CESI
Shaping a Better Energy Future

TESTATA: Technology Watch (Elettricità Futura)

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DEADLINE: 19 luglio 2022

LUNGHEZZA: 7.184 (spazi inclusi)

Resilient grids to empower the energy transition

The decarbonization of the electricity sector requires upgraded analyses to design systems that can ensure reliability and continuity of the electricity supply, given that the future generation pool will be largely based on non-programmable renewable energy sources, such as solar and wind. In Europe, the adoption of renewables has undergone a significant acceleration following the recent RePowerEU, which aims for 45% of renewables in the final consumption by 2030. In the recent Public Assembly of Elettricità Futura, it emerged that achieving the REPowerEU 2030 objectives would mean, for Italy, adding 85 GW of new renewable power and 80 GWh of new large storage capacity. If the targets were achieved, Italy would reach an 84% share of renewables in the electricity mix in 2030, compared to 41% in 2021.

Such growth of renewable sources makes the development of networks essential, in compliance with the requirements of security, adequacy, quality of service, resilience and efficiency. Furthermore, renewable energy plants have dimensions and operating mechanisms that are often different from traditional ones, therefore they also differ in the components used. Independent tests and certifications based on accepted international standards are one of the best ways to improve the quality of components and therefore represent a fundamental step to reduce the incidence of the main disturbances in service delivery. It also ensures that the equipment meets the basic levels of safety, reliability and performance required for use on the network. The proof of why independent testing is so important can be found in result that approximately 25% of the components that are tested in a laboratory initially fail to meet the IEC standards. T&D components are 'high tech' components that cannot just be ordered from a catalogue and require a careful process of type testing in combination with tendering, overseeing product manufacturing, FAT and SAT. Only then, high-quality products in the network can be guaranteed which is the base of improved network performance and grid resilience.

In this respect, in our KEMA Labs (CESI's Testing, Inspection and Certification Division) facilities, we test these components often with innovative test methods, changing the traditional paradigm of the equipment testing, towards a comprehensive system testing ("hardware in the loop"). Indeed, the evolution of components is a continuous process, to which we have always been accustomed and which has already posed even more complex challenges in the past, such as the construction of UHV (ultra-high-voltage) transmission networks or the development of direct current networks (HVDC, or high-voltage-direct-current).

The integration of non-programmable renewable energy sources poses challenges to the grids. In this respect, in our Flex Power Grid Lab in Arnhem (The Netherlands), we can faithfully replicate the behavior of portions of electrical networks to evaluate the functionality and performance of energy converters used in photovoltaic systems or of storage batteries often used in conjunction with panels, as well as several other components. From time to time, you choose what should be digitally simulated and what should be physically present in the test laboratory. It is the so-called cyber-physical test, which combines the best of in situ tests with those done via software.

Indeed, when it comes to renewable energy, what has also significantly changed the approach to testing activities, is the fact that testing individual components is not enough anymore: everything must be evaluated from a systematic perspective. Therefore, it is essential to take into due consideration the interactions of thousands of components distributed throughout the territory and connected to each other through the electricity grid, with very high risks of instability. In this context, real-time control systems, plant automation, measurement sensors, the exchange of communications to and from the network, the quality of the generated power and, finally, the aspects of IT security, become increasingly more important.

In an electrical network that is becoming more and more digital, where electrons and bits run together, KEMA Labs has updated its approach by setting up with multidisciplinary environments, in which it is possible to test the interaction between different devices, in different configurations. Digital technologies such as smart meters, remote control systems of transmission and distribution networks, Internet of Things and electric vehicle charging infrastructures, favor – and will increasingly favor in the future – real-time control and automatic management of the electricity network, optimizing consumption and the efficient use of renewable energy, while increasing the resilience of networks in response to extreme weather phenomena.

These technologies, which we verify in our laboratories, offer the possibility of providing the electricity grid with sensors spread throughout the territory, with data collected in real-time, allowing the network to be managed through sophisticated algorithms that ensure optimal and low-cost operation. Thanks to this, the electricity grid is transformed, losing its traditional mono-directionality and centralization. On the contrary, energy flows no longer come only from centralized systems to be, later, distributed towards the periphery, but can originate in the periphery itself, thus transforming the consumer into a prosumer, a conscious actor who intervenes personally in reducing consumption and improving the operating conditions of the network.

Furthermore, if we are to keep up with the REPowerEU goals, the construction chain of renewable power plants needs to be accelerated up to an average of 10 GW per year compared to about 1 GW / year today. In this respect, the importance of networks as enablers of the integration of renewable energy sources if crucial. However, the flexibility of the system must also be ensured. Such characteristic of the power system can be achieved either through a coordinated planning approach of the networks by TSOs and DSOs or via a full market-based approach for storage and other flexibility solutions.

In this regard, our analyses aimed at the planning and operation of decarbonized electrical systems are increasingly focused on technologies that can guarantee the flexibility of the system, from electrochemical batteries to the smart integration of electric vehicle charging systems, as well as on aspects of digitalization to react better to unexpected external events, including cyber-attacks. The criteria for evaluating the profitability of investments are changing as well, with increasing attention being devoted to achieving the United Nations Sustainable Development Goals. For example, CESI carries out studies based on multidisciplinary teams, composed of experts in electrical systems, network components, digital technologies, electricity markets, and cross-sector coupling, which derives from the electrification of transport and the need to produce hydrogen from renewable sources for the decarbonization of all sectors that are difficult to electrify.