Guest Editorial Introduction to the Special Section on Innovative Electrified Vehicles

WE ARE entering the era of the electric vehicle. According to the "Global EV Outlook 2021" of International Energy Agency (IEA), ten million electric cars were on the world's roads in 2020. It was an important year for the electrification of mass market transportation with the share of 4.6% of total car sales around the world, despite of Covid-19 pandemic and its related economic downturn and lockdowns. Nevertheless, the challenge remains enormous to reach the target of 230 million EVs on the world's roads by 2030, according to the IEA Sustainable Development Scenario. In addition to technologies related to road vehicles, the electrification of railway vehicles, air and water vehicles also requires fast development to combat the global climate change.

IEEE Vehicle Power and Propulsion Conference (VPPC) is an annual conference of the IEEE Vehicular Technology Society (VTS). After Chicago 2018, Hanoi 2019, the 17th IEEE-VPPC rotated to Europe and was held in Gijon, Spain from 18 November to 16 December 2020. Although the conference had to run virtually (due to the pandemic), the program committee received many papers submitted (248), of which 161 were accepted. To further promote research excellence in vehicle power and propulsion, in collaboration with the 2020 IEEE VPPC organizing committee and the VPP technical committee, a Special Section of the IEEE Transactions on Vehicular Technology has been organized to focus on the development of innovative electrified vehicles.

The manuscripts submitted to this Special Section had to offer substantial novel contributions beyond the previous work presented in the conference paper (substantial change more than 50%). Papers co-authored by the Guest Editors of this Special Section cannot be accepted. The submissions have been first checked by the Editor-in-Chief and it should be highlighted that some submissions have been directly rejected due to a high similarity index (desk-rejection). This process might be considered as questionable by the authors, but they should know that if the conference paper can have only 30% of similarity, another similarity can be found in other sources and the result will be reflected in the cumulative similarity index. As this process is growing in any high-quality international journal, they are encouraged to take sufficient margin to avoid this issue. Then 18 submissions have been transmitted to the Guest Editors. Each paper has been associated with a Guest Editor from a different country than each author's country of origin, and was reviewed by at least three independent reviewers. After the reviewing process that includes a unique possible revision, 6 papers have been accepted for publication (33% of acceptation rate).

Energy storage systems, their hybrid configuration and management strategies are still ones of the biggest concerns of the electrification to extend the travelling distance of the vehicles per charge. The first four papers deal with this challenge for different platforms: Plug-in Hybrid Electric Vehicles, Fuel Cell-Ultracapacitor-Battery Vehicles, Fuel Cell HEVs, and Li-ion Battery Hybrid Diesel-Electric Railway Vehicles.

- "Predictive Energy Management of Plug-in Hybrid Electric Vehicles by Real-time Optimization and Data-driven Calibration" by Ningyuan Guo, Xudong Zhang, Yuan Zou, Guangze Du, Chao Wang, and Lingxiong Guo.

This paper proposes a predictive energy management strategy of plug-in hybrid electric vehicles by real-time optimization and data-driven calibration. The continuation/ general minimal residual algorithm is proposed for real-time optimization. To tackle the parameters' tuning difficulties, the Bayesian optimization (BO) algorithm is proposed to optimize control parameters. Simulation and hardware-in-the-loop validations are carried out and verify the effectiveness and real-time applicability for proposed approach.

- "Impact of Energy Management Strategies on Hydrogen Consumption and Start-up/Shut-down Cycles in Fuel Cell-Ultracapacitor-Battery Vehicles" by Alessandro Ferrara and Christoph Hametner.

This paper studies the energy management of fuel cell-ultracapacitor-battery hybrid vehicles, investigating different criteria for fuel cell operation to find the best trade-off between hydrogen consumption and the number of start-up/shutdown cycles, which are the most important source of fuel cell degradation are start-up/shut-down cycles. The simulation results indicate that the fixed-setpoint strategy yields a better trade-off between hydrogen consumption and start-up/shut-down cycles than the charge-balancing one. Additionally, the study demonstrates that a predictive energy management strategy can significantly reduce degradation without hindering system efficiency.

- "Online Health-Conscious Energy Management Strategy for a Hybrid Multi-Stack Fuel Cell Vehicle Based on Game Theory" by Razieh Ghaderi, Mohsen Kandidayeni, Mehdi Soleymani, Loïc Boulon and João F. Trovão.

