Bio-Sketch of Dr. Qing-Chang Zhong

Dr. Qing-Chang Zhong is the Max McGraw Endowed Chair Professor in Energy and Power Engineering at the Illinois Institute of Technology and the Founder and CEO of Syndem, LLC. He is a visionary researcher, educator, inventor, and entrepreneur whose transformative contributions across systems science, control theory, power electronics, and power systems have redefined how modern power grids operate. With four research monographs, over 250 peer-reviewed publications, and 18 patents, he has profoundly impacted both academia and industry, advancing autonomous, sustainable, and democratized power systems. He was an Associate Editor of four IEEE Transactions (Automatic Control, Power Electronics, Industrial Electronics, and Control System Technology) and a Distinguished Lecture of three IEEE societies (Control Systems, Power Electronics, and Power and Energy). He has delivered 200+ invited talks in over 20 countries, including a plenary lecture at the 2017 World Congress of the International Federation of Automatic Control (IFAC), the world's largest systems and control conference with over 3500 participants. He is a Fellow of both IEEE (2017) and IET (2010).

Transformative Contributions

Dr. Zhong's most transformative contribution is the invention of the SYNDEM (Synchronized-and-Democratized) Architecture, a paradigm-shifting framework that merges synchronization principles in natural sciences and democracy concepts in social sciences. It circumvents the limitations of democratized structures outlined in Nobel Laureate Kenneth Arrow's Impossibility Theorem, ensuring a synchronized consensus for stability as he has recently proven mathematically using the port-Hamiltonian theory. This novel approach makes it possible to continue adopting the deep-rooted synchronization mechanism, which has underpinned the power system operation for over a century, to govern future power systems dominated by distributed energy players. By addressing the fundamental compatibility and scalability challenges, the SYNDEM architecture enables autonomous, sustainable, decentralized power systems while ensuring stability and reliability and advancing energy equity, contributing to solving one of the most critical global challenges of the 21st century.

In addition to theoretical advancements, Dr. Zhong has invented the synchronverter technology to operate power electronic converters as Virtual Synchronous Machines (VSM), redefining how inverter-based energy players interact with the grid. His 2011 seminal paper on synchronverters, cited over 3,400 times, ranks among the Top 3 Most-Cited Non-Survey Papers in the 43-year history of *IEEE Transactions on Industrial Electronics*, making it one of the most influential contributions in the field. This technology is essential for integrating distributed energy players while maintaining grid stability, fundamentally shaping the concept of grid-forming inverters. His self-synchronization synchronverter paper (cited over 1,200 times) achieved synchronization without using any phase-locked loop (PLL), setting a new industry norm. Moreover, his robust droop control paper (cited over 1,000 times) identified and corrected three fundamental flaws in conventional droop control when applied to power converters, providing a universal solution for proportional power sharing with tight voltage and frequency regulation, regardless of component mismatches. He also revealed the structural resemblance among droop-controlled converters, VSM and PLL, laying a solid mathematical foundation to achieve inherent self-synchronization without using any PLL, and to qualify the robust (universal) droop-controlled converters as the second-generation VSM. His 2016 cover story on VSM in *IEEE Power Electronics Magazine* is the Most Popular Technical Article and a Highly-Cited Paper in the magazine's history.

Policy Impact and Global Influence

Dr. Zhong's research has shaped energy policy and regulatory frameworks worldwide. His SYNDEM and VSM technologies were cited in the 2018 U.S. Congress Hearing on *"The Electric Grid of the Future,"* recognizing their potential to enhance grid resilience and energy independence. In addition, Michael Pesin, Deputy Assistant Secretary at the U.S. Department of Energy (DOE), invited Dr. Zhong to discuss his work at the DOE headquarters and commented, *"Sooner or later, this will be deployed worldwide,"* acknowledging the inevitability of these groundbreaking technologies in shaping the future of global power systems. DOE also invited Dr. Zhong to deliver a talk on next-generation smart grids, which was well attended and well received by DOE policy makers and influential leaders, including Dr. C.D. (Dan) Mote Jr., former President of the National Academy of Engineering. Dr. Zhong's pioneering work foresees and directly aligns with major DOE initiatives introduced several years later, including the $25M UNIFI Consortium (2021) for unifying inverter-based energy resources and the $30M GRADIENTS Program (2025) on Grid Reliability with Automatic Damping and Inertia.

