The proposed special issue (SI) has invited submissions related to renewable energy, energy storage, power converters and electric drive systems for electrified transportation and smart grid applications [1–10]. The particular topics of interest have included:

- New emerging technologies for power converters, electric drives and energy storage;
- Aging mechanisms of power converters, electric drives and energy storage devices;
- Electronic control units for energy storage system (ESS) monitoring and management;
- Online estimation of state-of-charge (SoC) and state-of-health (SoH);
- Power electronic converters for renewable energy sources (RES);
- Fast chargers and smart chargers for electric-vehicles, including wireless power transfer;
- Integration of charging infrastructures in the smart grid for e-transportation;
- Predictive diagnostic for renewables and ESS;
- Methods for design and verification of hardware (HW) and software (SW) for energy storage and renewables;
- Embedded systems, machine learning (ML), artificial intelligence (AI) and deep neural network (DNN) for energy storage, conversion and management;
- Integration of Internet of Things (IoT) and digitalization into e-transportation.

Research and technology transfer activities in ESS, such as batteries and super/ultra-capacitors, are essential for the success of electric transportation and to foster the use of RES. ESS are the key to increase the adoption of RES in the smart grid. However, major challenges have yet to be solved, such as the design of high-performance and cost-effective ESS, the on-line estimation of SoC/SoH of batteries and super/ultra-capacitors, the estimation of aging effects, the design and optimization of fast chargers and the integration within the smart grid of the charging infrastructure for electrified transportation [11–13]. The strategic interest for this R&D activity is proved by the rise of initiatives such as the Battery 2030+ initiative or the European Battery Alliance [14], where a mixed effort of the European commission, industries and research organizations aims at developing an innovative, sustainable and competitive battery “ecosystem” in Europe.

Power converters and electric drives also need optimization in terms of increased efficiency and implementation of predictive diagnostic features. Beside the HW parts, the role of the SW is also increasing, and new design and verification methods have to be investigated to achieve high functional safety levels. Due to the increasing role of Information and Communication Technology (ICT) in smart grid and electrified transportation, toward an Internet of Energy scenario, cybersecurity is also becoming a key issue.

The main objective of the 10 manuscripts published in this SI is, hence, to provide timely solutions for the design and management of ESS, of RES and of the relevant power electronics converter topologies and their control and modulation techniques. The accepted articles addressed these issues from the low component level, up to the integration of all these sub-systems within the smart grid for e-transportation and smart/green cities.
The SI includes, after a strict review process, 10 papers, of which nine are original research papers [1–9] and one is a comprehensive review paper [10].

The first work [1], entitled “Minimization of Cross-Regulation in PV and Battery Connected Multi-Input Multi-Output DC to DC Converter”, written by a group of authors from India and South Africa, Vibha Kamaraj et al., deals with a digital model predictive controller (DMPC) for a multi-input multi-output (MIMO) DC-DC converter interfaced with renewable energy resources in a hybrid system. This paper proposes a controller, which increases the speed of response maintaining the output stable by regulating the load voltage independently. To prove the efficacy of the proposed DMPC controller, simulations followed by the experimental results are executed on a hybrid system consisting of a dual-input dual-output (DIDO) positive Super-Lift Luo converter (PSLLC) interfaced with a photovoltaic (PV) renewable energy resource.

The second paper [2], entitled “Voltage-Balancing Strategy for Three-Level Neutral-Point-Clamped Cascade Converter under Sequence Smooth Modulation”, by Le Yu et al., from China, mainly discusses the open-circuit fault in the DC-side of the three-level neutral-point clamped cascaded converters (3LNPC-CC). A sequence smooth modulation (SSM) optimized by the sequence pulse modulation to keep the DC-side voltage balance while the 3LNPC-CC suffers an open-circuit fault from the DC-side is proposed. The SSM found an efficient switch-state path through a 3D cube model and simplified the path from thousands of switch states. The SSM avoids the complex calculation in the voltage-balancing modulation, while its dynamic characteristics were less influenced. At the same time, the modulation changes the voltage level smoothly and balances the fault DC-side voltage effectively.

