Qing-Chang Zhong

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Selected Highlights

- AAAS Fellow (2025 Class), IEEE Fellow (2017 Class), IET Fellow (2010 Class).
- He invented the Synchronized-and-Democratized (SYNDEM) architecture and pioneered its enabling virtual synchronous machine (VSM) technologies, establishing a unified physics-based foundation for autonomous, stable, and resilient power-electronic grids. The SYNDEM architecture and VSM technologies were cited in the **2018 U.S. House hearing, "The Electric Grid of the Future"** [M12].
- His 2011 seminal paper, "Q.-C. Zhong and G. Weiss, Synchronverters: Inverters That Mimic Synchronous Generators," published in *IEEE Transactions on Industrial Electronics,* ranks among the **three most-cited non-survey papers in the journal's 44-year history**, with nearly 4,000 Google Scholar citations as of June 2026.
- His 2016 invited, sole-authored *IEEE Power Electronics Magazine* cover story, "Virtual Synchronous Machines: A Unified Interface for Grid Integration," ranked among the magazine's two most-cited and two most-popular papers as of June 2026 and was recognized as its Top Paper of 2016.
- As of June 2026, his self-synchronization paper ranked among the top 30 most-cited non-survey papers in the 40-year history of *IEEE Transactions on Power Electronics*, with 1,350+ Google Scholar citations, and his robust-droop control paper had more than 1,100 Google Scholar citations.
- Semi-plenary speaker at the 2017 World Congress of the International Federation of Automatic Control (IFAC), marking IFAC's 60th anniversary and attracting 3,500+ participants; he delivered the sole lecture on power systems among its eleven plenary and semi-plenary lectures.
- His UK-based technical leadership convinced State Grid Corporation of China of the strategic importance of VSM technology and established the institutional foundation for State Grid to designate it as one of its Ten Key Science and Technology Innovation Projects, independently implement and commission the 140 MW Zhangbei VSM demonstration, and subsequently publish field results.
- His synchronverter invention was Highly Commended in 2009 IET Innovation Awards, and he received a Royal Academy of Engineering/Leverhulme Trust Senior Research Fellowship (2009–2010).
- His research was featured by Canary Media as a "Game Changer for Grid", by IEEE Spectrum three times (2025, 2017, 2013), by IEEE Power Electronics Magazine as a cover story, and included by IEEE PES Task Force report as Path to the Future, reached public officials via American City&County and policy-makers & utilities via IEEE Smart Grid and Institute of Public Utilities [M38].
- Distinguished Lecturer of three IEEE societies: Control Systems Society (CSS, 2015-2018), Power Electronics Society (PELS, 2014-2017), Power and Energy Society (PES, 2016-2027).
- Associate Editor of four IEEE Transactions: *TAC*, *TCST*, *TIE*, and *TPEL*.
- One PhD student received the Control and Automation Doctoral Dissertation Award, Institution of Engineering and Technology (IET), UK and two PhD students received the Chinese National Award for Outstanding Students Abroad including one Grand Prize (only 10 around the world each year).
- Four research monographs, including Q.-C. Zhong, *Power Electronics-Enabled Autonomous Power Systems: Next Generation Smart Grids*, Wiley-IEEE Press, 2020, a Top-3 Best Power Systems Book for Beginners by BookAuthority.org, the world's leading site for book recommendations.
- Delivered 26 plenary/keynote talks and 200+ invited lectures in 20+ countries.
- Initiated IEEE Std 2988-2024 and chaired the working group that developed it from ideation through publication, establishing the first global standard dedicated to VSMs.
- Licensed the synchronverter patent (first-generation VSM) to Synvertec, an Israeli company.
- Founded Syndem LLC in 2017 to develop and commercialize later-generation VSM technologies and extend SYNDEM into engineering practice:
  - SYNDEM Smart Grid Research and Educational Kits are adopted in 10+ countries; VSM products are adopted in three countries; cumulative product sales exceeded $1.6 million as of June 2026.
  - Completed four federally supported projects; built an autonomous six-VSM renewable home grid; carried out DOE-supported field tests with 20 VSM-equipped converters; manufactured and delivered 30 VSMs for a DOE-supported project involving Brookhaven National Laboratory; and helped establish Texas Tech's SYNDEM Smart Grid Testbed comprising 108 physical converters.
  - OPAL-RT and Syndem announced a strategic partnership in March 2026 for integration, hardware validation, joint marketing, and sales.

Education

2001.6-2003.12	Ph.D.	Dept. of Electrical & Electronic Engineering, Imperial College London, UK
1997.4-1999.12	Ph.D.	Dept. of Automation, Shanghai Jiao Tong University, China
1994.9-1997.4	M.Sc.	Dept. of Electrical Engineering, Hunan University, China
1985.9-1990.7	B.Eng.	Dept. of Electrical Engineering, Hunan Institute of Engineering, China

Current and Previous Positions

Date	Employer	Position
2014.8-now	Dept. of Electrical and Computer Engineering, Illinois Institute of Technology, Chicago, USA	Max McGraw Endowed Chair Professor of Energy and Power Engineering and Management
2017.5-now	Syndem LLC, Greater Chicago, USA	Founder & CEO
2012.4-2016.9	Dept. of Automatic Control and Systems Eng., Univ. of Sheffield, UK	Chair Professor then Research Professor after 2014.9
2012.8-2013.4	Center for Power Electronics Systems, Virginia Tech, Blacksburg, USA	Visiting Professor
2012.2-2014.12	China Electric Power Research Institute (CEPRI), Beijing, China	Consultant
2012.1-2012.8	Dept. of Mechanical and Aerospace Eng., Univ. of California, San Diego, USA	Visiting Scholar
2010.8-2012.4	Dept. of Aeronautical and Automotive Engineering, Loughborough Univ., UK	Chair Professor
2005.8-2010.8	Dept. of Electrical Engineering and Electronics, Univ. of Liverpool, UK	Senior Lecturer
2004.1-2005.7	School of Electronics, University of Glamorgan, UK	Senior Lecturer, then Reader
2001.4-2003.12	Dept. of Electrical and Electronic Engineering, Imperial College London, UK	Postdoctoral Fellow
2000.2-2001.4	Faculty of Mechanical Engineering, Technion-Israel Institute of Technology, Israel	Postdoctoral Fellow
1998.7-1999.9	Dept. of Automation, Shanghai Jiao Tong Univ., China	Research Assistant
1995.9-1996.2	Dept. of Electrical Engineering, Hunan University, China	Research Assistant
1990.7-1994.9	Dept. of Electrical Engineering, Xiangtan Institute of Mech. and Elec. Tech., China	Assistant Lecturer

Strategic Career Advancements

He has successfully made six strategic advancements in his career:

- **From Hardware to Hardware & Software.** He began his professional career in 1990 as a hardware engineer, working on motor drives, power electronics, PLCs, and embedded systems using micro-computers (Intel, Atmel, Motorola, Zilog). His role evolved to integrate software, beginning with a line-by-line study of an operating system in assembly language. Then, he developed ~100 KB object code in assembly language for a 16-reactor production line (1992), a 10,000-line C program for a flexible manufacturing system (1995), and a web-based PowerBuilder database (1997). This hardware-software integration was mostly practice-oriented and laid a strong foundation for his future career.
- **From Practice to Practice & Theory.** In 1997, he shifted from purely practical work to integrating theoretical research, beginning with chemical process control and later on robust control theory. Through extensive study, including tracing mathematical literature back to the 1930s, he solved several fundamental H_∞ control problems of delay systems. This led to his 1st research monograph, *Robust Control of Time-delay Systems* (2006). His 2nd monograph, *Control of Integral Processes with Dead Time* (2010, co-authored with A. Visioli), further solidified his key role in control engineering.
- **From Control to Control & Power Electronics.** After relocating to the UK in 2001, he expanded his focus on control to include power electronics. He developed many enabling control technologies for power electronic converters and invented several novel hardware converter topologies. This led to his 3rd research monograph, *Control of Power Inverters in Renewable Energy and Smart Grid Integration* (2013, Wiley-IEEE Press), co-authored with his former PhD student Tomas Hornik.
- **From Control & Power Electronics to Control, Power Electronics, and Power Systems.** While working on control and power electronics, he identified many challenges in future power systems and naturally expanded his research accordingly. In 2008, he invented the synchronverter technology (and coined the English word “synchronverter”) as the first practical, experimentally validated voltage-controlled virtual synchronous machine (VSM) realization. This earned him a Royal Academy of Engineering/Leverhulme Trust Senior Research Fellowship, UK, in 2009 to advance the technology. He later invented a control strategy to achieve synchronization without using any phase-locked loop, which was then widely regarded as essential for grid-tied converters. As the work progressed, he recognized that the challenge was not merely technical but systemic, requiring systems-level thinking.
- **From Engineering to Systems Science.** He decided to look for solutions from systems science. After thinking for many years and reading books and papers on large-scale natural, engineered, and societal systems, he merged the widely studied synchronization principles in natural sciences with the well-established democracy concepts in social sciences to create the holistic SYNDEM (meaning Synchronized-and-Democratized) architecture. This harmonizes and unifies the integration and interaction of conventional and renewable generation, network converters, energy storage, electric vehicles, and flexible loads, with power converters controlled as VSMs. Hence, the synchronization mechanism of synchronous machines, which has underpinned the operation and expansion of power systems for 100+ years, can continue to be used to govern future power systems. This addresses the compatibility and scalability problems faced by future power systems, while his later port-Hamiltonian, passivity, and input-to-state stability frameworks provide rigorous scalable stability foundations. Moreover, it circumvents the limitations of democratized societies as characterized by Nobel Laureate Kenneth Arrow’s Impossibility Theorem. This led to his 4th monograph, *Power Electronics-Enabled Autonomous Power Systems: Next Generation Smart Grids* (2020, Wiley-IEEE Press).
- **From Research and Education to Entrepreneurship - Closing the Theory-Practice Cycle.** Recognizing the profound societal impact of the SYNDEM architecture and VSM technologies, he took on a new challenge and founded Syndem LLC in 2017 to translate SYNDEM and VSM technologies into engineering practice. He delivered 26 plenary and keynote talks and 200+ invited talks in 20+ countries, initiated IEEE Std 2988-2024 and chaired its development from ideation to publication, and created SYNDEM Smart Grid Research and Educational Kits for workforce development. Syndem built an autonomous six-VSM renewable home grid, completed four federally supported projects, conducted DOE-supported field tests involving 20 VSM-equipped converters, manufactured and delivered 30 VSM units for a DOE-supported project, commercialized two product lines globally, and achieved cumulative product sales exceeding $1.6 million.

Summary of Major Contributions

Google Scholar Citations: 20,931; **h-index**: 64; **i10-index**: 169 (June 23, 2026)

Dr. Zhong is a multidisciplinary researcher and engineer specializing in systems science, control theory, power electronics, and power systems, a pioneering theorist shaping fundamental systems concepts, and a visionary entrepreneur driving groundbreaking innovations across academia, industry, and technology. His principal contribution is an integrated architecture-to-practice arc for power-electronic grids. He invented the Synchronized-and-Democratized (SYNDEM) architecture and pioneered its enabling virtual synchronous machine (VSM) technologies, including the synchronverter as his foundational first-generation practical voltage-controlled VSM invention, followed by advances in self-synchronization and robust and universal droop control. He established scalable mathematical foundations based on port-Hamiltonian systems theory, passivity, and input-to-state stability; launched and drove a sustained global initiative that transformed institutional pathways in China, United States, and Great Britain, and through the IEEE Standards Association; and, through his UK-based technical leadership, convinced State Grid Corporation of China of the strategic importance of VSM technology and established the institutional foundation for State Grid to designate it as one of its Ten Key Science and Technology Innovation Projects, independently implement and commission the 140 MW Zhangbei VSM demonstration, and subsequently publish field results. He validated the SYNDEM architecture and VSM technologies in autonomous multi-converter systems, DOE-supported field tests, Texas Tech's 108-converter SYNDEM Smart Grid Testbed, and the independently implemented Zhangbei demonstration; initiated IEEE Std 2988-2024 and chaired its development from ideation to publication, establishing the first global standard dedicated to VSMs; and translated successive generations of VSM technologies into practice through licensing, manufacturing, commercial products, and partnerships. Together, these contributions establish a unified physics-based foundation for autonomous, stable, and resilient power-electronic grids.

Systems Science: SYNDEM Architecture and Ghost Power Theory

Synchronized-and-Democratized (SYNDEM) Architecture

He merged the widely studied synchronization principles in natural sciences with the well-established democracy concepts in social sciences to form the SYNDEM architecture for large-scale systems, and applied it to address the systemic challenges faced by future power systems with distributed energy players [M43], [127], [B1], [36]. This circumvents the limitations of democratized societies characterized by Nobel laureate and economist Kenneth Arrow's Impossibility Theorem[1], enabling autonomous power systems with enhanced grid stability and reliability. This holistic architecture solves the compatibility and scalability problems arising from the paradigm shift in power systems from electric-machine-based to power-electronics-based systems, enabling autonomous operation of future power systems and advancing energy freedom and energy equity.

Operationally, SYNDEM provides a backward-compatible universal interface through which conventional and renewable generation, network converters, energy storage, electric vehicles, and, critically, flexible loads share a common synchronization law inherited from the existing grid and can participate continuously in voltage and frequency regulation according to capacity. Basic synchronization and regulation arise through electrical interaction without reliance on continuous high-speed communication or centralized control, providing a communication-independent layer of decentralized cyber-physical grid security against external telecommunications disruption or manipulation, while digital systems remain available for monitoring, management, markets, optimization, and supervisory set-points. Through energy bridges, local systems can black-start, regulate voltage and frequency, merge, island, recover, resynchronize, and reconnect autonomously, supporting scalable self-organization while containing disturbances and reducing cascading-failure risk.

As written in his research monograph [B1], "future power systems will not only be democratized but also should be synchronized. This leads to the concept of Synchronized-and-Democratized (in short, SYNDEM) smart grids. … The synchronization mechanism of synchronous machines, which has underpinned the organic growth and stable operation of power systems for over 100 years, can continue

[1] Arrow's Impossibility Theorem says that, when there are more than two distinct candidates, there does not exist a voting (democratic) system that can convert individual preferences about the candidates into a transitive, i.e. strictly ranked, order of community preferences if four fairness criteria, which are perfectly reasonable when considered separately, are required at the same time.

serving as the Rule of Law for SYNDEM smart grids. Moreover, the power electronic converters that are adopted to integrate different players can be equipped with the synchronization mechanism through control to achieve Legal Equality. … The synchronization phenomenon has intrigued some of the most brilliant minds of the 20th century, including Albert Einstein, Richard Feynman, and Norbert Wiener. In 2017, the Nobel Prize in Physiology/Medicine was awarded to Jeffrey C. Hall, Michael Rosbash and Michael W. Young for their discoveries of molecular mechanisms that synchronize cellular metabolism and organismal behavior to the light-dark cycle to generate biological rhythms with 24 h periodicity. Hence, adopting the synchronization mechanism of synchronous machines as the Rule of Law to govern SYNDEM smart grids is probably also the most natural option."

His research monograph [B1] is recognized as a *Top-3 Best Power Systems Book for Beginners by BookAuthority.org*[2], the world's leading site for book recommendations. Keith Schneider, a New York Times correspondent since 1982, wrote that the monograph "*offers a technical solution to implement the lateral power envisioned by futurist Jeremy Rifkin that underpins the Third Industrial Revolution*." Michael Pesin, then Deputy Assistant Secretary at the U.S. Department of Energy (DOE), invited him to DOE headquarters and commented, "*Sooner or later, this will be deployed worldwide.*" He was recognized by the International Federation of Automatic Control (IFAC) as a semi-plenary speaker [127] at the 2017 IFAC World Congress, the world's largest systems and control conference —nicknamed "the Olympics in Control"—which attracted 3,500+ participants. He was appointed a Distinguished Lecturer by three IEEE societies—the Power Electronics Society, Control Systems Society, and Power & Energy Society—and delivered lectures on this work worldwide. Overall, he has delivered 200+ invited lectures in 20+ countries. The SYNDEM architecture and VSM technologies were **cited in the 2018 U.S. House Hearing on "The Electric Grid of the Future"** [M12], and featured by Canary Media in 2017 as a "Game Changer for Grid" [M19], by SmartGridNews.com as "a self-directed smart grid" [M24], and by IEEE Spectrum in 2013 as "Completely Self-Controlled Power Systems … millions of active players" [M25], in 2017 as a "vision for a harmonious grid" [M16], and in 2025 as a "technology to prevent blackouts." The work was also featured by IIT Magazine as "*Tao of Power*" [M15], included in an IEEE PES Task Force report as a "Path to the Future," and communicated to city, county, and state officials via American City&County [M41] and to policymakers and utilities through IEEE Smart Grid [M43] and the Institute of Public Utilities [M38]. He was interviewed by Science News Radio Network in 2014 [M23].

Ghost Power Theory

The concepts of real power and reactive power play a vital role in various physical domains. The physical meaning of real power is clear: it represents the power (energy) that does the real work. However, the physical meaning of reactive power is not clear – it is an imaginary mathematical concept. He introduced the ghost operator to physically construct the ghost of a sinusoidal signal, by adding $\pi/2$ radians to the phase, and further the ghost of a system with sinusoidal inputs by adding the ghost operator to the inputs [34], [B1]. With the concept of the ghost system, the reactive power of a system is the real power of the ghost system with its input being the ghost of the input to the original system. For an electrical machine, the real power is related to the electromagnetic *torque* T but no similar quantity is defined to associate with the reactive power. In order to close this gap, he coined the term *quorte* Γ as the dual of torque, representing the ratio of the reactive power to the flux [B1], [8], [125]. Since no reactive power concept was defined for mechanical systems, he then introduced reactive power for mechanical systems, placing the last piece to complete the analogy between electrical systems and mechanical systems. Furthermore, he generalized this to any dynamic system that can be described by a port-Hamiltonian (PH) system model, establishing a significantly simplified instantaneous power theory, referred to as the ghost power theory. This theory is applicable across multiple physical domains with multiple frequencies (harmonics) and multiple phases. It has been adopted by several researchers to improve the performance of motor drives and is expected to be applied to other domains as well because of its fundamentality.

Power Electronics and Power Systems: VSM and Converter Technologies

Synchronverter and Virtual Synchronous Machine (VSM) Technologies

He invented the synchronverter technology in 2008 as the first practical, experimentally validated voltage-controlled VSM, embedding the mathematical model of a conventional synchronous generator with inertia and damping directly in converter-voltage generation [82], [199], [P20], and then applied it to integrate

[2] BookAuthority.org, The Best Power Systems Books for Beginners, https://bookauthority.org/books/beginner-power-systems-books?t=1yj0cz&s=award&book=1118803523.

wind turbines [70], [173], PV panels [155], STATCOM [175], rectifiers [176], and motor drives [191], [192], among other applications. Unlike earlier current-controlled VSM approaches, such as VISMA, this invention is crucial because power systems are dominated by voltage sources. The seminal paper [82], published in *IEEE Transactions on Industrial Electronics,* ranks among the three most-cited non-survey papers in the journal's 44-year history, with nearly 4,000 Google Scholar citations and 44,000+ downloads/views on ieee.org as of June 29, 2026. The technology was recognized as "game changer for grid" [M19] and received a Highly Commended distinction in the 2009 IET Innovation Awards. The invited, sole-authored cover story "Virtual Synchronous Machines: A Unified Interface for Grid Integration" [43], published in *IEEE Power Electronics Magazine* in 2016, ranked among the magazine's two most-cited and two most-popular papers as of June 2026 and was recognized as its Top Paper of 2016. It outlines how power electronic converters, either on the supply side or on the load side, can all be controlled to behave like virtual synchronous machines (VSM) with the inherent dynamics of synchronous machines, *providing a unified interface for seamless smart grid integration with virtual damping and inertia* to facilitate large-scale utilization of distributed energy resources and enhance grid stability and reliability. This 2016 unified-interface synthesis is an important reference point in the U.S. field-building and later federal-priority chronology summarized in Institutional Transformation and Policy Impact.

Self-synchronization Without Using any Phase-Locked Loop

He proposed, for the first time, to achieve synchronization for inverters through control without measuring grid frequency or using any phase-locked loop (PLL) [72], improving control performance and stability while reducing complexity and computational burden. This defines a new norm for industry practice as the current industry has been relying on PLL for synchronization, although there are many known drawbacks. The paper [72] ranked among the top 30 most-cited non-survey papers in the 40-year history of *IEEE Trans. on Power Electronics*, with 1,350+ Google Scholar citations and 16,000+ views as of June 29, 2026.

Robust Droop Control and Universal Droop Control

He identified and corrected three fundamental flaws of the conventional droop control when applied to power converters, ensuring proportional sharing of real power and reactive power while achieving specified voltage and frequency regulation [184], [77], regardless of the impedance value, parameter mismatch of components, and numerical errors. Later, he mathematically proved the robust droop controller to be universal for converters with different impedance types as well [165], [59], paving the way for mass manufacturing of power converters. Moreover, he established the structural resemblance among droop-controlled converters, VSMs and PLL [51], [166], laying a solid mathematical foundation to achieve self-synchronization without using any PLL [72], [48], and to qualify the robust (universal) droop controlled converters with any physically-implementable impedance as the second-generation VSM [36], [B1]. The robust droop control paper [77] received 1,100+ Google citations with 12,000+ views.

Power Electronic Converters with a Common DC and AC Ground

Ground is one of the most fundamental concepts in electrical engineering. The importance of a common ground is well recognized in the telecom industry, with the governing standard ANSI/TIA-607. However, this has not been recognized in the power industry. Along with the large-scale deployment of power converters at high voltages, high currents, and high switching frequencies, this fundamental problem will gradually emerge and cause electro-magnetic interference (EMI) and leakage-current problems, because the DC ground and the AC ground of the power converters deployed nowadays are mostly separated. In order to prevent this from happening, he proactively invented several novel converter topologies with a common DC and AC ground, including an independently-controlled neutral leg [B2], [30], the θ-converter [45], [39], the Beijing converter [42], and the Syndem converters [P1], [P8], together with the necessary control strategies. These technologies are commercialized by his start-up company in products that enable grounded operation without using an isolation transformer for enhanced safety, the sharing of a common storage among multiple converters for reduced costs, significant reduction of leakage currents for lowered fire risks, and fast and accurate detection of ground faults for enhanced protection and safety. These technologies will be extremely important when wide-bandgap semiconductor devices are widely used for applications with high voltages, high currents, and high switching frequencies, which is imminent.

Current-limiting Controller

Power electronic converters can easily be damaged due to over-currents so it is essential to ensure converter currents stay below a given bound. He developed current-limiting control methods for DC/DC converters [23], single-phase rectifiers [55], and three-phase rectifiers [29], current-limiting droop control for grid-tied inverters [35], and current-limiting controller without using a PLL [53]. For the first time, he demonstrated that it was possible to ride through short-circuit faults on the AC side [53].

