Keynote Speech on

"A Futuristic Medium-Voltage Grid-Connected Multi-Port Public Electric-Vehicle Ultra-Fast Charging-Station with G2V and V2G capability"

by

Prof. Sanjib Kumar Panda

National University of Singapore

Email: eleskp@nus.edu.sg

Medium-voltage (MV) grid-connected solid-state-transformer (SST) based fast-charging (FC) stations provide several merits in terms of improved efficiency, power density, current limiting capability, etc. However, the propositions in literature are either not bidirectional (to simultaneously support V2G and G2V) or are unable to interface multiple types of plug-in electric-vehicles (PEVs), which are not able to meet the expectations of future fast-charging infrastructures. The fast-charging solutions available commercially are mostly for interfacing with the low voltage grid, and are unable to connect multiple type of PEVs. In this lecture, a futuristic MV grid-connected public multi-port FC/dC station is presented which not only resembles a conventional vehicle refuelling station's functionality by simultaneously interfacing all three types of PEV categories (heavy or hPEVs, medium or mPEVs and light or lPEVs), but also facilitates bidirectional power flow for V2G applications. The modulation, operation and control schemes of the front-end (FE) MVAC-LVDC single-stage conversion and back-end (BE) DC-DC conversion of the proposed architecture are presented in detail. Real-time digital-simulator (RTDS) based Hardware-in-loop (HIL) test results for full-scale 22 kV, 1 MVA architecture's bidirectional operation verifies the proposed operation and controller for full-scale operation. The architecture facilitates simultaneous FC/dC of 1 hPEV within 49.5 min, 2 mPEVs within 28 min and 4 lPEVs within 16 min, while adhering closely to the prescribed charging/discharging schedules of each PEV. Finally, a proportionally scaled down 1 kV, 13.2 kVA experimental verification validates the architecture's performance during drastic net power flow change conditions and exhibits a peak efficiency of 96.4% with a power density of 3.2 kVA/L. A comprehensive benchmarking of the proposed architecture with commercially available FC products is also presented.

Sanjib Kumar Panda (Fellow, IEEE) received his B. Eng. degree from the South Gujarat University (India) in 1983, M.Tech. degree from the Indian Institute of Technology, Banaras Hindu University (India) in 1987, and Ph.D. degree from the University of Cambridge (UK) in 1991, all in electrical engineering. Dr. Panda is currently the Chair of PELS TC 12 (Energy Access and Off-Grid Systems) and serves as an Associate Editor for various IEEE Transactions.

Achievements:
- – Cambridge-Nehru Scholarship (during Ph.D. study, 1987-1991)
- – Co-author of one book and several book chapters
- – Co-founded three start-up companies
- – Holds six patents
- – M.T. Mayer Graduate Scholarship (during Ph.D. study, 1987-1991)
- – Published over 450 peer-reviewed research papers

Research Interests: Building energy efficiency enhancement, Condition monitoring and predictive maintenance, High-performance control of motor drives and power electronic converters