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Importance of standards for DSOs – a CIRED policy brief

The CIRED community brings together a broad spectrum of expertise from stakeholders across the Distribution System Operator (DSO) domain, including academia, manufacturers, service providers, utilities/DSOs, and policy makers. To harness this collective knowledge, facilitate the exchange of insights, and offer strategic guidance, CIRED produces policy papers on key topics. This document presents the first of these papers, focusing on the importance of standardization

Executive summary

Standardization plays a key role in improving all the energy industry players, including network companies, to build new reliable, resilient, efficient, safe, and sustainable grid infrastructures, which increasingly are more and more crucial for the energy transition. It is a necessary foundation for succeeding with digitalization, electrification, sustainability, and increased reliability and resilience of the electrical system.

Deployment of standardized and sustainable solutions would foster the development of the whole electrical ecosystem, enabling innovation and also helping to meet the Net Zero targets by reducing greenhouse emissions provoked by power distribution grids, for instance, through the reduction of network losses and the implementation of eco-friendly materials, components, and devices.

Deep standardization of components and their interfaces and solutions can lead to benefits and reduced efforts for all the relevant stakeholders in the supply chain: engineering, procurement, testing, market supply availability, construction, operation, maintenance, asset management, and end-of-life management, leading to overall cost reduction.

Further, adopting common standards by all the relevant stakeholders can drive constant performance and quality improvement of technical solutions, business processes, and stakeholder interactions.

There are some downsides to developing, maintaining, and implementing standards. They contribute to increased complexity and (short-term) cost, but also a risk that (over-) standardization limits innovation. These can be mitigated by evaluating benefits over time and utilizing open standards.

To better enable the benefits of standardization, CIRED makes the following recommendations:

- Standards are the fundamental need for society as a whole and individual stakeholders to succeed with digitalization, electrification, sustainability, and increased resilience – and they need to evolve over time, thus requiring continuous work and alignment.
- A standardization process should be adopted to define systems standards for maximizing interoperability, transferability, or convergence among operators of large, interconnected areas.
- Based on cost-benefit analysis, actively phase out legacy and proprietary solutions (components, IT systems, life cycle management methods) and adopt open standards.
- Take an active part in developing, sharing, and using open standards as well as space to innovate – do it also through young professionals to ensure endurance.

The purpose of standardization

Standardization is crucial in managing electrical grids as it ensures interoperability, enhances safety, improves reliability, and fosters innovation across the complete value chain in energy systems, from standards for manufacturing electrical equipment to interoperability between different components and vendors towards standards for diverse grid connection options and types for end consumers (e.g., non-firm/flexible, dynamic tariffs).

The International Organisation of Standardisation (ISO) defines a standard as "a document that provides requirements, specifications, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context." The International Electrotechnical Commission (IEC) explains that standards "provide instructions, guidelines, rules or definitions that are then used to design, manufacture, install, test & certify, maintain and repair electrical and electronic devices and systems." Hence, standards include:

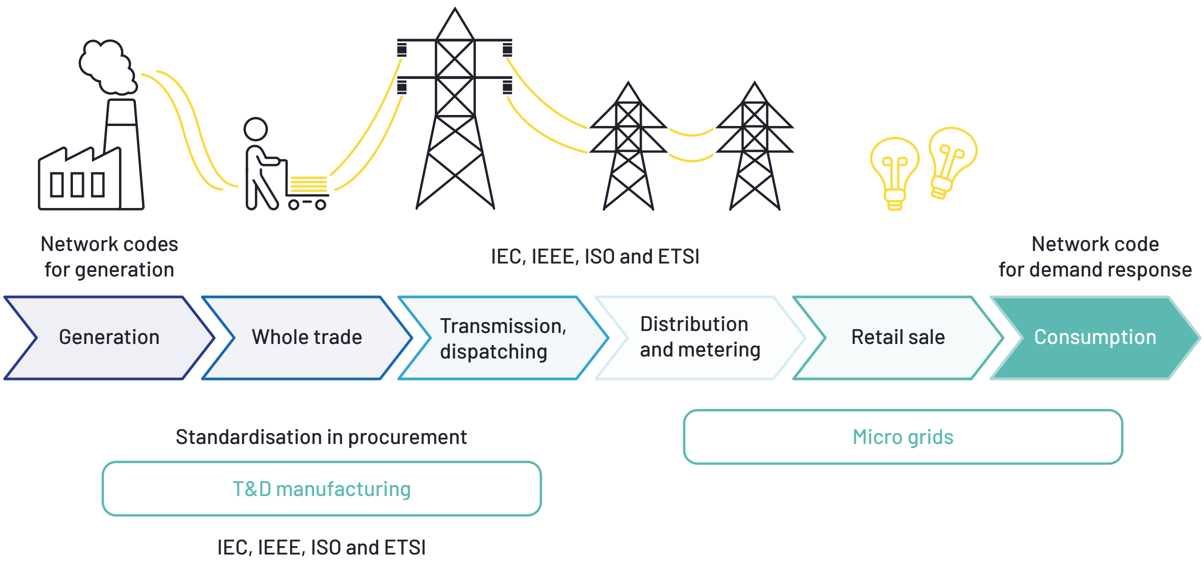
- Methods of manufacturing, designing, or drawing, supporting technology providers in the development and manufacturing process.
- Methods of testing, analyzing, verifying, or measuring to support quality assurance.
- Terms, abbreviations, and symbols to ensure speaking about the same things.