Impedance-Sum Stability Criteria

The small-signal stability of power converters is very important. He proved that the stability of single converter/source is equivalent to its impedance without any right-half-plane (RHP) zeros or RHP poles. He also proved that a system with two individually stable converters/sources is stable if and only if the sum of the individual impedances does not have any RHP zeros [22]. This impedance-sum stability criteria can be applied, regardless of the connection of the two converters/sources, whether in parallel operation, such as parallel-operated voltage-controlled inverters in microgrids and parallel-operated current-controlled inverters connected to the grid, or in series (cascaded) operation, such as cascaded DC/DC converters and grid-connected current-controlled converters.

Impedance Shaping for Enhanced Stability and Performance

Impedance determines the stability and behavior of a system. He introduced control strategies to change the impedance of normal converters from inductive to resistive [77] and capacitive [71], termed as R-converters and C-converters, respectively, to shape the converter impedance for enhanced power quality [174], virtual damping [B1], [P9], and stability [21], [46], [47], [54], [60], [62].

Power Quality Control

He identified and analyzed the mechanisms that could cause the degradation of converter power quality and proposed a series of control strategies to mitigate power quality degradation, including shaping the converter impedance to be capacitive at low frequencies [71], [182], adopting an unusual cascaded current-voltage control structure [76], injecting harmonic voltage components through a novel harmonic droop controller [78], adopting the H_∞ repetitive controller [81], [85], [100], adopting the UDE-based controller equipped with time-delayed filters [18], [24], bypassing harmonic current components to shape the impedance [174] etc. The power quality control is an important part of his book [B2], which once ranked No. 7 on Amazon's Best Sellers list for Power Generation & Distribution.

Mathematical Foundations and Control Theory

Passivity and Input-to-State Stability of Large-Scale Power Systems Enabled by VSM

He developed a VSM-based control framework for grid-tied or islanded converters to render a power electronic system passive without assuming constant frequency, voltage, or loads by adopting the port-Hamiltonian (pH) systems theory [8], [125]. *This theory combines the Hamiltonian modeling approach in geometric mechanics (a mathematics branch) and the port-based network modeling approach widely used in different physical domains (mechanical, electrical, hydraulic, thermal, etc.) to represent a system as a network of interconnected components. The dynamics of each component are described through a Hamiltonian function and the interactions between the components are governed by a Dirac structure that enforces energy conservation at the system level*. In a follow-on paper in 2024 [5], he generalized this mathematical control framework to model generic power systems dominated by power converters that are interconnected through a passive transmission and distribution (T&D) grid. This framework is scalable, applicable to power systems having an arbitrary number of power converters with passive controllers, passive loads, and different types of passive T&D lines connected in a meshed configuration without self-loops, and hence it is very generic. Moreover, the resulting power system is mathematically proven to be passive and input-to-state stable, ensuring a synchronized consensus for stability of SYNDEM smart grids. The LinkedIn post on this quickly received 27,000+ views.

Bounded Integral Controller for Guaranteed Closed-loop Stability

Feedback is one of the most fundamental concepts in control systems and engineering. However, the feedback mechanism cannot guarantee the stability of a closed-loop system even if the plant is open-loop stable. He introduced the bounded integral controller (BIC) [44] to guarantee the closed-loop system stability in the sense of boundedness for input-to-state (practically) stable (ISpS) plant systems, which holds for most engineering systems, by generating a bounded controller output independently from the plant parameters and states. He further designed the BIC parameters to ensure that the controller output stays within a given bound, extending the result for locally ISpS plant systems. The BIC can replace the traditional integral controller and guarantee asymptotic stability of the desired equilibrium point under certain conditions, thus solving the closed-loop stability problem of many engineering systems that are locally ISpS without requiring knowledge of the plant structure or parameters. This has been applied to bounded universal droop control [7], controller with limited control power [11], systems with input constraints [12], VSM with bounded frequency and voltage [28], bounded droop controller [69], etc.

UDE (Uncertainty and Disturbance Estimator)-based Robust Control Theory

He introduced the UDE (uncertainty and disturbance estimator)-based robust control theory for systems subject to uncertainties and external disturbances [96]. Based on the fact that any engineering signal has a finite frequency spectrum, he proposed a method for lumping uncertainties and disturbances within a system, passing them through a filter, and feeding the filtered output back into the system to compensate for these uncertainties and disturbances. Through a series of subsequent papers to address two-degree-of-freedom structure [80], asymptotic reference and disturbance rejection [37], output feedback control [15], stabilization [19], mismatched uncertainties and disturbances [9], [25], input constraints [12], etc., he established the UDE-based robust control theory, transforming complex robust control problems into straightforward filter design problems. Today, this theory is widely adopted across diverse applications, including time-delay systems [83], [84], [31], unmanned aerial vehicles [27], [56], power electronic converters [18], [24], [32], [33], wind turbines [40], piezoelectric stages [52], servo systems [63], wing rock motion stabilization [65], and chemical processes [49], [25], etc.

Robust Control of Time-delay Systems

He systematically and comprehensively studied robust H_∞ control of time-delay systems in the frequency domain using the state-space approach and solved several fundamental problems [B4], such as J-spectral factorization [94], controller parameterization [101], the delay-type Nehari problem [104], the extended Nehari problem [103], the standard H_∞ control problem for systems with a single delay [103], and an open problem related to the implementation of distributed delays in control laws [98], [95], [209], [213]. The standard H_∞ control problem of systems with a single input/output delay is transformed into a delay-free standard H_∞ control problem and a one-block problem with the delay, which is subsequently converted to an extended Nehari problem [103], using the chain-scattering approach. All the control laws incorporate a modified Smith predictor, of which a numerical issue is identified. To address this, a unified Smith predictor [214], [97] is proposed. Finally, the implementation of distributed delays in control laws is explored with three methods: using discrete delays [98] and rational functions obtained with the δ-operator [95] and the bilinear transformation [209]. This leads to two formulas that significantly enhance the accuracy of conventional rectangular numerical integration methods [B4].

Algebraic Riccati Equation, Similarity Transformation and Block Diagrams

He uncovered the hidden connection between the well-known Algebraic Riccati Equations (ARE) and the widely-used block diagrams, through the well-known mathematical tool of similarity transformations [206], [B4]. This linkage not only facilitates solving ARE but also provides deeper insights into the structure of ARE and establishes the equivalence of multiple ARE derived from different H_∞ control methods.

J-spectral Factorization and Similarity Transformation

He proved [94], [208] that the J-spectral factorization of a general regular para-Hermitian transfer matrix is equivalent to the existence of a common nonsingular matrix that similarly transforms the A-matrices of both the transfer matrix and its inverse into 2x2 lower and upper triangular block matrices with the (1, 1)-block capturing all the stable modes of the transfer matrix and its inverse, respectively.

Global Field Leadership: Institutional Transformation and Policy Impact

Soon after inventing the synchronverter in 2008, while based in the United Kingdom, Dr. Zhong launched a global initiative to build worldwide technical and institutional momentum around the emerging VSM direction. Through more than 200 invited lectures in over 20 countries and sustained engagement with universities, research centers, utilities, industry, and public institutions, he advanced the SYNDEM architecture and its enabling VSM technologies from foundational invention and research into a global engineering movement. The initiative unfolded through complementary pathways: technical and institutional transformation culminating in utility-scale demonstration in China; multidisciplinary field building, policy engagement, and federal technology development and validation in the United States, followed by convergence with major national research priorities; regulatory translation in Great Britain; and global standardization through IEEE Std 2988-2024.

The clearest institutional transformation within this initiative occurred at State Grid Corporation of China. During his earlier UK-based career, after inventing the synchronverter in 2008, Dr. Zhong introduced and championed VSM technology through dozens of lectures in China, convinced State Grid of VSM technology's importance and secured State Grid funding for a dedicated collaborative project between the China Electric Power Research Institute (CEPRI) and the University of Sheffield, and led the dedicated VSM project team at CEPRI beginning in 2012. Dr. Zhong moved to the United States in August 2014, and the UK-based collaboration later concluded after the project was completed. The technical and institutional foundation he had established proved decisive in State Grid's subsequent decision to designate VSM technology as one of its Ten Key Science and Technology Innovation Projects and undertake a utility-scale VSM demonstration. His invention, advocacy, program initiation, and technical and institutional leadership converted an original research direction first into State Grid's institutional commitment and then, through State Grid's independent implementation and commissioning, into the 140 MW Zhangbei VSM demonstration, with field results subsequently published by the engineers involved.

A complementary institutional and policy pathway unfolded in the United States. Years before grid-forming technologies became a consortium-scale U.S. federal research category, Dr. Zhong had already articulated the underlying direction and begun building U.S. institutional momentum through his global initiative. An early U.S. component of the initiative was a UK-funded international sabbatical that he initiated in October 2010 and undertook in 2012–2013. He visited and delivered lectures on the architecture and its enabling VSM technologies at three NSF-established Engineering Research Centers: Center for Power Electronics Systems (CPES), Future Renewable Electric Energy Delivery and Management Systems Center (FREEDM), and Center for Ultra-wide Area Resilient Electric Energy Transmission Networks (CURENT); one NSF Industry–University Cooperative Research Center: Grid-Connected Advanced Power Electronic Systems (GRAPES); two U.S. national laboratories: National Renewable Energy Laboratory (NREL) and Oak Ridge National Laboratory (ORNL); and approximately 20 leading U.S. universities. In September 2013, IEEE Spectrum reported his proposal for completely self-controlled power systems with millions of active participants, autonomous voltage and frequency regulation, and no central coordination. After moving to the United States in August 2014, he progressively advanced this direction through technical synthesis, policy engagement, multidisciplinary field building, federal technology development, and global standardization. His invited, sole-authored 2016 cover story framed VSMs as "A Unified Interface for Grid Integration." In 2017, Michael Pesin, then Deputy Assistant Secretary at the U.S. Department of Energy, invited Dr. Zhong to DOE headquarters for focused technical discussions on SYNDEM and VSM technologies and stated, "*Sooner or later, this will be deployed worldwide*." In 2018, the SYNDEM architecture and VSM technologies were cited in the U.S. House hearing "The Electric Grid of the Future," bringing their implications for grid resilience and energy independence into the congressional record.

In early 2019, Dr. Zhong initiated, secured NSF support for, and chaired a Workshop on Power Electronics-Enabled Operation of Power Systems, held at Illinois Tech on October 31–November 1, 2019. It convened the control, power-electronics, and power-systems communities and attracted more than 130 participants from government agencies, regulatory commissions, utilities, industry, research organizations, and universities [M10]. NSF also awarded a planning grant led by him for a proposed Engineering Research Center for Communication-network-free, Autonomous, Renewable Electric Power Systems (CARE), active from September 2019 to August 2020. In November 2019, DOE announced an award to Syndem for a project led by Dr. Zhong on autonomous grid-forming inverters enabled by always-on universal droop control without external communication or phase-locked loops; the project began in February 2020. Together, these NSF- and DOE-supported initiatives demonstrate his leadership in convening the field, advancing a center-scale research vision, and developing communication-network-independent autonomous power systems.

In December 2020, while Dr. Zhong's DOE project was underway, DOE issued a funding opportunity to establish a $25 million Grid-Forming Technologies Research Consortium. On January 22, 2021, Dr. Zhong initiated the IEEE VSM standardization project, and on March 31, 2021, DOE invited him to present "Next-Generation Smart Grids: Autonomous Power Systems" to policymakers and senior leaders, including Dr. C.D. Mote Jr., former President of the National Academy of Engineering.

In August 2021—*thirteen years after he invented the synchronverter, eight years after IEEE Spectrum featured his proposal for completely self-controlled power systems with millions of active participants, and five years after his 2016 cover story framed VSMs as "A Unified Interface for Grid Integration"*—DOE selected and funded the $25 million Universal Interoperability for Grid-Forming Inverters (UNIFI) Consortium to "develop a universal set of guidelines that enable seamless integration of inverter-based resources."[3] Nearly another four years later, in January 2025, DOE's Advanced Research Projects Agency–Energy announced the $30 million Grid Reliability with Automatic Damping and Inertia for

[3] DOE, UNIFI Consortium, https://www.energy.gov/eere/solar/unifi-consortium.

Electrical Networks and Transmission Systems (GRADIENTS) program to "help incorporate a variety of generation sources and stabilize the grid to prevent cascading failures that can lead to dangerous and costly blackouts" and "to enable better grid coordination, protection, and real-time control, resulting in a more reliable, more resilient American energy landscape."[4]

These landmark federal initiatives demonstrate that a unified interface for grid integration and the associated needs for interoperability, automatic damping and inertia, autonomous synchronization, coordinated control, and grid stability—an engineering direction Dr. Zhong had articulated and advanced for many years through the SYNDEM architecture and its enabling VSM technologies—subsequently emerged as major U.S. federal research priorities. This chronology underscores his engineering foresight and the enduring significance of the direction he defined and pioneered.

Great Britain served both as the original base of his global initiative and, later, as a distinct pathway of regulatory impact. Through sustained engagement with National Grid Electricity System Operator, now the National Energy System Operator, and participation in its VSM Expert Group, Dr. Zhong contributed to the technical foundation for Grid Code modification GC0137, which established a specification for grid-forming capability.

Dr. Zhong further extended the policy reach of his work through articles in *American City & County* [M41], addressing U.S. city, county, and state officials responsible for developing and implementing government policy, programs, and projects, and in Impact [M42], addressing the wider global public sector, funders, and policymakers. He served on the IEEE Smart Grid Steering Committee and delivered a Distinguished Lecture to the Institute of Public Utilities' Grid School, which is designed to strengthen regulatory capacity for grid-related policy development and decision-making across levels of government.

Validating SYNDEM and VSM Across Scales: From Testbeds to Utility Scale

Dr. Zhong's global initiative was grounded in engineering proof. He moved SYNDEM and VSM from architecture and field leadership into physical systems, field testing, commercial operation, and independent utility-scale validation. He established the world's first 100-percent-power-electronics-based SYNDEM smart-grid testbed, in which eight heterogeneous physical VSMs were connected to a common AC bus and collectively regulated voltage and frequency without ICT-based low-level coordination. Presented in his semi-plenary lecture at the 2017 IFAC World Congress, featured by IEEE Spectrum and Canary Media, and documented in his 2020 Wiley–IEEE research monograph, it provided architecture-level physical proof that a fully converter-based grid could coordinate autonomously under SYNDEM.

Validation then advanced from an autonomous six-VSM renewable home grid integrating solar, wind, storage, and utility-grid interaction to field tests of 20 VSM-equipped converters with solar panels, batteries, and the utility grid under grid-connected and islanded conditions, as part of a U.S. Department of Energy-supported program. At system scale, Texas Tech's reconfigurable SYNDEM Smart Grid Testbed, comprising 108 physical power converters, provides infrastructure for system-level validation, resilience research, and workforce development.

The autonomous operation of Syndem's five commercial VSM units further demonstrates repeatable SYNDEM behavior, including black-start, voltage and frequency regulation, grid detection, self-synchronization and connection, islanding, and resynchronization and reconnection.

Validation also reached utility scale. The technical and institutional foundation Dr. Zhong established during his UK-based career as part of his global initiative proved decisive in State Grid Corporation of China's subsequent decision to pursue VSM technology at utility scale. In 2017, State Grid, the world's largest utility, independently implemented and commissioned the 140 MW Zhangbei utility-scale VSM demonstration, comprising 59 wind turbines totaling 118 MW, twenty-four photovoltaic inverters totaling 12 MW, and two 5 MW station-level VSM units. Reported at the time as the world's largest VSM demonstration, Zhangbei provided independent utility-scale validation of the broader VSM direction that Dr. Zhong had pioneered and defined, with field measurements demonstrating critical virtual inertia (synthetic inertia) and robust fault ride-through capabilities in the transmission-connected project.

Selected engineering demonstration videos are shown below.

[4] ARPA-E Announces $30 Million to Increase Grid Resiliency Under Dynamic Conditions, https://arpa-e.energy.gov/news-and-events/news-and-insights/arpa-e-announces-30-million-increase-grid-resiliency-under-dynamic-conditions.

[Six-VSM Renewable Home Grid](#)

[DOE-Supported Twenty-VSM Field Tests](#)

[TTU 108-Converter SYNDEM Testbed](#)

[Five Commercial VSM Units](#)

Global Standardization: IEEE Std 2988-2024

He initiated IEEE Std 2988-2024, *IEEE Recommended Practice for Use and Functions of Virtual Synchronous Machines* (VSM), and chaired the working group that developed it from ideation to publication, completed it nine months ahead of the schedule with a 97% approval rate. This is the first global standard dedicated to VSMs, uniting contributions from key manufacturers, such as GE, Siemens, Hitachi, ABB, Toshiba-Mitsubishi, Eaton, SEL, S&C Electric, and Schneider Electric, and reliability organizations, system operators, utilities, and research institutions such as North American Electric Reliability Corporation (NERC), Electric Power Research Institute, ERCOT, Midcontinent Independent System Operator (MISO), Southern California Edison, National Grid, Energinet (Danish TSO), and CLP Power Hong Kong. The standard defines fundamental principles and essential and optional VSM functions for single-unit, multi-unit, islanded/off-grid, and grid-tied operation. Approved in 2024 and published in 2025, it institutionalized VSM technologies globally and is expected to play a pivotal role in facilitating the large-scale utilization of distributed energy resources and the integration of power converters to the grid, and advancing energy freedom and energy access.

Commercialization and Engineering Translation

Dr. Zhong has translated successive generations of VSM technology into engineering practice through two distinct commercialization routes. During his UK-based career, the synchronverter patent family was licensed to Synvertec for commercialization of first-generation VSM technology. Synvertec subsequently attracted public and private support from Horizon GreenTech Ventures, Israel Electric Corporation, the Israeli government, and the European Union's Horizon 2020 program, creating an independent commercialization pathway for the foundational invention.

In 2017, Dr. Zhong founded Syndem LLC in Greater Chicago to develop and commercialize later-generation VSM technologies, including second-generation VSMs based on universal robust droop control, and to extend SYNDEM into products, manufacturing, field validation, education, licensing, and partnerships. Syndem has carried out technology development and validation through four federally supported projects, completed DOE-supported field tests involving 20 VSM-equipped converters, and established in-house capabilities to design, test, and manufacture converters up to 20 kW. As an industry partner in a DOE-supported project led by Binghamton University and involving Brookhaven National Laboratory, Syndem manufactured and delivered 30 VSM units.

Syndem's reconfigurable and reprogrammable Smart Grid Research and Educational Kits have been adopted by institutions in more than 10 countries, while its VSM products have been sold to customers in three countries. Cumulative product sales exceeded $1.6 million as of June 2026. In March 2026, OPAL-RT and Syndem announced a strategic partnership for joint marketing, integration, and sales, combining real-time simulation and hardware-in-the-loop testing with VSM products and reconfigurable physical hardware to provide an end-to-end pathway from modeling to experimental validation.

Together, the Synvertec and Syndem routes demonstrate sustained translation from foundational invention through licensing, federally supported development, field testing, manufacturing, customer delivery, international sales, and an expanding engineering ecosystem. The two routes remain technically and institutionally distinct: Synvertec pursued commercialization of licensed first-generation VSM (synchronverter) technology, while Syndem develops later-generation VSM technologies. Syndem's operations are also institutionally separate from Dr. Zhong's academic activities at Illinois Tech.

Global Field Building: Education and Workforce Development

Dr. Zhong has built a global community around SYNDEM and VSM technologies through sustained international lecturing, scholarly resources, hands-on education, technical training, competitions, workshops, and mentorship. He has delivered 200+ invited lectures in 20+ countries, including 26 plenary and keynote talks, and has been appointed a Distinguished Lecturer by the IEEE Control Systems, Power Electronics, and Power & Energy Societies. He has authored four research monographs; organized 22 workshops and tutorials at major international conferences; conducted radio interviews; and engaged with the public through LinkedIn posts, press releases, and articles. At Sheffield, he established a $5M+ research laboratory for energy and power systems control, supported by Rolls-Royce, National Grid, National Instruments, Texas Instruments, Siemens, ALSTOM, Turbo Power Systems, Chroma, Yokogawa, OPAL-RT, and others. He developed reconfigurable and reprogrammable SYNDEM Smart Grid Research and Educational Kits to enable hands-on education and research; the kits have been adopted by institutions in more than 10 countries to educate next-generation engineers. He published educational papers [13], [1] to encourage professors around the world to Go Real and equip students with hands-on skills. He also helped build up world-class large-scale facilities for research and education [M7].

He established VSM as one of the two topics of the 2015 IEEE International Future Energy Challenge, an annual undergraduate student competition, attracting 12 proposals from six countries and culminating in hardware testing by seven finalist teams and an 80-plus-person workshop. He also led a 2019 National Science Foundation workshop that convened more than 130 participants from government, industry, utilities, research organizations, and universities.

During his UK-based career, Dr. Zhong mentored doctoral students who received the IET Control and Automation Doctoral Dissertation Award and Chinese National Awards for Outstanding Students Abroad, including one Grand Prize. He also founded and led the EPSRC-supported Network for New Academics in Control Engineering, which attracted more than 200 members and helped lay the groundwork for today's UK Automatic Control and Systems Engineering Network, with many former members now leading in academia and industry.

Media Recognition

[M1]. ITeN Editorial Board, Recognition highlights SYNDEM and Virtual Synchronous Machines (VSM) as a unifying foundation for the future of global power systems, *IE Technology News*, April 9, 2026, https://iten.ieee-ies.org/featured-news/2026/qing-chang-zhong-has-been-elected-fellow-of-the-american-association-for-the-advancement-of-science/.

[M2]. OPAL-RT Technologies, "OPAL-RT and SYNDEM Form Strategic Partnership to Advance Grid Stability and Hardware Validation for Modern Power Systems," March 10, 2026, available at https://www.opal-rt.com/press-room/opal-rt-and-syndem-form-strategic-partnership-to-advance-grid-stability-and-hardware-validation-for-modern-power-systems/.

[M3]. Qing-Chang Zhong and Rui Zhong, Could This Technology Prevent Blackouts? Virtual Synchronous Machines can help stabilize power grids, *IEEE Spectrum*, December 15, 2025, https://spectrum.ieee.org/virtual-synchronous-machines. Editorially-selected expert feature.

[M4]. Syndem LLC was recognized as a **Top Key Player in Smart Energy Market**, https://www.prophecymarketinsights.com/market_insight/smart-energy-market-5750, Jan. 2025.

[M5]. Innovation intelligence firm StartUs Insights, with instant access to 4.7M+ startups, features Syndem as a **Top 3 Power Electronics Startup** Out Of 123 In Grid Modernization, Dec. 2024, https://www.startus-insights.com/innovators-guide/3-top-power-electronics-startups-out-of-123/.

[M6]. Syndem LLC is recognized as one of **8 Best Smart Grid Companies to Watch in 2025** by ClimateSort.com, https://climatesort.com/smart-grid-companies/, December 2024.

[M7]. Allen Ramsey, Reimagining the Grid with **World-Class Facilities**, Texas Tech Today, Nov. 7, 2023, https://today.ttu.edu/posts/2023/11/Stories/Reimagining-the-Grid-with-World-Class-Facilities.

