先進寬能隙(WBG)元件在綠能電子的發展趨勢與應用研討會

2023 SEP. 01　9:00 -- ONLINE

時間	主題	講者	主持人
9:00 | 9:10	開　幕		陳耀銘 教授 NTU EE
9:10 | 10:40	採用 WBG 元件的分散式能源和電力電子設備	Prof. Liuchen Chang University of New Brunswick, Canada	陳耀銘 教授 NTU EE
10:40 | 12:10	推動電力電子技術發展的寬能隙(WBG)功率元件- 轉換器拓撲、建模和控制的創新	Prof. Yunwei Ryan Li University of Alberta, Canada	梁從主 教授 NCKU EE
13:30 | 15:00	GaN HEMT 在高頻功率轉換應用面臨的挑戰	Prof. Jason Lai Virginia Tech, USA	邱煌仁 教授 NTUST EE
15:00 | 16:30	WBG 電力電子轉換器的併網技術	Prof. Xiongfei Wang Kungliga Tekniska högskolan (KTH), Sweden	陳耀銘 教授 NTU EE
16:30 | 16:40	閉　幕		陳耀銘 教授 NTU EE

9:10-10:40 演講者一

Prof. Liuchen Chang,
Canadian Academy of Engineering Fellow
Dept. of Elec. and Comp. Eng.
University of New Brunswick
Fredericton, NB, Canada E3B5A3

題目 **"Distributed Energy Resources and Power Electronics with WBG Devices"**
採用 WBG 元件的分散式能源和電力電子設備

Abstract:
The transition of the electricity industry has led to a steady increase in the penetration of distributed energy resources (DERs) into grids. While the integration of these DER units in electric grids has brought significant challenges for grid operation, the tremendous potential of DERs in supporting power system operation as flexible resources has not been fully explored by utilities. This presents significant opportunities for new technologies and applications in DER integration, management and control. This presentation focuses on the recent advancements in DER markets in the context of power system transition, and the technical requirements for integrating DERs into power systems. As power electronic technologies are critical to system integration, performance enhancement and grid operation support involving DER systems, the pursuit of high performance and functionality has driven the advances in power converter technologies, including components, topologies, controls, and system support functions. Some of the highlights of the presentation include the WBG devices in DERs, developments in solid-state power filters in replacement of passive components, and direct load controls for ancillary services. Part of the presentation is based on the extensive review of the state-of-the-art technologies conducted by the IEEE International Technology Roadmap of Power Electronics for Distributed Energy Resources (ITRD).

Brief Bio:
Liuchen Chang received B.S. from Beijing Jiaotong University in 1982, M.Sc. from China Academy of Railway Sciences in 1984, and Ph.D. from Queen's University in 1991. He joined the University of New Brunswick in 1992 and is a Professor Emeritus at UNB. He was the NSERC Chair in Environmental Design Engineering during 2001-2007, and the Principal Investigator of Canadian Wind Energy Strategic Network during 2008-2014. He is a long-time volunteer for IEEE for over 30 years and was the President of the IEEE Power Electronics Society (2021-2022).
Dr. Chang was a recipient of the Canadian Wind Energy Association's Templin Award, New

Brunswick's Innovation Award for Excellence in Applied Research, and PELS Sustainable Energy Systems Technical Achievement Award. He is a fellow of the Canadian Academy of Engineering. He has published more than 400 refereed papers in journals and conference proceedings. Dr. Chang has focused on research, development, demonstration and deployment of distributed energy systems.

10:40-12:10 演講者二

Prof. Yunwei Ryan Li,
IEEE Fellow
Professor and Interim Chair, Department of Electrical and Computer Engineering
University of Alberta, Canada

題目 "**Advancement of Power Electronics Technologies enabled by Wide bandgap (WBG) Power Devices – Innovations in Converter Topologies, Modelling and Control**"
推動電力電子技術發展的寬能隙(WBG)功率元件--轉換器拓撲、建模和控制的創新

Abstract:
The recent development of wide bandgap (WBG) power devices has facilitated the rapid advancement of power electronics technologies and their industry applications. This development is particularly crucial to meet the pressing demands of distributed energy resources (DER), including renewable energy integrations, energy storage systems, and electric vehicles. In these applications, innovations in power electronic converter topologies and operational strategies can result in higher efficiency, improved reliability, and reduced physical footprint. Power electronics technologies play a vital role in addressing challenges within today's grids, encompassing energy management, system reliability, and efficient energy conversion. This presentation will specifically focus on recent advancements that tackle these challenges. It will cover various aspects, such as converter topology, design, and advanced control methods, including model predictive control and multi-rate-based techniques suitable for the high switching frequency of WBG-based power converters. Furthermore, it will explore the development of innovative topologies and modulation approaches inspired by graph theory-based methodologies.

Brief Bio:
Dr. Yunwei (Ryan) Li is currently a Professor and Chair with the Department of Electrical and Computer Engineering, University of Alberta, Canada. Dr. Li received the Ph.D. degree from Nanyang

Technological University, Singapore. Dr. Li was a Visiting Scholar with the Aalborg University, Denmark in 2005, and a Postdoctoral Research Fellow at Ryerson University, Canada 2006 - 2007. In 2007, he also worked at Rockwell Automation Canada before joined University of Alberta. His research interests include PWM and control of power electronics in distributed generation, microgrid, renewable energy, and electric motor drives. His research has produced more than 400 papers with over 20,000 citations.

