/2559/DTR | | 2024-11 |
| IEC TR 61850-90-22 ED1 | Communication networks and systems for power utility automation - Part 90-22: SCD based substation network auto-routing with visualization and supervision support | 57/2692/DTR | | 2024-11 |
| IEC TR 61850-90-30 ED1 | Communication networks and systems for power utility automation - Part 90-30: IEC 61850 Function Modelling in SCL | 57/2693/DTR | | 2024-11 |
| IEC TR 62351-90-4 ED1 | Power systems management and associated information exchange - Data and communications security - Part 90-4: Migration of cryptographic algorithms | 57/2672/CD | | 2025-04 |

## 2) ISO/IEC JTC 1 [1] [3]

### 2a) ISO/IEC JTC 1 SC 41 “Internet of Things and Digital Twin” [1] [3]

*Table 4: Projects in WGs of ISO/IEC JTC 1 SC 41 [1]*

| Project Reference | Title | Document Reference | Working Group | Fcst. Publ. Date |
|---|---|---|---|---|
| ISO/IEC 30141 ED3 | Internet of Things (IoT) - Reference architecture | JTC1-SC41/434/RR | WG 3 | 2025-10 |
| ISO/IEC 30141 ED2 | Internet of Things (IoT) - Reference architecture | JTC1-SC41/417/FDIS | WG 3 | 2024-07 |
| ISO/IEC 21823-5 ED1 | Internet of things – Interoperability for IoT systems – Part 5: Behavioural and policy interoperability | JTC1-SC41/397/NP | WG 4 | 2027-06 |
| ISO/IEC 30178 ED1 | Internet of Things (IoT) - Data format, value and coding | JTC1-SC41/447/CD | WG 4 | 2025-10 |
| ISO/IEC 30181 ED1 | Internet of Things (IoT) - Functional architecture for resource identifier interoperability | JTC1-SC41/393/CDV | WG 4 | 2025-01 |
| ISO/IEC 30198 ED1 | Internet of Things (IoT) - Edge computing gateway interoperability framework | JTC1-SC41/394/NP | WG 4 | 2027-06 |
| PWI TR JTC1-SC41-18 | (AWI) Internet of Things (IoT) - Guidance on IoT application to home healthcare | | WG 5 | |
| ISO/IEC 30180 ED1 | Internet of Things (IoT) - Functional requirements to determine the status of self-quarantine through Internet of Things data interfaces | JTC1-SC41/366/CDV | WG 5 | 2025-09 |
| ISO/IEC 30184 ED1 | Internet of Things (IoT) - Autonomous IoT object identification in connected home - Requirements and framework | JTC1-SC41/384/CDV | WG 5 | 2024-11 |
| ISO/IEC 30187 ED1 | Internet of Things (IoT) - Evaluation indicators for IoT systems | JTC1-SC41/437/CD | WG 5 | 2025-12 |
| ISO/IEC 30197 ED1 | Internet of Things (IoT) - IoT for stress management, good health and well-being | JTC1-SC41/383/NP | WG 5 | 2027-06 |
| PWI TR JTC1-SC41-20 | (AWI) Digital Twin - Fidelity metric of digital twin system | | WG 6 | |
| PNW JTC1-SC41-440 ED1 | IoT and digital twins – Guidance on the connection to data spaces | JTC1-SC41/440/NP | WG 6 | 2027-06 |
| PNW JTC1-SC41-444 ED1 | Digital Twin - Extraction and transactions of data products | JTC1-SC41/444/NP | WG 6 | 2027-11 |
| ISO/IEC 30186 ED1 | Digital twin – Maturity model and guidance for a maturity assessment | JTC1-SC41/400/CD | WG 6 | 2025-10 |
| ISO/IEC 30188 ED1 | Digital Twin - Reference architecture | JTC1-SC41/333/NP | WG 6 | 2026-06 |
| ISO/IEC 30177 ED1 | Internet of Things (IoT) - Underwater network management system (U-NMS) interworking | JTC1-SC41/411/CDV | WG 7 | 2025-04 |
| ISO/IEC 63573-1 ED1 | Internet of Things (IoT) — Multi-modal underwater wireless communication technologies — Part 1: Overview and requirements | JTC1-SC41/395/NP | WG 7 | 2027-06 |
| ISO/IEC TR 30189-1 ED1 | Internet of Things (IoT) - IoT-based management of tangible cultural heritage assets - Part 1: Framework | JTC1-SC41/429/DTR | | 2024-08 |
| ISO/IEC TR 30194 ED1 | Internet of Things (IoT) and digital twin – Best practices for use case projects | JTC1-SC41/416/DTR | | 2024-12 |
| ISO/IEC TR 30195 ED1 | Internet of Things (IoT) - IoT Applications for Long-distance Oil and Gas Pipeline | JTC1-SC41/428/CD | | 2025-04 |
| ISO/IEC TR 30196 ED1 | Internet of Things (IoT) – IoT applications for natural gas distribution system | JTC1-SC41/419/CD | | 2025-04 |
| PWI TR JTC1-SC41-10 | Internet of Things (IoT) – IoT-based cultural heritage management – Part 2: Use cases | | | |
| PWI TR JTC1-SC41-12 | (AWI) Internet of Things (IoT) – Environmental and ecological effects, risks, and considerations of underwater acoustic signalling | | | |
| PWI JTC1-SC41-15 | Internet of Things (IoT) – System requirements of IoT-based fixed asset seizure management | | | |
| PWI JTC1-SC41-19 | (ISO/IEC 30153) Digital Twin- Guidelines for digital entity modeling | | | |
| PWI TR JTC1-SC41-21 | (AWI) (ISO/IEC TR 40141) Internet of Things (IoT) – Reference architecture guidance | | | |

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|---|---|---|---|---|
| PWI TR JTC1-SC41-22 | Internet of Things (IoT) – Architecture considerations for IoT, edge and cloud | | | |
| PWI JTC1-SC41-23 | Internet of Things (IoT) – General requirements of information publishing system based on IoT | | | |
| PWI JTC1-SC41-24 | Internet of Things (IoT) — IoT systems using wireless power technology | | | |

### 2b) ISO/IEC JTC 1 SC 42 "Artificial Intelligence" [1] [3]

*Table 5: Projects in WGs of ISO/IEC JTC 1 SC 42 [1]*

| Description | Scope | Working Group | Creation Date |
|---|---|---|---|
| Foundational standards | Foundational standards | WG 1 | 2019-10-11 |
| Data | Data | WG 2 | 2019-10-11 |
| Trustworthiness | Trustworthiness | WG 3 | 2019-10-11 |
| Use cases and applications | Use cases and applications | WG 4 | 2019-10-11 |
| Computational approaches and computational characteristics of AI systems | Computational approaches and computational characteristics of AI systems | WG 5 | 2019-10-11 |
| Joint Working Group ISO/IEC JTC1/SC 42 - ISO/IEC JTC1/SC 7 : Testing of AI-based systems | Joint Working Group ISO/IEC JTC1/SC 42 - ISO/IEC JTC1/SC 7 : Testing of AI-based systems | JWG 2 | 2023-07-20 |
| Joint Working Group ISO/IEC JTC1/SC42 - ISO/TC 215 WG : AI enabled health informatics | Joint Working Group ISO/IEC JTC1/SC42 - ISO/TC 215 WG : AI enabled health informatics | JWG 3 | 2023-07-20 |
| AI standardization roadmapping | AI standardization roadmapping | AG 3 | 2023-06-05 |

### 3) IEC/TC 65 [1]

*Table 6: Projects in WGs of IEC/TC 65 [1]*

| Project Reference | Title | Document Reference | Working Group | Fcst. Publ. Date |
|---|---|---|---|---|
| IEC 62443-2-1 ED2 | Security for industrial automation and control systems - Part 2-1: Security program requirements for IACS asset owners | 65/1044/FDIS | WG 10 | 2024-08 |
| IEC PAS 62443-2-2 ED1 | Security for industrial automation and control systems – Part 2-2: IACS Security Protection | 65/1051/DPAS | WG 10 | 2024-09 |
| IEC TS 62443-6-2 ED1 | Security evaluation methodology for IEC 62443 - Part 4-2: Technical security requirements for IACS components | 65/932/CD | WG 10 | 2024-12 |
| IEC 63131-1 ED1 | Application function blocks and logic diagrams for Upstream Oil & Gas processes – System Control Diagrams – Part 1: General principles | 65/919/NP | WG 12 | 2025-09 |
| IEC TS 63069 ED1 | Framework for safety and security | 65/1018/CD | WG 20 | 2025-07 |
| IEC TR 63283-2 ED2 | Industrial-process measurement, control and automation - Smart manufacturing - Part 2: Use cases | 65/1019/CD | WG 23 | 2025-04 |
| PNW 65-1032 ED1 | Asset Administration Shell for industrial applications – Part 5: Interfaces | 65/1032/NP | WG 24 | 2026-12 |
| IEC 63278-2 ED1 | Asset Administration Shell for Industrial Applications – Part 2: Information meta model | 65/992/CD | WG 24 | 2025-08 |
| IEC 63278-3 ED1 | Asset Administration Shell for Industrial Applications – Part 3: Security provisions for Asset Administration Shells | 65/916/NP | WG 24 | 2025-08 |
| IEC 63278-4 ED1 | Asset administration shell for industrial applications - Part 4: Use cases and modelling examples | 65/1024/CD | WG 24 | 2025-10 |
| IEC 61010-2-201 ED3 | Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 2-201: Particular requirements for control equipment | 65/1049/FDIS | JWG 13 | 2024-08 |
| IEC 61010-2-203 ED1 | Safety requirements for electrical equipment for measurement, control and laboratory use - Part 2-203: Particular requirements for industrial communication circuits and communication port interconnection | 65/1054/FDIS | JWG 13 | 2024-10 |
| ISO 20140-5 ED2 | Automation systems and integration - Evaluating energy efficiency and other factors of manufacturing systems that influence the environment - Part 5: Environmental performance evaluation data | 65/1046/FDIS | JWG 14 | 2024-08 |

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|---|---|---|---|---|
| IEC 63339 ED1 | Unified reference model for smart manufacturing | 65/1020/FDIS | JWG 21 | 2024-08 |
| IEC 60050-351 ED5 | International Electrotechnical Vocabulary (IEV) - Part 351: Control technology | 65/869/RR | | 2025-09 |
| IEC TR 63283-4 ED1 | Industrial-process measurement, control and automation – Smart Manufacturing – Part 4:Recommendations for the usage of new technologies | 65/1040/CD | | 2025-04 |
| IEC TR 63283-5 ED1 | Industrial-process measurement, control and automation – Smart manufacturing – Part 5: Market and innovation trends analysis | 65/1008/DTR | | 2024-08 |
| IEC TR 63319 ED1 | A meta-modelling analysis approach to smart manufacturing reference models | 65/812/DTR | | 2024-08 |