[M8]. Jennifer Runyon, **Tests completed** of grid-forming solar & storage inverters, RenewableEnergyWorld.com, March 15, 2022, https://www.renewableenergyworld.com/energy-business/energy-finance/doe-helps-fund-20-field-tests-of-grid-forming-solar-storage-inverters/.

[M9]. Ashok Bindra, **U.S. Department of Energy funds Syndem** to advance solar inverter technology, *IEEE Power Electronics Magazine*, https://ieeexplore.ieee.org/abstract/document/9118994, 2020.

[M10]. Q.-C. Zhong, "Power Electronics-Enabled Operation of Power Systems [Happenings]," in *IEEE Power Electronics Magazine*, vol. 7, no. 1, pp. 12-14, Mar. 2020. NSF-funded field-building report.

[M11]. Eric Reinhardt, NYSERDA announces 19 semifinalists in this year's 76West competition, Central New York Business Journal, July 16, 2019, https://www.cnybj.com/nyserda-announces-19-semifinalists-in-this-year-s-76west-competition/.

[M12]. THE ELECTRIC GRID OF THE FUTURE, **HEARING BEFORE THE SUBCOMMITTEE ON ENERGY COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY, HOUSE OF REPRESENTATIVES, 150th CONGRESS**, SECOND SESSION, Serial No. 115–63, JUNE 7, 2018, https://www.congress.gov/115/chrg/CHRG-115hhrg30326/CHRG-115hhrg30326.pdf. "This (Synchronized-and-Democratized) novel architecture will allow diverse power suppliers to interface with the grid as virtual synchronous machines, playing an active role in the regulation of system frequency and voltage."

[M13]. Qing-Chang Zhong **[People in Control]**, in *IEEE Control Systems Magazine*, vol. 38, no. 3, pp. 27-29, June 2018, doi: 10.1109/MCS.2018.2810518.

[M14]. Marcia Faye, Moving Toward a **More Sustainable Power Grid**, August 24, 2018, available at https://www.iit.edu/news/moving-toward-more-sustainable-power-grid.

[M15]. Marcia Faye, **Tao of Power**, *Illinois Tech Magazine* (Online Exclusives), Spring 2018, available at http://www.syndem.com/Tao_of_Power.pdf.

[M16]. J. Ge, P. Song, H. Liu, et al., "Research and Demonstration Application of Virtual Synchronous Generator Technology in Renewable Energy Power Station," *Journal of Global Energy Interconnection*, vol. 1, no. 1, pp. 39–47, 2018. Reports field results, including virtual inertia and robust fault ride-through, from the independently implemented 140 MW Zhangbei VSM demonstration by engineers from the implementing organizations and demonstration station.

[M17]. **National Energy Administration/Xinhua**, "**New-Energy Power Station with Virtual-Synchronous-Machine Functions Commissioned in Hebei**," December 29, 2017, available at https://www.nea.gov.cn/2017-12/29/c_136859301.htm.

[M18]. David Wagman, Smart Power Electronic Converters May Help Stabilize the Grid - Qing-Chang Zhong lays out his vision for a **harmonious grid**, ***IEEE Spectrum***, October 19, 2017, available at https://spectrum.ieee.org/can-power-electronic-converters-lead-to-grid-stability

[M19]. Keith Schneider, **Illinois engineer's invention expected to be game changer for grid**, *Canary Media*, September 13, 2017, available at https://www.canarymedia.com/articles/enn/illinois-engineers-invention-expected-to-be-game-changer-for-grid

[M20]. China Electric Power News, "**The World's Largest-Capacity Virtual Synchronous Machine Demonstration Project Will Be Built in Zhangbei**," December 29, 2016, available at https://www.escn.com.cn/news/show-381754.html.

[M21]. M. Dehong Xu, International Future Energy Challenge Report for 2015 [Society News], *IEEE Power Electronics Magazine*, vol. 2, no. 4, pp. 15-18, Dec. 2015.

[M22]. IIT Armour College of Engineering **Names Dr. Qing-Chang Zhong as McGraw Endowed Chair** of Energy and Power Engineering and Management, *Illinois Tech News*, 08/04/2014, available at

https://www.iit.edu/news/iit-armour-college-engineering-names-dr-qing-chang-zhong-mcgraw-endowed-chair-energy-and-power

[M23]. **Radio Interview by Science News Radio Network**, January 27, 2014, available at http://www.promiseoftomorrow.biz/audio/012714/partone.mp3.

[M24]. Jesse Berst, What's next after self-healing? How about a self-directed smart grid, **SmartGridNews.com**, Sept. 17, 2013, archived at http://www.syndem.com/SmartGridNews.pdf.

[M25]. Bill Sweet, Completely Self-Controlled Power Systems Are Proposed, ***IEEE Spectrum***, Sept. 13, 2013, https://spectrum.ieee.org/completely-selfcontrolled-power-systems-are-proposed.

Public Engagement

[M26]. LinkedIn post on "Fundamentals prevail — given time," January 6, **~60,000** impressions, https://www.linkedin.com/feed/update/urn:li:activity:7414319894508265472/.

[M27]. LinkedIn post on IEEE Standard 2988-2024, January 28, 2025, ~**12,000** impressions, https://www.linkedin.com/feed/update/urn:li:share:7290021163185881089.

[M28]. LinkedIn post on generic control and modelling framework for power systems, January 9, 2024, ~**28,000** impressions, https://www.linkedin.com/feed/update/urn:li:share:7150486664505643010.

[M29]. LinkedIn post on Smart Grid Research and Educational Kits, ~**20,000** impressions, Sep 20, 2023, https://www.linkedin.com/feed/update/urn:li:share:7110255406605627392.

[M30]. Syndem LLC, Syndem Completes the Field Tests of Twenty Grid-Forming Inverters for a Project Funded by the Department of Energy, EIN Presswire, https://lnkd.in/d4fVQdVk , 2-Mar-22, Picked up by **198 websites**, The LinkedIn post on this attracted over 11,000 impressions.

[M31]. Syndem LLC, Wiley-IEEE Publish Syndem CEO's Book on Power Electronics-Enabled Autonomous Power Systems: Next Generation Smart Grids, EIN Presswire, https://www.einpresswire.com/article/517763787 , 9-Jun-21, Picked up by about **270 websites**. The LinkedIn post on this received over 10,000 impressions.

[M32]. Syndem LLC, Syndem Founder and CEO Dr. Zhong to lead IEEE Standards Working Group on Virtual Synchronous Machines (VSM), EIN Presswire, https://lnkd.in/epKdC-F, 6-Apr-21, Picked up by **101 websites**. The LinkedIn post on this received 6500 impressions.

[M33]. Syndem LLC, Syndem Joins PowerAmerica to Accelerate Manufacturing of Wide-bandgap Devices-Enabled Grid-Forming Inverters in the U.S., EIN Presswire, https://www.einpresswire.com/article/533432458 , 24-Dec-20, Picked up by **811 websites**.

[M34]. Syndem LLC, Syndem to Provide Grid-forming Solar and Storage Inverters for a Project Selected by the U.S. Department of Energy, EIN Presswire, https://lnkd.in/erPyd6h, 21-Dec-20, Picked up by **552 websites**.

[M35]. Syndem LLC, IEEE TV Releases Syndem CEO's Keynote at IECON 2020 on Next-Generation Smart Grids, EIN Presswire, https://www.einpresswire.com/article/532495732, 10-Dec-20, Picked up by 84 websites.

[M36]. Syndem LLC, American City & County Features Syndem's Rethinking on Renewable Power Systems, EIN Presswire, https://www.einpresswire.com/article/508786707/american-city-county-features-syndem-s-rethinking-on-renewable-power-systems, 20-Feb-20, Picked up by about **300 websites**.

[M37]. Syndem LLC, U.S. Department of Energy Funds Syndem to Advance its Solar Inverter Technology, EIN Presswire, https://lnkd.in/eZzCJXi, 14-Jan-20, Picked up by **100 websites**.

[M38]. Distinguished Lecture, Power Electronics-Enabled Autonomous Power Systems: Synchronized-and-Democratized (SYNDEM) Smart Grids, **Institute of Public Utilities (IPU) Grid School**, East Lansing, Michigan, April 9-12, 2018.

[M39]. Distinguished Lecture, Synchronization and Democratization of Future Power Systems, **Summer Institute on Sustainability and Energy (SISE)**, Chicago, 2017.

[M40]. Qing-Chang Zhong, Primary Frequency Control of Future Power Systems, *IEEE Smart Grid Newsletter*, June 2017, available at https://dyh28w2y3a9av.cloudfront.net/video/private/SGNL0243/SGNL0243.pdf.

[M41]. Qing-Chang Zhong, Rethinking Renewable Power Systems, *American City&County*, pp.10-14, March 2020, available at https://secure.viewer.zmags.com/publication/1c544127#/1c544127/12.

[M42]. Qing-Chang Zhong, Pioneering next-generation smart grids, *Impact*, September 2017, pp. 6-7, DOI: https://doi.org/10.21820/23987073.2017.7.6.

[M43]. Qing-Chang Zhong, How to Achieve Completely Autonomous Power in the Next Generation of Smart Grids, ***IEEE Smart Grid***, September 13, 2013, available at http://www.syndem.com/IEEE_SmartGrid_SGNL2013.pdf.

Awards and Honors

- "Q.-C. Zhong and G. Weiss, Synchronverters: Inverters That Mimic Synchronous Generators," published in *IEEE Transactions on Industrial Electronics* in April 2011, ranks among the three most-cited non-survey papers in the journal's 44-year history, with nearly 4,000 Google Scholar citations as of June 29, 2026.
- "Q.-C. Zhong, Virtual Synchronous Machines: A unified interface for grid integration" published in *IEEE Power Electronics Magazine* in Dec. 2016 as a **cover story,** ranked among the magazine's two most-cited and two most-popular papers as of June 2026 and was recognized as its Top Paper of 2016.
- The Synchronized-and-Democratized (SYNDEM) architecture and enabling Virtual Synchronous Machines (VSM) technologies he invented for power systems were **cited in the U.S. Congress hearing** on "THE ELECTRIC GRID OF THE FUTURE" in 2018 [M12].
- Semi-plenary Speaker, 2017 World Congress of the International Federation of Automatic Control (**the world's largest conference in systems/control engineering** with 3500+ participants), France, 2017.
- Fellow, AAAS (American Association for the Advancement of Science), 2025 Class, elected "for inventing the Synchronized-and-Democratized (SYNDEM) architecture by merging synchronization principles in natural sciences and democracy concepts in social sciences, and for pioneering Virtual Synchronous Machines (VSM) technologies to revolutionize power systems."
- Fellow, IEEE (Institute of Electrical and Electronics Engineers, USA), 2017 Class.
- Fellow, IET (Institution of Engineering and Technology, UK), 2010 Class.
- Distinguished Lecturer: IEEE Power Electronics Society (PELS, 2014-2017), IEEE Control Systems Society (CSS, 2015-2018), IEEE Power and Energy Society (PES, 2016-2027)
- Innovation Award for synchronverters, Institute of Engineering and Technology (IET), UK, 2009
- Senior Research Fellow, Royal Academy of Engineering/Leverhulme Trust, UK, 2009-2010
- Best Doctoral Thesis (the Eryl Cadwaladar Davies Prize), Imperial College London, UK, 2004
- Outstanding Reviewer for *Automatica*, 2004
- Awards to Supervised Students and Postdocs:
  - Postdoc Mohammad Amin, IEEE IES Students and Young Professionals Paper Assistance (SYPA) Competition Award, 2018.
  - PhD student Wenlong Ming, IET Control & Automation PhD Award, UK, 2017.
  - PhD student Xin Zhang, Chinese National Award for Outstanding Students Abroad, Grand Prize (10 awards around the world each year), 2016.
  - PhD student Wenlong Ming, Chinese National Award for Outstanding Chinese Students Abroad by the China Scholarship Council (500 awards around the world each year), 2015.
  - MEng student Tomas Hornik, IET Prize, 2007
- Selected recognitions to his startup company Syndem LLC founded in 2017
  - 2018: Finalist for Exelon's Climate Change Investment Initiative (2c2i).
  - 2019: Semifinalist for $1M 76west Competition, which is "one of the largest" competitions in U.S. that focuses on supporting entrepreneurs to build clean-energy businesses and economic development, by New York State Energy Research and Development Authority (NYSERDA).
  - 2024: Top 3 Power Electronics Startups Out of 123 In Grid Modernization by Innovation intelligence firm StartUs Insights [M5].

- 2024: 8 Best Smart Grid Companies to Watch in 2025 by ClimateSort.com [M6].
- 2025: Top Key Players in Smart Energy Market, prophecymarketinsights.com [M1].

Plenary and Keynote Talks

1. Keynote talk, Power-Electronics-Enabled Autonomous Power Systems: Next-Generation Smart Grids, at the *Workshop on Powering the Future: Mastering Grid-Forming Inverters in Renewable Energy Systems*, Doha, Qatar, December 4-5, 2024.
2. Keynote talk, Power-Electronics-Enabled Autonomous Power Systems: Next-Generation Smart Grids, at the *IEEE Workshop on Smart Converters for Sustainable Energy Systems*, Stockholm, Sweden, December 2, 2024.
3. Plenary talk, Power-Electronics-Enabled Autonomous Power Systems: Next-Generation Smart Grids, at the *2023 Panda Forum on Power and Energy*, Chengdu, China, April 27-30, 2023.
4. Keynote talk, Power Electronics-Enabled Autonomous Power Systems: Next Generation Smart Grids, *IEEE Int. Conf. on Electrical Engineering & Sustainable Technologies*, Lahore, Pakistan, Dec. 2022.
5. Keynote talk, Power Electronics-Enabled Autonomous Power Systems: Next Generation Smart Grids, at *the 46th Annual Conference of the IEEE Industrial Electronics Society (IECON 2020)*, Singapore, October 18-21, 2020.
6. Keynote talk, Synchronized-and-Democratized Smart Grids - Next Generation Smart Grids, the *24th International Conference on Electrical Engineering (ICEE 2018)*, Seoul, South Korea, June, 2018
7. Semi-plenary talk, Autonomous Distributed Control of Next-Generation Smart Grids, at *The 2017 Asian Control Conference*, Gold Coast, Australia, December 2017.
8. Keynote talk, Next-Generation Smart Grids: Architecture and Technical Route, at *The 2017 Southern Power Electronics Conference*, Puerto Varas, Chile, December 2017.
9. Plenary talk, Autonomous Distributed Control of The Next-Generation Smart Grid, at *The XIII National Conference - Control in Power Electronics and Electric Drives*, Lodz, Poland, November 2017.
10. Semi-plenary talk, Synchronized-and-Democratized Smart Grids (SYNDEM), at *The 20th World Congress of the International Federation of Automatic Control (IFAC)*, Toulouse, France, July 2017.
11. Opening Keynote, Next-Generation Smart Grids: Power Electronics-Enabled Autonomous Power Systems, *the Digital Energy Summit at NIWeek 2017*, Austin, Texas, May 22-25, 2017.
12. Keynote talk, Next-Generation Smart Grids: Power Electronics-Enabled Autonomous Power Systems, at the First IEEE Workshop on Smart Grids - UFSM, The Federal University of Santa Maria (UFSM), Brazil, September 26, 2016.
13. Keynote talk, The Democratization of Power Systems: Architecture and Technical Route, at the *Digital Utilities Europe 2016 Conference*, London, UK, May 2016.
14. Keynote talk, Next-Generation Smart Grids: Architecture and Technical Routes, at *Global Energy Interconnection Forum*, Chicago IL, Nov. 2015.
15. Keynote talk, Next-Generation Smart Grids: Architecture and Technical Routes, *the 5th International Conference on Power Engineering, Energy and Electrical Drives*, Riga, Latvia, May 11-13, 2015.
16. Plenary talk, Distributed Control of Next-Generation Smart Grids with Many Players, at the *1st Indian Systems and Controls Conference*, Chennai, India, Jan. 5-7, 2015.
17. Keynote talk, Next-Generation Smart Grids: Completely Autonomous Power Systems (CAPS), *20th Int. Conference on Automation and Computing (ICAC2014)*, Cranfield, UK, Sept. 12-13, 2014.
18. Keynote talk, Next-Generation Smart Grids: Completely Autonomous Power Systems (CAPS), at *Real-Time 2014 Conference*, Montreal, Canada, June 9-12, 2014.

19. Distinguished Lecture, Next-Generation Smart Grids: Completely Autonomous Power Systems (CAPS), *26th Chinese Control and Decision Conference (CCDC)*, Changsha, China, May 31, 2014.

20. Plenary talk, Next-Generation Smart Grids: Completely Autonomous Power Systems (CAPS), at *Delta Power Electronics Forum*, Suzhou, China, May 30, 2014.

21. Keynote talk, Next-Generation Smart Grids: Completely Autonomous Power Systems (CAPS), at *2014 IEEE International Energy Conference*, Croatia, May 13-16, 2014.

22. Plenary talk, Next-Generation Smart Grids: Completely Autonomous Power Systems (CAPS), the *8th Symposium on Power Electronics and Electrical Drives (SPEED)*, Wuhan, China, April 11-13, 2014.

23. Plenary talk, Next-Generation Smart Grids: Completely Autonomous Power Systems (CAPS), at the *6th IEEE Annual Green Technologies Conference* in Corpus Christi, Texas, April 3-4, 2014.

24. Plenary talk, Next-Generation Smart Grids: Completely Autonomous Power Systems (CAPS), at the *3rd Int. Conference on Advances in Control and Optimization of Dynamical Systems (ACODS)*, IIT Kanpur, India, March 13-15, 2014.

25. Plenary talk, Next-Generation Smart Grids: Completely Autonomous Power Systems (CAPS), at *the 29th Annual Conference of Chinese Universities on Electric Power Systems and Automation*, Yichang, China, Nov. 7-10, 2013.

26. Plenary talk, Next-Generation Smart Grids: Completely Autonomous Power Systems (CAPS), at *the 4th IEEE Conference on Power Electronics for Distributed Generation Systems (PEDG)* in Rogers, Arkansas, July 8 – 11, 2013. ***The first plenary talk after he established the architecture and its enabling VSM technology framework*.**

Workshops, Tutorials and Panel Discussions

1. Tutorial on Advancing Grid-Forming Control with Standardized Virtual Synchronous Machines (VSM): IEEE Std 2988-2024, SYNDEM Architecture, and Hands-On Workforce Development, at the 2026 IEEE Energy Conversion Congress & Exposition (ECCE 2026), Vancouver, British Columbia, Canada, October 04, 2026.

2. Moderator, Panel on Large-scale Utilization of Distributed Energy Resources in D.C.: Challenges and Solutions, IEEE PES General Meeting, Washington D.C., July 2021.

3. Tutorial on Grid-forming Inverters, Virtual Synchronous Machines, and Power Electronics-enabled Autonomous Power Systems, IEEE Energy Conversion Congress & Expo, Detroit, MI, Oct. 2020

4. NSF Workshop on Power Electronics-enabled Operation of Power Systems, Chicago, Oct. 31, 2019.

5. Panel on *The University at the Energy Barricades* at The Empowering Communities and Cities, Chicago, IL, November 2017.

6. Panel on *Primary Frequency Response,* the 2017 IEEE PES General Meeting, Chicago, IL, July 2017.

7. Panel on *Synchronous Control of Power Converters for Renewable Applications and Beyond* at the 2017 IEEE PES General Meeting, Chicago, IL, July 2017.

8. Tutorial on *Next-Generation Smart Grids: Architecture and Technical Routes* at the 2016 IEEE International Symposium on Industrial Electronics, Santa Clara CA, June 2016.

9. Panel Discussion on *Power Electronics-enabled Autonomous Power Systems* at the 2016 IEEE PES General Meeting, Boston, MA, July 2016.

10. Tutorial on *Virtual Synchronous Machines for Power Electronics based Power Systems and Microgrids* at 2015 IEEE Energy Conversion Congress & Exposition (ECCE 2015), Montreal, Canada, September 20, 2015.

11. Workshop on *Next Generation Smart Grids: Power Electronics Based Power Systems* at the 2015 American Control Conference, Chicago, IL, June 30, 2015.
12. International Future Energy Challenge (Topic B), Sheffield, UK, July 20-22, 2015.
13. Tutorial on *Power Electronics based Power Systems: Next Generation Smart Grids* at the 40th Annual Conference of the IEEE Industrial Electronics (IECON), Dallas, TX, Oct. 29-Nov. 1, 2014.
14. Tutorial on *Control of Power Inverters for the Smart Grid*, at the 19th IFAC World Congress, Cape Town, South Africa, August 24-29, 2014.
15. Tutorial on *Control of Power Inverters for Smart Grids*, at the 5th International Symposium on Power Electronics for Distributed Generation Systems (PEDG2014), Galway, Ireland, June 24-27, 2014.
16. Tutorial on *Control of Power Inverters for the Smart Grid*, at the 2014 American Control Conference, Portland, OR, June 4 - 6, 2014.
17. Workshop on *Control of Power Inverters for the Smart Grid* at the 2013 American Control Conference, Washington, DC, June 16, 2013.
18. *Next-Generation Smart Grid: Completely Autonomous Power Systems (CAPS)*, 2013 CPES Annual Conference, Center of Power Electronics, Virginia Tech, April 7, 2013**.**
19. Workshop on *Control of Power Inverters in Renewable Energy and Smart Grid Integration*, CPES, Virginia Tech, March 9, 2013.
20. Workshop on *Control and Power Electronics for Renewable Energy and Smart Grid Integration* at the 51st IEEE Conference on Decision and Control, Hawaii, Dec., 2012.
21. Tutorial on *Control of Power Inverters for Renewable Energy and Smart Grid Integration,* at the 38th Annual Conference of the IEEE Industrial Electronics, Montreal, Canada, October 27, 2012, which was the most welcomed tutorial at the conference with all 100 seats reserved well before the closure of online registration.
22. Workshop on *Control of Power Inverters for Renewable Energy and Distributed Generation*, at the 2012 American Control Conference, Montréal, Canada, June 26, 2012.

Selected Invited Talks

200+ invited talks at universities, institutions and companies around the world. Some are listed below.

1. Invited talk, Power-Electronics-Enabled Autonomous Power Systems: Hardware-based Case Studies, RT25 Global User Conference, Chicago, IL, October 27-30th, 2025.
2. Invited talk for the inauguration of the Guwahati Subsection of the IEEE Industry Applications Society (IAS) Chapter Power-Electronics-Enabled Autonomous Power Systems: Next-Generation Smart Grids, India, October 16, 2024.
3. Distinguished lecture on Power-Electronics-Enabled Autonomous Power Systems: Next-Generation Smart Grids, organized by IEEE Austin - PES, IAS, PELS & IES Joint Chapter, June 22, 2021.
4. Invited talk, Next-generation Smart Grids: Autonomous Power Systems, **Department of Energy**, U.S., March 31, 2021. **Well attended and well received by DOE policy makers and influential leaders, including Dr. C.D. Mote Jr., former President of the National Academy of Engineering**.
5. Invited talk, SYNDEM Technology to Emulate Synchronous Machines, webinar organized by Midcontinent Independent System Operator (MISO), March 11, 2021.
6. IEEE CSS Distinguished lecture on Autonomous Distributed Control of the Next-Generation Smart Grid, Guayaquil, Ecuador, November 13, 2019.
7. IEEE PES Distinguished lecture on Next-Generation Smart Grids: Synchronized-and-Democratized (SYNDEM) Smart Grids, Binghamton University, October 17, 2019.