Dr. Li was the Editor-in-Chief for IEEE Transactions on Power Electronics Letters 2019-2023. Prior to that, he was Associate Editor for IEEE Transactions on Power Electronics, IEEE Transactions on Industrial Electronics, IEEE Transactions on Smart Grid, and IEEE Journal of Emerging and Selected Topics in Power Electronics. Dr. Li served as the general chair of IEEE Energy Conversion Congress of Exposition (ECCE) in 2020. He is currently the Vice President for Products of IEEE Power Electronics Society (PELS), as well as the AdCom Member at Large for PELS. Dr. Li received the Nagamori Foundation Award in 2022 and the Richard M. Bass Outstanding Young Power Electronics Engineer Award from IEEE PELS in 2013. He is a Fellow of IEEE and recognized as the Clarivate Highly Cited Researcher.

13:30-15:00 演講者三

Prof. Jason Lai
IEEE Fellow
Virginia Tech James S. Tucker Professor
Dept. of Elec. and Comp. Eng.
Yushan Fellow Visiting Professor
National Yang Ming Chiao Tung University
International College of Semiconductor Technology

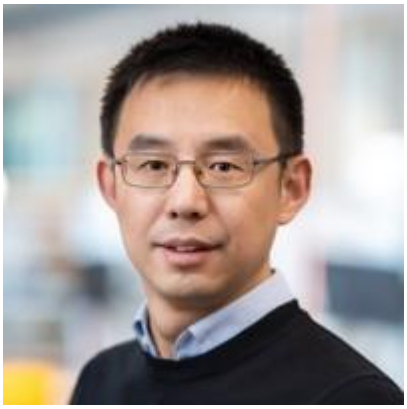
題目"**Challenges of GaN HEMT in High-Frequency Power Conversion Applications**"
GaN HEMT 在高頻功率轉換應用面臨的挑戰

Abstract:
Gallium nitride (GaN) high-electron-mobility-transistors belong to a distinct category of semiconductor devices that do not rely on doping materials for channel conduction. As a result, these transistors offer significantly faster switching speeds compared to conventional silicon devices, making them ideal for ultrahigh frequency switching and high-power-density converter designs. However, applying GaN HEMTs to high-frequency applications presents three major challenges. The first challenge pertains to parasitic components that can impact the device's switching characteristics. These parasitic elements originate from two sources: traditional wire-bond parasitic inductance and circuit layout related PCB inductances traces and copper planes

which contribute to parasitic inductance and capacitance. The second challenge revolves around thermal management, which becomes particularly challenging due to the need for compact designs and parasitic reduction. Conventional plastic packages may allow for heat sink mounting, but their inherent parasitic components are not acceptable for GaN HEMTs. The third challenge concerns the reverse conduction voltage drop. Wide bandgap devices have been notorious for exhibiting high reverse conducting voltage drops. In direct drive d-mode GaN, the negative gating voltage leads to an extra voltage drop. This high reverse conducting voltage drop can be considered a part of switching losses. In this presentation, some device characteristics and design examples will be explored to illustrate the aforementioned challenging aspects of using GaN HEMTs in megahertz switching converters.

Brief Bio:

Jih-Sheng (Jason) Lai received M.S. and Ph.D. in electrical engineering from the University of Tennessee, Knoxville, in 1985 and 1989, respectively. From 1989 to 1993, he was the senior power electronics engineer and manager at the Electric Power Research Institute (EPRI) Power Electronics Applications Center, where he managed EPRI-sponsored power electronics research projects. From 1993 to 1996, he worked with the Oak Ridge National Laboratory (ORNL) as the Power Electronics Lead Scientist, where he initiated a high power electronics program and developed several novel high power converters including multilevel converters and auxiliary resonant snubber based soft-switching inverters. He joined Virginia Tech in August 1996. Currently he holds James. S. Tucker Endowed Chair Professorship. In addition, he is also a Yushan Fellow Visiting Professor of National Yang Ming Chiao Tung University, Hsinchu, Taiwan. Dr. Lai is the recipient of 2016 IEEE Industry Applications Society Gerald Kliman Innovation Award, Technical Achievement Award in Lockheed Martin Award Night in 1995 and 14 Best Paper Awards from IEEE conferences and journals. His student teams won the First Prize Award in TI Analog Design Competition in 2011, Grand Prize Award from International Future Energy Challenge in 2013, the Top Three Finalist Award from Google Little Box Challenge in 2016



15:00-16:30 演講者四

Prof. Xiongfei Wang

IEEE Fellow

Kungliga Tekniska högskolan (KTH), Sweden

（瑞典皇家理工學院）

DIVISION OF ELECTRIC POWER AND ENERGY SYSTEMS

題目 **“Grid Integration of Wide-Bandgap Power Electronic Converters”**
WBG 電力電子轉換器的併網技術

Abstract:
The wide-Bandgap (WBG) power semiconductor devices are increasingly found in the grid-connected power converters. While WBG devices furnish several superior features to power converters, they pose challenges to the grid integration of converters. The faster switching behavior of WBG devices allows reducing the size of passive filters, yet it tends to widen the frequency range of control interactions of converters and with power grids. This lecture will discuss the opportunities and challenges with the use of WBG devices for grid-interactive power converters. A review of the state of the art solutions for addressing the challenges will then be presented.

Brief Bio:
Xiongfei Wang is a professor at KTH Royal Institute of Technology, Sweden, and at Aalborg University, Denmark. His research interests include modeling and control of power electronic converters, stability and power quality of power-electronic-based power systems, and high-power converters.
Dr. Wang is an IEEE Fellow and the Executive Editor for the IEEE Power Electronics Letters, and the Associate Editor for the IEEE Journal of Emerging and Selected Topics in Power Electronics. He received ten IEEE Prize Paper Awards, the 2018 Richard M. Bass Outstanding Young Power Electronics Engineer Award, the 2019 IEEE PELS Sustainable Energy Systems Technical Achievement Award, and the 2022 Isao Takahashi Power Electronics Award.