The third paper [3], entitled “Technical and Economic Analysis of One-Stop Charging Stations for Battery and Fuel Cell EV with Renewable Energy Sources”, written by Saumya Bansal et al., a group of authors from the Netherlands, Denmark, Norway and China, investigates a technical and economic analysis of a one-stop charging station for battery electric vehicles (BEV) and fuel cell electric vehicles (FCEV). The hybrid optimization model for electric renewables (HOMER) SW and the heavy-duty refueling station analysis model (HDRSAM) are used to conduct the case study for a one-stop charging station. A total of 42 charging station scenarios by considering two systems (a grid-connected system and an off-grid connected system) are analyzed. For each system three different charging station designs (design A—hydrogen load; design B—an electrical load, and design C—an integrated system consisting of both hydrogen and electrical load) are set up for analysis. Furthermore, seven potential wind turbines with different capacity are selected from the HOMER database for each system. A total of 18 scenarios are analyzed with variations in the hydrogen delivery option, production volume and hydrogen dispensing option. The optimal solution from HOMER for a lifespan of 25 years is integrated into design C with the grid-connected system. The optimal solution design consists of tube trailer as hydrogen delivery with a cascade dispensing option at 350 bars together with a high production volume.

The fourth paper [4], entitled “Design of Adaptive Controller Exploiting Learning Concepts Applied to a BLDC-Based Drive System”, by P. Dini and S. Saponara, from the University of Pisa-Italy, proposes a novel and innovative control architecture, which takes its ideas from the theory of adaptive control techniques and the theory of statistical learning at the same time. The main idea was to divide the architecture of the adaptive controller into three different levels, considering the architecture of a classical neural network with several hidden levels. The design of the control system is reported from both a rigorous and an operational point of view. As an application example, the proposed control technique is applied on a second-order non-linear system. The authors consider a servo-drive based on a brushless DC (BLDC) motor, whose dynamic model considers all the non-linear effects related to the electromechanical nature of the electric machine itself, and also an accurate model of the switching power converter. The reported example shows the capability of
the control algorithm to ensure trajectory tracking while allowing for disturbance rejection with different disturbance signal amplitudes.

The fifth paper [5], entitled “Trusted Simulation Using Proteus Model for a PV System: Test Case of an Improved HC MPPT Algorithm”, by Abdelilah Chalh et al., from Morocco and Saudi Arabia, presents a trusted simulation of a PV system designed with the Proteus SW. The proposed PV simulator can be used to verify and evaluate the performance of MPPT algorithms with a closer approximation to the real implementation. The main advantage of this model is related to the fact that the same code for the MPPT algorithm can be used in the simulation and the real implementation. In contrast, when using a SW program/simulation tool, like PSIM or MATLAB/Simulink, the code of the algorithm must be rewritten once the real experiment begins, because these tools do not provide a microcontroller or an electronic board in which our algorithm can be implemented and tested in the same way as the real experiment. A modified Hill-Climbing (HC) algorithm is also introduced. The proposed algorithm can avoid the drift problem posed by conventional HC under a fast variation in insolation. The simulation results show that this method presents good performance in terms of efficiency (99.21%) and response time (10 ms), which improved by 1.2% and 70 ms, respectively, compared to the conventional HC algorithm.

The sixth paper [6], written by A. Plesca and Lucian Mihet, from the Technical University of Iasi-Romania and Østfold University College-Norway, entitled “Thermal Analysis of Power Rectifiers in Steady-State Conditions”, proposes a new mathematical model to calculate the junction and the case temperature in power diodes as part of a three-phase bridge rectifier used in electric traction applications, which supplies an inductive-resistive load. The new thermal model may be used to investigate the thermal behavior of the power diodes in a steady-state regime for various values of the tightening torque, direct current through the diode, airflow speed and load parameters (resistance and inductance). The obtained computed values were compared with 3D thermal simulation results and experimental tests.

The seventh paper [7], entitled “Microcontroller-Based Strategies for the Incorporation of Solar to Domestic Electricity”, by Mabunda and Joseph, from the University of Johannesburg-South Africa, deals with innovative methods to reduce the reliance on national grid energy and to supplement this source of energy with alternative methods. A microcontroller is used to monitor the energy consumed by household equipment and then decide, based on the power demand and available solar energy. In this research, a special circuit was also designed to control geyser power and align it to the capacity of the RES. This geyser control circuit includes a Dallas temperature sensor and a triode for an alternating current (TRIAC) circuit that is included to control the output current drawn from a low-power, RES. Alternatively, two heating elements may be used instead of the TRIAC circuit. The first heating element is powered by solar to maintain the water temperature and to save energy. The second heating element is powered by national grid power and is used for the initial heating, and therefore saves water heating time. The strategy used was to add a programmed microcontroller-based control circuit and a low power element. The current is the controlled element of the geyser circuit thereby photovoltaic (PV) energy was used to save the energy geysers consume from the domestic electricity source when they are not in use.