The fundamental purpose of electrotechnical standards is to provide general safety and reliability of products and systems. This is of high importance in complex and critical infrastructures like power systems, which consist of a large number of different interconnected technologies from different suppliers. The power system standards provide the basis for the safe use of electrical energy. From a distribution system community´s perspective, the purpose of standardization is:

- Enabling transparency and interoperability as well as aligning the needs of many stakeholders in the distribution system.
- Simplify processes, like procurement procedures.
- Achieving quality assurance by accessing reliable products and allowing testing of them.
- Facilitate a holistic perspective and ensure homogeneity and competition of vendors.
- Improve efficiency by lowering procurement and life-cycle costs, including maintenance and upgrade costs. This results in reduced long-term investment risks and, thus, costs.

Furthermore, standardization is essential to ensure that supply chains are sufficient, and that equipment is available in the required quantities at the correct times and at reasonable costs. System operators and manufacturers shall collaborate and work together efficiently and transparently. Part of the solution involves further harmonizing practices, which encompasses long-term measures, such as technical standardization and network codes, and short-term actions, including common practices and specifications.

Figure 1: Energy sector supply chain including standardization



Achieving all the above-mentioned purposes is more efficiently enabled by easy access to open international standards at low or no cost. In addition, standards need to be updated frequently to keep pace with changing technology and business models.

Important/key existing and new areas for standardization

International standard development organizations like IEC, IEEE, ISO and ETSI ensure that grid technologies' quality, reliability, and efficiency, as well as overall safety and quality management, are addressed by all relevant stakeholders globally and facilitate that equipment from different manufacturers can work together 'seamlessly.' For example, IEC Standard 61850, developed under the scope of IEC Technical Committee 57 (TC 57), establishes an international standard for communication protocols used by intelligent electronic devices (IEDs) in electrical substations. TC 57 focuses on standards for power system control and associated communications, ensuring that communication protocols and data models are harmonized across the industry. Moreover, IEC 61850 extends beyond substations to facilitate communication with distributed energy resources (DER), enabling seamless integration of decentralized generation, storage, and demand-side management within modern power grids.

With the increasing decarbonization of the energy system and the influx of distributed energy resources (DERs, e.g., PV, eMobility, battery storage), standards enabling the integration of decentralized energy resources, including their deployment in microgrids and decentralized energy systems, play a key role in supporting the transition towards a more decentralized energy landscape. They ensure the seamless operation of these assets within the electrical system, particularly in terms of voltage and frequency stability, while also facilitating advanced grid technologies and concepts. Requirement standards are complemented by testing standards to verify the compliance of market products and solutions.

Also, nature-based extreme events are increasing in frequency and intensity, causing severe damage to electricity infrastructure. Distribution resilience is the ability of the electric distribution grid to withstand and recover rapidly from power outages, allowing electric customers to continue operating with electricity. Guaranteeing an increasingly standardized network in terms of project design, assets, structures, interfaces, etc., is mandatory to ensure a more harmonized and effective resilience in terms of adaption and recovery response.

Another example of standardization that is becoming increasingly important is ISO 55000, which provides a framework and guidance for structured, efficient, and transparent asset management throughout their lifecycle. In the energy sector, IEC Technical Committee 123 (TC 123) complements this approach by developing standards specifically tailored to the management of electrical assets, ensuring their reliability, performance optimization, and alignment with evolving grid requirements. These standards help organizations maximize asset value while maintaining consistency with strategic and operational objectives.