### 4) IEC/SyC Smart Energy [1]

*Table 7: Projects in WGs of IEC/SyC Smart Energy [1]*

| Project Reference | Title | Document Reference | Working Group | Fcst. Publ. Date |
|---|---|---|---|---|
| IEC SRD 63443 ED1 | Distributed Energy Resource Aggregation Business System: Architecture and Service scenario | SyCSmartEnergy/251/CD | WG 2 | 2025-07 |
| IEC TS 63586 ED1 | SRD: Reference Guidance for Energy Service Business Using Controllable Loads | SyCSmartEnergy/249/NP | WG 2 | 2025-10 |
| IEC SRD 63417 ED1 | Guide and plan to develop Smart energy Ontologies | SyCSmartEnergy/222/CD | WG 6 | 2024-11 |
| IEC SRD 63460 ED1 | Architecture and use-cases for EVs to provide grid support functions | SyCSmartEnergy/241/CD | JWG 3 | 2024-12 |
| IEC TS 63443-2 ED1 | Distributed Energy Resource Aggregation Business System - Part 2: Risk assessment and treatment | SyCSmartEnergy/256/NP | | 2026-06 |
| PWI SyCSmartEnergy-2 | Extension of the SGAM to include Distributed Ledger Technologies (DLT-SGAM-Reference Architecture Model) | | | |
| PWI SyCSmartEnergy-3 | Archetypes of DLT-based business models for the energy sector | | | |

### 5) IEC/TC 8 [1]

*Table 8: Projects in WGs of IEC/TC 8 [1]*

| Project Reference | Title | Document Reference | Working Group | Fcst. Publ. Date |
|---|---|---|---|---|
| IEC TS 62749 ED3 | Assessment of power quality - Characteristics of electricity supplied by public networks | 8/1671/RR | WG 11 | 2025-07 |
| IEC TS 63222-1 ED2 | Power quality management - Part 1: General guidelines | 8/1672/RR | WG 11 | 2026-01 |
| IEC TS 63222-4 ED1 | Power quality management - Part 4: Harmonic analysis over public supply network | 8/1711/CD | WG 11 | 2025-07 |
| IEC TR 63222-101 ED1 | IEC TR 63222-101 Power quality management - Part 101: Power quality data application | 8/1708/CD | WG 11 | 2025-04 |
| IEC 60050-602/AMD1 ED1 | Amendment 1 - International Electrotechnical Vocabulary (IEV) - Part 602: Generation, transmission and distribution of electricity - Generation | 8/1568/RR | JWG 1 | 2025-10 |
| IEC 60050-603/AMD2 ED1 | Amendment 2 - International Electrotechnical Vocabulary (IEV) - Part 603: Generation, transmission and distribution of electricity - Power systems planning and management | 8/1569/RR | JWG 1 | 2025-10 |
| IEC 60050-605/AMD1 ED1 | Amendment 1 - International Electrotechnical Vocabulary (IEV) - Part 605: Generation, transmission and distribution of electricity - Substations | 8/1570/RR | JWG 1 | 2025-10 |
| IEC 60050-614/AMD1 ED1 | Amendment 1 - International Electrotechnical Vocabulary (IEV) - Part 614: Generation, transmission and distribution of electricity - Operation | 8/1571/RR | JWG 1 | 2025-10 |
| IEC 60050-617 ED2 | International Electrotechnical Vocabulary (IEV) - Part 617: Organization/Market of electricity | 8/1703/CD | JWG 1 | 2025-06 |

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|---|---|---|---|---|
| IEC 60050-691/AMD2 ED1 | Amendment 2 - International Electrotechnical Vocabulary (IEV) - Part 691: Tariffs for electricity | 8/1543/RR | JWG 1 | 2025-10 |
| IEC TR 63282 ED2 | LVDC systems - Assessment of standard voltages and power quality requirements | 8/1695/DTR | JWG 9 | 2024-08 |
| IEC TR 63282-101 ED1 | IEC TR 63282-101 LVDC systems: DC power distribution system for typical scenarios | 8/1707/CD | JWG 9 | |
| IEC TR 63282-102 ED1 | IEC TR 63282-102 LVDC systems: Technical report for low-voltage DC electric island power supply systems | 8/1691/CD | JWG 9 | 2025-04 |
| PWI TR 8-12 | IEC TR 62786-100 Distributed energy resources connection with the grid - Part 100 Generating units grid connection standard mapping | | JWG 10 | |
| PWI TR 8-13 | IEC TR 62786-101 Distributed energy resources connection with the grid – Part 101 Gravity storage connection to the grid | | JWG 10 | |
| PWI TR 8-14 | IEC TR 62786-102 Distributed energy resources connection with the grid – Part 102 CAES connection to the grid | | JWG 10 | |
| PWI TR 8-15 | IEC TR 62786-103 Distributed energy resources connection with the grid – Part 103 V2G application scenarios for the grid | | JWG 10 | |
| IEC TS 62786-2 ED1 | Distributed energy resources connection with the grid - Part 2 Additional requirements for PV generation | 8/1683/NP | JWG 10 | 2026-05 |
| IEC TS 62786-42 ED1 | Distributed energy resources connection with the grid – Part 42 Requirements for voltage measurement used to control DER and loads | 8/1567/NP | JWG 12 | 2025-07 |
| IEC 60038/AMD2/FRAG1 ED7 | Amendment 2 (Fragment 1) - Standard voltages for LVDC supply and LVDC equipment (Proposed horizontal standard) | 8/1627/RR | MT 1 | 2025-07 |
| IEC 60038/AMD2/FRAG2 ED7 | Amendment 2 (Fragment 2) - Standard voltages for HVDC supply and HVDC equipment (Proposed horizontal standard) | 8/1627/RR | MT 1 | 2025-07 |
| PWI TR 8-16 | IEC TR 63282-103: LVDC systems – Part 103: Flexible interconnection systems with LVDC | | | |

The project lists of IEC/TC 8 SC 8A, IEC/TC 8 SC 8B and IEC/TC 8 SC 8C can be found on the IEC website [1].

### 6) CLC/TC 8x [2]

*Table 9: Projects in CLC/TC 8x [2]*

| Project reference | Title | Forecasted voting date |
|---|---|---|
| EN 50160:2022/prA1:2024 (pr=78493) | Voltage characteristics of electricity supplied by public electricity networks | 02.04.2025 |
| prEN 50549-10 (pr=78903) | Requirements for generating plants to be connected in parallel with distribution networks – Part 10: Tests for conformity assessment of generating units | 25.06.2025 |
| CLC/prTS 50744-1 (pr=77890) | Electrical characteristics of grid-forming generating and storage units to be connected in parallel with electrical networks - definitions and tests | |
| EN 60038:2011/prA2 (Fragment 2) (pr=75674) | Standard voltages for HVDC supply and HVDC equipment (Proposed horizontal standard) | 22.04.2024 |
| EN 60038:2011/prA2 (Fragment 1) (pr=63051) | Standard voltages for LVDC supply and LVDC equipment (Proposed horizontal standard) | 01.10.2018 |

### 7) IEC/TC 120 [1]

*Table 10: Projects of WGs in IEC/TC 120 [1]*

| Project Reference | Title | Document Reference | Working Group | Fcst. Publ. Date |
|---|---|---|---|---|
| IEC TS 62933-2-3 ED1 | Electric Energy Storage (EES) Systems - Part 2-3: Unit parameters and testing methods - Performance assessment test after site operation | 120/342/CD | WG 2 | 2025-07 |
| IEC TR 62933-2-201 ED1 | Review of testing for BESS in consideration of implementing repurpose and reuse batteries | 120/366/DTR | WG 2 | 2024-08 |
| IEC 62933-3-1 ED1 | Electrical energy storage (EES) systems - Part 3-1: Planning and performance assessment of electrical energy storage systems - General specification | 120/328/CD | WG 3 | 2025-09 |

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|---|---|---|---|---|
| IEC TR 62933-3-200 ED1 | Electrical Energy Storage (EES) Systems - Part 3-200: Design principles of electrochemical based EES systems | 120/341/CD | WG 3 | 2024-11 |
| IEC 62933-4-2 ED1 | Electric Energy Storage Systems - Part 4-2- Assessment of the environmental impact of battery failure in an electrochemical based storage system | 120/316/CDV | WG 4 | 2024-12 |
| IEC 62933-4-3 ED1 | Electrical energy storage(EES) systems - Part 4-3: The protection requirements of BESS according to the environmental conditions and location types | 120/370/CD | WG 4 | 2025-08 |
| IEC 62933-5-4 ED1 | Electrical energy storage (ESS) systems Part 5-4 - Safety test methods and procedures for grid integrated EES systems - Lithium-ion battery-based systems | 120/332/CD | WG 5 | 2025-09 |
| IEC 62933-5-2 ED2 | Electrical energy storage (EES) systems - Part 5-2: Safety requirements for grid-integrated EES systems - Electrochemical-based systems | 120/353/CDV | MT 7 | 2025-05 |
| IEC 62933-5-1 ED1 | Electrical energy storage (EES) systems - Part 5-1: Safety considerations for grid-integrated EES systems - General specification | 120/368/FDIS | MT 8 | 2024-08 |

# B. Annex B: Standardization Matrices

On the following pages, each Standardization Matrix variant has been divided into three extracts for better readability.

**1) Matrix variant 1: IEC/CENELEC TC and int:net WP**

Orange: IEC/CENELEC Technical Committees (TC) and int:net Work Packages (WP)

**2) Matrix variant 2: IEC/CENELEC TC and int:net IFG**

Yellow: IEC/CENELEC Technical Committees (TC) and int:net Interoperability Focus Groups (IFG)

**3) Matrix variant 3: IEC/CENELEC TC and EDSCP**

Green: IEC/CENELEC Technical Committees (TC) and Energy Data Space Cluster Projects (EDSCP)

The original matrices used in the int:net project [6] are Excel sheets.

