Research Statement

My research focuses on developing intelligent power electronic systems that enable resilient, efficient, & sustainable electricity networks with high penetration of renewable energy resources. As power systems transition from centralized fossil-fuel generation to converter-dominated distributed energy systems, significant challenges arise in voltage regulation, power quality, stability, protection, & coordinated control. My research seeks to address these challenges through advanced power electronic converter control, real-time digital simulation, & experimentally validated solutions for hybrid AC/DC power systems.

My research has primarily centred on **interconnected & networked microgrids**, where coordinated operation of multiple distributed energy resources can improve resilience, operational flexibility, & energy security. During my doctoral research at Nanyang Technological University, I investigated coordinated control strategies for hybrid multi-microgrid systems operating under varying grid conditions. This work established the foundation for my continuing research programme in intelligent converter control and distributed energy management.

A major contribution of my research has been the introduction of the concept of **non-local harmonic current and reactive power compensation**, demonstrating that power quality disturbances can be mitigated remotely through coordinated control rather than solely at the point of disturbance. This work resulted in the development of the **Series–Shunt Network Device (SSND)**, providing a new framework for network-level harmonic mitigation and reactive power compensation within interconnected microgrids. Building upon this foundation, my current research focuses on the **Multi-Functional Distribution Network Device (MDND)**, an intelligent power electronic converter capable of simultaneously providing voltage regulation, harmonic mitigation, reactive power support, coordinated real power flow control, and seamless energy exchange between AC and DC distribution networks.

My research philosophy emphasizes the integration of **theoretical modelling, control algorithm development, simulation, and software-in-loop (SIL) validation**. Rather than relying solely on analytical or simulation-based studies, I seek to validate new control strategies using real-time digital simulation and Hardware-in-the-Loop (HIL) methodologies. My current work at Edge Hill University, supported through an Internal Research Investment Fund project and conducted in collaboration with the **Power Electronics and Machines Centre (PEMC) at the University of Nottingham**, applies OPAL-RT technology to evaluate advanced converter control strategies under realistic operating conditions. This approach significantly improves the practical relevance and technology readiness of my research.

Looking ahead, my long-term objective is to establish an internationally recognised research programme in **AI-enabled intelligent power electronic systems for resilient and sustainable electricity networks**. My future research will integrate artificial intelligence & model predictive converter control to develop next-generation solutions for renewable-rich power systems. I also intend to strengthen interdisciplinary collaborations with academia, industry, and electricity network operators while securing competitive funding through EPSRC, UKRI, Horizon Europe, and industrial partnerships.

Throughout my career, I have viewed research and education as mutually reinforcing activities. I actively involve undergraduate & postgraduate students in research projects, integrating contemporary research challenges into teaching while fostering the next generation of researchers in power electronics & sustainable energy technologies. I aim to develop innovative technologies that contribute to the reliability, sustainability, and resilience of future electrical energy systems.