In addition, with progressing digitalization and automation, as well as the dynamic and interconnection of energy systems, emerging areas of standardization for grid modernization (e.g., IEEE 2030 standards) sector coupling, grid flexibility and demand response, as well as cyber security, IT/OT convergence and cloud architecture standards. For example, the IEC Systems Committee Smart Energy works on standards covering areas like smart grid, energy storage, demand response, electric vehicles, energy management, and the overall architecture and interfaces of smart energy systems. Its scope includes standardization of systems, interfaces, and interoperability for integrating various energy technologies and infrastructures, such as electricity, gas, heat/cold, and transportation.

It is also important to mention that IEC Technical Committee 13 (TC 13) plays a key role in standardizing electricity metering, including smart metering systems and associated information models, which are essential for accurate energy measurement, billing, and grid management in modern power systems.

Of course, the field of equipment standardization is one of the oldest and most developed, as it encompasses the requirements and specifications applicable to all equipment in the electrical grid, which concretely helps improve their quality and reduce acquisition costs for grid operators.

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How can stakeholders improve their work with standardization?

All stakeholders can benefit from standardization, but far from all know how to approach the work. For example, asset management can benefit from standardization through all the components and plant lifecycle, starting from the interoperability of components, which implies wider market availability, reduced necessity of warehouse stocks, lower level of workforce specialization, and faster maintenance operations up to the end-of-life management with easier procedures and lower costs. Other stakeholders can build a similar rationale.

In order to foster standardization and remove barriers to the progressive replacement of legacy and possible proprietary solutions, it is essential to first engage actively in the development of standards, whether at the national level by participating in the work of one's national standardization committee, or at the regional or international level (IEC, IEEE, etc.). By participating in the creation of these standards, we can ensure that they are well-suited to the needs of the industry and reflect a balanced, comprehensive approach, rather than simply advocating for specific frameworks without considering the broader context. Some other actions would be needed by stakeholders:

- Perform cost-benefit analysis to assess the return of investments of different standardization penetration scenarios and do it with a long term perspective
- Participate in pre-standards activities including workshops and conferences that may develop standards roadmaps or proposals
- Develop, share, and use standards
- Develop incentive scenarios to promote the production and adoption of standard power components, protection, monitoring and control devices, and communication protocols.
- Harmonize new smart grid device characteristics to ensure homogeneity in future grids.
- Develop regulatory frameworks to progressively replace legacy solutions.

Vision - common DSO "standards"?

The technical expertise of DSOs often allows them to identify solutions that manufacturers and/or policy-makers have not considered (yet). However, if these needs are not expressed within the standardization process, DSOs risk sidelining themselves from both the standardization and the market. Furthermore, these needs will likely not gain significant traction, leading to missed benefits for all. However, even if all operators used the same component in different pre-existing plants, this would not necessarily result in economies of scale unless the entire process follows the same rules. If type or acceptance tests are conducted differently by operators, the costs and times for the tests will multiply, and the component itself may not be the same since it is tested differently. This leads to uncertainty for manufacturers, even if the components are (apparently) identical. Therefore, DSOs should converge on adhering to standards in terms of testing procedures, which is immediately feasible, rather than seeking a possible homogenization of components that may be welcome but which is far from the concept and the definition of standardization.

Standardization solutions are even more relevant when it comes to system standards. For decades, each operator defined its own rules based on the principle that only the monopolist knows how to manage its own monopoly. This led to grid codes of unquestionable quality but without any possibility of interoperability, transferability, or convergence between operators, particularly at the European level. Only recently, starting from EU Regulation on the internal market for electricity, have national and European approaches been adopted to create Network Codes common to multiple operators, directly involved on the preparation and implementation, stemming from decades of independent evolution of national or regional systems. This approach is highly beneficial in case innovative requirements are to be incorporated, thanks to the multiplicity of the document's author, but also accelerates and facilitates the translation of system standard requirements into product standards, particularly when Network Codes are developed providing general guidance to be complemented within the national or European standardization process. .

Additionally, the number of companies and countries that are participating in standards development is increasing. The increasing participation will be good in the long-term in that it will create standards relevant to a much wider number of stakeholders. But in the short-term, the increased activity of means that more volunteers than ever are needed to work together to discuss new standardization topics and to drive towards consensus.

To achieve these types of benefits, a profound change is necessary. Often, the people companies designated to participate in standardization are selected based on previous experience with the specific subject (component or system), which usually implies a long tenure in the company and, therefore, an older age. This, in turn, leads to a limited engagement in standardization activities, typically associated with the final years before retirement or even requiring/postponing the involvement to the post-retirement period. Familiarizing with standardization early on in a company, even as users, is vital for accessing methodologies networks of peers and content essential in a globalized economic and production system, where those who do not consciously and intelligently adhere to international standards inevitably find themselves excluded from the market. Evolving standards development beyond the printed format may attract and benefit young professionals and new stakeholders.