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EDITORIAL

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Special issue: Transition management of energy systems towards carbon neutrality

A profound transition of energy system is central to China's "3060" goal since the bulk of anthropogenic emissions arises from energy use. Covering the production, conversion, transmission, distribution and consumption of energy, energy system has complex internal structure and close linkages with the surrounding economic and social systems. Energy system transition towards carbon neutrality has presented tremendous challenges in a wide range of aspects, including technology, finance market, business models, governance structure, policy regime, etc. A better understanding of the dynamics and mechanism underlying energy system transition is critical to the transition management of energy systems.

Focusing on the theme of "Transition management of energy systems towards carbon neutrality", this special issue in *Frontiers of Engineering Management* collects 10 papers with an aim to assess critical determinants driving transition, reveal transition paths, quantify costs and benefits, examine relevant governance and policy issues, and advise targeted measures to advance a sustainable transition of energy systems.

Yang et al. present a scenario-based assessment of China's energy system using the Low Emissions Analysis Platform model to assess possible transition pathways. CO_2 emission path, energy return on investment and relevant uncertainties under different energy transition scenarios are examined. Policy implications regarding renewables, technology development and energy security during the transition are discussed.

Focusing on how to maintain the stable, reliable, and efficient operation of power system, **Zhou et al.** study the integration of energy storage system (ESS) and energy system. A comprehensive review of ESS management from the perspectives of planning, operation, and business model is presented. The authors show that both the initial configuration and actual operation are critical to the efficiency of ESS management.

Qiu et al. propose a systematic framework that includes various energy chains of new energy vehicles formed with different technologies. The authors further quantify the levelized costs of three typical carbon-neutral energy chains using the life cycle cost model while considering the technological learning effect, based on which some policy recommendations on developing energy chains to promote the diffusion of new energy vehicles in China are suggested.

With regard to the energy finance market transition, **Dai et al.** explore the price leadership of China's crude oil futures and identify its price co-movement to uncover whether it truly shakes up the global oil spots markets. Oil spots under different gravities, sulfur contents and geographical origins are examined. It is found that China's oil futures may not have good price leadership in global spots markets, but it features favorable price co-movement.

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Yang et al. investigate the sustainability performance of environmental innovation system by accounting for its internal structure, i.e., the research and development (R&D) and conversion subsystems. A two-stage data envelopment analysis model is developed for this purpose while considering shared resources. Applying the proposed model to China, the authors show that China as a whole presents high environmental innovation efficiency with evident region heterogeneity.

Zhou et al. provide a microscopic evidence of rebound effect in the context of China. The authors use China's firm-level data to estimate the rebound effect in manufacturing subsectors, providing a detailed picture of rebound effect across sectors and regions during 2001–2008. The results show that partial rebound effect is evident and prevalent in China's manufacturing industry, which nevertheless presents an upward trend for most subsectors.

Liu et al. explore economic structure adjustment strategies for the reduction of carbon dioxide emissions by combining multi-regional input–output (MRIO) model with linear programming (LP) model. The optimal regulation sequence of final products in various regions to reduce CO_2 emissions with the minimum loss in GDP is identified. The proposed MRIO–LP model considers the inter-relationship among various sectors and regions and is expected to aid regulators in designing effective policy for industrial structure adjustment at the regional level to achieve the national environmental and economic targets.

Yang et al. identify possible policy entry points regarding transformative and enduring changes in the electricity and socio–economic systems to facilitate electricity transition. Within the multi-level perspective framework, the authors locate four entry points, i.e., destabilising fossil fuels-based electricity regime, reconfiguring the electricity regime, addressing the socio–economic impact of coal power phase-out, and facilitating a shift in transition governance. Relevant policy interventions have been further discussed.

To facilitate the growth of the lithium battery sector which is critical to China's energy transition and carbon neutrality, **Bai et al.** aim to identify proper ways of promoting R&D efficiency in the lithium battery industry. Little indication of meaningful improvement in R&D efficiency in China's 22 listed lithium battery enterprises is found. It is suggested that assisting businesses in developing efficient managerial processes for R&D is more useful than simply increasing investment scale.

Zheng et al. build a power consumption and carbon emission measurement model based on the operating margin factor to assess the dynamics and determinants of emissions from the electricity generation. The dependency of carbon emissions from electricity on China's economic development and population changes is comprehensively revealed. The results provide a new perspective to understand carbon emission reduction potentials in electricity production of China.

Finally, we would like to express our sincere gratitude to the contributing authors who generously share their insights and views. We are also grateful to the reviewers, the journal editors and the publisher for their help in facilitating the review and editorial process of this special issue.

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