8. Power Electronics-enabled Autonomous Power Systems: Synchronized-and-Democratized (SYNDEM) Smart Grids, NSF Workshop on Power Electronics-enabled Operation of Power Systems, Chicago, October 31-November 1, 2019.
9. Distinguished lecture on Next-Generation Smart Grids: Synchronized-and-Democratized (SYNDEM) Smart Grids, organized by IEEE Rockford Chapter, September 19, 2019.
10. Distinguished lecture on Next-Generation Smart Grids: Synchronized-and-Democratized (SYNDEM) Smart Grids, organized by IEEE PES Dallas Chapter, July 16, 2019.
11. IEEE PELS Webinar on Synchronized-and-Democratized Smart Grids, March 20, 2018.
12. IEEE PELS Distinguished Lecture on Synchronized-and-Democratized Smart Grids: Next-Generation Smart Grids, Santiago, Chile on Dec. 1, 2017.
13. IEEE CSS Distinguished Lecture, Autonomous Distributed Control of The Next-Generation Smart Grid, Warsaw University of Technology, Poland, November 23, 2017.
14. IEEE CSS Distinguished Lecture on Autonomous Distributed Control of Next-Generation Smart Grid for the IEEE Rocky Valley section, Rockford, IL, Nov 16, 2017.
15. IEEE PELS/CSS/PES Distinguished Lecture on Synchronized-and-Democratized Smart Grids: Next-Generation Smart Grids, Illinois Institute of Technology, November 3, 2017.
16. IEEE PELS Distinguished Lecture on Synchronized-and-Democratized Smart Grids: Next-Generation Smart Grids, Grand Rapids, Western Michigan, Oct 18, 2017.
17. IEEE PELS Distinguished Lecture on Enabling Technologies in Control and Power Electronics for Power and Energy Systems, Montreal, Canada, Oct 10, 2017.
18. IEEE CSS Distinguished Lecture on Autonomous Distributed Control of Next-Generation Smart Grid, for the IEEE Coulee Subsection, La Crosse WI, Sept 19, 2017.
19. IEEE CSS Distinguished Lecture on Autonomous Distributed Control of Next-Generation Smart Grid, for the IEEE Southern Minnesota Section, Rochester MN, Sept 18, 2017.
20. IEEE PELS Distinguished Lecture on Next-Generation Smart Grids: Power Electronics-Enabled Autonomous Power Systems, ERCOT, Austin, August 23, 2017.
21. Virtual Synchronous Machine and Autonomous Power Systems, Southwest Jiaotong University (SWJTU), May 5, 2017.
22. IEEE PELS Distinguished Lecture on Next-Generation Smart Grids: Power Electronics-Enabled Autonomous Power Systems, Pittsburgh, PA, April 25, 2017.
23. Virtual Synchronous Machine and Autonomous Power Systems, China Electric Power Research Institute (CEPRI), Beijing, China, March 21, 2017.
24. Virtual Synchronous Machine and Autonomous Power Systems, Hunan Institute of Engineering (HNIE), Xiangtan, China, March 18, 2017.
25. IEEE PES Distinguished Lecture on Next-Generation Smart Grids: Power Electronics-Enabled Autonomous Power Systems, IEEE PES Chicago Chapter, March 8, 2017.
26. IEEE PELS Distinguished Lecture on Next-Generation Smart Grid: Power Electronics-Enabled Autonomous Power Systems, Sao Paulo, Brazil, September 30, 2016.
27. IEEE PELS Distinguished Lecture on Next-Generation Smart Grid: Power Electronics-Enabled Autonomous Power Systems, Santa Maria, Brazil, September 24, 2016.
28. Next-Generation Smart Grid: Control Architecture and Technical Route, Oak Ridge National Laboratory (ORNL), September 06, 2016.
29. Next-Generation Smart Grid: Control Architecture and Technical Route, Pacific Northwest National Laboratory (PNNL), August 29, 2016.
30. IEEE CSS Distinguished Lecture on Autonomous Distributed Control of The Next-Generation Smart Grid, Universidad de Piura, Peru, August 1, 2016.
31. Virtual Synchronous Machine and Autonomous Power Systems, State Grid Corporation of China (SGCC) - Sichuan, Chengdu, China, June 2, 2016.
32. Virtual Synchronous Machine and Autonomous Power Systems, State Grid Corporation of China (SGCC) - Jiangsu, China, May 26, 2016.

33. IEEE CSS Distinguished Lecture on Autonomous Distributed Control of the Next-Generation Smart Grid, Peru, August 3, 2016.
34. Bounded Control that Preserves System Stability and its Applications, University of Cambridge, Cambridge, UK, May 10, 2016.
35. Virtual Synchronous Machine and Autonomous Power Systems, Goldwind, March 17, 2016.
36. Virtual Synchronous Machine and Autonomous Power Systems, China Electric Power Research Institute (CEPRI), Beijing, China, March 18, 2016.
37. IEEE PELS & CSS Distinguished Lecture on Next-Generation Smart Grids: Power Electronics-based Autonomous Power Systems, Aalborg University, December 22, 2015.
38. Next-Generation Smart Grids: Architecture and Technical Route, Argonne National Laboratory (ANL), November 12, 2015.
39. IEEE PELS & CSS Distinguished Lecture on Next-Generation Smart Grids: Power Electronics-Enabled Autonomous Power Systems, Atlanta, November 23, 2015.
40. Grid of the Future: Control Architecture, University of Illinois Chicago, October 6, 2015.
41. IEEE PELS Distinguished Lecture on Next-Generation Smart Grids: Completely Autonomous Power Systems (CAPS), Smart Grid Institute, August 10, 2015.
42. IEEE PELS Distinguished Lecture on Next-Generation Smart Grids: Completely Autonomous Power Systems (CAPS), Harbin Institute of Technology, August 5, 2015.
43. IEEE PELS Distinguished Lecture on Next-Generation Smart Grids: Completely Autonomous Power Systems (CAPS), Wasion Group, Changsha, China, August 2, 2015.
44. IEEE PELS Distinguished Lecture on Next-Generation Smart Grids: Completely Autonomous Power Systems (CAPS), Hunan Institute of Engineering (HNIE), December 31, 2014.
45. IEEE PELS Distinguished Lecture on Next-Generation Smart Grids: Completely Autonomous Power Systems (CAPS), Zhejiang University, December 30, 2014.
46. IEEE PELS Distinguished Lecture on Next-Generation Smart Grids: Completely Autonomous Power Systems (CAPS), Shanghai Jiao Tong University (SJTU), December 29, 2014.
47. IEEE PELS Distinguished Lecture on Integrated Control and Power Electronics for Energy and Power Systems, National Instruments, Austin, TX, October 26, 2014.
48. IEEE PELS Distinguished Lecture on Integrated Control and Power Electronics for Energy and Power Systems, Texas Instruments, Sugar Land, TX, October 23, 2014.
49. IEEE PELS Distinguished Lecture on Next-Generation Smart Grids: Completely Autonomous Power Systems (CAPS), University of Novi Sad, Serbia, May 16, 2014.
50. IEEE PELS Distinguished Lecture on Next-Generation Smart Grids: Completely Autonomous Power Systems (CAPS), University of Zagreb, Croatia, May 12, 2014 .
51. No More Phase-Locked Loops in Power Electronic Systems, North China Electric Power University, April 21, 2014.
52. IEEE PELS Distinguished Lecture on Integrated Control and Power Electronics for Energy and Power Systems, Beijing Jiaotong University, April 21, 2014.
53. IEEE PELS Distinguished Lecture on Next-Generation Smart Grids: Completely Autonomous Power Systems (CAPS), Southwest Jiaotong University (SWJTU), April 16, 2014.
54. IEEE PELS Distinguished Lecture on Next-Generation Smart Grids: Completely Autonomous Power Systems (CAPS), University of Electronic Science and Technology of China (UESTC), April 15, 2014.
55. IEEE PELS Distinguished Lecture on Next-Generation Smart Grids: Completely Autonomous Power Systems (CAPS), Michigan State University, March 27, 2014.
56. Integrated Control and Power Electronics for Energy and Power Systems ---The Link between Devices and Next-Generation Smart Grids, Illinois Institute of Technology (IIT), February, 2014.
57. IEEE PELS Distinguished Lecture on Next-Generation Smart Grids: Completely Autonomous Power Systems (CAPS), The University of Southampton, Jan. 29, 2014.

58. Enabling Technologies in Control and Power Electronics for Energy and Power Systems, North China Electric Power University (NCEPU), December 25, 2013.
59. Autonomous Distributed Control of Next-Generation Smart Grids, The Chinese Academy of Sciences (CAS), Institute of Systems Science (ISS), Dec. 19, 2013.
60. Next-Generation Smart Grids: Completely Autonomous Power Systems (CAPS), The National Renewable Energy Laboratory (NREL), Sept. 20, 2013.
61. Next-Generation Smart Grids: Completely Autonomous Power Systems (CAPS), The University of Colorado Denver, Sept. 19, 2013.
62. Next-Generation Smart Grid: Completely Autonomous Power Systems (CAPS), Tsinghua University, August 16, 2013.
63. Next-Generation Smart Grid: Completely Autonomous Power Systems (CAPS), North China Electric Power University (NCEPU), August 14, 2013.
64. Next-Generation Smart Grid: Completely Autonomous Power Systems (CAPS), The Nanjing University of Aeronautics and Astronautics (NUAA), August 10, 2013.
65. Control of Power Inverters in Renewable Energy and Smart Grid Integration, Wenzhou University, August 9, 2013.
66. Control of Power Inverters in Renewable Energy and Smart Grid Integration, China Southern Grid Electric Power Research Institute (SEPRI), August 6, 2013.
67. Control of Power Inverters in Renewable Energy and Smart Grid Integration, China Three Gorges University, August 3, 2013.
68. Control of Power Inverters in Renewable Energy and Smart Grid Integration, The Hunan University of Science and Technology (HNUST), August 2, 2013.
69. Next-Generation Smart Grid: Completely Autonomous Power Systems (CAPS), China Electric Power Research Institute (CEPRI), July 31, 2013.
70. Next-Generation Smart Grid: Completely Autonomous Power Systems (CAPS), Cardiff University, Cardiff, UK, May 28, 2013.
71. Enabling Technologies in Control and Power Electronics for Energy Systems, University of Southampton, UK, May 29, 2013.
72. Next-Generation Smart Grid: Completely Autonomous Power Systems (CAPS), ALSTOM, Staffordshire, UK, June 26, 2013.
73. Next-Generation Smart Grid: Completely Autonomous Power Systems (CAPS), Imperial College London, UK, May 16, 2013.
74. Integration of Renewable Energy into Smart Grids, University of Texas at Dallas, April 2, 2013.
75. Next-Generation Smart Grid: Completely Autonomous Power Systems (CAPS), University of Cambridge, May 31, 2013.
76. Next-Generation Smart Grid: Completely Autonomous Power Systems (CAPS), The Center for Power Electronics Systems (CPES), Virginia Tech, March 8, 2013.
77. Control of Power Inverters in Renewable Energy and Smart Grid Integration, University of California, Los Angeles (UCLA), January 9, 2013.
78. Control of Power Inverters in Renewable Energy and Smart Grid Integration, China Electric Power Research Institute (CEPRI), Jan. 7, 2013.
79. Control of Power Inverters in Renewable Energy and Smart Grid Integration, University of Tennessee, Knoxville, November 30, 2012.
80. Control of Power Inverters in Renewable Energy and Smart Grid Integration, North Carolina State University (NC State), November 28, 2012.
81. Control of Power Inverters in Renewable Energy and Smart Grid Integration, The University of Colorado Boulder, November 5, 2012.
82. Control of Power Inverters in Renewable Energy and Smart Grid Integration, The University of Massachusetts Amherst, October 30, 2012.

83. Control of Power Inverters in Renewable Energy and Smart Grid Integration, Boston University, November 1, 2012.
84. Control of Power Inverters in Renewable Energy and Smart Grid Integration, Northeastern University, October 31, 2012.
85. Control of Power Inverters in Renewable Energy and Smart Grid Integration, Polytechnic Institute of New York University, October 22, 2012.
86. Control of Power Inverters in Renewable Energy and Smart Grid Integration, The Center for Power Electronics Systems (CPES), Virginia Tech, October 19, 2012.
87. Control of Power Inverters in Renewable Energy and Smart Grid Integration, University of California, Irvine, August 9, 2012.
88. Control of Power Inverters in Renewable Energy and Smart Grid Integration, North China Electric Power University (NCEPU), June 8, 2012.
89. Synchronisation Strategies for Grid Connection of Renewable Energy and Smart Grid Integration, Changsha University of Science and Technology (CSUST), June 1, 2012.
90. Robust Droop Controller for Parallel Operation of Inverters, Hunan Institute of Engineering (HNIE), June 1, 2012.
91. Control of Power Inverters in Renewable Energy and Smart Grid Integration, Huazhong University of Science and Technology, June 4, 2012.
92. Control of Power Inverters in Renewable Energy and Smart Grid Integration, Taiyuan University of Technology, May 24, 2012.
93. Recent Developments in Smart Grid Integration, Tsinghua University, May 19, 2012.
94. Control of Power Inverters in Renewable Energy and Smart Grid Integration, General Atomics, May 2012.
95. Control of Power Inverters in Renewable Energy and Smart Grid Integration, University of California, Santa Barbara, May 4, 2012.
96. Control of Power Inverters in Renewable Energy and Smart Grid Integration, California Institute of Technology, April 30, 2012.
97. Control of Power Inverters in Renewable Energy and Smart Grid Integration, Cymer Center of Control Systems and Dynamics, University of California, San Diego, April 27, 2012.
98. Enabling Technologies in Control and Power Electronics for Smart Grids, INVT, December 31, 2011.
99. C-Inverters: Inverters with Capacitive Output Impedances, Hunan University, December 28, 2011
100. C-Inverters: Inverters with Capacitive Output Impedances, Changsha University of Science and Technology (CSUST), December 28, 2011.
101. C-Inverters: Inverters with Capacitive Output Impedances, Hunan Institute of Engineering, December 27, 2011.
102. Enabling Technologies in Control and Power Electronics for Smart Grids, Shanghai Jiao Tong University (SJTU), December 26, 2011.
103. Synchronverters: Inverters that mimic synchronous generators, Central South University, Oct. 2011.
104. Robust droop controller for Parallel Operation of Inverters, Shandong University, August 2011.
105. Synchronverters: Inverters that mimic synchronous generators, Southwest Jiaotong University (SWJTU), July 26, 2011.
106. Control of power inverters for renewable energy and distributed generation, University of Electronic Science and Technology of China (UESTC), July 27, 2011.
107. Robust Droop Controller for Parallel Operation of Inverters, Changsha University of Science and Technology (CSUST), July, 2011.
108. Control of power inverters for renewable energy and distributed generation, Supélec, France, July 19, 2011.
109. On H-infinity control of time-delay systems, University of Oxford, Oxford, UK, June 23, 2011.
110. Synchronverters: Inverters that mimic synchronous generators, University of Kent, June 14, 2011.

111. Grid Connection of Renewable Energy: Key Technologies, Hunan Institute of Engineering (HNIE), April 27, 2011.
112. Proportional Load Sharing of Inverters in Parallel Operation, NARI Technology, April 22, 2011.
113. Proportional Load Sharing of Inverters in Parallel Operation, Nanjing University of Aeronautics and Astronautics (NUAA), April 21, 2011.
114. Control of Time-Delay Systems and its Applications, North China Electric Power University (NCEPU), April 20, 2011.
115. Platform technologies in control of power inverters for renewable energy and distributed generation, Areva, February, 2011.
116. Control in power electronics and renewable energy: Recent developments, Zhejiang University December 2010.
117. Control of Time-delay Systems and Possible Applications to Supply Chain Management, Cardiff University, November 26, 2010.
118. Control in power electronics and renewable energy: Recent developments, Xi'an University of Technology, July 2010.
119. On standard H-infinity control of time-delay systems, Shanghai Jiao Tong University, April 2010.
120. Control in power electronics and renewable energy: Recent developments Xi'an Jiaotong–Liverpool University (XJTLU), April, 2010.
121. Synchronverters: Inverters that mimic synchronous generators, Sichuan University, March 31, 2010.
122. Control in power electronics and renewable energy: Recent developments, Beihang University (BUAA), March 30, 2010.
123. Control in power electronics and renewable energy: Recent developments, Beijing Institute of Technology (BIT), March 29, 2010.
124. Advanced Control in Distributed Generation and Renewable Energy, Donghua University, Shanghai, China, March, 2010.
125. Synchronverters: Inverters that mimic synchronous generators, Aalborg University, March 9, 2010.
126. H-infinity and repetitive control of grid-connected inverters, Hunan University, December 29, 2009.
127. Synchronverters: Inverters that mimic synchronous generators, City University of Hong Kong, August 26, 2009.
128. Synchronverters: Inverters that mimic synchronous generators, NARI Technology, August 20, 2009.
129. Synchronverters: Inverters that mimic synchronous generators, Shandong University, Aug. 17, 2009.
130. Synchronverters: Inverters that mimic synchronous generators, Hunan University, August 5, 2009.
131. Control in power electronics and renewable energy: Recent developments, Xi'an Jiaotong University, July 30, 2009.
132. Synchronverters: Inverters that mimic synchronous generators, Tsinghua University, July 20, 2009.
133. Synchronverters: Inverters that mimic synchronous generators, University of Cambridge, Cambridge, UK, June 12, 2009.
134. H-infinity and repetitive control for grid-connected inverters in distributed generation and renewable energy, Gdynia Maritime University, June 29, 2009.
135. Provision of a neutral line, Gdynia Maritime University, June 29, 2009.
136. Synchronverters: Inverters that mimic synchronous generators, Gdynia Maritime University, June 29, 2009.
137. Control in power electronics and renewable energy: Recent developments, Ariel University, Israel, June 21, 2009.
138. Synchronverters: Inverters that mimic synchronous generators, Nanjing University of Aeronautics and Astronautics (NUAA), April 8, 2009.
139. Energy Recovery from Landing Aircraft, Nanjing University of Aeronautics and Astronautics (NUAA), April 6, 2009.

140. On standard H-infinity control of time-delay systems, National University of Singapore, March 2007.
141. Control of Integral Processes with Dead Time, National University of Singapore, March 2007.
142. Control of Time-Delay Systems and its Applications, Queen's University of Belfast, June, 2005
143. The delay-type Nehari problem, Queen's University of Belfast, June, 2005.
144. A unified Smith predictor for time-delay systems, The Academy of Mathematics and Systems Science, The Chinese Academy of Sciences (CAS), April 11, 2005.
145. J-spectral factorization of regular para-Hermitian transfer matrices, The Academy of Mathematics and Systems Science, The Chinese Academy of Sciences (CAS), March 28, 2005.
146. The delay-type Nehari problem, The Academy of Mathematics and Systems Science, The Chinese Academy of Sciences (CAS), March 28, 2005.
147. Recent results on H-infinity control of single-delay systems, Imperial College London, April 30, 2004.

Professional Service and Technical Leadership

- Working Group Chair, IEEE Standard P2988-2024: Recommended Practice for Use and Functions of Virtual Synchronous Machines, 2021 – 2025, https://standards.ieee.org/ieee/2988/10581/.
- IEEE PES Technical Committee Working Group Award for Outstanding Technical Report of Task Force on Measurement, Monitoring and Reliability Issues Related to Primary Governing Frequency Response, 2019.
- Member, IEEE Smart Grid Steering Committee, representing IEEE PELS, 2017 – 2020.
- Member, National Grid Energy System Operator (now National Energy System Operator) VSM Expert Group (GC0137), 2018-2021.
- Associate Editor for
  - *IEEE Trans. on Power Electronics*, Nov. 2010 – Dec. 2018
  - *IEEE Trans. on Automatic Control,* Jan. 2015 – Dec. 2016
  - *IEEE Trans. on Industrial Electronics*, March 2014 – August 2019
  - *IEEE Trans. on Control Systems Technology*, Jan. 2014 – Dec. 2016
  - *IEEE Access*, March 2013 - 2018
  - *European Journal of Control*, Jan. 2014 – June 2016.
  - *IEEE Journal of Emerging and Selected Topics in Power Electronics*, 2013 -2017
  - Conference Editorial Board of the IEEE Control Systems Society, 2009 – 2016
  - Special Issue on Wind Applications, *IEEE Journal of Emerging and Selected Topics in Power Electronics*, 2013.
  - Special issue on Power Electronics for Microgrids, *IEEE Trans. Power Electronics*, 2010.
- IEEE Power Electronics Society AdCom, 2017
- Reviewer of international grant proposals
  - Canada Foundation for Innovation, 2016
  - Singapore National Research Foundation, 2015
  - Finnish Funding Agency for Technology and Innovation, 2014.
  - Kuwait Foundation for the Advancement of Sciences, 2014.
  - Italian Evaluation of Research Quality exercise (VQR 2004-2010), Italian Ministry of Education, University and Research, 2012.
  - Netherlands NWO, 2013.
  - Israel Science Foundation (ISF), 2013.
  - UK EPSRC, 2008 - 2024, ranked top 6% of all reviewers in 2017/18
- UK representative, European Control Association (EUCA), August 2013 – July 2015.