*Table 11: Standardization Matrix in three variants (Annex B)*

**Matrix IEC/CENELEC Technical Committees and int:net WPs**

1 = awareness
2 = follow
3 = contribution

| | | | WP | int:net WP1 | int:net WP2 | int:net WP3 | int:net WP4 | int:net WP5 |
|---|---|---|---|---|---|---|---|---|
| | | | Title | Interoperability best practices and knowledge base | Develop Interoperability Maturity Model and Reference Implementation | Community of Interoperability Testing Facilities | Standardization, coordination and regulation | Communication, Dissemination and Networking for a European Interoperability |
| | | | Key words (WP) | -catalogue initiatives<br>-analysis use cases, value chain, business models<br>-lifecycle process<br>-energy data spaces | -reference framework<br>-IMM<br>-database/user interface maturity tracking<br>-modeling, protocols | -testing concepts procedures<br>-evolvement and community of testing facilities | -standards environment<br>-regulatory framework<br>-governmental, regulatory institutions | -approaching initiatives<br>-network platform<br>-roadmap, start network<br>-capacity building, dissemination events |
| **Technical Committee (TC)<br>Subcommittee (SC)<br>Working Group (WG)<br>System Committee (SyC)<br>Joint Technical Committee (JTC)** | **Title of TC/SC/WG/SyC/JTC** | **Key words (TC/SC/WG/SyC/JTC)** | | | | | | |
| **IEC/TC 8** | System aspects of electrical energy supply | power systems | | | | | | |
| SC 8A | Grid Integration of Renewable Energy Generation | connection requirements, grid integration, data spaces: interoperability, sector coupling | | 2 | 3 | 2 | 2 | 1 |
| -WG 2 | Renewable energy power prediction | forecast, benchmarking, prognosis, renewables | | 2 | 3 | 2 | 2 | 1 |
| -WG 6 | Connection of Renewable Energy with HVDC System | HVDS, system, TSO | | 2 | 3 | 2 | 2 | 1 |
| -WG 7 | Integrating distributed PV into DC systems and use cases | renewables, grid integration | | 2 | 3 | 2 | 2 | 1 |
| -WG 8 | Modeling of renewable energy generation for power system dynamic analysis | modeling, simulation | | 2 | 3 | 2 | 2 | 1 |
| SC 8B | Decentralized electrical energy systems | renewables, grid integration, DSO, data spaces: interoperability, sector coupling | | 2 | 3 | 2 | 2 | 1 |
| -WG 3 | Microgrid monitoring, control and energy management systems | islanding, generation, market, emergency, renewables, virtual power plants | | 2 | 3 | 2 | 2 | 1 |
| -WG 4 | Virtual Power Plants | generation, market, emergency, renewables, | | 2 | 3 | 2 | 2 | 1 |
| -WG 5 | Direct current and hybrid distribution systems | DSO, grid integration | | 2 | 3 | 2 | 2 | 1 |
| -WG 6 | Demand side resources utilization | market, renewables, demand response, flexibility | | 2 | 3 | 2 | 3 | 1 |
| SC 8C | Network management in Interconnected Electric Power Systems | DSO, grid integration, renewables, data spaces: interoperability, sector coupling | | 2 | 3 | 2 | 2 | 1 |
| -WG 2 | Electricity market integration | market, renewables, demand response, flexibility | | 2 | 3 | 2 | 2 | 1 |
| -WG 3 | Power system stability control | grid integration, frequency, voltage | | 2 | 3 | 2 | 2 | 1 |
| WG 11 | Power Quality | control, protection, grid integration, frequency | | 2 | 3 | 2 | 2 | 1 |
| **CLC/TC 8x** | System Aspects of Electrical Energy Supply | power systems, data spaces: interoperability, sector coupling | | | | | | |
| WG 3 | Requirements for connection of generators to distribution networks | connection requirements, protection, grid integration, frequency | | 2 | 3 | 2 | 2 | 1 |
| WG 4 | Ah WG 38 – Endorsement of IEC 60038 as European Standard | control, protection, grid integration, frequency | | 2 | 3 | 2 | 2 | 1 |
| WG 5 | Smart grid requirements | connection requirements, grid integration | | 2 | 3 | 2 | 2 | 1 |
| WG 6 | System aspects for HVDC grid | HVDS, system, TSO | | 2 | 3 | 2 | 2 | 1 |
| WG 7 | Power frequency measurement for DER management | control, protection, grid integration, frequency | | 2 | 3 | 2 | 3 | 1 |
| WG AHG | Assessment of Standards for Network Code Compliance | grid integration, frequency, voltage | | 2 | 3 | 2 | 3 | 1 |

**Extract 1 of 3**

**Standardization Matrix - variant 1**

IEC/CENELEC Technical Committees (TC) and int:net Work Packages (WP)

**CONTINUATION**

| | Title of TC/SC/WG/SyC/JTC | Key words (TC/SC/WG/SyC/JTC) | | int:net WP1 | int:net WP2 | int:net WP3 | int:net WP4 | int:net WP5 |
|---|---|---|---|---|---|---|---|---|
| **IEC/TC 57** | Power systems management and associated information exchange | information exchange, data spaces: interoperability, sector coupling | | | | | | |
| WG 3 | Telecontrol protocols | telecontrol protocols | | 2 | 3 | 3 | 3 | 1 |
| WG 10 | Power system IED communication and associated data models | communication, protocol, application, interface | | 2 | 3 | 3 | 3 | 1 |
| WG 13 | Software interfaces for operation and planning of the electric | substation, grid integration | | 2 | 3 | 3 | 3 | 1 |
| WG 14 | Enterprise business function interfaces for utility operations | CIM, market, data model | | 2 | 3 | 3 | 3 | 1 |
| WG 15 | Data and communication security | cybersecurity, end2end, access control, grid integration, trust management, data transactions | | 2 | 3 | 3 | 3 | 1 |
| WG 16 | Deregulated energy market communications | communication, market, grid integration | | 2 | 3 | 3 | 3 | 1 |
| WG 17 | Power system intelligent electronic device communication and associated data models for microgrids, distributed energy resources and distribution automation | data exchange, renewables | | 2 | 3 | 3 | 3 | 1 |
| WG 18 | Hydroelectric power plants – Communication for monitoring and control | monitoring, control, hydro strorage | | 2 | 3 | 3 | 3 | 1 |
| WG 19 | Interoperability within TC 57 in the long term | SGAM, grid integration, CIM, mapping | | 2 | 3 | 3 | 3 | 1 |
| WG 20 | Power Line Carrier Communication Systems | PLC, communication | | 2 | 3 | 3 | 3 | 1 |
| WG 21 | Interfaces and protocol profiles relevant to systems connected to the electrical grid | SGAM, grid integration | | 2 | 3 | 3 | 3 | 1 |
| **IEC/TC 65** | Industrial-process measurement, control and automation | integration of components into systems, safety, | | | | | | |
| WG 10, 12, 20, 23, 24 | | | | 2 | 2 | 3 | 2 | 1 |
| JWG 13, 14, 21 | | | | 2 | 2 | 3 | 2 | 1 |
| SC 65A | System aspects | operational conditions, methodology for assemessment of systems, functional safety | | 2 | 3 | 3 | 2 | 1 |
| -WG 4, 19 | | | | 2 | 3 | 3 | 2 | 1 |
| -JWG 21 | | | | 2 | 3 | 3 | 2 | 1 |
| SC 65B | Measurement and control devices | measurement devices, analysing equipment, actuators, programmable logic controllers, interchangeability, performance evaluation | | 3 | 2 | 3 | 2 | 1 |
| -WG 30, 37, 51 | | | | 3 | 2 | 3 | 2 | 1 |
| -JWG 1 | | | | 3 | 2 | 3 | 2 | |
| SC 65C | Industrial networks | interoperability, co-existence, performance | | 2 | 3 | 3 | 2 | 1 |
| -WG 12, 17, 18 | | | | 2 | 3 | 3 | 2 | 1 |
| -JWG 10 | | | | 2 | 3 | 3 | 2 | 1 |
| SC 65E | Devices and integration in enterprise systems | device properties, classification, selection, configuration, commissioning, monitoring, diagnostics | | 3 | 2 | 3 | 2 | 1 |
| -WG 2, 3, 4, 8, 9, 10, 12, 13, 14 | | | | 3 | 2 | 3 | 2 | 1 |
| -JWG 5 | | | | 3 | 2 | 3 | 2 | 1 |
| **IEC/TC 120** | Electrical Energy Storage (EES) systems | EES, data spaces: interoperability, sector coupling | | | | | | |
| WG 1 | Terminology | terms, definitions | | 2 | 2 | 1 | 2 | 1 |
| WG 2 | Unit parameters and testing methods | testing | | 2 | 2 | 1 | 2 | 1 |
| WG 3 | Planning and installation | set-up, connection requirements, maintenance | | 2 | 2 | 1 | 2 | 1 |
| WG 4 | Environmental issues | environmental protection, recycling | | 2 | 2 | 1 | 2 | 1 |
| WG 5 | Safety considerations | safety, handling, emergency | | 2 | 2 | 1 | 2 | 1 |

**Extract 2 of 3**

**Standardization Matrix - variant 1**

IEC/CENELEC Technical Committees (TC) and int:net Work Packages (WP)

**CONTINUATION**

| | Title of TC/SC/WG/SyC/JTC | Key words (TC/SC/WG/SyC/JTC) | | int:net WP1 | int:net WP2 | int:net WP3 | int:net WP4 | int:net WP5 |
|---|---|---|---|---|---|---|---|---|
| **IEC/SyC** | Smart Energy | smart grid, smart energy, systems level standardization, data spaces: interoperability, sector | | 2 | 3 | 2 | 3 | 1 |
| WG 2 | IEC Smart Energy Development Plan | smart grid, development plan | | 2 | 3 | 2 | 3 | 1 |
| JWG3 | Smart Enegy Roadmap (joint with ISO/IEC JTC1/SC41 IoT and digital twin | smart grid, roadmap, IoT, digital twin | | 2 | 3 | 2 | 3 | 1 |
| WG 5 | Methodology and Tools | use cases, actors, use case repository, interoperability, requirement engineering | | 2 | 3 | 2 | 3 | 1 |
| WG 6 | Generic Smart Grid Requirements | smart grid, functionality, requirement engineering | | 2 | 3 | 2 | 3 | 1 |
| WG 8 | Distributed energy trading infrastructure | reference architecture, distributed grid management | | 2 | 3 | 2 | 3 | 1 |
| **ISO/IEC JTC 1** | Information Technology | IT | | | | | | |
| SC 7 | Software and systems engineering | systems engineering, software engineering, requirements engineering, architecture, | | 2 | 3 | 3 | 2 | 1 |
| SC 27 | Information security, cybersecurity and privacy protection | security, cybersecurity, digital twin | | 2 | 3 | 3 | 2 | 1 |
| SC 32 | Data managemeng and interchange | data, ontologies, metadata, registries, data usage | | 3 | 3 | 3 | 2 | 1 |
| SC 38 | Cloud computing and distributed platforms | cloud, data spaces | | 2 | 3 | 3 | 2 | 1 |
| SC 41 | Internet of things and digital twin | IoT, digital twin, data spaces: interoperability, sector coupling, data transactions | | 2 | 3 | 3 | 3 | 1 |
| SC 42 | Artificial intelligence | AI, data spaces: interoperability, sector coupling, trust | | 2 | 3 | 3 | 2 | 1 |

**Extract 3 of 3**

**Standardization Matrix - variant 1**

IEC/CENELEC Technical Committees (TC) and int:net Work Packages (WP)

