# Advances in Power and Energy Systems

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Processing electrical energy is one of the most important research fields in our society. So far, tremendous efforts have been made to improve the efficiency of each step in electrical systems: generation systems have been enhanced by introducing renewable energy sources and new control systems for conventional generators, losses have been reduced, the power quality of distribution and transmission systems has been increased, the life-time and state-of-health of energy storage devices have been extended, and sections of the power grid have been isolated for intelligent energy management.

In this edition, were received submissions from Colombia, Venezuela and Denmark, and the acceptance rate was 41.2%. Moreover, the authors of these papers have an average h-index (Scopus) of 4, and some reach even higher values: 63, 19 and 15. Those statistics show the high-quality of the solutions reported in this special section. This Edition of the TecnoLógicas Journal is specially focused on recent Advances in Power and Energy Systems, and 10 out of the 14 articles in it report novel developments in power systems, renewable energy systems, energy storage systems, energy management, and smart grids. Such contributions address the previous topics, providing timely solutions to practical problems.

In the first work, *Island operation capability in the Colombian electrical market: a promising ancillary service of distributed energy resources*, the authors analyze the islanded operation of a distributed generator to improve the reliability, security and flexibility of an electrical distribution system. In particular, the work presents the main problems and advantages of the islanded operation mode, which is complemented with an economic analysis of the reliability of the service that accounts for islanded operation capability. Such analysis concludes that operation by islands could reduce non-supplied energy by up to 50%.

In turn, the study named *Transmission network expansion planning considering weighted transmission loading relief nodal indexes* proposes a solution for transmission network expansion planning integrating security constraints. Such solution takes into account both shift and power distribution factors by modeling the problem using weighted transmission loading relief indexes. One of the main features in that work is

concerned with measuring the severity of overloads in normal conditions and under contingencies. Finally, the proposed method enables to find a satisfactory balance between expansion plan costs and security levels.

Other authors describe an analytical formulation to calculate lightning electromagnetic fields in a transmission line. Such solution is based on a simplification of the current wave shape: assuming a linear rising of the wave with a flat top. This analytical result—described in *Implementation of an analytical formulation for LEMP to assess the lightning performance of a distribution line*—is useful to calculate the electromagnetic fields and lightning-induced voltages in a typical overhead distribution line. The main advantage of this novel approach is the satisfactory trade-off between accuracy and speed, since it provides errors under 5 % in contrast to classical solutions but requires 50 % of the computation time.

Besides, a novel secondary voltage regulator for improving the voltage profile of a grid is introduced in *Secondary voltage regulation based on average voltage control*. This new solution is designed to be integrated into well-stablished hierarchical voltage control systems; hence it is applicable to existing power grids. To improve the network voltage profile, the proposed secondary voltage regulator takes into account both the classical pilot nodes voltages and the average voltages of the defined control zones; thus, the control actions are calculated to impact all the nodes. Finally, the effectiveness of this approach was demonstrated by contrasting the voltage profiles of both the novel and classical solutions.

Modeling and estimating the parameters of compact fluorescent lamps for harmonic analysis under terminal voltage variation is presented in another work, which clearly describes the equations and experiments used for modeling the lamps. As a result, this method can be extended to other types of loads. The main feature of this solution is the model's validity, not only at the rated terminal voltage but also within the operation range of the terminal voltage suggested by the manufacturer. Thus, the total harmonic distortion introduced by the lamps is accurately predicted by the authors of *Experimental characterization of compact fluorescent lamps for harmonic analysis of power distribution systems*.

In *Quasi-switched inverter using space vector pulse width modulation with triangular comparison for photovoltaic applications*, different researchers propose the adoption of a space vector PWM to increase the voltage conversion ratio of a quasi-switched boost inverter in order to make it suitable for designing PV microinverters. The experimental measurements presented in this paper demonstrate the effectiveness of the proposed modulation technique, which enable the prototype to increase the voltage gain factor and improve the input current profiles; hence, less noise is introduced into the PV source. Lastly, the design of a proof-of-concept PV microinverter is reported.

In addition, a method to select municipalities that would benefit from using urban solid waste as a potential source of renewable energy is described in another study. Its method is based on the rural/urban population ratio, number of inhabitants, and available information about waste management plans. Such work—*Electricity generation potential from solid waste in three Colombian municipalities*—is focused on estimating the electric energy production potential achievable from urban solid waste,

which could be extracted by incineration (thermal conversion) or anaerobic digestion (biological conversion), among other options. Also, these authors present the method using three realistic scenarios.

Furthermore, a photovoltaic battery charger based on a buck converter is described in the paper *Photovoltaic battery charger with sliding mode control and charging current derivative limitation*. The control system of this charging device is composed of three components: a sliding-mode controller to ensure stability, a MPPT algorithm to ensure maximum power production, and a current derivative limiter to protect the battery from artificial aging due to fast current transients. This work analyzes the transversality and reachability conditions of the sliding-mode controller in terms of the current limitation needed to avoid battery damage. Those results ensure global stability in any operation condition.

The stability of a buck converter under the action of both a Zero Average Dynamics controller and Fixed-Point Induction Control is examined in a different study that uses bifurcation diagrams to analyze the system's robustness to changes in the controller's parameters, reference voltage, and source voltage. The numerical results derived from this work—titled *Numerical and experimental validation with bifurcation diagrams for a controlled DC–DC converter with quasi-sliding control*—are validated with experimental measurements, which demonstrates that the adopted controller successfully regulates the output voltage in presence of input voltage perturbations. This solution is suitable for constant load regulation in DC microgrids.

Finally, the article *Integration of distributed energy resources in isolated microgrids: the Colombian paradigm* reflects on the state of art Distributed Energy Resources in said country, as well as the challenges and potential benefits to be faced and enjoyed thanks to the integration of these resources into distribution systems. Its authors also propose common strategies to mitigate the vulnerability of the introduction of such technologies in microgrids. Their work considers isolated Colombian regions as a natural laboratory where the economic and technical effects of integrating Distributed Energy Resources and the operation requirements of renewable generation units can be analyzed.

In conclusion, the reported contributions are state-of-the-art advances in power and energy systems, which will stimulate the development of new solutions both in commercial and research fields.