- Scientific Advisory Board Member, NSF FREEDM Systems Center, North Carolina State Univ., 2014.
- University Technology Partnership Board Member, Rolls-Royce Plc, 2014-2015.
- Member, EPSRC Peer Review College, 2012 – 2024.
- Senior Member of IEEE, 2004 –2016.
- Vice Chair, IFAC Technical Committee 6.3 (Power and Energy Systems), 2011 – 2020.
- Vice Chair, IFAC Technical Committee 2.2 (Linear Control Systems), 2011 – 2017.
- International Editorial Board Member of *Journal of the Chinese Institute of Engineers*, 2003-2008.
- Founding Director, Loughborough Centre in Control Engineering, 2011-2012.
- **Founding Director, New-ACE (EPSRC-funded Network for New Academics in Control Engineering), 2007–2011, UK, 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 overseas. His leadership and mentorship in New-ACE laid the groundwork for today's UK Automatic Control Engineering (ACE) Network, funded by EPSRC in 2024.
- Member, IFAC Technical Committee 2.2 (Linear control systems), 2006 -
- Member, IChemE Process Management and Control Subject Group Comm., 2009-2011
- Member, IEEE IES TC on Renewable Energy Systems, 2013 –
- Member, IEEE PELS TC on Sustainable Energy Systems, 2013 –
- Member, IEEE PELS TC on Power & Control Core Technologies, 2013 –
- Member, IEEE CSS TC on Smart Grids, 2013 -
- Member, IEEE CSS TC on Systems with Uncertainty, 2010 -
- Member, IEEE CSS TC on Power Generation, 2010 -
- Member of UK Automatic Control Council (UKACC), 2006 –2010
- Tutorials Chair, ECCE 2016, Milwaukee WI, 2016.
- Track Chair, IECON 2016, Florence, Italy, 2016.
- General Co-Chair (2017), Topic B Chair (2015), International Future Energy Challenge
- IPC Co-Chair of the IFAC Workshop on Time-Delay Systems, Boston, 2012
- Regional Chair (UK), The 10th IEEE International Conference on Control & Automation (IEEE ICCA 2013, Hangzhou, China, June 2013.
- International Program Committee member of
    - 2017 IFAC World Congress, France, July 2017.
    - 11th UKACC International Conference on Control, Belfast, UK, September 2016.
    - 27th Chinese Control and Decision Conference, Qingdao, China, May 23-25, 2015.
    - 2014 IFAC World Congress, South Africa, August 2014.
    - 2014 UKACC International Conference on Control (CONTROL 2014), Loughborough, UK, 9th - 11th July 2014.
    - 26th Chinese Control and Decision Conference, Changsha, China, May 31-June 2, 2014.
    - 2014 Sixth Annual Green Technologies Conference, Texas 78401, USA, April 2014.
    - The 13th IFAC Symposium on Large Scale Complex Systems: Theory and Applications (IFAC LSS 2013), Shanghai, China, July 2013.
    - The 31st Chinese Control Conference, Hefei, Anhui, China, July 25-27, 2012.
    - The 24th Chinese Control and Decision Conference, Taiyuan, China, May 2012.
    - The 9th World Congress on Intelligent Control and Automation (WCICA 2012), Beijing, China, from July 6 to 8, 2012.

- IFAC Conference on Advances in PID Control, Brescia, Italy, March 2012.
- The 30th Chinese Control Conference (CCC'11), Yantai, China, July 2011.
- The 2010 IEEE Int. Conference on Mechatronics and Automation, Xi'an, China, August 2010.
- The 2010 IEEE Int. Conference on Information and Automation, Harbin, China, June 2010.
- The 8th World Congress on Intelligent Control and Automation, China, July 2010.
- The 9th IFAC Workshop on Time Delay Systems, Prague, June 2010.
- IFAC Conference on Control Methodologies and Technology for Energy Efficiency, CMTEE 2010, Vilamoura, Portugal, March 29-31, 2010
- The 8th IFAC Workshop on Time Delay Systems, Sinaia, Romania, September 2009.
- The 2009 IEEE International Conference on Mechatronics and Automation (ICMA 2009), Changchun, China, August 2009.
- The 6th Workshop on Compatibility and Power Electronics, Badajoz, Spain, May 2009.
- The 7th World Congress on Intelligent Control and Automation, China, June 2008.
- The 5th IEEE International Scientific Workshop on Compatibility in Power Electronics - CPE 2007, Gdansk, Poland, June 2007.
- The 6th IFAC Workshop on Time-Delay Systems, L'Aquila, Italy, July 2006.
- The 1st International Symposium on Systems and Control in Aerospace and Astronautics, Harbin, China, Jan. 2006.
- The Int. Symposium on Systems Theory, Automation, Robotics, Computers, Informatics, Electronics and Instrumentation, Craiova, Romania, 10/2005.
- The 7th Asia-Pacific Conf. On Complex Systems, Cairns Australia, 12/2004.
- The 5th IFAC Workshop on Time-Delay Systems, Leuven, Belgium, 09/2004.

Research Grants and Sponsored Projects

Total funding received in USA (from 2014/08): $2,883,768.

Total funding received in UK: £3,194,534, which is about $6M.

For Illinois Institute of Technology:

No.	Grantees	Project Title	Source	Period	Amount*
1.	Q.-C. Zhong (IIT PI)	GOALI: ASCENT: Online Stability Assessment, Flexibility, and Enhancement of IBR-dominated Power Systems	NSF	9/2023-8/2026	$300,000
2.	Q.-C. Zhong (IIT PI)	Scalable Multi-Timescale Analysis Platform Based on System Transient and Dynamic Models	DOE/ Argonne National Lab	10/2021-9/2024	$210,000
3.	Q.-C. Zhong (PI), M. Shahidehpour, Beibei Ren, Terrence Chambers, Stephen Bayne	Planning Grant: Engineering Research Center for Communication-network-free, Autonomous, Renewable Electric Power Systems (CARE)	NSF	9/2019-8/2020	$99,977
4.	Q.-C. Zhong (PI)	Workshop on Power Electronics-enabled Operation of Power Systems	NSF	7/2019-6/2020	$49,978
5.	Q.-C. Zhong (PI), Z. Li, Z. Shen, A. Flueck,	MRI: Acquisition of Large-Scale Real-Time Simulators for Next-	NSF	10/2018-09/2021	$349,143

* The amount listed here is the share allocated to him if he is a Co-PI or the total funding if he is the PI.

	M. Shahidehpour, et al	Generation Smart Grids			
6.	Q.-C. Zhong (PI)	Stability and Stabilization of Large-scale Modern Power Systems via the Passivity Theory of Port-Hamiltonian Systems	NSF	07/2018-06/2021	$289,666
7.	S. Bahramirad (PI), M. Shahidehpour, Z. Li, Q.-C. Zhong, et al	Microgrid-Integrated Solar-Storage Technology (MISST) (Project funding: $4.0M)	DoE	01/2017-12/2019	$315,131
				Total	**$1,613,895**

For Syndem LLC:

No.	Grantees	Project Title	Source	Period	Amount*
1.	Q.-C. Zhong (Syndem PI)	Building Pandemic Resilience for Native American Communities	NIST/ PowerAmerica	3/2022-2/2024	$199,996
2.	Z. Zhang (PI), M. Yue, R. Lofaro, N. Zhou, P. Zhang, J. Li, L. Yu, Y. Lin, G. Stefopoulos, S. Upreti, Q.-C. Zhong	Asynchronous Distributed and Adaptive Parameter Tuning (ADAPT) for Hybrid PV Plants (Project funding $2.6M)	DOE	4/2021-3/2024	$240,000
3.	Q.-C. Zhong, Y. Wang	Grid-forming, Reliable, Efficient, Affordable, and Transformerlessly-grounded Photovoltaic-storage System (GREAT PVs)	DOE	6/2020-3/2021	$206,424
4.	Q.-C. Zhong (PI), Beibei Ren, Stephen Bayne, Mark Harral, Jeff Groenewold	Autonomous Grid-forming Inverters Enabled by Always-on Universal Droop Control without External Communication or Phase-Locked Loops	DOE	2/2020-1/2022	$623,453
				Total	**$1,269,873**

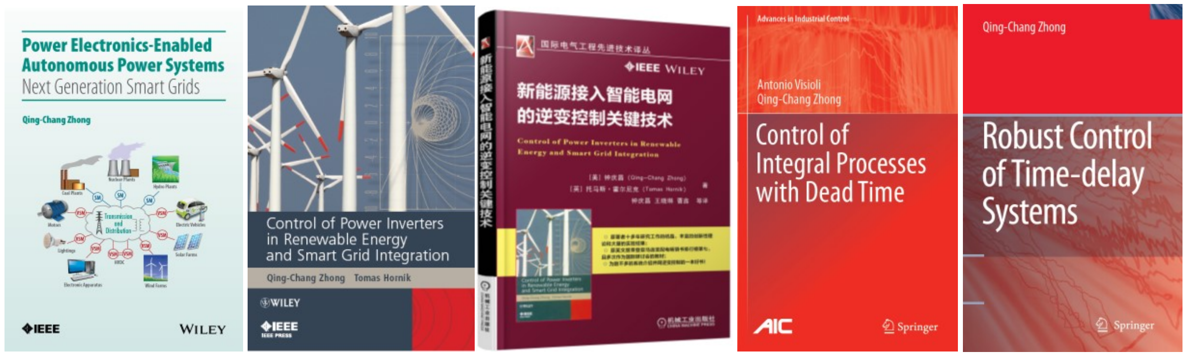
For UK universities:

No.	Grantees	Project Title	Source	Period	Amount*
1.	M.P. Foster, D.A. Stone, P. Hall. Q.-C. Zhong and D.T. Gladwin	Grid Connected Energy Storage Research Demonstrator (Project funding: £4.2M)	EPSRC	07/2013-09/2014	£838,147
2.	Q.-C. Zhong and M. Krstic	Distinguished Visiting Fellowship: Robust control of systems with delays and control applications in energy systems	RAEng	05/2013-12/2013	£6,000
3.	Q.-C. Zhong	Developing Fundamental Theory and Enabling Technologies for Parallel Operation of Inverters to Facilitate Large-scale Utilisation of Renewable Energy	EPSRC	10/2012-09/2015	£459,598
4.	Q.-C. Zhong	International Collaboration Sabbatical: To Foster Long-term Collaboration with Leading Control and Power Electronics Experts in the USA	EPSRC	09/2011-09/2012	£179,167
5.	R. Thring (PI), G. Offer,	Developing FUTURE Vehicles (Fundamental Understanding of	EPSRC	09/2011-08/2015	£571,423

	M. McCulloch, Q.-C. Zhong, F. Assadian, et al	Technologies for Ultra Reduced Emission Vehicles) (Project funding: £3.5M)			
6.	Q.-C. Zhong	Charging Systems with Grid Support for Electric Vehicles	EPSRC (KTA)	10/2010-08/2012	£126,530
7.	Q.-C. Zhong	Further Development of the Synchronverter Tech. to Increase its Technology-Readiness Level	EPSRC (KTA)	06/2010-05/2011	£120,447
8.	Q.-C. Zhong	HOMES: High-efficiency Off-grid Multi-source Electrical Supplies	EPSRC, PSW & TSB	08/2010-10/2012	£181,527
9.	Q.-C. Zhong	Development of common key technology for grid connection in distributed generation and renewable energy	Royal Academy of Engineering	09/2009-09/2010	£41,292
10.	P. Stewart (PI), Q.-C. Zhong, and M. Eftekhari	Feasibility Study of Energy Recovery from Landing Aircraft (Project funding: £ 199, 224)	EPSRC	07/2009-06/2010	£111,759
11.	E. Burke (PI), P. Stewart, M. Eftekhari, Q.-C. Zhong	SANDPIT: Integrating and Automating Airport Operations (Project funding: £ 681, 924)	EPSRC	10/2009-09/2012	£68,421
12.	Q.-C. Zhong	The 47th IEEE Conference on Decision and Control (travel)	Royal Society	12/2008	£1,280
13.	Q.-C. Zhong	Software Re-configurable Control Circuitry	EPSRC (DHPA)	10/2008-09/2012	£45,000
14.	Q.-C. Zhong	Software Re-configurable Control Circuitry	Add2 Ltd, UK	10/2008-09/2012	£45,000
15.	Q.-C. Zhong	Control System Design for the newly-invented Nheolis ATG Wind turbine	EPSRC (DHPA)	10/2008-09/2012	£45,000
16.	Q.-C. Zhong	Control System Design for the newly-invented Nheolis ATG Wind turbine	Nheolis, France	10/2008-09/2012	£45,030
17.	Q.-C. Zhong	Exploiting Collaborative Oppor-tunities with Chinese Partners in Control and Embedded Systems	Royal Academy of Engineering	06/2008-07/2008	£1,200
18.	Q.-C. Zhong (PI), *et al*	New-ACE: A Network of New Academics in Control Engineering	EPSRC	10/2007-09/2010	£87,800
19.	Q.-C. Zhong	Control of grid-connected inverters in renewable energy power plants	EPSRC (DTA)	10/2007-09/2010	£50,000
20.	Q.-C. Zhong	Control and Stability Analysis of Time-Delay Systems	EPSRC	09/2005-09/2008	£126,413
21.	Q.-C. Zhong	International Travel Grant	Royal Academy of Engineering	06/2006	£600
22.	Q.-C. Zhong	Control and Optimisation Problems in Wind-Hydrogen-Electricity Systems	University of Liverpool	07/2005-07/2006	£6,000
23.	Q.-C. Zhong	International Travel Grant	Royal Academy of Engineering	04/2004	£900
24.	Q.-C. Zhong	A PhD studentship	Univ. of Glamorgan	06/2004	£36,000
				Total	**£3,194,534**

Publications

Research Monographs



[B1] Q.-C. Zhong, *Power Electronics-Enabled Autonomous Power Systems: Next Generation Smart Grids*, Wiley-IEEE Press, 2020. **A Top 3 Best Power Systems Book for Beginners by BookAuthority.org, the world's leading site for book recommendations.**

[B2] Q.-C. Zhong and T. Hornik, *Control of Power Inverters in Renewable Energy and Smart Grid Integration*, Wiley-IEEE Press, 2013, available for download (with subscription or payment) at https://ieeexplore.ieee.org/book/6381785 and https://onlinelibrary.wiley.com/doi/book/10.1002/9781118481806. **It once made No. 7 of Best Sellers in Power Generation and Distribution on amazon.co.uk and the global rights in Chinese were licensed out within three months of its publication.**

[B3] A. Visioli and Q.-C. Zhong, *Control of Integral Processes with Dead Time*, Springer-Verlag Limited, London, 2010, available for download (with subscription or payment) at http://www.springer.com/engineering/robotics/ book/978-0-85729-069-4.

[B4] Q.-C. Zhong, *Robust Control of Time-delay Systems*. ISBN: 1-84628-264-0. Springer-Verlag Limited, London, 2006, available for download (with subscription or payment) at http://www.springer.com/engineering/control/book/978-1-84628-264-5.

Academic Journal Papers

[1] J. R. de Oliveira, B. C. Torrico, F. J.S. Vasconcelos, Q.-C. Zhong, Control of cascaded time-delay processes based on a multi-stage predictor, *Journal of Process Control*, Vol. 165, 2026, 103782, https://doi.org/10.1016/j.jprocont.2026.103782.

[2] K. Yu, K. Norman, B. Ren and Q.-C. Zhong, Design and Implementation of an All-in-One Solid-State Wind Turbine Simulator, *IEEE Power Electronics Magazine*, vol. 12, no. 3, pp. 84-91, Sept. 2025.

[3] Q.-C. Zhong, IEEE Std 2988-2024 and the Recommended Practice for Use and Functions of Virtual Synchronous Machines, *IEEE Power Electronics Magazine*, vol. 12, no. 3, pp. 78-83, Sept. 2025.

[4] K. Norman, B. Ren and Q.-C. Zhong, Learning-by-Doing: Design and Implementation of a Solar Array Simulator With a SYNDEM Smart Grid Research and Educational Kit, *IEEE Power Electronics Magazine*, vol. 11, no. 1, pp. 47-54, March 2024.

[5] Q.-C. Zhong and M. Stefanello, Generic Modeling and Control Framework for Power Systems Dominated by Power Converters Connected Through a Passive Transmission and Distribution Grid, *CSEE Journal of Power and Energy Systems*, vol. 10, no. 1, pp. 292-301, Jan. 2024.

[6] C. Qi, K. Wang, Q.-C. Zhong, J. Xu, and G. Li, Transient Angle Stability of Inverters Equipped with Robust Droop Control, *CSEE Journal of Power and Energy Systems*, vol. 9, no. 2, pp. 659-670, March 2023.

[7] Y. Dong, B. Ren and Q.-C. Zhong, Bounded Universal Droop Control to Enable the Operation of Power Inverters Under Some Abnormal Conditions and Maintain Voltage and Frequency

Within Predetermined Ranges, *IEEE Trans. on Industrial Electronics*, vol. 69, no. 11, pp. 11633-11643, Nov. 2022.

[8] Q.-C. Zhong, and M. Stefanello, A Port-Hamiltonian Control Framework to Render a Power Electronic System Passive, *IEEE Trans. on Automatic Control*, vol. 67, no.4, 1960 - 1965, 2022.

[9] Z. Tian, Q.-C. Zhong, B. Ren, J. Yuan, UDE-based Robust Control for Systems with Mismatched Uncertainties via Feedback Compensation, *Int. Journal of Control*, vol. 94, no. 7, pp. 1723-1733, 2021.

[10] C. Wang, Q.-C. Zhong, N. Zhu, S. Chen, and X. Yang, Space Vector Modulation in the 45° Coordinates α'β' for Multilevel Converters, *IEEE Trans. on Power Electronics*, vol. 36, no. 6, pp. 6525-6536, 2021.

[11] Y. Wang, B. Ren, Q.-C. Zhong, and J. Dai, Bounded Integral Controller with Limited Control Power for Nonlinear Multiple-Input and Multiple-Output Systems, *IEEE Trans. on Control Systems Technology*, vol. 29, no. 3, pp. 1348-1355, 2021.

[12] Y. Wang, B. Ren, and Q.-C. Zhong, Bounded UDE-based Controller for Input Constrained Systems with Uncertainties and Disturbances, *IEEE Trans. on Industrial Electronics*, vol.68, no.2, pp. 1560-1570, 2021.

[13] Q.-C. Zhong, Y. Wang, Y. Dong, B. Ren and M. Amin, Go Real: Power Electronics From Simulations to Experiments in Hours, *IEEE Power Electronics Magazine*, vol. 7, no. 3, pp. 52-61, 2020

[14] M. Amin, Q.-C. Zhong, and Z. Lyu, An Anti-islanding Protection for VSM Inverters in Distributed Generation*, IEEE Open Journal of Power Electronics*, vol.1, no.1, pp. 378-382, 2020.

[15] B. Ren, J. Dai, and Q.-C. Zhong, UDE-based Robust Output Feedback Control with Applications to a Piezoelectric Stage, *IEEE Trans. on Industrial Electronics*, vol.67, no.9, pp. 7819-7828, 2020.

[16] M. Amin and Q.-C. Zhong, Resynchronization of Distributed Generation based on the Universal Droop Controller for Seamless Transfer Between Operation Modes, *IEEE Trans. on Industrial Electronics*, vol.67, no.9, pp. 7574-7582, 2020.

[17] Q.-C. Zhong, Yeqin Wang, and Beibei Ren, Connecting the Home Grid to the Public Grid: Field Demonstration of Virtual Synchronous Machines, *IEEE Power Electronics Magazine*, vol. 6., No. 4, pp. 41-49, Dec. 2019.

[18] S.Y. Gadelovits, D. Insepov, V. Kadirkamanathan, Q.-C. Zhong, and A. Kuperman, UDE-Based Controller Equipped with a Multiple-Time-Delayed Filter to Improve the Voltage Quality of Inverters, *IEEE Trans. on Industrial Electronics*, vol.66, no.11, pp. 8947-8957, 2019.

[19] Z. Tian, Q.-C. Zhong, B. Ren, J. Yuan, Stabilisability analysis and design of UDE-based robust control, *IET Control Theory & Applications*, Vol. 13, No. 10, pp. 1445-1453, 2019.

[20] Q.-C. Zhong and Z. Lyu, Droop-Controlled Rectifiers that Continuously Take Part in Grid Regulation, *IEEE Trans. on Industrial Electronics*, vol. 66, no. 8, pp. 6516-6526, 2019.

[21] X. Zhang, Q.-C. Zhong, V. Kadirkamanathan, J. He, and J. Huang, Source-side Series-virtual-impedance Control to Improve the Cascaded System Stability and the Dynamic Performance of Its Source Converter, *IEEE Trans. on Power Electronics*, vol.34, no.6, pp. 5854-5866, 2019.

[22] Q.-C. Zhong and X. Zhang, Impedance-Sum Stability Criterion for Power Electronic Systems with Two Converters/Sources, *IEEE Access*, vol. 7, pp. 21254-21265, 2019.

[23] G. Konstantopoulos and Q.-C. Zhong, Current-limiting DC/DC Power Converters, *IEEE Trans. on Control Systems Technology*, vol.27, no. 2, 855-863, 2019.

[24] S. Gadelovits, Q.-C. Zhong, V. Kadirkamanathan and A. Kuperman, UDE-Based Controller Equipped with a Time-Delayed Filter to Improve the Voltage Quality of Inverters, *IEEE Trans. on Industrial Electronics*, vol.66, no.1, pp. 459-469, 2019.

[25] J. Dai, B. Ren and Q.-C. Zhong, Uncertainty and Disturbance Estimator-Based Backstepping Control for Nonlinear Systems With Mismatched Uncertainties and Disturbances, *ASME J. Dyn. Syst., Meas., Control*, vol.140, no.12, pp.121005,2018.

[26] X. Cao, Q.-C. Zhong, Y.-C. Qiao, and Z.-Q. Deng, Multilayer Modular Balancing Strategy for Individual Cells in a Battery Pack, *IEEE Trans. on Energy Conversion*, vol.33, no. 2, pp. 526-536, 2018.

