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SALAMANCA DECLARATION

This declaration was made during the XVI International Renewable Energy and Power Quality Conference (ICREPQ'18) held at the University of Salamanca, from the 21th to the 23th of March 2018. It contains an outline of the state-of-the-art in the fields of renewable energies and power quality including the latest results presented at the conference. At the end of the conference this declaration was proposed and approved by the participants. This document aims to assess the contribution of the scientific community and to recognize the prestige of the University of Salamanca in the occasion of the commemoration of its first eight centuries, a process which reaches its culmination in the same year in which the ICREPQ'18 is held.

The use of renewable energy sources (RES) is continuously growing, it offers a valid solution to mitigating CO_2 emissions. Unfortunately, they exhibit a slow growth compared to the energy demand that is still satisfied by fossil fuels. The target to satisfy 50% of the market share (corresponding to the transition from the use of fossil sources to the use of renewable sources) is still far from reach. For this reason, they need to be sustained by current technologies.

There are many factors that are helping the increasing use of RES, among them the adoption of power conditioning devices for electrical energy conversion. These lead to increased efficiency conversion and reduction of the additional investments.

The new advanced power electronic devices, available in the market, together with new conversion topologies, allow fast switching methods that reduce losses and their higher operating temperature. Moreover, the efficiency of solar and wind generation is improving contributing to the reduction of the payback time and encouraging capital investments.

The continuous growth of the RES have to be taken into account during distribution grid planning. It was conceived for a unidirectional power flow generated by conventional sources. Now new analysis techniques have to be developed to consider the bidirectional power flow in case of distributed generation, taking into account the presence of resulting harmonics.

Adoption of the RES reduces the inertia of conventional generation systems, leading to possible instabilities, especially for non-robust grids. Therefore, a virtual inertia must be provided, so that in case of failure a relevant amount of power can be delivered to the grid to maintain voltage and frequency stability and to avoid collapse.

The availability of energy generated by RES requires that the maximum energy is extracted to cover the demand required by the customer. This situation is very different from conventional generation by fossil sources in which energy can be reduced according to the demand of the customer. For efficient utilization of the available renewable energy, maximum power tracking techniques have to be considered by interfacing the RES with the grid. As a matter of fact, the intermittency of the energy produced by RES usually is not enough to satisfy the demand. In case of a renewable energy deficit, fossil source use is required. If, the RES generation overcome the required energy, the excess energy is lost. The solution consists of the adoption of a storage system. There are some solutions available in the market, but they need further studies to reduce overall costs and enhance the system performance. In addition environmental aspects should be taken into account. Storage facilities currently exist, such as batteries, plug-in-hybrid electric vehicles, flywheels, supercapacitors, superconducting coils and others. All these systems store energy but need further studies to optimize design and operation to fulfill the customers' requirements.

There are many fields in which the use of RES can be encouraged. For example, water desalination processes require electricity that can be produced by RES, avoiding its transmission over long distances, assuring clean water.

The trigeneration, of combined cooling, heating and electrical power generation, is able to produce chilled water for air conditioning or refrigeration by a part of the heat delivered by cogeneration plants. This type of plant gives high efficiency production of electricity and heat with reduced fuel and energy costs. Moreover, they lower the peak demand during hot seasons. The energy management of hybrid energy generation, including the new trend of producing electric vehicles, requires the availability of efficient communication facilities in smart grid operations.

Deregulation of the electric power industry, namely the classification into generation, transmission, and distribution subsystems, leads to an increased research interest of the delivered power quality. It is no longer just an issue for technical groups within the utility but also requires investigation of unusual problems of interaction between the power system and customer facilities including basic design, maintenance issues, and the required investments to protect the equipment within these facilities as well as the implementation of new technologies.

Electrical power quality issues can have not only significant economic consequences for customers, but also serious economic impacts on utility companies, because of the ability of the customers to choose which power sources serve them in new and free competitive markets. In practice, the new, free markets throughout the world are changing the framework in which power quality is addressed, and power quality objectives are now of great importance to all power system operators.

Power quality represents a complex area covering many different topics. However, simplifying the matter, it can be seen as a set of electrical boundaries allowing equipment to function in its intended manner without significant loss of performance or life expectancy.

The subject of power quality is very broad by nature, covering all aspects of power system engineering, from generation, transmission and distribution level analyses to end-user problems. Among the three components of the electricity infrastructure — the distribution system is often the most critical part of the unified power system in terms of its effect on reliability and quality of service, cost of electricity, and impact on society.

From this perspective, electric power quality has become the concern of utilities, end users as well as manufacturers. Suppliers are interested in the quality of their service, manufacturers have to build equipment compliant to a series of standards and regulations with respect to power quality and finally fulfillment of customers' requirements to have comfort in using electrically powered products.

The term power quality may often seem ambiguous, having different meaning to different people. Therefore, power quality could be at the same time a problem to be solved and a product, depending on the person's perspective. For power quality experts, power quality is obviously a problem that must be solved, while for a power marketer for instance, power quality is an important feature of a product named electrical power.

The problems related to power quality are often difficult to solve, and may allow different solutions, so the choice is not always simple. The optimal solution to a power quality problem is usually a mix of solutions for a specific situation. Evaluation of solutions is probably the key element in power quality problem solving, both for technical and economic reasons.

There are several factors determining an increased need to prevent and solve power quality problems:

- increased use of power quality–sensitive equipment,
- increased use of equipment that causes power quality problems,
- increased interconnectedness of power systems,
- deregulation of the power industry.

The increased use of power electronic components within the distribution system and the reliance on renewable energy sources which have converters as interface between the source and the power system lead to power quality problems.

The problem of voltage quality is gaining increasing importance due to the widespread use of power electronics (increasing emitted interference) on the one hand, and the reduction in the signal levels in electronic equipment (increased interference susceptibility) on the other hand.

Electromagnetic interference represents the degradation in the performance of equipment, transmission channel or system caused by an electromagnetic disturbance, namely any electromagnetic phenomenon which may degrade the performance of a device, equipment or system, or adversely affect living or inert matter.

The concept of electromagnetic interference is an important part of electromagnetic compatibility, defined as the ability of equipment or a system to satisfy three criteria:
- to cause no interference with other systems;

- to be not susceptible to emissions from other systems.
- to cause no interference with itself.

The lack of electromagnetic compatibility or a precarious solution of its issues might have several consequences, like unforeseeable and unreliable operation of equipment, culminating with high risks upon the ecosystem and/or human life.

In most electromagnetic compatibility issues there are aggressor of the electromagnetic environment and one or several victims. The aggressor conducts or radiates a sufficient amount of electromagnetic energy, able to interfere with equipment representing a victim. On the other hand, the victim misoperates due to the interference with the aggressor or due to the electromagnetic fields present in its environment.

Unfortunately, “victims” are not always completely innocent and that is why a poor electromagnetic compatibility design of equipment can make them sensitive to the environmental electromagnetic fields and highly susceptible to electromagnetic noise.

In recent years there has been considerable increase in nonlinear loads. These draw harmonic currents which have detrimental effects including communication interference, loss of reliability, increased operating costs, equipment overheating, machine, transformer and capacitor failures, and inaccurate power metering.

A deficient quality of electrical power supplied to equipment results in the degradation of their performance, loss of productivity, loss of equipment, injury to personnel, and in some cases, loss of life. All that is needed to prevent such consequences is a clear understanding of electrical power quality and its effects on power system performance.

Based on the above, the participants of the conference are quite sure that the scientific community will comprehensively cooperate to achieve the future goals towards energy sustainability, to protect our planet and to assure a better quality of life for the next generations.

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