On a global scale, Dr. Zhong has led the development of IEEE Standard 2988-2024, the first international standard for Virtual Synchronous Machines, involving key manufacturers, such as GE, Siemens, Hitachi, Toshiba-Mitsubishi, ABB, Eaton, Schneider Electric, S&C Electric, SEL, and major utilities, such as North American Electric Reliability Corporation (NERC), ERCOT, Midcontinent Independent System Operator (MISO), Southern California Edison, and National Grid. His contributions to the UK National Grid Energy System Operator's VSM Expert Group (2018) have shaped the UK Grid Code Change GC0137 (2021), formally establishing regulatory specifications for grid-forming (formerly VSM) capability.

Broader Recognition and Public Engagement

Beyond academia and policy, Dr. Zhong's work has gained broad media attention. His work has been featured in *IEEE Spectrum*, *Canary Media*, and *SmartGridNews.com*. New York Times veteran correspondent Keith Schneider described Dr. Zhong's inventions as "*the sort of breakthrough — like the touch screen in smart phones — that helps to push an industry from one era to the next.*" Schneider further hailed Dr. Zhong's work as *"a game changer for grid,"* offering "*a technical solution to implement the lateral power envisioned by futurist Jeremy Rifkin that underpins the Third Industrial Revolution.*"

Dr. Zhong has actively communicated his work to the broader public. He has authored articles in *American City & County*, participated in radio interviews, organized NSF workshops, contributed to IEEE Smart Grid initiatives, and shared insights on LinkedIn (with one post received 27,000+ views), to foster public understanding of energy systems and sustainability. Dr. Zhong also pitched his work to a large public crowd and a group of investors at the $1M 76West Clean Energy Competition, where he was recognized as a semi-finalist.

Scientific Education and Mentorship Excellence

Dr. Zhong is also an exceptional educator and mentor. Some of his Ph.D. students have received prestigious awards, such as the IET Control and Automation Doctoral Dissertation Award and the Chinese National Award for Outstanding Students Abroad including one Grand Prize (only 10 around the world each year). He developed Smart Grid Research and Educational Kit, now used in 10+ countries, to prepare future energy leaders with the practical skills necessary to address global energy challenges. He organized IEEE International Future Energy Challenge, widening participation of international students. Dr. Zhong has delivered 200+ plenary/keynote/invited talks in 20+ countries, influencing the direction of global research and education in power and energy.

Dr. Zhong founded and led the Network for New Academics in Control Engineering (New-ACE) with support from the Engineering and Physical Sciences Research Council (EPSRC), UK, from 2007 to 2011, attracting 200+ members. This initiative played a pivotal role with a lasting impact in shaping the future of the UK control community, fostering collaboration, and supporting early-career researchers. Many former members are now leading figures in academia and industry, both in the UK and worldwide. His leadership and mentorship in New-ACE laid the groundwork for today's UK Automatic Control Engineering (ACE) Network funded in 2024 by EPSRC.

Interdisciplinary Vision and Entrepreneurial Leadership

A key driver behind Dr. Zhong's impact is his strategic interdisciplinary vision. Over the years, he has strategically and successfully advanced his career across multiple domains—starting with hardware engineering, integrating software development, advancing control theory, pioneering power electronics, and ultimately shaping power system architectures. He published monographs in different areas, on *Robust Control of Time-Delay Systems*, *Control of Power Inverters in Renewable Energy and Smart Grid Integration*, and *Power-Electronics-Enabled Autonomous Power Systems*. Recognizing the systemic challenges in power systems, he merged fundamental principles of natural and social sciences to form the SYNDEM architecture, a framework that enables global energy sustainability with inherent compatibility and scalability.

Dr. Zhong has not only advanced scientific theory but has also successfully commercialized his inventions. He licensed the synchronverter (the 1st-generation VSM) patent to an Israeli company and founded Syndem LLC in Greater Chicago, USA**,** to manufacture the 2nd-generation VSM. Syndem LLC has secured and completed four federal grants, field-tested the VSM technologies, developed commercial VSM products, and sold VSM domestically and internationally, driving the widespread adoption of his groundbreaking technologies. So far, Syndem has generated over $1.5M sales revenue, sustaining its organic growth. Dr. Zhong also participated in a competition and was offered investment by mHUB Product Impact Fund.