[27] Q. Lu, B. Ren, S. Parameswaran, and Q.-C. Zhong, UDE-based Robust Trajectory Tracking Control for a Quadrotor in a GPS-denied Environment, *ASME J. Dyn. Syst., Meas., Control*, vol. 140, no. 3, 031001, 2018.
[28] Q.-C. Zhong, G.C. Konstantopoulos, B. Ren and M. Krstic, Improved Synchronverters with Bounded Frequency and Voltage for Smart Grid Integration, *IEEE Trans. on Smart Grid*, vol. 9, no.2, 786-796, 2018.
[29] Q.-C. Zhong and G. Konstantopoulos, Current-limiting Three-phase Rectifiers, *IEEE Trans. on Industrial Electronics*, vol.65, no.2, pp. 957-967, 2018.
[30] Q.-C. Zhong and W.-L. Ming, Reducing the Inductors of Rectifiers having Two Outputs to Improve Power Density, *IEEE Trans. on Power Electronics*, vol. 32, no. 10, 8150 - 8162, 2017.
[31] R. Sanz-Diaz, P.J. Garcia Gil, P. Albertos and Q.-C. Zhong, Robust Controller Design for Input-Delayed Systems using Predictive Feedback and an Uncertainty Estimator，*Int. Journal of Robust and Nonlinear Control*, vol. 27, no. 10, pp. 1826–1840, 2017.
[32] S. Gadelovits, Q.-C. Zhong, V. Kadirkamanathan and A. Kuperman, UDE-based Controller Equipped with a Multi-Band-Stop Filter to Improve the Voltage Quality of Inverters, *IEEE Trans. on Industrial Electronics*, vol.64, no.9, pp. 7433-7443, 2017.
[33] Q.-C. Zhong, Y. Wang, and B. Ren, UDE-Based Robust Droop Control of Inverters in Parallel Operation, *IEEE Trans. on Industrial Electronics*, vol.64, no.9, pp. 7552-7562, 2017.
[34] Q.-C. Zhong, The Ghost Operator and its Applications to Reveal the Physical Meaning of Reactive Power for Electrical and Mechanical Systems and Others, *IEEE Access*, vol. 5, pp. 13038-13045, 2017.
[35] Q.-C. Zhong and G. Konstantopoulos, Current-limiting Droop Control of Grid-connected Inverters, *IEEE Trans. on Industrial Electronics*, vol.64, no.7, pp. 5963-5973, 2017.
[36] Q.-C. Zhong, Power Electronics-enabled Autonomous Power Systems: Architecture and Technical Routes, *IEEE Trans. on Industrial Electronics*, vol.64, no.7, pp. 5907-5918, 2017.
[37] B. Ren, Q.-C. Zhong and J. Dai, Asymptotic Reference Tracking and Disturbance Rejection of UDE-Based Robust Control, *IEEE Trans. on Industrial Electronics*, vol.64, 3166-3176, 2017.
[38] Z.-H. Liu, H.-L. Wei, Q.-C. Zhong, and K. Liu, Parameter Estimation for VSI-Fed PMSM based on a Dynamic PSO with Learning Strategies, *IEEE Trans. on Power Electronics*, vol. 32, no. 4, pp. 3154-3165, 2017.
[39] W.-L. Ming and Q.-C. Zhong, Current-stress Reduction for the Neutral Inductor of θ-Converters, *IEEE Trans. on Power Electronics*, vol. 32, no. 4, pp. 2794-2807, 2017.
[40] B. Ren, Y. Wang, and Q.-C. Zhong, UDE-based Control of Variable-speed Wind Turbine Systems, *Int. Journal of Control*, vol. 90, no. 1, pp. 137-152, 2017.
[41] R. Sanz-Diaz, P.J. Garcia Gil, Q.-C. Zhong and P. Albertos, Predictor-based Control of a Class of Time-Delay Systems and its Application to Quadrotors, *IEEE Trans. on Industrial Electronics*, vol.64, no.1, pp. 459-469, 2017.
[42] Q.-C. Zhong, W.-L. Ming, W. Sheng and Y. Zhao, Beijing Converters: Bridge Converters with a Capacitor added to Reduce Leakage Currents, DC-bus Voltage Ripples and Total Capacitance Required, *IEEE Trans. on Industrial Electronics*, vol.64, no.1, pp. 325-335, 2017.
[43] Q.-C. Zhong, Virtual Synchronous Machines: A unified interface for grid integration, *IEEE Power Electronics Magazine*, vol. 3., No. 4, pp. 18-27, Dec. 2016. **Invited cover story. Ranked among the magazine's two most-cited and two most-popular papers as of June 2026 and was recognized as its Top Paper of 2016.**
[44] G.C. Konstantopoulos, Q.-C. Zhong, B. Ren and M. Krstic, Bounded Integral Control of Input-to-State Practically Stable Non-linear Systems to Guarantee Closed-loop Stability, *IEEE Trans. on Automatic Control*, vol. 61, no.12, 4196-4202, 2016.
[45] Q.-C. Zhong and W.-L. Ming, A theta-Converter that Reduces Common Mode Currents, Output Voltage Ripples and Total Capacitance Required, *IEEE Trans. on Power Electronics*, vol. 31, no. 12, pp. 8435-8447, 2016.
[46] X. Zhang and Q.-C. Zhong, Improved Adaptive-Series-Virtual-Impedance Control Incorporating Minimum Ripple Point Tracking for Load Converters in DC Systems, *IEEE Trans. on Power Electronics*, vol. 31, no. 12, pp. 8088-8095, 2016.

[47] X. Zhang, Q.-C. Zhong, and W.-L. Ming, A Virtual RLC Damper to Stabilize DC/DC Converters Having an LC Input Filter while Improving the Filter Performance, *IEEE Trans. on Power Electronics*, vol. 31, no. 12, pp. 8017-8023, 2016.
[48] Q.-C. Zhong, W.-L. Ming and Y. Zeng, Self-Synchronized Universal Droop Controller, *IEEE Access*, vol. 4, pp. 7145-7153, 2016. **Received over 1,350 Google Scholar citations as of June 29, 2026.**
[49] L. Sun, D. Li, Q.-C. Zhong, and K.-Y. Lee, Control of a Class of Industrial Processes with Time Delay based on a Modified Uncertainty and Disturbance Estimator, *IEEE Trans. on Industrial Electronics*, vol.63, no.11, pp. 7018-7028, 2016.
[50] Y. Wang, B. Ren, and Q.-C. Zhong, Robust Power Flow Control of Grid-connected Inverters, *IEEE Trans. on Industrial Electronics*, vol.63, no.11, pp. 6887-6897, 2016.
[51] Q.-C. Zhong and D. Boroyevich, Structural Resemblance Between Droop Controllers and Phase-Locked Loops, *IEEE Access*, vol. 4, pp. 5733-5741, 2016.
[52] J. Chen, B. Ren, and Q.-C. Zhong, UDE-based Trajectory Tracking Control of Piezoelectric Stages, *IEEE Trans. on Industrial Electronics*, vol.63, no.10, pp. 6450-6459, 2016.
[53] G. Konstantopoulos, Q.-C. Zhong, and W.-L. Ming, PLL-less Nonlinear Current-limiting Controller for Single-phase Grid-tied Inverters: Design, Stability Analysis and Operation Under Grid Faults, *IEEE Trans. on Industrial Electronics*, vol.63, no. 9, pp. 5582-5591, 2016.
[54] X. Zhang, Q.-C. Zhong, and W.-L. Ming, Stabilization of Cascaded DC/DC Converters via Adaptive Series-Virtual-Impedance Control of the Load Converter, *IEEE Trans. on Power Electronics*, vol. 31, no. 9, pp. 6057-6063, 2016.
[55] G. Konstantopoulos, and Q.-C. Zhong, Nonlinear Control of Single-Phase PWM Rectifiers with Inherent Current-Limiting Capability, *IEEE Access*, vol. 4, pp. 3578-3590, 2016.
[56] R. Sanz-Diaz, P.J. Garcia Gil, Q.-C. Zhong and P. Albertos, Robust Control of Quadrotors Based on an Uncertainty and Disturbance Estimator, *ASME J. Dyn. Syst., Meas., Control*, vol. 138, no. 7, 071006, 2016.
[57] Q.-C. Zhong, W.-L. Ming, X. Cao and M. Krstic, Control of Ripple Eliminators to Improve the Power Quality of DC Systems and Reduce the Usage of Electrolytic Capacitors, *IEEE Access*, vol. 4, pp. 2177-2187, 2016.
[58] H. Wu, X. Ruan, D. Yang, X. Chen, Q.-C. Zhong and Z. Lv, Small-Signal Modelling and Parameters Design for Virtual Synchronous Generators, *IEEE Trans. on Industrial Electronics*, vol.63, no. 7, pp. 4292-4303, 2016.
[59] Q.-C. Zhong and Y. Zeng, Universal Droop Control of Inverters with Different Types of Output Impedance, *IEEE Access*, vol. 4, pp. 702-712, 2016.
[60] X. Zhang, Q.-C. Zhong and W.-L. Ming, Stabilization of a Cascaded DC Converter System via Adding a Virtual Adaptive Parallel Impedance to the Input of the Load Converter, *IEEE Trans. on Power Electronics*, vol. 31, no. 3, pp. 1826-1832, 2016.
[61] W.-L. Ming and Q.-C. Zhong, A Single-phase Four-Switch Rectifier with Significantly Reduced Capacitance, *IEEE Trans. on Power Electronics*, vol. 31, no. 2, pp. 1618-1632, 2016.
[62] X. Zhang, X.-B. Ruan and Q.-C. Zhong, Improving the Stability of Cascaded DC/DC Converter Systems via Shaping the Input Impedance of the Load Converter with a Parallel or Series Virtual Impedance, *IEEE Trans. on Ind. Electronics*. vol. 62, no. 12, pp. 7499-7512, 2015.
[63] B. Ren, Q.-C. Zhong and J. Chen, Robust Control of Non-affine Nonlinear Systems with an Uncertainty and Disturbance Estimator (UDE), *IEEE Trans. on Industrial Electronics*, vol.62, no.9, pp. 5881-5888, 2015.
[64] G.C. Konstantopoulos, Q.-C. Zhong, B. Ren and M. Krstic, Stability and fail-safe operation of Inverters Operated in Parallel, *Int. Journal of Control*, vol. 88, no. 7, pp. 1410-1421, 2015.
[65] A. Kuperman and Q.-C. Zhong, UDE-based linear robust control for a class of nonlinear systems with application to wing rock motion stabilization, *Nonlinear Dynamics*, 2015.
[66] W.-L. Ming and Q.-C. Zhong, A single-phase rectifier having two independent voltage outputs with reduced fundamental frequency voltage ripples, *IEEE Trans. on Power Electronics*, vol. 30, no. 7, pp. 3662-3673, 2015.
[67] X. Cao, Q.-C. Zhong and W.-L. Ming, Ripple eliminator to smooth DC-Bus voltage and reduce the total capacitance required, *IEEE Trans. on Industrial Electronics*, vol.62, no. 4, pp. 2224-2235, 2015.

[68] A.T. Alexandridis, G.C. Konstantopoulos, and Q.-C. Zhong, Advanced Integrated Modeling and Analysis for Adjustable Speed Drives of Induction Motors Operating with Minimum Losses, *IEEE Trans. on Energy Conversion*, vol.30, no.3, pp. 1237-1246, 2015.

[69] G.C. Konstantopoulos, Q.-C. Zhong, B. Ren, and M. Krstic, Bounded Droop Controller for Parallel Operation of Inverters, *Automatica*, Vol. 53, no. 3, pp. 320-328, 2015.

[70] Q.-C. Zhong, Z. Ma, W.-L. Ming and G.C. Konstantopoulos, Grid-friendly wind power systems based on the synchronverter technology, *Energy Conversion and Management*, vol. 89, pp. 719-726, 2015.

[71] Q.-C. Zhong and Y. Zeng, Control of inverters via a virtual capacitor to achieve capacitive output impedance, *IEEE Trans. on Power Electronics*, vol. 29, no. 10, pp. 5568-5578, 2014.

[72] Q.-C. Zhong, P.-L. Nguyen, Z. Ma and W. Sheng, Self-synchronised synchronverters: Inverters without a dedicated synchronisation unit, *IEEE Trans. on Power Electronics*, vol. 29, no. 2, pp. 617–630, Feb., 2014.

[73] Q.-C. Zhong, AC Ward Leonard drive systems: Revisiting the four-quadrant operation of AC machines, *European Journal of Control*, vol. 19, No. 5, 426–436, 2013.

[74] S.M. Disney, R.D. H. Warburton and Q.-C. Zhong, Net present value analysis of the economic production quantity, *IMA Journal of Management Mathematics*, vol. 24, No. 4, 423–435, 2013.

[75] T. Hornik and Q.-C. Zhong, Parallel PI voltage–H-infinity current controller for the neutral point of a three-phase inverter, *IEEE Trans. on Industrial Electronics*, vol.60, no.4, 1335-1343, 2013.

[76] Q.-C. Zhong and T. Hornik, Cascaded current-voltage control to improve the power quality for a grid-connected inverter with a local load, *IEEE Trans. on Industrial Electronics*, vol.60, no.4, 1344-1355, 2013.

[77] Q.-C. Zhong, Robust droop controller for accurate proportional load sharing among inverters operated in parallel, *IEEE Trans. on Industrial Electronics*, vol.60, no.4, 1281-1290, 2013. **Received over 1,100 Google Scholar citations as of June 29, 2026.**

[78] Q.-C. Zhong, Harmonic droop controller to reduce the voltage harmonics of inverters, *IEEE Trans. on Industrial Electronics*, vol.60, no.3, 936-945, 2013.

[79] X.-L. Wang, Q.-C. Zhong, Z.-Q. Deng and S.-Z. Yue, Current-controlled multi-phase slice permanent magnetic bearingless motors with open-circuited phases: Fault-Tolerant Controllability and its Verification, *IEEE Trans. on Industrial Electronics*, vol. 59, no. 5, 2059-2072, 2012.

[80] Q.-C. Zhong, A. Kuperman and R.K. Stobart, Design of UDE-based controllers from their two-degree-of-freedom nature, *Int. Journal of Robust and Nonlinear Control*, vol. 21, 1994–2008, 2011.

[81] T. Hornik and Q.-C. Zhong, A current control strategy for voltage-source inverters in microgrids based on H-infinity and repetitive control, *IEEE Trans. on Power Electronics*, vol. 26, no. 3, 943-952, 2011.

[82] Q.-C. Zhong and G. Weiss, Synchronverters: Inverters that mimic synchronous generators, *IEEE Trans. on Industrial Electronics*, vol.58, no.4, 1259-1267, 2011. **One of the three Most-cited Non-survey Papers in the journal's 44-year history with nearly 4000 Google Scholar citations as of June 29, 2026. The technology received the IET Innovation Award in 2009.**

[83] R.K. Stobart, A. Kuperman and Q.-C. Zhong, Uncertainty and disturbance estimator (UDE)-based control for uncertain LTI-SISO systems with state delays, *ASME J. Dyn. Syst., Meas., Control*, vol. 133, 024502, 1-6, 2011.

[84] A. Kuperman and Q.-C. Zhong, Robust control of uncertain nonlinear systems with state delays based on an uncertainty and disturbance estimator, *Int. Journal of Robust and Nonlinear Control*, vol.21, no.1, 79-92, 2011.

[85] T. Hornik and Q.-C. Zhong, H-infinity repetitive voltage control of grid-connected inverters with a frequency adaptive mechanism, *IET Power Electronics*, vol.3, no.6, 925-935, 2010.

[86] S. Shen, J. Zhang, X. Chen, Q.-C. Zhong and R. Thornton, ISG hybrid powertrain: A rule-based driver model incorporating look-ahead information, *Vehicle System Dynamics*, vol. 48, no.3, 301-337, 2010.

[87] S. Hadd and Q.-C. Zhong, On feedback stabilizability of linear systems with state and input delays in Banach spaces, *IEEE Trans. on Automatic Control*, vol. 54, no.3, 438-451, 2009.

[88] Q.-C. Zhong, A. K. Nandi and M. F. Aburdene, Efficient implementation of the discrete Pascal transform using difference operators, *IET Electronics Letters*, vol. 43, no. 24, 1348-1350, 2007.

[89] J. Sun, Q.-G. Wang and Q.-C. Zhong, A less conservative stability test for second-order linear time-varying vector differential equations, *Int. Journal of Control*, vol. 80, no. 4, 523–526, 2007.

[90] Q.-C. Zhong, J. Liang, G. Weiss, C.-M. Feng and T. Green. H-infinity control of the neutral point in 4-wire 3-phase DC-AC converters. *IEEE Trans. Industrial Electronics*, vol. 53, no.5, 1594-1602, 2006.

[91] B. Wang, D. Rees and Q.-C. Zhong. Control of Integral Processes with Dead Time. Part IV: Various Issues about PI controllers. *IEE Proc. Control Theory & Appl.*, vol. 153, no. 3, 302-306, 2006.

[92] R. Majumder, B. Chauduri, B. Pal and Q.-C. Zhong. A unified Smith predictor approach for power system damping control using remote signals. *IEEE Trans. on Control Systems Technology*, vol. 13, no.6, 1063-1068, 2005.

[93] Q.-C. Zhong, L. Hobson, M.G. Jayne. Classical control of the neutral point in 4-wire 3-phase DC-AC converters. *Electrical Power Quality and Utilisation*, vol. 11, no.2, 111-119, 2005.

[94] Q.-C. Zhong. *J*-spectral factorization of regular para-Hermitian transfer matrices. *Automatica*, vol.41, no.7, 1289-1293, 2005.

[95] Q.-C. Zhong. On distributed delay in linear control laws. Part II: Rational implementations inspired from the δ-operator. *IEEE Trans. on Automatic Control*, vol. 50, no.5, 729-734, 2005.

[96] Q.-C. Zhong and D. Rees. Control of uncertain LTI systems based on an uncertainty and disturbance estimator. *ASME J. Dyn. Syst., Meas., Control*, vol.126, no.4, 905-910, 2004.

[97] Q.-C. Zhong and G. Weiss. A unified Smith predictor based on the spectral decomposition of the plant. *Int. J. of Control*, vol. 77, no.15, pp.1362-1371, 2004.

[98] Q.-C. Zhong. On distributed delay in linear control laws. Part I: Discrete-delay implementations. *IEEE Trans. Automatic Control*, vol. 49, no.11, pp.2074-2080, 2004.

[99] Q.-C. Zhong and C.-C. Hang. Control of processes with dead time and input constraints using control signal shaping. *IEE Proc. Control Theory & Appl.*, vol. 151, no. 4, 473-480, 2004.

[100] G. Weiss, Q.-C. Zhong, T. Green and J. Liang. H-infinity repetitive control of DC-AC converters in micro-grids. *IEEE Trans. on Power Electronics*, vol. 19, pp.219-230, 2004.

[101] L. Mirkin and Q.-C. Zhong. 2DOF Controller parametrization for systems with a single I/O delay. *IEEE Trans. Automatic Control,* vol. 48, no.11, pp. 1999-2004, 2003.

[102] Q.-C. Zhong. Robust stability analysis of simple systems controlled over communication networks. *Automatica,* vol.39, no.7, pp. 1309-1312, 2003.

[103] Q.-C. Zhong. On standard H-infinity control of processes with a single delay. *IEEE Trans. Automatic Control*, vol.48, no.6, pp. 1097-1103, 2003.

[104] Q.-C. Zhong. Frequency domain solution to the delay-type Nehari problem. *Automatica*, vol. 39, no. 3, pp. 499-508, 2003.

[105] Q.-C. Zhong. H-infinity control of dead-time systems based on a transformation. *Automatica*, vol. 39, no. 2, pp. 361-366, 2003.

[106] Q.-C. Zhong. Control of integral processes with dead time. Part 3: Dead-beat disturbance response. *IEEE Trans. Automatic Control*, vol. 48, no. 1, pp. 153-159, 2003.

[107] G. Meinsma, L. Mirkin and Q.-C. Zhong. Control of systems with I/O delay via reduction to a one-block problem. *IEEE Trans. Automatic Control,* vol. 47, no.11, pp.1890-1895, 2002.

[108] Q.-C. Zhong and L. Mirkin. Control of integral processes with dead time. Part 2: Quantitative analysis. *IEE Proc. Control Theory & Applications,* vol. 149, no. 4, pp. 291-296, 2002.

[109] Q.-C. Zhong, J.E. Normey-Rico. Control of integral processes with dead time. Part 1: Disturbance-observer based 2DOF control scheme. *IEE Proc. Control Theory Applications,* vol. 149, no. 4, pp. 285-290, 2002.
[110] Q.-C. Zhong and H.-X. Li. Two-degree-of-freedom PID-type controller with Smith principle for processes with dead-time. *Industrial & Engineering Chemistry Research*, vol. 41, no.10, pp. 2448-2454, 2002.

[111] Q.-C. Zhong, J.Y. Xie and Q. Jia. Time-delay-filter-based dead-beat control of process with dead time. *Industrial & Engineering Chemistry Research*, vol.39, no.6, pp. 2024-2028, 2000.
[112] Q.-C. Zhong and J.Y. Xie. Robust Smith predictive controller for processes with inverse response. *Journal of Shanghai Jiaotong University,* vol. E-4, no.2, pp. 10-16, 1999.

Peer-reviewed Conference Papers

[113] K. Yu, K. Norman, S. Y. Aurko, B. Ren, Q.-C. Zhong. Design and Implementation of a Rotorless Wind Turbine Simulator, in *Proceedings of The 2024 Annual Conference of the IEEE Industrial Electronics Society (IECON 2024)*, Chicago, Illinois. Nov., 2024.
[114] K. Norman, B. Ren and Q.-C. Zhong, Control of Parallel Solar-Battery Systems Enabled by a theta-Converter Topology, *2024 American Control Conference (ACC), in Toronto*, CANADA, July 2024.
[115] Q.-C. Zhong, Y. Wang, M. Amin, Y. Dong, and B. Ren, Smart Grid Research and Educational Kit to Enable the Control of Power Electronic-based Systems from Simulations to Experiments in Hours, in *Proceedings of The 21st IFAC World Congress*, Berlin, Germany, July 12-17, 2020.
[116] T.C. Ionescu, O.V. Iftime, and Q.-C. Zhong, Model Reduction by Moment Matching: Case Study of an FIR System, *2019 European Control Conference*, Napoli, Italy, June 25-28, 2019.
[117] Y. Wang, B. Ren and Q.-C. Zhong. Bounded UDE-based Controller for Systems with Input Constraints. *2018 IEEE Conference on Decision and Control (CDC)*, 2018.
[118] M. Amin, Q.-C. Zhong, L. Zhang, Z. Li and M. Shahidehpour, Small-Signal Modeling and Analysis of VSM for Distributed Generation in a Weak Grid, in *Proc. of the 44th Annual Conference of the IEEE Industrial Electronics Society (IECON 2018)*, 2018. **(Postdoc M. Amin received the IEEE IES Students and Young Professionals Paper Assistance (SYPA) Competition Award.)**
[119] M. Amin, Q.-C. Zhong, Z. Lyu, L. Zhang, Z. Li and M. Shahidehpour, An Anti-islanding Protection for Inverters in Distributed Generation, in *Proc. of the 44th Annual Conference of the IEEE Industrial Electronics Society (IECON 2018)*, 2018.
[120] Y. Wang, Y. Dong, B. Ren and Q.-C. Zhong. UDE-based Robust Control for AC/DC Converters, in *Proc. of the 44th Annual Conference of the IEEE Industrial Electronics Society (IECON 2018)*, 2018.
[121] C. Qi, K. Y. Wang, G. J. Li, X. C. Jiang, Q.-C. Zhong, Application and Validation of Virtual Synchronous Machines in Power System Operation, in *Proc. of the 44th Annual Conference of the IEEE Industrial Electronics Society (IECON 2018)*, 2018.
[122] Z. Tian, Q.-C. Zhong, Z. Lyu, J.Q. Yuan, Robust Estimation of Grid Voltage Parameters via a Second-order Sliding Mode Observer, in *Proc. of 2018 American Control Conference*, 2018.
[123] Y. Wang, B. Ren and Q.-C. Zhong. Bounded Integral Controller for MIMO Nonlinear Systems with Inputs Constraint, in *Proc. of 2018 American Control Conference*, 2018.
[124] J. Dai, B. Ren and Q.-C. Zhong. Output Feedback Trajectory Tracking Control via Uncertainty and Disturbance Estimator, in *Proc. of 2018 American Control Conference*, 2018.
[125] Q.-C. Zhong and M. Stefanello, Port-Hamiltonian Control of Power Electronic Converters to Achieve Passivity, in *Proc. of the 56th IEEE Conference on Decision and Control*, Melbourne, Australia, Dec. 2017.
[126] Z. Lv and Q.-C. Zhong, Control of Modular Multilevel Converters as Virtual Synchronous Machines, in *Proceedings of The 2017 IEEE PES General Meeting*, Chicago, IL, July, 2017.
[127] Q.-C. Zhong, Synchronized-and-Democratized Smart Grids To Underpin The Third Industrial Revolution, in *Proceedings of The 20th IFAC World Congress*, Toulouse, France, July 9-14, 2017.