**Matrix IEC/CENELEC Technical Committees and int:net IFGs**

1 = awareness
2 = follow
3 = contribution

| | | | IFG | IFG-1 | IFG-2 | IFG-3 | IFG-4 | IFG-5 |
|---|---|---|---|---|---|---|---|---|
| | | | Title | Interoperability Profiles in Data Spaces | Increasing Maturity in Interoperability | The Interoperability Regulatory Landscape | Interoperability Testing Approaches, Test Cases, and Test Facilities | Smart Grid related Use Cases and SGAM |
| | | | Key words (IFG) | -interoperability profiles<br>-data spaces<br>-trusted data sharing | -organizational maturity<br>-collaboration in interoperability<br>-interoperable solutions | -policy and regulatory initiatives<br>-promote development of interoperable energy services<br>-stakeholders | -testing approaches, test cases, test facilities<br>-harmonisation of testing procedures<br>-integrated pan-European network of testing facilities | -smart grid related use cases<br>-SGAM<br>-IEC 62559-2<br>-interoperability |
| **Technical Committee (TC)<br>Subcommittee (SC)<br>Working Group (WG)<br>System Committee (SyC)<br>Joint Technical Committee (JTC)** | **Title of TC/SC/WG/SyC/JTC** | **Key words (TC/SC/WG/SyC/JTC)** | | | | | | |
| **IEC/TC 8** | System aspects of electrical energy supply | power systems | | | | | | |
| SC 8A | Grid Integration of Renewable Energy Generation | connection requirements, grid integration, data spaces: interoperability, sector coupling | | 3 | 2 | 2 | 3 | 3 |
| -WG 2 | Renewable energy power prediction | forecast, benchmarking, prognosis, renewables | | 3 | 2 | 1 | 3 | 3 |
| -WG 6 | Connection of Renewable Energy with HVDC System | HVDS, system, TSO | | 3 | 2 | 1 | 3 | 3 |
| -WG 7 | Integrating distributed PV into DC systems and use cases | renewables, grid integration | | 3 | 2 | 2 | 3 | 3 |
| -WG 8 | Modeling of renewable energy generation for power system dynamic analysis | modeling, simulation | | 3 | 2 | 1 | 3 | 3 |
| SC 8B | Decentralized electrical energy systems | renewables, grid integration, DSO, data spaces: interoperability, sector coupling | | 3 | 2 | 2 | 3 | 3 |
| -WG 3 | Microgrid monitoring, control and energy management systems | islanding, generation, market, emergency, renewables, virtual power plants | | 3 | 2 | 1 | 3 | 3 |
| -WG 4 | Virtual Power Plants | generation, market, emergency, renewables, | | 3 | 2 | 1 | 3 | 3 |
| -WG 5 | Direct current and hybrid distribution systems | DSO, grid integration | | 3 | 2 | 1 | 3 | 3 |
| -WG 6 | Demand side resources utilization | market, renewables, demand response, flexibility | | 3 | 2 | 2 | 3 | 3 |
| SC 8C | Network management in Interconnected Electric Power Systems | DSO, grid integration, renewables, data spaces: interoperability, sector coupling | | 3 | 2 | 2 | 3 | 3 |
| -WG 2 | Electricity market integration | market, renewables, demand response, flexibility | | 3 | 2 | 2 | 3 | 3 |
| -WG 3 | Power system stability control | grid integration, frequency, voltage | | 3 | 2 | 1 | 3 | 3 |
| WG 11 | Power Quality | control, protection, grid integration, frequency | | 3 | 2 | 1 | 3 | 3 |
| **CLC/TC 8x** | System Aspects of Electrical Energy Supply | power systems, data spaces: interoperability, sector coupling | | | | | | |
| WG 3 | Requirements for connection of generators to distribution networks | connection requirements, protection, grid integration, frequency | | 3 | 2 | 1 | 3 | 3 |
| WG 4 | Ah WG 38 – Endorsement of IEC 60038 as European Standard | control, protection, grid integration, frequency | | 3 | 2 | 1 | 3 | 3 |
| WG 5 | Smart grid requirements | connection requirements, grid integration | | 3 | 2 | 1 | 3 | 3 |
| WG 6 | System aspects for HVDC grid | HVDS, system, TSO | | 3 | 2 | 1 | 3 | 3 |
| WG 7 | Power frequency measurement for DER management | control, protection, grid integration, frequency | | 3 | 2 | 1 | 3 | 3 |
| WG AHG | Assessment of Standards for Network Code Compliance | grid integration, frequency, voltage | | 3 | 2 | 1 | 3 | 3 |

**Extract 1 of 3**

**Standardization Matrix - variant 2**

IEC/CENELEC Technical Committees (TC) and int:net Interoperability Focus Groups (IFG)

**CONTINUATION**

| | Title of TC/SC/WG/SyC/JTC | Key words (TC/SC/WG/SyC/JTC) | | IFG-1 | IFG-2 | IFG-3 | IFG-4 | IFG-5 |
|---|---|---|---|---|---|---|---|---|
| **IEC/TC 57** | Power systems management and associated information exchange | information exchange, data spaces: interoperability, sector coupling | | | | | | |
| WG 3 | Telecontrol protocols | telecontrol protocols | | 3 | 2 | 1 | 3 | 3 |
| WG 10 | Power system IED communication and associated data models | communication, protocol, application, interface | | 3 | 2 | 1 | 3 | 3 |
| WG 13 | Software interfaces for operation and planning of the electric | substation, grid integration | | 3 | 2 | 1 | 3 | 3 |
| WG 14 | Enterprise business function interfaces for utility operations | CIM, market, data model | | 3 | 2 | 2 | 3 | 3 |
| WG 15 | Data and communication security | cybersecurity, end2end, access control, grid integration, trust management, data transactions | | 3 | 2 | 2 | 3 | 3 |
| WG 16 | Deregulated energy market communications | communication, market, grid integration | | 3 | 2 | 2 | 3 | 3 |
| WG 17 | Power system intelligent electronic device communication and associated data models for microgrids, distributed energy resources and distribution automation | data exchange, renewables | | 3 | 2 | 2 | 3 | 3 |
| WG 18 | Hydroelectric power plants – Communication for monitoring and control | monitoring, control, hydro strorage | | 3 | 2 | 1 | 3 | 3 |
| WG 19 | Interoperability within TC 57 in the long term | SGAM, grid integration, CIM, mapping | | 3 | 2 | 2 | 3 | 3 |
| WG 20 | Power Line Carrier Communication Systems | PLC, communication | | 3 | 2 | 2 | 3 | 3 |
| WG 21 | Interfaces and protocol profiles relevant to systems connected to the electrical grid | SGAM, grid integration | | 3 | 2 | 2 | 3 | 3 |
| **IEC/TC 65** | Industrial-process measurement, control and automation | integration of components into systems, safety, | | | | | | |
| WG 10, 12, 20, 23, 24 | | | | 3 | 2 | 1 | 3 | 3 |
| JWG 13, 14, 21 | | | | 3 | 2 | 1 | 3 | 3 |
| SC 65A | System aspects | operational conditions, methodology for assemessment of systems, functional safety | | 3 | 2 | 1 | 3 | 3 |
| -WG 4, 19 | | | | 3 | 2 | 1 | 3 | 3 |
| -JWG 21 | | | | 3 | 2 | 1 | 3 | 3 |
| SC 65B | Measurement and control devices | measurement devices, analysing equipment, actuators, programmable logic controllers, interchangeability, performance evaluation | | 3 | 2 | 1 | 3 | 3 |
| -WG 30, 37, 51 | | | | 3 | 2 | 1 | 3 | 3 |
| -JWG 1 | | | | 3 | 2 | 1 | 3 | 3 |
| SC 65C | Industrial networks | interoperability, co-existence, performance | | 3 | 2 | 1 | 3 | 3 |
| -WG 12, 17, 18 | | | | 3 | 2 | 1 | 3 | 3 |
| -JWG 10 | | | | 3 | 2 | 1 | 3 | 3 |
| SC 65E | Devices and integration in enterprise systems | device properties, classification, selection, configuration, commissioning, monitoring, diagnostics | | 3 | 2 | 1 | 3 | 3 |
| -WG 2, 3, 4, 8, 9, 10, 12, 13, 14 | | | | 3 | 2 | 1 | 3 | 3 |
| -JWG 5 | | | | 3 | 2 | 1 | 3 | 3 |
| **IEC/TC 120** | Electrical Energy Storage (EES) systems | EES, data spaces: interoperability, sector coupling | | | | | | |
| WG 1 | Terminology | terms, definitions | | 3 | 2 | 1 | 3 | 3 |
| WG 2 | Unit parameters and testing methods | testing | | 3 | 2 | 1 | 3 | 3 |
| WG 3 | Planning and installation | set-up, connection requirements, maintenance | | 3 | 2 | 1 | 3 | 3 |
| WG 4 | Environmental issues | environmental protection, recycling | | 3 | 2 | 1 | 3 | 3 |
| WG 5 | Safety considerations | safety, handling, emergency | | 3 | 2 | 1 | 3 | 3 |

**Extract 2 of 3**

**Standardization Matrix - variant 2**

IEC/CENELEC Technical Committees (TC) and int:net Interoperability Focus Groups (IFG)

**CONTINUATION**

| | Title of TC/SC/WG/SyC/JTC | Key words (TC/SC/WG/SyC/JTC) | IFG-1 | IFG-2 | IFG-3 | IFG-4 | IFG-5 |
|---|---|---|---|---|---|---|---|
| **IEC/SyC** | Smart Energy | smart grid, smart energy, systems level standardization, data spaces: interoperability, sector | 3 | 3 | 2 | 3 | 3 |
| WG 2 | IEC Smart Energy Development Plan | smart grid, development plan | 2 | 3 | 3 | 2 | 2 |
| JWG3 | Smart Enegy Roadmap (joint with ISO/IEC JTC1/SC41 IoT and digital twin | smart grid, roadmap, IoT, digital twin | 2 | 3 | 3 | 2 | 2 |
| WG 5 | Methodology and Tools | use cases, actors, use case repository, interoperability, requirement engineering | 2 | 3 | 3 | 2 | 2 |
| WG 6 | Generic Smart Grid Requirements | smart grid, functionality, requirement engineering | 2 | 3 | 3 | 2 | 2 |
| WG 8 | Distributed energy trading infrastructure | reference architecture, distributed grid management | 2 | 3 | 3 | 2 | 2 |
| **ISO/IEC JTC 1** | Information Technology | IT | | | | | |
| SC 7 | Software and systems engineering | systems engineering, software engineering, requirements engineering, architecture, | 2 | 1 | 3 | 2 | 1 |
| SC 27 | Information security, cybersecurity and privacy protection | security, cybersecurity, digital twin | 2 | 1 | 3 | 2 | 1 |
| SC 32 | Data managemeng and interchange | data, ontologies, metadata, registries, data usage | 3 | 1 | 3 | 2 | 1 |
| SC 38 | Cloud computing and distributed platforms | cloud computing | 3 | 1 | 3 | 2 | 1 |
| SC 41 | Internet of things and digital twin | IoT, digital twin, data spaces: interoperability, sector coupling, data transactions | 3 | 2 | 2 | 3 | 3 |
| SC 42 | Artificial intelligence | AI, data spaces: interoperability, sector coupling, trust | 3 | 2 | 2 | 3 | 3 |

**Extract 3 of 3**

**Standardization Matrix - variant 2**

IEC/CENELEC Technical Committees (TC) and int:net Interoperability Focus Groups (IFG)

**Matrix IEC/CENELEC Technical Committees and EDSCP (Energy Data Space Cluster Projects)**

1 = awareness
2 = follow
3 = contribution

| Technical Committee (TC) Subcommittee (SC) Working Group (WG) System Committee (SyC) Joint Technical Committee (JTC) | Title of TC/SC/WG/SyC/JTC | Key words (TC/SC/WG/SyC/JTC) | Data Space Cluster Project | omega-x | SYNERGIES | Enershare | DATA CELLAR | EDDIE (European Distributed Data Infrastructure for Energy) |
|---|---|---|---|---|---|---|---|---|
| | | Key words (Data Space Cluster Project) | | -data spaces -text | -data management -smart grid -interoperability -AI, analytics -IoT, smart metering -energy/flexibility markets -e-mobility, storage -renewable energy | -data spaces -text | -data spaces -text | -data spaces -text |
| **IEC/TC 8** | System aspects of electrical energy supply | power systems | | | | | | |
| SC 8A | Grid Integration of Renewable Energy Generation | connection requirements, grid integration, data spaces: interoperability, sector coupling | | | 2 | | | 1 |
| -WG 2 | Renewable energy power prediction | forecast, benchmarking, prognosis, renewables | | | 2 | | | 1 |
| -WG 6 | Connection of Renewable Energy with HVDC System | HVDS, system, TSO | | | 1 | | | 1 |
| -WG 7 | Integrating distributed PV into DC systems and use cases | renewables, grid integration | | | 1 | | | 1 |
| -WG 8 | Modeling of renewable energy generation for power system dynamic analysis | modeling, simulation | | | 2 | | | 1 |
| SC 8B | Decentralized electrical energy systems | renewables, grid integration, DSO, data spaces: interoperability, sector coupling | | | 2 | | | 2 |
| -WG 3 | Microgrid monitoring, control and energy management systems | islanding, generation, market, emergency, renewables, virtual power plants | | | 2 | | | 1 |
| -WG 4 | Virtual Power Plants | generation, market, emergency, renewables, | | | 2 | | | 1 |
| -WG 5 | Direct current and hybrid distribution systems | DSO, grid integration | | | 1 | | | 1 |
| -WG 6 | Demand side resources utilization | market, renewables, demand response, flexibility | | | 2 | | | 2 |
| SC 8C | Network management in Interconnected Electric Power Systems | DSO, grid integration, renewables, data spaces: interoperability, sector coupling | | | 2 | | | 1 |
| -WG 2 | Electricity market integration | market, renewables, demand response, flexibility | | | 2 | | | 2 |
| -WG 3 | Power system stability control | grid integration, frequency, voltage | | | 2 | | | 1 |
| WG 11 | Power Quality | control, protection, grid integration, frequency | | | 2 | | | 1 |
| **CLC/TC 8x** | System Aspects of Electrical Energy Supply | power systems, data spaces: interoperability, sector coupling | | | | | | |
| WG 3 | Requirements for connection of generators to distribution networks | connection requirements, protection, grid integration, frequency | | | 1 | | | 1 |
| WG 4 | Ah WG 38 – Endorsement of IEC 60038 as European Standard | control, protection, grid integration, frequency | | | 1 | | | 1 |
| WG 5 | Smart grid requirements | connection requirements, grid integration | | | 1 | | | 1 |
| WG 6 | System aspects for HVDC grid | HVDS, system, TSO | | | 1 | | | 1 |
| WG 7 | Power frequency measurement for DER management | control, protection, grid integration, frequency | | | 1 | | | 1 |
| WG AHG | Assessment of Standards for Network Code Compliance | grid integration, frequency, voltage | | | 1 | | | 1 |

