Jorge Varela Barreras et al., Adv Automob Eng 2017, 6:3(Suppl)
DOI: 10.4172/2167-7670-C1-008



## Smart balancing systems: Towards virtually ideal Li-ion battery packs

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A lithium-ion battery pack consists of a number of cells in a series-parallel arrangement. The series connection, like in any chain, makes the performance limited by the weakest cell. If the cells were identical, this would not be a problem. However, there are cell-to-cell differences, which increase over battery lifetime, that lead to limited electrical performance and uneven temperature distributions. Nowadays, automotive industry overcomes this problem in the design of battery packs for Electric Vehicles partially by adopting the so-called passive balancing systems. These systems carry out selective discharge of cells during battery charging, allowing all the cells to be fully-charged at the end-of-charge. Thus, losses in useful capacity related to differences in initial state-of-charge are compensated. Active balancing systems have also been proposed. They conduct selective dis/charge of cells during dis/charging, allowing all cells to be always at a similar state-of-charge level. Thus, losses in useful capacity related to differences in state-of-charge at any time are minimized. However, they do not get the full endorsement of automotive industry, which usually considers the partial advantages offered to be insufficient to justify the extra costs and complexity. Our research aims to bring a paradigm shift, by improving the design and control of these systems. The goal is to overcome not some, but all the problems related with cell-to-cell variations, by developing a smart balancing system (SBS) that makes the performance of any battery pack virtually ideal. The SBS transfers the energy between cells in such a smart way that the temperatures are minimized and equalized, and the electrical performance is optimized, in terms of losses, power capability and useful capacity. Potential advantages in Electric Vehicle performance include extended driving range, extended operation without de-rating the max. available power and longer battery lifespan.

### Biography

Jorge Varela Barreras has completed his Postdoctral degree in Engineering Science at University of Oxford, UK, with interests in novel electric vehicle concepts and lithium-ion battery modeling, simulation, emulation, diagnostics, prognostics and management. He pursued his PhD in Battery Management at Aalborg University, Denmark, where he also received MSc degree in Power Electronics. Previously, he received MSc degree in Electrical Engineering from University of Vigo, Spain, where he co-founded a photovoltaic consulting company. He is a founder member of the Danish Battery Society and the representative of the Oxford Research Staff Society in the Department of Engineering Science, University of Oxford. He serves in the Editorial Board of Frontiers in Energy Research. He has been a Guest Lecturer at University Carlos III (2016), Aalborg University (2014-16) and, Faculty of Engineering of University of Porto (2015), University of Sfax (2016). From 2017, he is the major Lecturer in Engineering at the Oxford Tradition academic program, held in Pembroke College and Corpus Christi College.

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