[128] Q.-C. Zhong and X. Zhang. Impedance-Sum Stability Criterion for Cascaded Power Electronic Systems, in *Proceedings of The 20th IFAC World Congress*, Toulouse, France, July 9-14, 2017.
[129] S. Gadelovits, Q.-C. Zhong, V. Kadirkamanathan, and G. Konstantopoulos, Design of a UDE Frequency Selective Filter to Reject Periodical Disturbances, in *Proceedings of The 20th IFAC World Congress*, Toulouse, France, July 9-14, 2017.
[130] Y. Wang, B. Ren and Q.-C. Zhong. Bounded-voltage Power Flow Control for Grid-tied PV Systems, in *Proceedings of The 20th IFAC World Congress*, Toulouse, France, July 9-14, 2017.
[131] Y. Wang, B. Ren and Q.-C. Zhong. Robust Control of DC-DC Boost Converters for Solar Systems. In Proceedings of the 2017 American Control Conference, Seattle, USA, May 24-26, 2017.
[132] X. Zhang, Q.-C. Zhong and W.-L. Ming, Source-side Series-virtual-impedance Control Strategy to Stabilize the Cascaded System with Improved Performance, in *Proc. of the IEEE Energy Conversion Congress & EXPO (IEEE ECCE*), Milwaukee, Wisconsin, USA, 18-22 September 2016.
[133] Y. Wang, Q.-C. Zhong and B. Ren, UDE-Based Robust Droop Control for Parallel Operated Inverters, in Proc. of the IEEE Energy Conversion Congress & EXPO (IEEE ECCE), Milwaukee, Wisconsin, USA, 18-22 September 2016.
[134] W.-L. Ming and Q.-C. Zhong, Current-stress Reduction of the Neutral Inductor in a Rectifier with Two Independent Outputs, in *Proc. of the IEEE Energy Conversion Congress & EXPO (IEEE ECCE*), Milwaukee, Wisconsin, USA, 18-22 September 2016.
[135] J. Dai, B. Ren and Q.-C. Zhong. UDE-based Robust Control for Nonlinear Systems with Mismatched Uncertainties and Input Saturation, in *Proc. of the 35th Chinese Control Conference*, Chengdu, China July 27-29, 2016.
[136] Y. Wang, B. Ren and Q.-C. Zhong. Robust Power Flow Control of Grid-tied Inverters Based on the Uncertainty and Disturbance Estimator, in *Proc. of the American Control Conference (ACC2016)*, Boston, USA, July 6-8, 2016.
[137] Q.-C. Zhong, and G. C. Konstantopoulos, Nonlinear Current-Limiting Control for Grid-tied Inverters, in *Proc. of the American Control Conference (ACC2016)*, Boston, MA, USA, 6-8 July 2016.
[138] J. Dai, B. Ren and Q.-C. Zhong. UDE-based Dynamic Surface Control for Strict-feedback Systems with Mismatched Disturbances, in *Proc. of the American Control Conference (ACC2016)*, Boston, USA, July 6-8, 2016.
[139] S. Gadelovits, Q-C Zhong and V. Kadirkamanathan, Cascaded control to shape output virtual impedance and improve output voltage quality for power inverter, in *Proc. of IEEE PEDG*, 2016.
[140] X. Zhang, Q.-C. Zhong and W.-L. Ming, Stabilization of Cascaded DC/DC Converters via Shaping the Load Input Impedance by Adaptive Series-Virtual-Impedance Control, in *Proc. of IEEE PEDG*, 2016.
[141] G. C. Konstantopoulos and Q.-C. Zhong, Nonlinear control of dc/dc power converters with inherent current and power limitation, in *Proc. of the Mediterranean Conference on Control and Automation (MED2016)*, Athens, Greece, 21-24 June 2016.
[142] J. Chen, B. Ren and Q.-C. Zhong. High-Bandwidth Control of a Piezoelectric Stage in the Presence of Rate-Dependent Hysteresis, in *Proc. of the 25th ASME Annual Conference on Information Storage and Processing Systems (ISPS)*, Santa Clara, California, USA, June 20-21, 2016.
[143] S. Gadelovits, Q.-C. Zhong, V. Kadirkamanathan, and A. Kuperman, Impedance shaping for parallel operation of inverters in islanded AC microgrids, in *Proc. of IEEE PEDG*, pp. 1-6, 2015.
[144] X. Zhang, Q.-C. Zhong, W.-L. Ming and S. Gadelovits, Impedance-Based Local Stability Criterion for Standalone PV-battery Hybrid System, in *Proc. of IEEE PEDG*, pp.717-723, 2015.
[145] X. Zhang, Q.-C. Zhong, W.-L. Ming and X.-B Ruan, Stabilization of a Cascaded DC System via Adding a Virtual Impedance in Parallel with the Load Converter, in *Proc. of IEEE PEDG*, pp.335-341, 2015.
[146] X. Zhang, Q.-C. Zhong, W.-L. Ming and X.-B Ruan, Stabilization of a Cascaded DC System via Adding a Virtual Impedance in Series with the Load Converter, in *Proc. of IEEE PEDG*, pp.677-683, 2015.

[147] X. Zhang, Q.-C. Zhong and W.-L. Ming, Fast Scale Instability Problem and Phase-Shifted-Carrier Solution of Buck Derived Cascaded System, in *Proc. of the 2015 IEEE Energy Conversion Congress and Exposition*, 2015.
[148] J. Dai, Q. Lu, B. Ren and Q.-C. Zhong, Robust Attitude Tracking Control for a Quadrotor Based on the Uncertainty and Disturbance Estimator, in *Proc. of the 2015 ASME Dynamic Systems and Control Conference*, Columbus, Ohio, October 2015.
[149] G. C. Konstantopoulos, Q.-C. Zhong, B. Ren, and M. Krstic, Boundedness of Synchronverters, in *Proc. of the European Control Conference (ECC'15)*, Linz, Austria, pp. 1050-1055, 15-17 July 2015.
[150] J. Chen, B. Ren and Q.-C. Zhong. Hysteresis Compensation in Piezoelectric Actuator Positioning Control Based on the Uncertainty and Disturbance Estimator, in *Proc. of the American Control Conference (ACC'15)*, Chicago, IL, USA, July 1-3, 2015.
[151] G. C. Konstantopoulos and Q.-C. Zhong, Current-Limiting Non-linear Controller for Single-phase AC/DC PWM Power Converters, in *Proc. of the American Control Conference (ACC'15)*, Chicago, IL, USA, pp. 1029-1034, 1-3 July 2015.
[152] G. C. Konstantopoulos, Q.-C. Zhong, B. Ren, and M. Krstic, Bounded Integral Control for Regulating Input-to-State Stable Non-linear Systems, in *Proc. of the American Control Conference (ACC'15)*, Chicago, IL, USA, pp. 4024-4029, July 2015.
[153] R. Sanz-Diaz, P.J. Garcia Gil, Q.-C. Zhong and P. Albertos, Control of Disturbed Systems with Measurement Delays: Application to Quadrotor Vehicles, *The 23rd Mediterranean Conference on Control and Automation*, Spain, June 2015.
[154] J. Cai and Q.-C. Zhong, A compact power converter for hybrid energy systems, in *Proc. of the 40th Annual Conference of IEEE Industrial Electronics Society*, October 2014.
[155] W.-L. Ming and Q.-C. Zhong, Synchronverter-based Transformerless PV Inverters, in *Proc. of the 40th Annual Conference of IEEE Industrial Electronics Society*, October 2014.
[156] J. Cai and Q.-C. Zhong, An asymmetrical gamma z-source hybrid power converter with space vector pulse-width modulation, in *Proc. of the 2014 IEEE Energy Conversion Congress and Exposition*, September 2014.
[157] W.-L. Ming, Q.-C. Zhong and W. Sheng, A Single-phase Rectifier with a Neutral Leg to Reduce DC-bus Voltage Ripples, in *Proc. of the 2014 IEEE Energy Conversion Congress and Exposition*, September 2014.
[158] Y. Zeng and Q.-C. Zhong, A droop controller achieving proportional power sharing without output voltage amplitude or frequency deviation, in *Proc. of the 2014 IEEE Energy Conversion Congress and Exposition*, September 2014.
[159] J. Cai, Q.-C. Zhong, and D. Stone, A Gamma-Z-source based Hybrid Power Converter for Battery-Fuel Cell Hybrid Electric Vehicles, in *Proc. of the 10th UKACC International Conference on Control*, July 2014.
[160] W.-L. Ming and Q.-C. Zhong, A single-phase rectifier with a wide-range output voltage and reduced ripples, in *Proc. of the 5th International Symposium on Power Electronics for Distributed Generation Systems (PEDG)*, June 2014.
[161] J. Cai and Q.-C. Zhong, A Compact Bidirectional DC-DC Converter with Two Sources, in *Proc. of the 5th International Symposium on Power Electronics for Distributed Generation Systems (PEDG)*, June 2014.
[162] G. C. Konstantopoulos, Q.-C. Zhong, B. Ren, and M. Krstic, Bounded Droop Controller for Accurate Load Sharing Among Paralleled Inverters, in *Proc. of the American Control Conference (ACC'14)*, Portland, OR, US, June 4-6 2014.
[163] X. Cao, Q.-C. Zhong and W.-L. Ming, Analysis and Control of Ripple Eliminators in DC Systems, in *Proc. of the 2014 Sixth IEEE Annual Green Technologies Conference*, Corpus Christi, Texas, April 2014.
[164] B. Ren and Q.-C. Zhong. UDE-based Robust Control of Variable-Speed Wind Turbines, in *Proc. of the 39th Annual Conference of the IEEE Industrial Electronics Society (IECON 2013)*, Vienna, Austria, November 2013.
[165] Q.-C. Zhong and Yu Zeng, Parallel operation of inverters with different types of output impedance, in *Proc. of the 39th Annual Conference of the IEEE Industrial Electronics Society (IECON 2013)*, Vienna, Austria, November 2013.

[166] Q.-C. Zhong and D. Boroyevich, A Droop Controller is intrinsically a Phase-Locked Loop, in *Proc. of the 39th Annual Conference of the IEEE Industrial Electronics Society (IECON 2013)*, Vienna, Austria, November 2013.
[167] B. Ren and Q.-C. Zhong. UDE-Based Robust Control for a Class of Non-affine nonlinear systems. 2013 ASME Dynamic Systems and Control Conference, Palo Alto, CA, USA, October 21-23, 2013
[168] Q.-C. Zhong and W.-L. Ming, Single-phase Voltage-doubler with Mismatched Capacitors for Balanced Output Voltages and Reduced DC-bus Voltage Ripples, in *Proc. of 2013 IEEE Energy Conversion Congress and Exposition (ECCE)*, Denver, Colorado, September, 2013.
[169] Q.-C. Zhong, W.-L. Ming and M. Krstic, Improving the Power Quality of Traction Power Systems with a Single-feeding Wire, in *Proc. of 2013 IEEE Fifth Annual Green Technologies Conference, Denver, Colorado, April, 2013.*
[170] Q.-C. Zhong, W.-L. Ming and M. Krstic, A Single-phase to Three-phase Power Conversion System with Reduced Switches and Improved Output Voltages, in *Proc. of 2013 IEEE Fifth Annual Green Technologies Conference, Denver, Colorado, April, 2013.*
[171] Q.-C. Zhong, W.-L. Ming, X. Cao and M. Krstic, Reduction of DC-bus Voltage Ripples and Capacitors for Single-phase PWM-controlled Rectifiers, in *Proc. of the 38th Annual Conference of the IEEE Industrial Electronics Society (IECON 2012)*, Montreal Canada, October 2012.
[172] Q.-C. Zhong, Z. Ma and P.-L. Nguyen, PWM-controlled Rectifiers without the Need of an Extra Synchronisation Unit, in *Proc. of the 38th Annual Conference of the IEEE Industrial Electronics Society (IECON 2012)*, Montreal Canada, October 2012.
[173] Z. Ma and Q.-C. Zhong, Synchronverter-based Control Strategy for Back-to-back Converters in Wind Power Applications, in *Proc. of The 8th IFAC Symposium on Power Plants and Power Systems Control (PP&PSC*), Toulouse, France, Sept. 2012.
[174] Q.-C. Zhong, F. Blaabjerg, J.M. Guerrero and T. Hornik, Improving the Voltage Quality of an Inverter via Bypassing the Harmonic Current Components, in *Proc. of the 2012 IEEE Energy Conversion Congress and Exposition*, Raleigh, North Carolina, USA, Sept. 2012.
[175] P.-L. Nguyen, Q.-C. Zhong, F. Blaabjerg and J. M. Guerrero, Synchronverter-based Operation of STATCOM to Mimic Synchronous Condensers, in *Proc. of the 7th IEEE Conference on Industrial Electronics and Applications (ICIEA 2012)*, Singapore, July 2012.
[176] Z. Ma, Q.-C. Zhong and J. Yan, Synchronverter-based Control Strategies for Three-phase PWM Rectifiers, in *Proc. of the 7th IEEE Conference on Industrial Electronics and Applications (ICIEA 2012)*, Singapore, July 2012.
[177] Q.-C. Zhong, Power Delivery to a Current Source and Reduction of Voltage Harmonics for Inverters, in *Proc. of the 2012 American Control Conference*, Montréal, Canada, June 2012.
[178] Q.-C. Zhong, Active Capacitors: Concept and Implementation, in *Proc. of the 2012 IEEE International Symposium on Industrial Electronics (ISIE 2012)*, Hangzhou, China, May 2012.
[179] Q.-C. Zhong and P.-L. Nguyen, Sinusoid-Locked Loops based on the Principles of Synchronous Machines, in *Proc. of the 24th Chinese Control and Decision Conference (2012 CCDC),* Taiyuan, China, May 2012.
[180] T. Hornik and Q.-C. Zhong, H-infinity current control strategy for the neutral point of a three-phase inverter, in *Proc. of the 50th IEEE Conference on Decision and Control and European Control Conference*, Orlando, FL, USA, Dec. 2011.
[181] A. Kuperman, Q.-C. Zhong and Richard Stobart, Robust Control of Wing Rock Motion based on an Uncertainty and Disturbance Estimator, in *Proc. of the 50th IEEE Conference on Decision and Control and European Control Conference*, Orlando, FL, USA, Dec. 2011.
[182] Q.-C. Zhong and Y. Zeng, Can the Output Impedance of an Inverter Be Designed Capacitive?, in *Proc. of the 37th Annual Conference of the IEEE Industrial Electronics Society (IECON)*, Melbourne, Australia, November 2011.
[183] Q.-C. Zhong, F. Blaabjerg, J.M. Guerrero and T. Hornik, Reduction of Voltage Harmonics for Parallel-operated Inverters Equipped with a Robust Droop Controller, in *Proc. of the 2011 IEEE Energy Conversion Congress and Exposition*, Phoenix, USA, Sept. 2011.
[184] Q.-C. Zhong, Control of parallel-connected inverters to achieve proportional load sharing with voltage regulation, in *Proc. of the 18th IFAC World Congress*, Milan, Italy, Sept. 2011.

[185] T. Hornik and Q.-C. Zhong, H-infinity repetitive current-voltage control of inverters in microgrids, in *Proc. of the 36th Annual Conference of the IEEE Industrial Electronics Society (IECON)*, Phoenix, USA, Nov. 2010.
[186] X.-L. Wang, Q.-C. Zhong, Z.-Q. Deng, Fault-tolerant control of multi-phase permanent magnetic bearingless motors, in *Proc. of the International Conference on Electrical Machines (ICEM 2010)*, Roma, Italy, Sept. 2010.
[187] Q.-C. Zhong, C. Matthews, P.-L. Nguyen and S. Clarke, Low-cost rapid control prototyping paradigm, in *Proc. of the UKACC International Conference on CONTROL* 2010, Coventry, UK, September 2010.
[188] A. Kuperman, Q.-C. Zhong and R.K. Stobart, Filter Design for UDE-based Controllers, in *Proc. of the UKACC International Conference on CONTROL* 2010, Coventry, UK, September 2010.
[189] X. Zhang, Q.-C. Zhong, H. Zhang and X. Ma, Proportional load sharing method for parallel connected inverters, in *Proc. of the IEEE International Symposium on Industrial Electronics* (ISIE-2010), Bari, Italy, July 2010.
[190] T. Hornik and Q.-C. Zhong, Voltage control of grid-connected inverters based on H∞ and repetitive control, in *Proc. of the 8th World Congress on Intelligent Control and Automation*, China, July 2010.
[191] Q.-C. Zhong, Speed-sensorless AC Ward Leonard drive systems, in *Proc. of the* 20th International Symposium on Power Electronics, Electrical Drives, Automation and Motion, Pisa, Italy, June 2010.
[192] Q.-C. Zhong, Four-quadrant operation of AC machines powered by inverters that mimic synchronous generators, in *Proc. of the 5th IET International Conference on Power Electronics, Machines and Drives*, Brighton, UK, April 2010.
[193] T. Hornik and Q.-C. Zhong, H-infinity repetitive current controller for grid-connected inverters, in Proc. of the 35th Annual Conference of the IEEE Industrial Electronics Society (IECON), Porto, Portugal, 3-5 November 2009.
[194] S. Hadd and Q.-C. Zhong, On approximate controllability of infinite dimensional neutral systems, in *Proc. of the 7th Asian Control Conference*, Hong Kong, China, August 27–29, 2009.
[195] A. Kuperman and Q.-C. Zhong, Control of uncertain linear systems with a state delay based on an uncertainty and disturbance estimator, in *Proc. of the 6th IFAC Symposium on Robust Control Design,* Haifa, Israel, June 16-18, 2009.
[196] T. Hornik and Q.-C. Zhong, Control of grid-connected DC-AC converters in distributed generation: Experimental comparison of different schemes, in *Proc. of the 6th Workshop on Compatibility and Power Electronics - CPE 2009*, Badajoz, Spain, May 20-22, 2009.
[197] A. Kuperman and Q.-C. Zhong, Robust UDE-based control of uncertain nonlinear state-delay systems, in *Proc. of the IEEE Region 8 Conference EUROCON 2009*, St.–Petersburg, Russia, May 2009.
[198] Q.-C. Zhong, Ground-operated energy recovery system for landing aircraft, in *Proc. of SUPERGEN 2009: 1st International Conference on Sustainable Power Generation and Supply*, Nanjing, China, April 2009.
[199] Q.-C. Zhong and G. Weiss, Static synchronous generators for distributed generation and renewable energy, in *Proc. of the 2009 IEEE PES Power Systems Conference & Exhibition (PSCE)*, Seattle, Washington, USA, March 2009.
[200] S. Hadd and Q.-C. Zhong, Perturbation theory of boundary value problems and approximate controllability of perturbed boundary control problems, in *Proc. of the 47th IEEE Conference on Decision and Control*, Cancun, Mexico, Dec. 2008.
[201] A. Visioli and Q.-C. Zhong, Control of integral processes with dead time: Practical issues and experimental results, in Proceedings of the International Conference on Control 2008, Manchester, UK, September 2008.
[202] S. Hadd and Q.-C. Zhong. Necessary and sufficient conditions for feedback stabilizability of time–delay systems in Banach spaces, in *Proc. of the 18th Int. Symposium on Mathematical Theory of Networks and Systems (MTNS2008)*, Virginia, USA, July 2008.
[203] S. Hadd and Q.-C. Zhong, Passivity of infinite-dimensional linear systems with state, input and output delays, in *Proc. of the 17th IFAC World Congress*, Seoul, South Korea, July 2008.

[204] Q.-C. Zhong, Recent results on robust control of time-delay systems, in *Proc. of the 7th World Congress on Intelligent Control and Automation*, Chongqing, China, June 2008.

[205] S. Hadd and Q.-C. Zhong, Conditions on feedback stabilization of systems with state and input delays in Banach spaces, in *Proc. of the 46th IEEE Conf. on Decision & Control*, New Orleans, USA, Dec. 2007.

[206] Q.-C. Zhong. Similarity transformation and algebraic Riccati equations, in *Proc. of the 45th IEEE Conf. on Decision & Control*, San Diego, USA, Dec. 2006.

[207] Q.-C. Zhong. A case study for the delay-type Nehari problem, in *Proc. of the 44th IEEE Conf. on Decision & Control*, Seville, Spain, Dec. 2005.

[208] Q.-C. Zhong. *J*-spectral factorisation via similarity transformations, in *Proc. of the 16th IFAC World Congress*, Prague, Czech Rep., July 2005.

[209] Q.-C. Zhong. Rational implementation of distributed delay using extended bilinear transformations, in *Proc. of the 16th IFAC World Congress*, Prague, Czech Rep., July 2005.

[210] Q.-C. Zhong, L. Hobson and M. Jayne. Generating A Stable Neutral Point For 3-Phase 4-Wire DC-AC Converters, in *Proc. of the 4th Int. Workshop on Compatibility in Power Electronics* (CPE 2005), Gdynia, Poland, June 2005.

[211] Q.-C. Zhong and C.-C. Hang. Two-level control of processes with dead time and input constraints, in *Proc. of the 5th IFAC Workshop on Time-Delay Systems*, Leuven, Belgium, September 2004.

[212] A. Kuperman, R. Rabinovici and Q.-C. Zhong. Time-delay compensation in solid-state excited autonomous induction generators, in *Proc. of the 2nd Int. Conference on Power Electronics, Machines and Drives,* vol.2, pp.769-774, Scotland, UK, April 2004.

[213] Q.-C. Zhong. What's wrong with the implementation of distributed delay in a control law? in *Proc. of the 4th IFAC Workshop on Time-Delay Systems* (TDS'03), Rocquencourt, France, September 2003.

[214] Q.-C. Zhong. Unified Smith predictor for dead-time systems, in *Proc. of the 4th IFAC Workshop on Time-Delay Systems* (TDS'03), Rocquencourt, France, September 2003.

[215] Q.-C. Zhong. Stability analysis of simple control algorithms in communication networks, in *Proc. of the 2003 European Control Conference*, Cambridge, UK, September 2003.

[216] Q.-C. Zhong, S.-I. Niculescu and A. M. Annaswamy. Stability analysis of low-order combustion systems, in *Proc. of the 11th Mediterranean Conference on Control and Automation*, Rhodes, Greece, June 2003.

[217] Q.-C. Zhong, T. Green, J. Liang and G. Weiss. Robust repetitive control of grid-connected DC-AC converter, in *Proc. of 41st IEEE Conf. on Decision & Control*, Las Vegas, USA, Dec. 2002.

[218] G. Meinsma, L. Mirkin and Q.-C. Zhong. H-infinity control of systems with a single delay via reduction to a one-block problem. in *Proc. of the 41st IEEE Conf. on Decision & Control*, Las Vegas, USA, Dec. 2002.