The eighth paper [8], authored by Dini and Saponara, entitled “Cogging Torque Reduction in Brushless Motors by a Nonlinear Control Technique”, addresses the problem of mitigating the effects of the cogging torque in PM synchronous motors, particularly brushless motors, which is a main issue in precision electric drive applications. A method for mitigating the effects of the cogging torque is proposed, based on the use of a nonlinear automatic control technique known as feedback linearization, that is ideal for underactuated dynamic systems. The aim of this work was to present an alternative to classic solutions based on the physical modification of the electrical machine to try to suppress the natural interaction between the PMs and the teeth of the stator slots. Such modifications of
electric machines are often expensive because they require customized procedures, while the proposed method does not require any modification of the electric drive. With respect to other algorithmic-based solutions for cogging torque reduction, the proposed control technique is scalable to different motor parameters, deterministic and robust, and hence easy to use and verify for safety-critical applications. As an application case example, the work reports the reduction of the oscillations for the angular position control of a PM synchronous motor vs. classic proportional-integrative (PI) cascaded control.

The ninth work [9], entitled “Spatio-Temporal Model for Evaluating Demand Response Potential of Electric Vehicles in Power-Traffic Network”, by Chen et al., a group of authors from China and UK, introduces a composite methodology that takes into account the dynamic road network (DRN) information and fuzzy user participation (FUP) for obtaining spatio-temporal projections of demand response potential from electric vehicles (EV) and the EV aggregator. A dynamic traffic network model taking over the traffic time-varying information is developed by graph theory, and a trip chain based on a housing travel survey is set up, where the Dijkstra algorithm is employed to plan the optimal route of EVs in order to find the travel distance and travel time of each trip of EVs. To demonstrate the uncertainties of the EVs’ travel pattern, a simulation analysis is conducted using the Monte Carlo method. Subsequently, the authors suggest a fuzzy logic-based approach to uncertainty analysis that starts with investigating EV users’ subjective ability to participate in a DR event, and develop the FUP response mechanism, which is constructed by three factors including the remaining dwell time, remaining SOC and incentive electricity pricing. The FUP is used to calculate the real-time participation level of a single EV. Finally, the authors use a simulation example with a coupled 25-node road network and 54-node power distribution system to demonstrate the effectiveness of the proposed method.

Last but not least, the tenth contribution [10] is a comprehensive review paper by S. Vadi et al., a group of authors from Turkey (Gazi University), Denmark (Aalborg University) and Norway (Østfold University College), entitled “A Review on Optimization and Control Methods Used to Provide Transient Stability in Microgrids”. The authors propose a comprehensive review on optimization and control methods in Microgrids, with DERs such as PV systems and wind turbines, and storage systems. The paper also points out the fact that the microgrids are an efficient source in terms of inexpensive, clean and renewable energy for distributed RES that are connected to the existing grid, but these RES can also cause many difficulties to the microgrid due to their characteristics. These difficulties mainly include voltage collapses, voltage and frequency fluctuations and phase difference faults in both islanded and grid-connected operation modes. That is why the stability of the microgrid structure is necessary for providing transient stability using intelligent optimization methods to eliminate the abovementioned difficulties that affect power quality. This paper also highlights some optimization and control techniques that can be used to provide transient stability in the islanded or grid-connected operation modes of a microgrid-based RES.

In conclusion, the SI entitled “Power Converters, Electric Drives and Energy Storage Systems for Electrified Transportation and Smart Grid” has accepted for publication 10 original research papers, among which one comprehensive review paper, related to the emerging trends in solar power, energy storage, power converters and electric drives. These open-access publications already received by now more than 50 citations (with approx. 9000 views).

This SI follows the previous successful SI [13] in Energies, entitled “Energy Storage Systems and Power Conversion Electronics for E-Transportation and Smart Grid”, which published 21 papers from 40 submitted.

The published articles provide an overview of the most recent research advances in Microgrids, exploiting the opportunities offered by the use of RES, BESS, power converters, innovative control and energy management strategies. These publications have also been addressing both algorithmic-level and HW-level works, where the focus was on applications such as transportation electrification (full EV and hybrid EV (HEV), mainly
for automotive and railway scenarios) and the evolution of the microgrid to a smart grid, with a massive use of RES. Moreover, a close integration is foreseen between the smart electric grid and the electrified vehicles due to the need of an efficient and fast recharging infrastructure. Adaptive control methods for brushless DC motor (BDCM) Drives as well as voltage balancing strategies for cascade power converters with smooth modulation techniques have also been highlighted.

Based on our previous records, obtained from this SI’s publications and the previous one, we have already decided, together with MDPI Energies Editors, to launch a new SI on a similar topic.

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