Partial completion

**Extract 1 of 3**

**Standardization Matrix - variant 3**

IEC/CENELEC Technical Committees (TC) and Energy Data Space Cluster Projects (EDSCP)

**CONTINUATION**

| | Title of TC/SC/WG/SyC/JTC | Key words (TC/SC/WG/SyC/JTC) | | omega-x | SYNERGIES | Enershare | DATA CELLAR | EDDIE |
|---|---|---|---|---|---|---|---|---|
| **IEC/TC 57** | Power systems management and associated information exchange | information exchange, data spaces: interoperability, sector coupling | | | | | | |
| WG 3 | Telecontrol protocols | telecontrol protocols | | | 1 | | | 1 |
| WG 10 | Power system IED communication and associated data models | communication, protocol, application, interface | | | 2 | | | 1 |
| WG 13 | Software interfaces for operation and planning of the electric | substation, grid integration | | | 3 | | | 1 |
| WG 14 | Enterprise business function interfaces for utility operations | CIM, market, data model | | | 3 | | | 1 |
| WG 15 | Data and communication security | cybersecurity, end2end, access control, grid integration, trust management, data transactions | | | 3 | | | 1 |
| WG 16 | Deregulated energy market communications | communication, market, grid integration | | | 2 | | | 3 |
| WG 17 | Power system intelligent electronic device communication and associated data models for microgrids, distributed energy resources and distribution automation | data exchange, renewables | | | 3 | | | 1 |
| WG 18 | Hydroelectric power plants – Communication for monitoring and control | monitoring, control, hydro strorage | | | 1 | | | 1 |
| WG 19 | Interoperability within TC 57 in the long term | SGAM, grid integration, CIM, mapping | | | 3 | | | 2 |
| WG 20 | Power Line Carrier Communication Systems | PLC, communication | | | 1 | | | 1 |
| WG 21 | Interfaces and protocol profiles relevant to systems connected to the electrical grid | SGAM, grid integration | | | 1 | | | 3 |
| **IEC/TC 65** | Industrial-process measurement, control and automation | integration of components into systems, safety, | | | | | | |
| WG 10, 12, 20, 23, 24 | | | | | 1 | | | 1 |
| JWG 13, 14, 21 | | | | | 1 | | | 1 |
| SC 65A | System aspects | operational conditions, methodology for assemessment of systems, functional safety | | | 1 | | | 1 |
| -WG 4, 19 | | | | | 1 | | | 1 |
| -JWG 21 | | | | | 1 | | | 1 |
| SC 65B | Measurement and control devices | measurement devices, analysing equipment, actuators, programmable logic controllers, interchangeability, performance evaluation | | | 1 | | | 1 |
| -WG 30, 37, 51 | | | | | 1 | | | 1 |
| -JWG 1 | | | | | 1 | | | 1 |
| SC 65C | Industrial networks | interoperability, co-existence, performance | | | 1 | | | 1 |
| -WG 12, 17, 18 | | | | | 1 | | | 1 |
| -JWG 10 | | | | | 1 | | | 1 |
| SC 65E | Devices and integration in enterprise systems | device properties, classification, selection, configuration, commissioning, monitoring, diagnostics | | | 1 | | | 1 |
| -WG 2, 3, 4, 8, 9, 10, 12, 13, 14 | | | | | 1 | | | 1 |
| -JWG 5 | | | | | 1 | | | 1 |
| **IEC/TC 120** | Electrical Energy Storage (EES) systems | EES, data spaces: interoperability, sector coupling | | | | | | |
| WG 1 | Terminology | terms, definitions | | | 2 | | | 2 |
| WG 2 | Unit parameters and testing methods | testing | | | 1 | | | 1 |
| WG 3 | Planning and installation | set-up, connection requirements, maintenance | | | 1 | | | 1 |
| WG 4 | Environmental issues | environmental protection, recycling | | | 1 | | | 1 |
| WG 5 | Safety considerations | safety, handling, emergency | | | 2 | | | 1 |

**Extract 2 of 3**

**Standardization Matrix - variant 3**

IEC/CENELEC Technical Committees (TC) and Energy Data Space Cluster Projects (EDSCP)

**CONTINUATION**

| | Title of TC/SC/WG/SyC/JTC | Key words (TC/SC/WG/SyC/JTC) | | omega-x | SYNERGIES | Enershare | DATA CELLAR | EDDIE |
|---|---|---|---|---|---|---|---|---|
| **IEC/SyC** | Smart Energy | smart grid, smart energy, systems level standardization, data spaces: interoperability, sector | | | | | | |
| WG 2 | IEC Smart Energy Development Plan | smart grid, development plan | | | 2 | | | 1 |
| JWG3 | Smart Enegy Roadmap (joint with ISO/IEC JTC1/SC41 IoT and digital twin | smart grid, roadmap, IoT, digital twin | | | 2 | | | 1 |
| WG 5 | Methodology and Tools | use cases, actors, use case repository, interoperability, requirement engineering | | | 2 | | | 2 |
| WG 6 | Generic Smart Grid Requirements | smart grid, functionality, requirement engineering | | | 2 | | | 1 |
| WG 8 | Distributed energy trading infrastructure | reference architecture, distributed grid management | | | 2 | | | 1 |
| **ISO/IEC JTC 1** | Information Technology | IT | | | | | | |
| SC 7 | Software and systems engineering | systems engineering, software engineering, requirements engineering, architecture, | | | 2 | | | 2 |
| SC 27 | Information security, cybersecurity and privacy protection | security, cybersecurity, digital twin | | | 2 | | | 1 |
| SC 32 | Data managemeng and interchange | data, ontologies, metadata, registries, data usage | | | | | | |
| SC 38 | Cloud computing and distributed platforms | cloud, data spaces | | | 2 | | | 2 |
| SC 41 | Internet of things and digital twin | IoT, digital twin, data spaces: interoperability, sector coupling, data transactions | | | 2 | | | 1 |
| SC 42 | Artificial intelligence | AI, data spaces: interoperability, sector coupling, trust | | | 2 | | | 1 |

**Extract 3 of 3**

**Standardization Matrix - variant 3**

IEC/CENELEC Technical Committees (TC) and Energy Data Space Cluster Projects (EDSCP)

# C. Annex C: Standardization Table

This part of the appendix contains the Standardization Table, which was motivated and described in section 2.6.

It includes a total of 81 entries, comprising both standards and de facto standards, which are compared based on the following properties:

- **ID:** A sequential number for the unique identification of the entry.
- **Name:** The name of the standard or relevant activity.
- **Responsible Organization(s):** The organizations or committees involved and responsible for the entry.
- **Link / Reference:** A link or reference to the respective entry.
- **Start Date:** The date when the entry was first made available.
- **Last Update Date:** The date when the entry was last updated, serving as an indicator of its currency.
- **Country:** The country where the entry was primarily developed.
- **Short Description:** A brief description of the entry.
- **Keywords:** Key terms for identifying the standard.
- **Relevant SGAM Domains & Zones:** The assignment of the element to the corresponding SGAM domains and zones, allowing for an agnostic view.
- **Component Layer, Communication Layer, Information Layer, Function Layer, Business Layer, and Framework Layer (Governance):** A boolean classification of the elements within the interoperability layers according to the SGAM framework.
- **Added value for int:net:** Describes how the respective entry can impact the int:net project, particularly by providing guidance on its utilization.

The comprehensive table includes various properties that facilitate a detailed analysis and application of standardization activities within the int:net project. These properties include:

- **Priority:** Assesses the relevance of the entry for its use within the project.
- **Author:** Identifies the responsible person for the entry, serving as the point of contact for any inquiries.
- **Status of the Standardization Blog:** Supports the planning and management of blog posts related to standardization topics.
- **Source of the Entry:** Facilitates the assignment of the entry to specific work packages and references the original source.

*Table 12: Standardization Table*

| ID | Name | Responsible Organization(s) | Links / Reference | Start Date | Last Update Date | Country | Short Description | Keywords | Domains of Relevance (acc. SGAM Domains) | Zones of Relevance (acc. SGAM Zones) | Added-value for int:net (Relevance; name also examples and possible WP/Tasks/Subtasks) | Component Layer | Communication Layer | Information Layer | Function Layer | Business Layer | Framework Layer (Governance) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | IEC 62559 Series - Use Case-Methodology | IEC SyC | https://syc-se.iec.ch/deliveries/iec-62559-use-cases/ | NA | NA | EU | Standardized documentation of use cases | Use Case, Interoperability | All | All | WP1, 2, 4 | X | X | X | X | X | (X) |
| 2 | IEC SRD 63200:2021 - Definition of extended SGAM smart energy grid reference architecture model | IEC SyC | https://webstore.iec.ch/publication/62757 | NA | NA | EU | Standardized documentation of use cases: Smart Grid Architecture Modelling-Framework as a Reference Designation System | SGAM, Interoperability | All | All | WP 2.1 | X | X | X | X | X | (X) |
| 3 | IEC TR 62357-1:2016 - Power systems management and associated information exchange - Part 1: Reference architecture | IEC TC 57 | https://webstore.iec.ch/publication/26251 | 2012 | 2016 | EU | Reference Designation for relevant standards in accordance to their respective domains and zones within SGAM. | SGAM, SIA, Interoperability | All | All | (WP 2.1) | | | | X | | |