[219] Q.-C. Zhong, T. Green, J. Liang and G. Weiss. H-infinity control of the neutral leg in 3-phase 4-wire DC-AC converters. in *Proc. of The 28th Annual Conference of the IEEE Industrial Electronics Society (IECON'02)*. Seville, Spain, Nov. 2002.

[220] G. Meinsma, L. Mirkin and Q.-C. Zhong. A Nehari theorem for continuous-time FIR systems, in *Proc. of 15th International Symposium on Mathematical Theory of Networks and Systems* (MTNS'02), Notre Dame, USA. August 2002.

[221] Q.-C. Zhong. Frequency domain solution to the delay-type Nehari problem, in *Proc. of the 15th IFAC World Congress*, Barcelona, Spain, July 2002.

[222] Q.-C. Zhong and H.-X. Li. Delay-type PID controller, in *Proc. of the 15th IFAC World Congress*, Barcelona, Spain, July 2002.

[223] L. Mirkin and Q.-C. Zhong. Coprime parameterization of 2DOF controller to obtain sub-ideal disturbance response for processes with dead time, in *Proc. of the 40th IEEE Conf. on Decision & Control*, Orlando, USA, 2001.

[224] Q.-C. Zhong and H.X. Li. Deadbeat disturbance response of integral process with dead time, in *Proc. of the 40th IEEE Conf. on Decision & Control*, Orlando, USA, 2001.

[225] Q.-C. Zhong and J.E. Normey-Rico. Disturbance observer-based control for processes with an integrator and long dead-time, *Proc. of 40th IEEE Conf. on Decision & Control*, Orlando, 2001.
[226] Q.-C. Zhong and L. Mirkin. Quantitative analyses of robust stability region and disturbance response of processes with an integrator and long dead-time, in *Proc. of the 40th IEEE Conf. on Decision & Control*, Orlando, USA, 2001.
[227] Q.-C. Zhong. H-infinity control of dead-time systems based on a transformation. In *Proc. of the 3rd IFAC Workshop on Time Delay Systems*, Santa Fe, New Mexico, USA, 2001.

Selected Academic Journal Papers in Chinese

[228] Q.-C. Zhong, Systems Theory, Chinese Culture, and Synchronized-and-Democratized (SYNDEM) Smart Grids (invited), *All About Systems and Control*, Vol.5 (2): 64-70, 2018, https://tcct.amss.ac.cn/sc-journal/2018/201802/20180264.pdf.
[229] Q.-C. Zhong, Virtual Synchronous Machines and Autonomous Power Systems, *Proceedings of the CSEE*, Vol.37, No.2, Jan. 2017.
[230] Q.-C. Zhong and J.Y. Xie. Time Delay Observer with Low-pass Filter for LTI-SISO Systems with Uncertainties. ACTA AUTOMATICA SINICA, 2002, 28(2), 272-278.
[231] Q.-C. Zhong and J.Y. Xie. Time delay control & its applications. Control Theory & Applications, 2002, 19(4): 500-504.
[232] Q.-C. Zhong and J.Y. Xie. Reduced-order time delay observer for LTI-SISO systems with uncertainties. Control Theory & Appl., 2002, 19(6):885.
[233] C.-Y. Liang, Q.-C. Zhong and J.Y. Xie. Time Delay Filter to Reduce Residual Vibration: Theories, Methods and Applications. Control and Decision, 2001, 16(3): 263-268.
[234] Q.-C. Zhong, Q. Jia and J.Y. Xie. Reduced-order Time Delay Observer with Low-pass Filter for LTI-SISO Systems with Uncertainties. Control & Decision, 2001, 16(4): 468-472.
[235] Q.-C. Zhong and J.Y. Xie. Time delay observer for systems with uncertainties. J. of Shanghai Jiao Tong Univ., 2001, 35(2): 297-300.
[236] Q.-C. Zhong, J.Y. Xie and S.-Y. Hu. Hydro-turbine governor with robust Smith predictor. Journal of Hydroelectric Engineering, 2001, no.1. 68.
[237] Q.-C. Zhong, C.-Y. Liang and J.Y. Xie. Feasible magnitude design of time-delay notch filters to eliminate residual vibrations. Journal of Vibration Engineering, 2001, no.1.
[238] Q.-C. Zhong, J.Y. Xie. Input Shaping Technique Based Deadbeat Control of Processes with Time Delay. Control and Decision, 2000, 15, 2, 230-232.
[239] Q.-C. Zhong, J.Y. Xie and Q. Jia. Analysis of Time Delay Filter with Damped Frequency Magnitude Characteristic. Journal of Shanghai Jiao Tong University, 2000, 34(5): 642-645.
[240] Q.-C. Zhong and J.Y. Xie. Discrete State Space Representation of Dynamic Matrix Controller and its Implementation with Simulink. Information & Control, 2000, 29(7): 639-645.
[241] Q.-C. Zhong and J.Y. Xie. Positive-Response Amplifier to Control Process with Inverse Response. Control and Decision, 2000, 15(5): 629-630 (636).
[242] C.-Y. Liang, Q.-C. Zhong and J.Y. Xie. Model Reference Based Adaptive PID Controller. J. of Shanghai Jiao Tong Univ., 2000, 34(5): 711-714.
[243] Q.-C. Zhong, J.Y. Xie and H. Li. Dynamic Matrix Controller with Model Truncation Error Compensation. Journal of Shanghai Jiao Tong University, 1999, 33(5): 622-625.
[244] Q.-C. Zhong, J.Y. Xie and H. Li. PID Controller with Variable Parameters. Information and Control, 1999, 28(4): 273-277.
[245] C.-W. Peng, Q.-C. Zhong, Q. Jia and J.Y. Xie. Automatic Tuning of the Robust PID Controller. Journal of Hunan University, 1999,26(5): 56-61.
[246] Q.-C. Zhong, J.Y. Xie and C.-W. Peng. Directly Compensating External Model Controller for Process with Time Delay. Journal of Hunan University, 1999, 26(1): 53-59.
[247] Q.-C. Zhong and J.Y. Xie. Model Reduction of Complex Industrial Process: Multi-point Digital Filter Method. Electrical Automation, 1999, 21(5):4-6.
[248] G.-C. Liu, Q.-C. Zhong and J.Y. Xie. Distributed Elevator Control System. Measurement & Control Technology, 1999,18(6): 42-44.
[249] C.-W. Peng, Q.-C. Zhong, Y.-H. Xiao and J.-M. Hu. Network Basic Input/Output Technology. Appl. of Electronic Techniques, 1996.9.

[250] Q.-C. Zhong, Y.-H. Xiao, C.-W. Peng and J.-M. Hu. Serial Communication with C: Questions and Solutions. Appl. of Electronic Techniques, 1996.8.
[251] C.-W. Peng, Y.-H. Xiao and Q.-C. Zhong. Study on the Pseudo-FMS Network Technology. Journal of Hunan University, 1996,6.
[252] Y.-H. Xiao, C.-W. Peng and Q.-C. Zhong. Reciprocity Communication Program Design Based on NetBIOS. J. of Hunan University, 1996,2.
[253] J.-M. Hu, C.-W. Peng and Q.-C. Zhong. Data Share between a MCS-51 Control-Area-Network and a Local-Area Network (LAN). Measurement & Control Technology, 1997,16(2).
[254] Q.-C. Zhong. Methods to Reduce the Number of I/O Points of a PLC Controlled Elevator. Electric Drive, 1993,1.
[255] Q.-C. Zhong. Keyboard Interface for Microcomputer Controlled Systems. Application of Electronic Techniques, 1992.11.
[256] Q.-C. Zhong, Phase-Sequence Detector, Application of Electronic Technique, 1992, 10. The very first paper. Thirty years later, the technology is adopted in Syndem VSM products.

Teaching and Mentorship

- PhD students supervised to completion:
  - Duo Wang, Large-Signal Transient Stability and Control of Inverter-Based Resources, Illinois Institute of Technology, May 2024.
  - Zijun Lv, Active Load Control in a Synchronized-and-Democratized (SYNDEM) Smart Grid, Illinois Institute of Technology, December 2021.
  - Xin Zhang, Impedance Control and Stability of DC/DC Converter Systems, University of Sheffield, 2016, awarded **the Grand Prize of National Awards for Outstanding Chinese Students Abroad** (10 awards around the world).
  - Yu Zeng, Droop Control of Parallel-Operated Inverters, University of Sheffield, 2015.
  - Wen-Long Ming, Active Control of Voltage Ripples in Power Electronic Converters, University of Sheffield, 2015, **awarded the National Awards for Outstanding Chinese Students Abroad** by **the China Scholarship Council (500 awards around the world), and the Control & Automation PhD Award by Institute of Engineering and Technology (IET),** UK, 2017.
  - Shamsul Aizam Zulkifli, Energy Recovery from Landing Aircraft, Loughborough University, 2012.
  - Zhenyu Ma, Synchronverter-based Control for Wind Power, Loughborough University, 2012.
  - Phi-Long Nguyen, Rapid Control Prototyping and Hardware-in-the-Loop: Platform Development and Applications in Energy Systems, Loughborough University, 2012.
  - Tomas Hornik, Power Quality in Microgrids, University of Liverpool, 2010.
- Partial List of Postdocs and Visiting Scholars
  - Bismark Claure Torrico, 8/2025-8/2026
  - Yang Ruan, 07/2018-07/2019
  - Mohammad Amin, 8/2017-4/2019
  - Cui Wang, 9/2017 – 8/2020
  - Yibo Zhang, 4/2019 – 4/2020
  - Wen Huang, 10/2018- 10/2019
  - Chen Qi, 10/2017 – 10/2019
  - Shungang Xu, 3/2018-3/2019
  - Junjie Hong, 2/2018 –2/2019
  - Zhiwei Jia, 12/2017-12/2018
  - Zhen Tian, 8/2017-5/2019
  - Pietro Lorenzetti, 10/2018-12/2018
  - Songrong Wu, 1/2017-1/2018
  - Tiancong Shao, 10/2016-10/2017

- Márcio Stefanello, 07/2016 – 7/2017
- Xiaoqiang Dang, 03/2016 -03/2017
- Youjun Zhang, 2/2016 – 2/2017
- Andre Yamashita, 1/2016 – 1/2017
- Yalan Xu, 08/2016 – 12/2016
- Ying Liang, 12/2015 - 12/2016
- Defeng Wu, 12/2015 – 12/2016
- Dongqi Liu, 11/2015 – 11/2016
- Yangyang Zhao, 10/2015 –10/2016
- Pedro J. Garcia, 2014
- Lingfei Xiao, 2013
- George C. Konstantopoulos, 2013-2015
- Tudor C. Ionescu, 09/2013-09/2015
- Yao Zhang, 05/2013 - 04/2016
- Jun Cai, 03/2013-03/2015
- Xianghua Ma, 06/2012-06/2013
- Xin Cao, 06/2011-09/2012
- Shaosheng Fan, 2010-2011
- Xiaolin Wang, 2009-2010
- Wuneng Zhou, 12/2009-1/2010
- Alon Kuperman, 2008-2009
- Said Hadd, 2006-2008

- Teaching activities
    - Modules coordinated/taught
        - Advanced Power Electronics, 2026-
        - Control Systems, 2026-
        - Next-Generation Smart Grids, 2018-
        - Robust Control, 2016-2025
        - Power Electronics Dynamics and Control, 2015-2026
        - Robust and hybrid control, 2014
        - Advanced Control, 2013
        - Computing, 2011
        - Power Electronics and Electromechanics (ELEC302), 2005-2009
        - Energy Conversion and Power Systems (ELEC220), 2005-2009
        - Digital Control (ELEC303), 2005-2009
        - Continuous and Discrete-time Signals and Systems (ELEC270), 2005-2009
        - MEng Group Project (ELEC450), 2005-2009
        - MEng Group Project for IE (ELEC451), 2005-2009
        - Electrical Principles, Methods & Simulation (EM2H09), 2004-2005
        - Measurement System Design (EM3S07), 2004-2005
        - Mechatronics - Automation and Control (EM3S03), 2004-2005
        - Power Electronics and Drives (EM3S02), 2004-2005
    - Other teaching interests: Classical and Modern Control Theory, Drives etc

- Lab coordinator for Aerospace Eng. students Year 1 EE lab, 2005-2009
- Lab demonstration for Year 2 EE students, Imperial College London, 2002
- Supervision of final-year projects for MEng, MSc and BEng students:
  - Univ. of Liverpool: 2006-2010; **one student, Tomas Hornik, won the IET Prize** (2007).
  - Univ. of Glamorgan: 2004-2005.
  - Imperial College London: 2002-2003.
  - Shanghai Jiao Tong University: 1998.
  - Hunan University: 1995-1996, **one of the students, Shutao Li, was awarded the Best Thesis Award**.
  - Xiangtan Inst. of Mech. and Elec. Tech.: 1990-1993, projects covered temperature control, AC/DC drive, NC lathes, elevator control etc.
- Courses taught at Xiangtan Institute of Mech. and Elec. Tech. (1990-1993) include Industrial Control Devices, Electrics Experiments (electric circuits, DC motor, AC motor etc), Electronics Experiments (analogue and digital circuits), Power Electronics Experiments (power electronics, AC/DC drive), Micro-computer Control Systems Experiments (assembly language, program logic controller, single-chip computer etc.).

Patents and Patent Applications

The patent portfolio listed below comprises 8 U.S. patents and 17 foreign patents, with 7 inventions protected in both U.S. and foreign jurisdictions, as well as 4 U.K. applications pending.

[P1]. Q.-C. Zhong, System and Method for Correctness-Oriented Artificial Intelligence Using Internal Domain Models with Model Refiners, UK patent GB2610876.1 filed on 5/10/2026.

[P2]. Q.-C. Zhong, Two-stage AC/DC-DC-DC Converters, UK patent GB2516392.4 filed on 10/1/2025.

[P3]. Q.-C. Zhong, Universal DC/AC converters from/to DC, UK patent GB2514793.5 filed on 9/7/2025.

[P4]. Q.-C. Zhong, Bi-directional Modular High-Gain DC/DC Converters, UK patent GB2514792.7 filed on 9/7/2025.

[P5]. Q.-C. Zhong, Power Electronic Converter with a Ground Fault Detection Unit that Shares a Common Ground with both DC Ports and AC Ports, UK patent GB2586343 (GB2010378.4 filed on July 7, 2020).

[P6]. Q.-C. Zhong, Rackless Thermal-Efficient Modular Power Electronic System, UK patent GB2586094 (GB2009448.8 filed on June 22, 2020), US patent 11,277,945 (17112950 filed on Dec 4, 2020).

[P7]. Q.-C. Zhong, Passive Virtual Synchronous Machine with Bounded Frequency and Virtual Flux, UK patent GB2574645 (GB1809724.6 filed on June 13, 2018). US Patent 10,651,771 (16236483 filed on 12/29/2018).

[P8]. Q.-C. Zhong, SYNDEM Converter, UK patent GB2573318 (GB1807264.5 filed on May 3, 2018). US Patent 10,554,143 (16236485 filed on 12/29/2018).

[P9]. Q.-C. Zhong, Reconfiguration of Inertia, Damping and Fault Ride-Through for a Virtual Synchronous Machine, UK patent GB2570151 (GB1800572.8 filed on Jan 14, 2018). US Patent 10,615,716 (16236515 filed on 12/30/2018).

[P10]. Q.-C. Zhong, Power Electronic Converters that Take Part in the Grid Regulation without Affecting the DC-port Operation, UK patent GB2567840 (GB1717573.8 filed in Oct 2017). US patent 10,797,616 (16147867 filed on 09/30/2018).

[P11]. Q.-C. Zhong, Cyber Synchronous Machine (Cybersync Machine), UK Patent GB2563086 (GB1708886.5 filed in June, 2017). US Patent 10,509,373 (15727600 filed in Oct 2017, 2018-0348712 A1 published 12/6/2018).

[P12]. Q.-C. Zhong, Operating Doubly-Fed Induction Generators as Virtual Synchronous Generators, UK Patent GB2554954 (GB1617589.5 filed in Oct. 2016).

[P13]. B. Ren, Y. Wang, and Q.-C. Zhong, UDE-Based Robust Droop Control for Parallel Inverter Operation, US Patent 10,651,656 (15/698,956, filed on September 08, 2017).

[P14]. Q.-C. Zhong, Self-synchronized robust droop controller, UK Patent GB1601730.3, filed in January 2016, GB2546804 granted on April 9 2019.

- [P15]. Q.-C. Zhong, Theta converter, UK Patent GB1516168.0, filed in Sept. 2015, GB2542194 granted on Oct 2, 2018.
- [P16]. Q.-C. Zhong and T. Hornik, Cascaded Current-Voltage Repetitive Controllers to Improve the Quality of Output Voltage and Current Simultaneously for Grid-Connected Inverters, UK Patent GB2483910, filed in September 2010, granted on 19/02/2013.
- [P17]. Q.-C. Zhong, Robust droop controller for inverters to achieve exact proportional load sharing when connected in parallel, UK Patent GB2483879, filed in September 2010, granted on 11/06/2013.
- [P18]. Q.-C. Zhong, AC Ward Leonard Drive Systems, UK Patent GB2473853, filed in September 2009, granted on 20/03/2012.
- [P19]. Q.-C. Zhong, A system and a method for converting the kinetic energy stored in landing aircraft into electricity, UK Patent GB2460132, filed in Dec. 2008, granted on 29/01/2013.
- [P20]. Q.-C. Zhong and G. Weiss, Static synchronous generators (Inverters that Mimic Synchronous Generators), EU/US/China Patent granted, EP2377238, US 8,880,236, CN102257720A, WO2010055322A3, filed in Nov. 2008.
- [P21]. H.-X. Li and Q.-C. Zhong, Delay PID controller, China Patent CN2724064Y granted, 2005.
- [P22]. Q.-C. Zhong, Multifunctional Lighting Lamp Controller, China Patent CN2119743U granted, 1992.

Entrepreneurship and Commercialization Record

- Licensed the synchronverter patent (EP2377238, US 8,880,236, CN102257720A, WO2010055322A3) [P20] to Synvertec in 2014; Synvertec later attracted support from Horizon GreenTech Ventures, Israel Electric Corporation, the Israeli government, and EU Horizon 2020.
- Founded Syndem LLC in Greater Chicago in 2017 to commercialize later-generation VSM technologies and extend SYNDEM into products, manufacturing, field validation, education, licensing, and partnerships for worldwide deployment to facilitate large-scale utilization of renewable energy resources and autonomous operation of power systems with distributed energy players, enhancing grid security and advancing energy freedom and energy equity; Syndem's operations are institutionally separate from his academic activities at Illinois Tech. Its major milestones are listed below.
  - 2018: Developed SYNDEM Smart Grid Research and Educational Kits to train next-generation engineers equipped with hands-on skills in control and power electronics to meet the increasing demand of a qualified workforce [13]. Now adopted by institutions in more than 10 countries
  - 2018: Recognized as a finalist for Exelon's Climate Change Investment Initiative (2c2i).
  - 2019: Developed its silicon-based 3kW VSM inverter [17]; built and field-tested an autonomous six-VSM renewable home grid integrating solar, wind, storage, and an Energy Bridge for utility-grid interaction, making it a 100% power-electronic-converter-based grid without having a master controller or relying on communication; it regulated voltage/frequency, disconnected on utility faults, and automatically resynchronized/reconnected upon grid recovery. See a short video at https://www.youtube.com/watch?v=vpvc_4-wkLI.
  - 2019: Recognized by New York State Energy Research and Development Authority (NYSERDA) as a semifinalist for $1M 76west Competition, which is "one of the largest" competitions in U.S. that focuses on supporting entrepreneurs to build clean-energy businesses and economic development.
  - 2020: Secured a grant (DE-EE0009030) from the U.S. Department of Energy Solar Energy Technology Office to further develop its VSM control algorithms for solar applications.
  - 2020: Secured an SBIR Phase I project from the U.S. Department of Energy Office of Science to develop a 6kW split-phase inverter (functional prototype) for U.S. residential solar applications.
  - 2021: Selected as the sole vendor to supply 30 VSM units for DOE project DE-EE0009341 with the field tests to be carried out at Brookhaven National Lab.
  - 2021: Invested to cast Syndem's own single-piece recyclable aluminum enclosure for products.
  - 2021: Established in-house design/testing/manufacturing capabilities for converters up to 20kW.

- 2022: Field-tested VSM technologies (not commercial products) for DOE project DE-EE0009030 with 20 SYNDEM Smart Grid Research and Educational Kits equipped with the VSM technologies [M8], connected to photovoltaic panels, batteries, and the utility grid under grid-connected and islanded conditions. See a short video at https://www.youtube.com/watch?v=00UBV9Kk30c.
- 2022: Secured funding (sub-awardee of PowerAmerica) from National Institute of Standards and Technology, Department of Commerce to build pandemic resilience in remote, difficult to reach, underserved Native American communities through clean-energy-powered services.
- 2022: Offered investment by mHUB Product Impact Fund, after going through a lengthy competition
- 2023: Commissioned Texas Tech's reconfigurable SYNDEM Smart Grid Testbed with 108 physical power converters [M7] for system-level validation, resilience research, and workforce development, in collaboration with Texas Tech University (TTU). See a short video at https://www.youtube.com/watch?v=-IHmJ0mYnBc.
- 2024: Started shipping its 9kW SiC-based VSM products to domestic and overseas customers; a five-unit system demonstrated black-start, regulation, grid detection, self-synchronization, islanding, and resynchronization/reconnection. See https://www.youtube.com/watch?v=8ePnhBYouxs.
- 2024: Recognized as a Top 3 Power Electronics Startup out of 123 In Grid Modernization by Innovation intelligence firm StartUs Insights [M5].
- 2024: Listed in 8 Best Smart Grid Companies to Watch in 2025 by ClimateSort.com [M6].
- 2025: Recognized as a Top Key Player in Smart Energy Market, prophecymarketinsights.com [M1].
- 2025: IEEE published IEEE Std 2988-2024 on Virtual Synchronous Machines, of which the development was led by Syndem's CEO, https://standards.ieee.org/ieee/2988/10581/.
- 2026: Established a strategic partnership with OPAL-RT for joint marketing, integration, hardware validation, and sales, combining real-time simulation and hardware-in-the-loop testing with VSM products and reconfigurable physical hardware to provide an end-to-end pathway from modeling to experimental validation.
- 2026: Cumulative product sales exceeded $1.6 million, sustaining Syndem's organic growth.

- Commercialized the China Patent CN2119743U [P22], established the supply chain, manufactured products at 100 units/batch, attracted a radio network for complimentary advertisements, and generated sales revenues, 1992.

Attribution and Collaboration Note

This CV is written in the third person. Descriptions of Dr. Zhong's contributions identify his roles in inventing, initiating, leading, enabling, or contributing to the relevant work. Many publications, projects, demonstrations, standards activities, educational initiatives, commercialization efforts, and institutional pathways involved students, coauthors, collaborators, industrial partners, standards participants, utilities, or implementing organizations. Unless explicitly stated as sole-authored or individually performed, such work should be understood as collaborative where appropriate, without weakening specific statements on invention, leadership, authorship, or contribution.