



# Guest Editorial: Identification, stability analysis, control, and situation awareness of power systems with high penetrations of renewable energy resources

## Abstract

It is with great pleasure that the authors introduce this special issue, commemorating the 8th Asia Conference on Power and Electrical Engineering held in Tianjin in 2023. This conference served as a nexus for researchers, practitioners, and industry experts from around the globe to convene and exchange cutting-edge insights, innovative ideas, and transformative advancements in the field of power and electrical engineering. The contributions featured in this special issue represent a diverse array of research endeavours, spanning from fundamental theories to practical applications, all aimed at addressing the myriad challenges and opportunities facing the power and electrical engineering domain. From novel methodologies in renewable energy integration to advancements in smart grid technologies, each article encapsulates the spirit of innovation and collaboration that characterised the conference. This special issue includes scientific investigations on topology modelling and virtual stability analysis methods for distribution networks with high penetration of renewable energy resources, monitoring and situation awareness on grid inertia and power-frequency evolution, novel voltage source converter control schemes, and reviews of low-carbon planning and operation of electricity, hydrogen fuel, and transportation networks.

In this Special Issue, titled 'Identification, Stability Analysis, Control, and Situation Awareness of Power Systems with High Penetrations of Renewable Energy Resources', we have presented eight original papers of high quality and innovation. These papers can be clustered into three categories: identification and novel control design, dispatch strategy and measurements, and review of the low-carbon era.

## 1 | IDENTIFICATION AND CONTROL DESIGN

*Wenpeng Luan et al.* present a data-driven method for identifying low voltage distribution network topology. This method addresses the challenges of transformer-customer pairing and

customer phase identification, particularly in networks with relatively balanced power supplies. The proposed algorithm is rigorously tested in two distinct real substations located in China and Europe, demonstrating high accuracy and robustness, especially in distribution networks with relatively balanced power supplies (DOI: 10.1049/esi2.12142).

*Lei Chen et al.* present a methodology for implementing active voltage support control based on virtual inertia coordination. To evaluate the proposed approach, we create a detailed MATLAB/Simulink model of double-terminal DC distribution networks (DCDNs) and simulate various voltage disturbance scenarios. Comparative simulations demonstrate that our approach effectively utilises DCDNs' inertia potential to suppress voltage sag and smooth voltage recovery processes. The validity and feasibility of the proposed method are thoroughly validated through these simulations (DOI: 10.1049/esi2.12123).

*Haixin Wang et al.* present the development of a virtual power system stabiliser (VPSS) to mitigate the adverse effects of negative damping torque exerted by virtual synchronous generator on synchronous generator through this pathway. Controller parameters are adjusted employing a phase compensation method. Finally, the efficacy of VPSS is validated through modal analysis and simulation comparisons (DOI: 10.1049/esi2.12119).

*Fuxin Ouyang et al.* present an interval small-signal stability analysis approach to assess system stability under multiparameter uncertainty. The effectiveness of the proposed interval stability analysis method was validated through Monte Carlo analysis and time-domain simulations of the grid-connected voltage source converter system. The results confirm the utility of this approach in accurately assessing system stability under multiparameter uncertainty (DOI: 10.1049/esi2.12141).

*Yang Wang et al.* present a method to mitigate the transient over voltage (TOV) in the line commutated converter based high voltage direct current sending-end system by dynamically adjusting the DC reference current based on alternative current TOV, which alleviates the TOV problem from the source. This paper conducts electromagnetic transient simulation based on the Conseil International Des Grands Reseaux

eLectriques HVDC Benchmark model and a  $\pm 800$  kV HVDC transmission system model located in Northwest China. The influence of improved control on the system voltage is further analysed, and the effectiveness of the designed control method is verified. This method exhibits strong applicability and can effectively suppress the TOV in numerous instances of threshold change. The comprehensive results demonstrate that the designed control method effectively suppresses the TOV and ensures system stability, providing benefits to the sending-end system with RPGs.

## 2 | DISPATCH STRATEGY AND MEASUREMENTS

*Wenlong Shi et al.* present a two-stage scheduling model for provincial-level power grids, encompassing day-ahead and intraday stages to optimise resource allocation within the province. Experiments conducted on the IEEE 39-node system validate the feasibility and effectiveness of the proposed approach.

*Hongtian Song et al.* present the polarisation and penetration effects of the interaction between the outer electrons of the caesium atom and the nuclear charge, so the Coulomb potential is corrected, and then the Numerov algorithm is used to obtain the low  $l$  state ( $S, P, D, F$  state). Accurate atomic wave function, further diagonalise the energy matrix under the action of external field to obtain the Stark structure diagram of different Rydberg states.

## 3 | REVIEW OF LOW CARBON ERA

*Yao Zhou et al.* present a comprehensive review of existing literature, relevant government policies, and future development trends. The current state of technology available for coordinating these systems and identifying key challenges that need to be addressed to facilitate future trends were evaluated. The insights gleaned from this overview provide valuable support for infrastructure planning and operations in the energy sector. Finally, the most pressing issues that necessitate further research to advance the seamless integration of these interconnected systems were summarised (DOI: 10.1049/esi2.12139).

### 3.1 | Summary and acknowledgement

We extend our heartfelt gratitude to the authors for their invaluable contributions and to the reviewers for their meticulous evaluation and constructive feedback, which have collectively ensured the calibre and rigour of the published works. Furthermore, we express our sincere appreciation to the organisers, sponsors, and participants of the 8th Asia Conference on Power and Electrical Engineering for their unwavering support and commitment to fostering excellence in research and scholarship.

As editors of this special issue, we are grateful for the original scientific contributions of the paper contributors, as well as for your future continuous attention and support for the IET Energy Systems Integration. It is our hope that the insights and discoveries presented herein will inspire further

exploration, spark new avenues of inquiry, and ultimately contribute to the advancement of knowledge and the realisation of a sustainable and resilient energy future.

Last but not least, we extend our thanks to the Chief Editor of the journal for their support and advice throughout this journey.

### KEYWORDS

distributed power generation, electric vehicles, photovoltaic power systems, power generation control

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### DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analysed in this study.

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