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| **4** | IEC 61970 Series - Energy management system application program interface (EMS-API) | IEC TC 57 | https://webstore.iec.ch/publication/61167#additionalinfo | NA | NA | EU | Information Model for Power Systems Communication | CIM, Semantic Interoperability | All | Operation, Enterprise | | | X | X | X | (X) | |
| **5** | IEC 61968 Series - Application integration at electric utilities - System interfaces for distribution management | IEC TC 57 | https://webstore.iec.ch/publication/32542 | NA | NA | EU | Information Model for Power Systems Communication | CIM, Semantic Interoperability | All | Operation, Enterprise | | | X | X | X | | |
| **6** | IEC 62325 Series - Framework for energy market communications | IEC TC 57 | https://www.entsoe.eu/digital/common-information-model/cim-for-energy-markets/ | NA | NA | EU | Information Model for Market Communication | CIM, Semantic Interoperability | All | Enterprise, Market | | | X | X | X | X | |
| **7** | IEC 61850 Series - Communication networks and systems for power utility automation | IEC TC 57 | https://webstore.iec.ch/publication/6028 | NA | NA | EU | It defines a common language for intelligent devices in electrical substations, function profiles and methods of exchanging data through any kind of network, including public networks. | Technical Interoperability, Semantical Interoperability | All | Process, Field, Station, (Operation) | | | X | X | X | | (X) |
| **8** | ISO/IEC 15504: SPICE | ISO/IEC JTC 1 | https://www.iso.org/standard/60555.html | 2004 | NA | Global | **S**oftware **P**rocess **I**mprovement and **C**apability **D**etermination for the assessment of maturity levels of processes | Assessment, Maturity Model | N/A | N/A | (REFERENCE WORK) WP 2.1 | | | | X | (X) | |

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| **9** | NISTIR 7628 - Guidelines for Smart Grid Cybersecurity | NIST | https://nvlpubs.nist.gov/nistpubs/ir/2014/nist.ir.7628r1.pdf | NA | NA | USA | MEMO: Maybe change to "CEN-CENELEC-ETSI Smart Grid Coordination Group<br>Smart Grid Information Security", or add both | Cybersecurity | All | All | | | (X) | (X) | (X) | (X) | (X) |
| **10** | IEC SRD 63417 ED1 - Guide and plan to develop Smart energy Ontologies | IEC SyC/WG 6 | https://www.iec.ch/dyn/www/f?p=103:38:108481523056 81:::FSP_ORG_ID,FSP_APEX_PAGE,FSP_PROJECT_ID:11825,23,105467 | 2021 | 2023 | EU | This publication provides a Guide and Plan to develop a Smart Energy Ontology and other domain-based ontologies within smart energy through semantic interoperability. This includes but is not limited to:<br>• Inventory and assessment of existing ontologies for the purpose of Smart energy applications:<br>Reuse of existing ontologies in the smart energy domain<br>Evaluation of developed smart energy ontologies<br>Cross domain semantic interoperability support and mapping to other ontologies<br>• Guide and Development plan for smart energy ontology development and usage including<br>Definition of smart energy ontology lifecycle process<br>Guidance for smart energy ontology use cases<br>Definition of a governance process | Energy, Ontology | All | All | | | | X | | | |
| **11** | SAREF4ENER | ETSI | https://saref.etsi.org/extensions.html#SAREF4ENER:~:text=SAREF4ENER%3A%20extension%20for%20the%20Energy%20domain | 2020 | 2020 | EU | The present document is a technical specification of SAREF4ENER, an extension of SAREF that was created in collaboration with Energy@Home (http://www.energy-home.it) and EEBus (http://www.eebus.org/en), the major Italyand Germany-based industry associations, to enable the interconnection of their (different) data models. The Energy@Home association, abbreviated in the rest of the document as E@H. E@H aims at developing and promoting technologies and services for energy efficiency in smart homes, based upon the interaction between user devices and the energy infrastructure. The E@H data model. EEBus is an important initiative in the area of the Internet of Things, which has its roots in the sector of smart and renewable energy. EEBus developed a standardized and consensus-oriented smart grid and smart home networking concept. The EEBus data model. SAREF4ENER is meant to enable the (currently missing) interoperability among various proprietary solutions developed by different consortia in the smart home domain. By using SAREF4ENER, smart appliances from manufacturers that support the EEBus or E@H data models will easily communicate with each other using any energy management system at home or in the cloud | Energy, Ontology | All | All | | | | X | | | |
| **12** | Data Catalog Vocabulary (DCAT) | W3C | https://www.w3.org/TR/vocab-dcat-3/ | NA | 2023 | Global | standard for data catalog information | ontology, data management, data catalog | information layer | All | WP3, WP4 | | | (X) | | | |

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| **13** | SAREF4GRID | ETSI | https://saref.etsi.org/saref4grid/v1.1.1/ | 2023 | 2023 | EU | SAREF4GRID is an extension to the Smart Appliance REFerence (SAREF) standard, specifically designed for the Smart Grid domain. It defines a set of standardized vocabulary and concepts for representing smart grid devices, their properties, and interactions. This allows different devices and systems from various manufacturers to communicate and exchange information seamlessly within a smart grid network. Essentially, it acts like a common language for smart grid devices, enabling them to understand each other and work together efficiently, ultimately contributing to a more intelligent and optimized energy system. | Energy, Ontology, Grid | All | All | | | | X | | | |
| **14** | Data Quality Vocabulary | W3C | https://www.w3.org/TR/vocab-dqv/ | NA | 2016 | Global | data standard for expressing data quality metrics of data (sets) | ontology, data management, data quality, data spaces | information layer | All | WP3, WP4 | | | (X) | | | |
| **15** | PROV-O - The PROV Ontology | W3C | https://www.w3.org/TR/prov-o/ | NA | 2013 | Global | data standard for expressing data lineage/provenance | ontology, data management, data lineage, data integrity, data spaces | NA | NA | WP3, WP4 | | (X) | X | | | |
| **16** | Open Digital Rights Language (ODRL) | W3C | https://www.w3.org/TR/odrl-model/ | NA | 2018 | Global | data standard for specifying data policies, rights and responsibilities of data users and producers | ontology, data governance, data spaces | information layer, function layer, business layer | | WP4 | | (X) | X | | | |
| **17** | IEC SRD 62913 Series – Use case approach in the Smart Energy domain | IEC SyC | https://syc-se.iec.ch/deliveries/use-case-approach/ | NA | NA | EU | How to elicit generic smart grid requirements by applying the IEC 62559 use case methodology | Use Case, Interoperability, Requirements | All | All | WP4 | | | X | X | X | |

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| **18** | Semantic Sensor Network Ontology | W3C | https://www.w3.org/TR/vocab-ssn/ | 2017 | 2017 | Global | Semantic Sensor Network (SSN) ontology is a way to describe sensors and their observations. It includes classes for sensors, observations, samples, and actuators, and it is modular, meaning it can be broken down into smaller parts for easier use and understanding | ontology | All | All | | | | X | | | |
| **19** | ISO/IEC 21823 Series - Interoperability for IoT systems | ISO/IEC JTC 1/SC 41 | https://www.iso.org/standard/71885.html | NA | NA | Global | Internet of things (IoT) — Interoperability for IoT systems | Internet of Things | All | All | | (X) | (X) | X | | | |
| **20** | Common Grid Model Exchange Specification (CGMES) | ENTSO-E | https://eepublicdownloads.entsoe.eu/clean-documents/CIM_documents/IOP/CGMES_2_5_TechnicalSpecification_61970-600_Part%201_Ed2.pdf | 2014 | 2023 | EU | The Common Grid Model Exchange Specification (CGMES) facilitates the exchange of power system models among European Transmission System Operators, supporting key analyses and operational processes. It serves as a baseline exchange standard for implementing Common Grid Model (CGM) methodologies, supporting analyses like load flow, contingency analyses, short circuit calculations, market information, capacity calculation for allocation and congestion management, and dynamic security assessment. | CGMES | All | All | | | X | X | X | | |
| **21** | IEC 60255-24:2013 - Measuring relays and protection equipment - Part 24: Common format for transient data exchange (COMTRADE) for power systems | IEC TC 95 | https://webstore.iec.ch/publication/1170 | NA | 2013 | EU | The IEC 60255-24:2013 standard specifies a universal format for exchanging data related to power system events and simulations. This format allows easy sharing of fault, test, and simulation data between different systems by defining a common structure for files stored on standard media like USB drives and CDs. It simplifies data exchange and analysis in the power system industry. | Data exchange | All | All | | | X | | | | |
| **22** | OCCP 2.0 - Open Charge Point Protocol | Open Charge Alliance | https://openchargealliance.org/protocols/ | 2018 | 2020 | Global (5 Continents) | An application protocol for communication between Electric vehicle, charging stations and a central management system | Communication /application protocol | Customer Premise | Operation, Enterprise, Station | | | X | | | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **23** | Modbus RTU (Remote Terminal Unit) | Modbus Organization, Inc | https://modbus.org/ | 1970 | NA | Global | Data communications protocol for using with programmable logic controllers (PLCs), where devices are connected to the same cable or Ethernet network. | Communication protocol | Distribution | Operation, Enterprise, Station, Field | | | X | | | | |
| **24** | NATS (New Automic Messaging System) | Synadia Communication | https://nats.io/ | NA | NA | Global | Protocol of messaging that enables the exchange of messages among computer applications and services, not depending on the network location. | Messaging protocol | Customer Premise | Enterprise | | | X | X | (X) | | |
| **25** | HTTPS (Hypertext Transfer Protocol Secure) | Internet Engineering | NA | 1994 | 2023 | Global | It is an extension of the Hypertext Transfer Protocol (HTTP), used for secure communication over a computer network. In HTTPS, the communication protocol is encrypted using Transport Layer Security (TLS) or, formerly, Secure Sockets Layer (SSL). | Communication protocol | All | All | | | X | | | | |
| **26** | IEEE 802.3 - ETHERNET | Institute of Electrical and | https://www.ieee802.org/3/ | 1983 | 2023 | Global | Protocol that defines the physical layer and data link layer's media access control (MAC) of wired Ethernet. | Ethernet Network Standards | Customer Premise | Station, Field | | X | X | X | X | | |
| **27** | ZigBee/RF | Zigbee Alliance | https://csa-iot.org/all-solutions/zigbee/ | 2004 | 2010 | Global | ZigBee/RF is a communication standard built on top of Radio Frequency (RF) technology, specifically targeting low-power devices for wireless mesh networks. | Wireless communication protocol | DER, Customer Premise | Station, Field | | | X | | (X) | | |
| **28** | API RESTful | NA | NA | NA | NA | Global | Application Programming Interface for REpresentational State Transfer. API is a software intermediary that allows two applications to talk to each other, whilst REST is an architectural style for distributed hypermedia systems, working stateless. Both define a set of distributed resources accessible and manipulable through a set of public functions. | API | All | All | | | X | | | | |
| **29** | JSON (JavaScript Object Notation) | Internet Engineering | https://www.json.org/ | NA | NA | Global | It is a human-friendly data format built on key-value pairs. It is a simple and versatile way to store and exchange data across different systems and applications. Widely used for its lightweight nature, clear structure, and ease of integration with web services and APIs. | Data exchange | All | All | | | X | | | | |

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| **30** | MQTT (Message Queuing Telemetry Transport) | OASIS (Organization | https://mqtt.org/ | 1999 | 2023 | Global | It is an open OASIS standard and an ISO recommendation (ISO/IEC 20922) over TCP/IP, being a lightweight, publish-subscribe network protocol that transports messages between devices. | Network protocol | DER, Customer Premise | Station, Field | | | X | | | | |
| **31** | TCP/IP - Transmission Control Protocol/Internet Protocol | Internet Engineering | NA | NA | NA | Global | A set of communication protocols used to interconnect network devices on the internet. It specifies how data is exchanged over the internet by providing end-to-end communications that identify how it should be broken into packets, addressed, transmitted, routed, and received at the destination. | Network protocol | All | All | | | X | | | | |
| **32** | IEEE 1901 - Standard for Broadband over Power Line Networks: Medium Access Control and Physical Layer Specifications | IEEE | https://standards.ieee.org/ieee/1901/7598/ | 2000 | 2012 | Global | IEEE 1901 standard enables high-speed data transfer directly through your electrical wiring, useful for smart homes, buildings, grids, and even industrial settings. It is used in connecting devices, automating systems, and monitoring energy usage all through your existing outlets, potentially reaching areas Wi-Fi can't. | Broadband over power lines (BPL) | All | All | | | X | | | | |
| **33** | EN 50090 Series - Home and Building Electronic Systems (HBES) | CENELEC | https://www.din.de/de/mitwirken/normenausschuesse/dke/veroeffentlichungen/wdc-beuth:din21:145117927 | NA | NA | EU | It establishes a common language (communication protocol) for devices in smart homes and buildings. This "openness" enables diverse equipment, from lighting and heating to security and energy systems, to seamlessly work together. | Home automation | DER, Customer Premise | All | | | X | | (X) | | |