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Multiple low-power fuel cells in the powertrain of a fuel cell hybrid electric vehicle have recently received considerable attention for their higher efficiency, durability, and reliability. This paper puts forward an energy management strategy based on game theory for this type of vehicle. The carried-out studies show that the total cost (hydrogen consumption and degradation) of the proposed strategy is almost 6% better than the rule-based strategies. Moreover, health unawareness of power sources can increase the hydrogen consumption up to 7% in the studied system.

- "Li-ion Battery-based Hybrid Diesel-Electric Railway Vehicle: In-depth Life Cycle Cost Analysis" by Josu Olmos, Inigo Gandiaga, Dimas Lopez, Xabier Larrea, Txomin Nieva and Iosu Aizpuru.

In this paper, the life cycle costs of railway projects involving hybrid diesel-electric vehicles are analysed for different types of li-ion batteries and different energy management strategies. The best lithium-ion battery technologies are found to be LTO and NMC, and the most appropriated strategy being a state-machine controller optimised by a genetic algorithm approach. The best case obtains a life cycle cost reduction of the 4% and diesel savings of the 14% compared to a traditional diesel-electric railway vehicle.

The following paper is dedicated for the Mutli-motor traction system for EVs to improve traction performance and energy efficiency.

- "Analysis and Comparison of Operational Characteristics of EV Traction Units Combining Two Different Types of Motors" by Huynh Thanh-Anh, Chen Po-Hsun and Hsieh Min-Fu.

This paper proposes a traction unit that combines an interior permanent magnet (IPM) motor and a PM-assisted synchronous reluctance motor (PMa-SynRM) for electric vehicles (EVs) to improve traction performance, enhance the energy efficiency, and reduce cost. Simulation results reveal that the overall efficiency of the proposed traction unit can be improved compared to the other configurations. The advantages and drawbacks of the proposed traction unit are also investigated. Finally, experiments are conducted to validate the analysis.

The last paper proposes a multi-issue negotiation protocol to establish load coordination for EVs charging in distribution networks.

- "Multi-Issue Negotiation EVs Charging Mechanism in Highly Congested Distribution Networks" by Khan Komal, El-Sayed Islam and Arboleya Pablo.

This paper describes a multi-issue negotiation protocol between active consumers and a management platform to establish load coordination in a highly congested network. The multi-issue negotiation protocol considers simultaneously the consumption interval, the price, and the size of the energy packages. The derived algorithm is applied to coordinate the charging of electric vehicles in a distribution network in which building loads represent critical loads. This algorithm is provided in a generic form, and it could be applied to any other scenario.

Recently, at the COP26 - Climate talks hosted by the United Nations in Scotland in November 2021, Governments agreed to keep alive the Paris Agreement target of limiting global warming to 1.5 degrees Celsius. For EVs to unleash their full potential to combat climate change by a long-term strategy of global Net zero emissions by 2050, the 2020s will need to be the decade of mass adoption of electrified vehicles. The articles presented in the Special Section cover important aspects of electrified vehicles and can stimulate the EV community to create new research axes for more innovative EVs. We believe that the presented papers have a considerable contribution to the forthcoming development in the automotive industries.

We would like to thank Prof. Nei Kato, previous Editor-in-Chief of the IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY, and his team for their support. We are also grateful to our reviewers who dedicated their time in reviewing the submitted papers and provided valuables suggestions to the authors.

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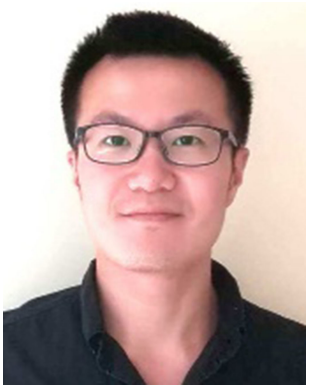

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His research interests at the L2EP (Laboratory of Electrical Engineering of Lille) include graphical descriptions (Energetic Macroscopic Representation) for control of electric drives, wind energy conversion systems, railway traction systems, hybrid electric vehicles, and hardware-in-the-loop testing. His collaborative works with industry on energy management for vehicles, include PSA Peugeot Citroen, Nexter Systems, Valeo, Renault Groupe, Siemens, and SNCF. From 2014 to 2019, he was nominated as the Chair of the Vehicle Power Propulsion Technical Committee by IEEE Vehicular Technology Society. Since 2016, has been elected as a Distinguished Lecturer by IEEE VTS. Since 2018, he is a French Coordinator of eCAMPUS, international associated laboratory on e-mobility between France and Canada. Since 2019, he is the Chair of the IEEE-VPPC steering committee.