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Preface

Special Issue ELECTRIMACS 2024 ENERGY – Modelling and computational simulation of electrical systems, energy storage technologies, microgrids, hydrogen systems, & optimization and forecasting of renewable systems' operation

This special issue, hereafter referred to as *"ELECTRIMACS 2024 ENERGY"*, brings together peer-reviewed research papers presented at **ELECTRIMACS 2024**, the 15th Conference of the IMACS Technical Committee *"ELECTRIMACS"*. The conference was held in Castelló de la Plana, Spain, from May 27th to 30th, 2024.

This edition served as a meeting point for researchers from 21 countries to share ideas and advances across a wide range of fields, including power electronic systems, electric machines and electromagnetic devices, power management of electrical systems, transportation systems, micro- and smart grids, electric and hybrid vehicles, wireless power transfer, renewable energy systems, energy storage technologies, batteries, supercapacitors, and fuel cells. Within these domains, the conference placed particular emphasis on modelling, simulation, analysis, design, optimization, the application of artificial intelligence, system identification, and diagnostics in electrical power engineering.

The technical program was enriched by four plenary lectures and four industrial talks delivered by leading experts from academia, research centers, and industry. These sessions complemented the four technical tracks and 11 special sessions that structured the conference. In total, 135 oral presentations were delivered, selected from 150 submitted works. The main institutional sponsor of the conference was the **Universitat Jaume I de Castelló (UJI)**, with the collaboration of the Diputació de Castelló and the Town Council of Benicàssim. The event also benefited from the technical co-sponsorship of IMACS, as well as financial support from numerous industries and private companies that sponsored the event or participated in the industrial exhibition. Overall, the conference gathered around 200 participants.

This special issue, together with its companion issue *"ELECTRIMACS 2024 ENGINEERING"*, includes original research papers invited for extended submission following a careful selection among the conference contributions. All papers underwent peer review according to the standards of *Mathematics and Computers in Simulation (MATCOM)*.

The Guest Editors wish to express their sincere appreciation to all authors and reviewers who contributed to this special issue. They are also grateful to the Editor-in-Chief, **Dr. Rosa Maria Spitaleri**, for her continuous support and collaboration, which have been instrumental in bringing this issue to fruition.

This special issue comprises 15 papers, selected from 26 invited submissions, with particular emphasis on emerging mathematical, modelling, and control approaches for modern energy systems and applications in electrical engineering. To facilitate navigation, the contributions are grouped into three thematic sections:

- Battery modelling, state estimation, and diagnostics.
- Forecasting, optimization, and control in power and energy systems.
- Microgrids, renewable integration, and energy management strategies.

A brief summary of each article is provided below.

The first group of contributions focuses on advanced modelling and data-driven strategies for battery assessment. Montes et al. [1] propose a multi-feature, data-driven model for rapid state-of-health estimation of second-life batteries, reducing the testing process from hours to seconds and eliminating costly pre-processing requirements. Barcellona et al. [2] develop and validate a machine learning-based algorithm for lithium-ion capacity estimation under different aging conditions, demonstrating high accuracy and

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adaptability compared to traditional approaches.

Several papers explore forecasting techniques and optimization strategies to support more efficient energy system operation. Failing et al. [3] investigate deep learning models for electricity price forecasting in the Spanish spot market, with a feedforward neural network achieving strong predictive performance and robustness. Lekhel et al. [4] present a residential load profile generator that integrates weather forecasts, occupancy data, and user-defined parameters, validated under real conditions and deployable on low-cost platforms. Cardo-Miota et al. [5] design a deep reinforcement learning-based strategy for residential prosumers, achieving substantial reductions in electricity bills by optimizing PV and storage operation.

The paper by López et al. [6] examines the disruptive impact of COVID-19 lockdown measures on short-term load forecasting in Spain, proposing corrective measures that improve model resilience in out-of-control scenarios. Wood et al. [7] provide a comparative analysis of peak load forecasting methods for residential and industrial buildings, highlighting the relative performance of statistical and AI-based techniques.

The remaining contributions address novel methodologies for microgrids, renewable integration, and advanced energy management. Nazer et al. [8] analyze hierarchical PV-to-PV series differential power processing architectures to mitigate accumulation effects, showing performance improvements through simulations. Yuan et al. [9] introduce an adaptive IDA-PBC strategy for DC microgrids, enhancing stability margins by redefining reference voltages and validating results with experiments. Díaz-Sanahuja et al. [10] propose a centralized control framework for offshore wind farms that integrates optimal power dispatch within a hierarchical structure, ensuring robustness and adaptability under varying conditions.

Agha Kassab et al. [11] address microgrid planning with a combined optimal sizing and energy management formulation applied to different French cities, emphasizing cost, emissions, and variability across regions. Molénat et al. [12] examine the impact of frequency variation in load-flow calculations for islanded AC microgrids, providing new algorithms that enhance accuracy, particularly near maximum loadability.

Shmaysani et al. [13] present a day-ahead energy management system for DC railway grids, integrating PV and storage while leveraging substation demand forecasts for optimal scheduling. D'Angelo et al. [14] propose an optimization strategy for microgrids with combined electrochemical and thermal storage, validated in an industrial facility with significant thermal demand. Bouzid et al. [15] evaluate the interaction of multiple distributed generators under diverse droop-based primary control strategies, identifying optimal configurations through extensive real-time simulations.

The contributions collected in this Special Issue highlight the rapid advancements in data-driven modelling, optimization, and control strategies for batteries, forecasting, and microgrids. Collectively, they demonstrate the potential of combining mathematical methods, artificial intelligence, and innovative control frameworks to address pressing challenges in energy transition and sustainable power systems.

We would like to thank all authors for their valuable contributions and the reviewers for their constructive efforts in ensuring the high quality of the published articles.

The next ELECTRIMACS 2026 (www.electrimacs2026.org) conference will take place in Palermo, Italy, in May 2026. We look forward to meeting you there!

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