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| **34** | EN 13321-1:2021 - Open data communication in building automation, controls and building management - Home and building electronic system - Part 1: Product and system requirements | CENELEC | https://www.din.de/de/mitwirken/normenausschuesse/nhrs/veroeffentlichungen/wdc-beuth:din21:329767212 | 2021 | 2022 | EU | It defines common rules for a class of multi-application bus systems used in building automation and management. It specifies basic requirements for products, systems, and their interoperability, ensuring they function together seamlessly within a decentralized communication network. | Home automation | DER, Customer Premise | All | | X | | | X | | |
| **35** | EN 14908 Series - Open Data Communication in Building Automation, Controls and Building Management - Building Network Protocol | CENELEC | https://www.din.de/de/wdc-beuth:din21:203805763 | NA | NA | EU | It defines the "Control Network Protocol" (CNP) for building automation, employing LonWorks technology. Encompassing both hardware and software specifications, it lays out a communication system based on the OSI model's "Protocol Stack." | Home automation | DER, Customer Premise | All | | X | X | X | X | | |
| **36** | EN 13757 Series - Communication systems for meters | CENELEC | https://www.din.de/de/mitwirken/normenausschuesse/nhrs/veroeffentlichungen/wdc-beuth:din21:339279330 | NA | NA | EU | It defines communication protocols for remote reading of meters in various applications, including water, gas, and electricity. It acts as a common language for meters and data collection systems, enabling seamless communication regardless of manufacturer. Key parts of the standard address physical and link layer (e.g., wired, wireless), application layer (data format, commands), and specific functionalities like wireless M-Bus communication. | Data exchange | Distribution, DER, Customer Premise | All | | X | X | X | (X) | | |

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| **37** | IEC 62056 Series - Electricity metering data exchange | IEC TC 13 | https://webstore.iec.ch/publication/6397 | NA | NA | Global | It is a standardized framework for electricity metering data exchange, encompassing communication protocols, data models, security mechanisms, and interoperability with other standards. | Smart metering | Distribution, DER, Customer Premise | All | | X | X | X | X | | |
| **38** | KNX | KNX Association | https://www.knx.org/knx-en/for-your-home/ | 1996 | 2013 (KNX Specification | Global | KNX is an OSI layer based communication standard for building automation that enhances energy efficiency through the intelligent control of heating, cooling, and lighting. | Communication protocol | DER, Customer Premise | Operation, Field | | | X | X | | | |
| **39** | Matter (as standard) | Connectivity Standards | https://csa-iot.org/all-solutions/matter/ | NA | 2019 | Global | Matter is a standard designed around Internet Protocol (IP) to facilitate communication among smart home devices, mobile apps, and cloud services. | Communication protocol, Internet of Things | DER, Customer Premise | Operation, Field | | | X | | | | |
| **40** | IEC 62196 Plugs, socket-outlets, vehicle connectors and vehicle inlets - Conductive charging of electric vehicles Part 2: Dimensional compatibility requirements for AC pin and contact-tube accessories | IEC SC23H | https://webstore.iec.ch/publication/64364 | 2011 | 2022 | EU | IEC 62196 Type 2, known as the Mennekes plug, is a European standard for electric vehicle charging connectors, defining the physical characteristics, communication protocols, and electrical specifications for the Type 2 plug and socket, ensuring compatibility and safety cross different EV models and charging infrastructure across Europe's EV infrastructure. | EV Charging, Electrical Standard | Distribution, DER, Customer Premise | Operation, Station, Field | | X | | | X | | |

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| **41** | P2030 - Guide for Smart Grid Interoperability of Energy Technology and Information Technology Operation with the Electric Power System (EPS), End-Use Applications, and Loads | IEEE SA | https://standards.ieee.org/ieee/2030/10261/ | 2009 | 2023 | Global | This guide 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. It includes the Smart Grid Interoperability Reference Model (SGIRM), defining interfaces in power systems, communication, and IT. | Interoperability | All | All | | | | X | | | |
| **42** | IEEE 2030.5:2023 - IEEE Approved Draft Standard for Smart Energy Profile Application Protocol | IEEE SA | https://standards.ieee.org/ieee/2030.5/11216/ | 2013 | 2023 | Global | This standard focuses on the interoperability of energy management systems, smart meters, and other devices in the smart grid. It supports advanced energy management and demand response capabilities. | Profile Application Protocol | All | Operation, Station, Field | | | X | X | X | | |
| **43** | ISO/IEC 9646 Series – Conformance testing methodology | ISO/IEC JTC 1 | https://www.iso.org/standard/17473.html | 1991 | 2000 | Global | ISO/IEC 9646 provides a framework for developing and conducting conformity tests based on the requirements of a wide range of standards, protocols, and specifications. It defines a set of generic test levels and procedures to ensure the interoperability, reliability, and security of smart grid devices and systems. | Conformance | All | All | | | | | | | (X) |
| **44** | ISO/IEC/IEEE 15288:2023 - Systems and software engineering - System life cycle processes | ISO/IEC JTC 1/SC 7 | https://ieeexplore.ieee.org/document/10123367, https://www.iso.org/standard/81702.html | 2008 | 2023 | Global | Specifies testing and testing as part of the life cycle process. | Life Cycle | All | All | | | | | X | | |

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| **45** | IEC TR 63097 Smart Grid Roadmap | IEC SyC | https://syc-se.iec.ch/deliveries/iec-tr-63097-smart-grid-roadmap/ | 2017 | 2017 | EU | The IEC TR 63097 Smart Grid Roadmap is a guideline document for selecting standards and specifications for Smart Energy use cases. It focuses on interoperability in the energy sector, addressing developments like smart metering, e-mobility, and microgrids. | Interoperability | All | All | | (X) | (X) | (X) | (X) | (X) | (X) |
| **46** | IEC Smart Grid standardization map | IEC | https://mapping.iec.ch/#/maps/1 | 2015 | 2022 | EU | Map of standards according to their domain (Generation, Distribution, DER, Consumption, Communication, Crosscutting) and their application area (e.g., power plant, generic substation, electromobility infra or home and building automation) | Interoperability | All | All | | (X) | (X) | (X) | (X) | (X) | (X) |
| **47** | IEC SRD 63199:2020 - Top priority standards development status in the domain of smart energy | IEC SyC | https://webstore.iec.ch/publication/62688 | 2020 | 2022 | EU | It presents the current status of the IEC systems committee Smart Energy (SyC SE) development plan for readers. It identifies items that require standardization, their current status and work required, possibly by multiple technical committees or working groups, to address any issues. | Interoperability | All | All | | (X) | (X) | (X) | (X) | (X) | (X) |
| **48** | NIST's interoperability framework | National Institute of Standards and | https://www.nist.gov/publications/nist-framework-and-roadmap-smart-grid-interoperability-standards-release-40 | 2007 | 2021 | USA | It facilitates smart grid understanding and communication among stakeholders. It includes a Smart Grid Conceptual Model and Communication Pathways Scenarios to explore varying system architectures and control strategies. This framework also covers Testing and Certification for Smart Grid Standards and Interoperability Profiles, crucial for smart grid technology development and integration. | Interoperability | All | All | | (X) | (X) | (X) | (X) | (X) | (X) |
| **49** | CGMES Conformity Assessment Framework | ENTSO-E | https://www.entsoe.eu/data/cim/cim-conformity-and-interoperability/ | ~2014/2015 | 2017 | EU | It focuses on ensuring interoperability of applications used by TSOs for operational and system development exchanges through compliance with the Common Grid Model Exchange Standard (CGMES) requirements. It involves facilitating the elaboration of relevant IEC specifications, supporting the implementation of European network codes, and aiding in system development studies. The framework includes a set of documentation such as test configurations and procedures for guiding conformity tests. This plays a crucial role in smooth data exchanges between TSOs and in maintaining operational efficiency. | Interoperability | TSO | All | | (X) | (X) | (X) | (X) | (X) | (X) |
| **50** | IES Method | Smartgrids Austria | https://www.smartgrids.at/integrating-the-energy-system-ies.html | 2016 | 2019 | EU | The "Initiative IES - Integrating the Energy System" focuses on creating a common framework and understanding to develop interoperability profiles for data exchange, moving away from proprietary solutions. It involves a three-pillar approach: developing technical frameworks containing integration profiles, providing software tools for interoperability testing, and publishing the developed frameworks and test results online. | Interoperability | All | All | | | | | | | |

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| **51** | OpenADR | openADR alliance | https://www.openadr.org/ | 2009 | 2023 | Global | OpenADR (Open Automated Demand Response) is a non-proprietary, open standardized demand response (DR) interface that enables electricity providers to communicate DR signals directly to their customers using a common language and existing communication methods such as the internet. | demand response communication | All | Operation, Station, Field | | | X | (X) | X | | |
| **52** | IEC 62351 series – Power systems management and associated information exchange - Data and communications security | IEC SyC | https://webstore.iec.ch/publication/6912 | NA | NA | Global | This standard addresses the security requirements and measures for protecting communication networks and systems in the smart grid. It provides guidelines for authentication, encryption, access control, and other security mechanisms. | Security | All | All | | X | X | X | X | | (X) |
| **53** | IEC 60870-5:2024 series (IEC 104) - Telecontrol equipment and systems - Part 5: Transmission protocols | IEC TC 57 | https://webstore.iec.ch/publication/3755 | NA | NA | Global | It is a set of international standards defining communication protocols for telecontrol equipment used in monitoring and controlling geographically dispersed processes, like power grids. It ensures interoperability between different devices by specifying data formats, transmission methods, and communication procedures. | Communication, Interoperability | All | Operation, Station, Field | | | X | X | X | | |
| **54** | IEEE P3158 - Standard for Trusted Data Matrix System Architecture | IEEE SA | https://standards.ieee.org/ieee/3158/10881/ | 2022 | 2022 | Global | The standard specifies the system architecture for a trusted data matrix which includes business, functional, process, and technology requirements. Based on consensus-made requirements, agreements and management tools, the trusted data matrix is a data and resource sharing digital infrastructure to facilitate trusted, secure, transparent and accountable data sharing, exchanging, circulation and trading among different stakeholders. | Security | All | All | | | X | | | | |
| **55** | IEC 62541 Series - OPC Unified Architecture | IEC SC 65E | https://webstore.iec.ch/publication/6803 | NA | NA | Global | This standard for OPC Unified Architecture is a platform-independent service-oriented architecture that integrates all the functionality of the individual OPC Classic specifications into one extensible framework. It provides a secure and scalable framework for interoperability between various devices, systems, and platforms in industrial environments. | Communication mechanism | All | All | | | X | X | X | | |

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| **56** | ISO/IEC/IEEE 42010:2022 - Software, systems and enterprise - Architecture description | ISO/IEC JTC 1/SC 7 | https://webstore.iec.ch/publication/80194 | 2007 | 2022 | Global | This standard provides a framework for the architecture description of systems, designed to guide the development of architectures for various systems, emphasizing the importance of defining the environment, entities of interest, stakeholder concerns, as well as viewpoints and views. | Architectural Description Framework | All | All | | | | | (X) | | |
| **57** | IEC TR 61334 Series - Distribution automation using distribution line carrier systems | IEC TC 57 | https://webstore.iec.ch/publication/5294 | NA | NA | Global | This series of technical reports provides a set of guidelines for the design, implementation, and operation of power line communication for distribution automation systems. These standards cover a wide range of topics, including the physical, data link, network, and application layers of the communication system, as well as performance characteristics and application guidelines. | Interoperability | All | Operation, Field | | X | X | X | | | |
| **58** | IEC 62361 Series - Power systems management and associated information exchange - Interoperability in the long term | IEC TC 57 | https://webstore.iec.ch/publication/6923 | NA | NA | Global | This series of standards is a comprehensive set of standards that standardizes communication, data exchange, and security for power systems management. The standards provide a common information model (CIM), a standardized communication protocol (IEC 61850), and guidelines for developing standardized profiles and security measures. | Information exchange | All | Operation, Field | | | | X | | | |
| **59** | IEC 62488 Series- Power line communication systems for power utility applications | IEC TC 57 | https://webstore.iec.ch/publication/7095 | NA | NA | Global | This series is a set of standards developed to standardize the planning, design, operation, and performance of power line communication (PLC) systems used to transmit information over power networks. | Powerline communication | All | Operation, Field | | | X | | | | |

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| **60** | IEC TR 62746 Series- Systems interface between customer energy management system and the power management system | IEC TC 57 | https://webstore.iec.ch/publication/22279 | NA | NA | Global | This series of technical reports provides guidance on architecture, use cases, communication interfaces, and data models for enabling seamless communication and data sharing between various stakeholders involved in energy management systems in smart grids. It defines a layered architecture model, identifies and describes use cases, specifies communication interfaces, defines data models, and provides guidelines for developing interoperable energy management systems. | Interoperability | All | Operation, Field | | | X | X | | | |
| **61** | IEC 62933 Series- Electrical energy storage (EES) systems | IEC TC 120 | https://webstore.iec.ch/publication/92274 | NA | NA | Global | These standards establish the terminology, unit parameters, testing methods, safety requirements, and performance assessment guidelines for electrical energy storage (EES) systems. | Energy Storage | All | Operation, Field | | X | | | X | | |
| **62** | IEC TR 63401 Series - Dynamic characteristics of inverter-based resources in bulk power systems | IEC SC 8A | https://webstore.iec.ch/publication/64424 | NA | NA | Global | It is a comprehensive guide to the dynamic characteristics of inverter-based resources (IBRs) in bulk power systems. It addresses various aspects of IBR integration, including interconnecting IBRs to low SCR networks, mitigating sub-synchronous control interactions (SSCIs), implementing fast frequency response (FFR) and frequency ride-through (FRT), and managing bus voltage variations. | RES Grid integration | All | Operation | | | | | X | | |
| **63** | IEC TS 63102:2021 - Grid code compliance assessment methods for grid connection of wind and PV power plants | IEC SC 8A | https://webstore.iec.ch/publication/31475 | 2017 | 2021 | Global | It is a technical specification that outlines recommended methods for assessing the grid code compliance of wind and PV power plants. It provides a comprehensive framework for evaluating the electrical behavior of these power plants, ensuring they operate within the specified frequency and voltage range, provide or absorb reactive power as needed, employ effective control strategies, maintain grid connectivity during faults, and minimize power quality disturbances. | RES Grid integration | All | Operation | | | | | X | | |

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| **64** | IEC 62934:2021 - Grid integration of renewable energy generation - Terms and definitions | IEC SC 8A | https://webstore.iec.ch/publication/27340 | 2012 | 2023 | Global | This standard provides a comprehensive set of terms and definitions, grid connection requirements, and grid interaction issues related to the grid integration of renewable energy generation. | RES Grid integration | NA | NA | | | | (X) | | | |
| **65** | IEC TR 63410:2023 - Decentralized electrical energy systems roadmap | IEC SC 8B | https://webstore.iec.ch/publication/65975 | 2022 | 2023 | Global | This technical report provides a road map for categorizing and understanding decentralized electrical energy systems (DEIS). It outlines DEIS characteristics and classification as well as the challenges and opportunities associated with their integration into the grid. | Standardization Roadmap | All | All | | (X) | (X) | (X) | (X) | (X) | (X) |
| **66** | IEC TS 62898 Series - Microgrids | IEC SC 8B | https://webstore.iec.ch/publication/88234 | NA | NA | Global | This technical report provides a set of use cases and Technical requirements related to the operations and management of microgrids, which are decentralized energy systems. | Microgrids | All | Field, Station, Operation | | | | | X | | |
| **67** | IEC TS 63189 Series - Virtual Power Plants | IEC SC 8B | https://webstore.iec.ch/publication/61957 | NA | NA | Global | It is a comprehensive technical specification that defines the architecture, functional requirements, and use cases for virtual power plants (VPPs). | Virtual power plan | All | All | | | | | X | (X) | |
| **68** | IEC SRD 63268:2020 - Energy and data interfaces of users connected to the smart grid with other smart grid stakeholders - Standardization landscape | IEC SyC | https://webstore.iec.ch/publication/65148 | 2020 | 2023 | Global | It is a Technical Specification on the standardization landscape for interfaces between grid users and grid stakeholders, which can be either physical or logical (i.e. power or communication). | Grid user interfaces, Standardization landscape | All | All | | (X) | (X) | (X) | (X) | (X) | (X) |

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| **69** | IEC 62056 Series - Electricity metering data exchange | IEC TC 13 | https://webstore.iec.ch/publication/6397 | NA | NA | Global | It is a standardized framework for electricity metering data exchange, encompassing communication protocols, data models, security mechanisms, and interoperability with other standards. | Smart metering | Distribution, DER, Customer Premise | All | | X | X | X | X | | |
| **70** | IEC 62439 Series - Industrial communication networks - High availability automation networks | IEC 65C | https://webstore.iec.ch/publication/24248 | NA | NA | Global | It is a comprehensive set of international standards for high-availability automation networks, establishing a framework of redundancy protocols, classification schemes, and availability calculation methodologies to safeguard industrial control systems against network failures. | Process automation | All | All | | | | | X | | |
| **71** | ISO/IEC 12139-1:2009 - Telecommunications and information exchange between systems - Powerline communication (PLC) - High speed PLC medium access control (MAC) and physical layer (PHY) - Part 1: General requirements | IEC TC 13 | https://webstore.iec.ch/publication/9704 | 2009 | 2009 | Global | It is a standard for high-speed powerline communication (PLC), defining the physical and medium access control (MAC) layer specifications for in-home and access networks. | Powerline communication | NA | NA | | | | | (X) | | |
| **72** | ISO/IEC 14543 Series - Home electronic systems (HES) architecture | ISO/IEC JTC 1/SC 25 | https://webstore.iec.ch/publication/10111 | NA | NA | Global | These are standards for home electronic system (HES) architecture, establishing a layered framework for communication, data formats, and management functions to facilitate seamless integration of different devices and enable effective control and management of home environments. | Home automation | Distribution, DER, Customer Premise | All | | | | (X) | X | | |

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| **73** | ISO/IEC 14908 Series - Control network protocol | IEC TC 13 | https://webstore.iec.ch/publication/10210 | NA | NA | Global | These are standards for a communication protocol used in control networks. It defines how devices can exchange data over different types of physical connections, including twisted pair cables, power lines, and IP networks. | Communication Protocols | All | All | | | X | | X | | |
| **74** | ISO/IEC 27001:2022 - Information security, cybersecurity and privacy protection | ISO/IEC JTC 1/SC 27 | https://webstore.iec.ch/publication/79694 | 2005 | 2022 | Global | It is a standard for information security management systems (ISMS). It is a risk-based approach that helps organizations to identify, assess, and mitigate their information security risks. The standard is structured around a process approach that breaks down information security management into a series of processes, each with inputs, outputs, and controls. | Information security management system | All | All | | | | | (X) | | |
| **75** | IEC TS 63531 ED1 - Specification for evaluation of renewable energy power forecasting results | IEC/TC 8/SC 8A- WG2 | https://www.iec.ch/dyn/www/f?p=103:38:612080969525840:::FSP_ORG_ID,FSP_APEX_PAGE,FSP_PROJECT_ID:10072,23,119156 | 2023 | Ongoing | Global | | Interoperability | All | All | | | | | | | |
| **76** | IEC TS 63487 ED1 - Joint commissioning for grid-connection of offshore wind farms via VSC-HVDC transmission | IEC/TC 8/SC 8A- WG6 | https://www.iec.ch/dyn/www/f?p=103:38:612080969525840:::FSP_ORG_ID,FSP_APEX_PAGE,FSP_PROJECT_ID:10072,23,113212 | 2022 | Ongoing | Global | | Interoperability | NA | NA | | | | | | | |
| **77** | IEC TR 63534 ED1 - Integrating distributed PV into LVDC systems and use cases | IEC/TC 8/SC 8A- WG7 | https://www.iec.ch/dyn/www/f?p=103:38:612080969525840:::FSP_ORG_ID,FSP_APEX_PAGE,FSP_PROJECT_ID:10072,23,103987 | 2020 | Ongoing | Global | | Interoperability | NA | NA | | | | | | | |

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| **78** | IEC TS 62898-3-5 ED1 - Microgrids - Technical requirements - Testing for Microgrid Monitoring, Control, and Energy Management Systems | IEC/TC 8/SC 8B- WG3 | https://www.iec.ch/dyn/www/f?p=103:38:612080969525840::::FSP_ORG_ID,FSP_APEX_PAGE,FSP_PROJECT_ID:20639,23,116874 | 2023 | Ongoing | Global | | Interoperability | NA | NA | | | | | | | |
| **79** | IEC TS 63354 ED1 - Guideline for the Planning and Design of Decentralized DC Distribution Systems | IEC/TC 8/SC 8B- WG5 | https://www.iec.ch/dyn/www/f?p=103:38:612080969525840::::FSP_ORG_ID,FSP_APEX_PAGE,FSP_PROJECT_ID:20639,23,103711 | 2019 | Ongoing | Global | | Interoperability | NA | NA | | | | | | | |
| **80** | IEC TS 63427 ED1 - Guideline for the adjustment potential evaluation of demand side resources | IEC/TC 8/SC 8C- WG3 | https://www.iec.ch/dyn/www/f?p=103:38:612080969525840::::FSP_ORG_ID,FSP_APEX_PAGE,FSP_PROJECT_ID:20639,23,106832 | 2021 | Ongoing | Global | | Interoperability | NA | NA | | | | | | | |
| **81** | IEC TR 63530 ED1 - Market Catalogue for Stable Grid Operation | IEC/TC 8/SC 8C- WG2 | https://www.iec.ch/dyn/www/f?p=103:38:602953958023699::::FSP_ORG_ID,FSP_APEX_PAGE,FSP_PROJECT_ID:25987,23,104882 | 2020 | Ongoing | Global | | Interoperability | NA | NA | | | | | | | |

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These sources are particularly valuable if the reader wants to find out more about standardization.