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Special issue: Low-carbon management

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This special issue of *Frontiers of Engineering Management* (FEM) targets at how to devise the strategies for low-carbon management. Climate change is one of the greatest threats that mankind is facing today. Global cooperation has been undertaken to address climate change and establish the goal of controlling the surface temperature rise by no more than 2 °C or even 1.5 °C by the end of 2100. This has not only caused the establishment and development of the new international governance system, but also greatly promoted the revolutionary change of world's energy system toward low-carbon development. Low-carbon management thus becomes an emerging megatrend.

Focusing on solving common and urgent issues such as greenhouse gases reduction from energy exploitation, conversion and utilization, which are commonly faced by industries, this special issue mainly explores how to realize the low-carbon management by fostering energy technology innovation and energy management performance promotion. To boost the low-carbon management, this special issue aims to cover the innovative research of theories, methods and practices of low-carbon management.

To accomplish a wider dissemination of the recent studies in low-carbon management, an open call for papers in *Frontiers of Engineering Management* was announced. After a high standard refereeing of all submissions, 12 papers were finally accepted for publication in this special issue. These papers show a variety of research topics of interest in low-carbon management.

In the paper “A global carbon market,” Michael POLLITT explores the prospects for a global carbon market as the centerpiece of any serious attempt to reach the ambitious goal for greenhouse gas reductions set by climate scientists. He tries to clarify the extent to which peoples know what policy might best support global decarbonization. He first discusses what people might mean by a global carbon market and its theoretical properties. He then discusses the EU Emissions Trading System experience and the recent experience with the Australian carbon tax. He also assesses recent carbon market initiatives in the US and in China. Finally, his argument is that while establishing the amount of emissions required and dividing it up acceptably between countries requires an enormous scientific and international negotiations effort, the economic instruments to deliver the agreed targets are readily at hand.

In the paper “Sufficient or insufficient: Assessment of the intended nationally determined contributions (INDCs) of the world's major greenhouse gas emitters,” Ge GAO et al. provide an analysis of the ambitiousness and fairness of the mitigation components of the INDCs submitted by major emitters to recent Conference of the Parties of the

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United Nations Framework Convention on Climate Change in Paris. They use a unified framework to assess 23 INDCs that cover 50 countries, which represent 87% of the global greenhouse gas emissions in 2012. First, they transform initial INDC files into reported reduction targets. Second, they create four schemes and six scenarios to determine the required reduction effort, which considers each nation's reduction responsibility, capacity, and potential, thereby reflecting their historical and current development status. Finally, they combine the reported reduction target and the required reduction effort to assess INDCs. Evaluation results indicate that European Union and Brazil are rated as "sufficient"; 7 emitters including China, United States, and Canada are rated as "moderate"; while 14 emitters such as India, Russia, and Japan are rated as "insufficient." Most pledges exhibit a considerable distance from representing a fair contribution.

In the paper "Geoengineering and the blockchain: Coordinating carbon dioxide removal and solar radiation management to tackle future emissions," Andrew LOCKLEY et al. point out that geoengineering is a proposed response to anthropogenic global warming. Conventionally it consists of two strands: Solar Radiation Management (SRM), which is fast acting, incomplete but inexpensive, and Carbon Dioxide Removal (CDR), which is slower acting, more expensive, and comprehensive. Pairing SRM and CDR offers a contractually complete solution for future emissions if effectively-scaled and coordinated. SRM offsets warming, while CDR takes effect. They suggest coordination using a blockchain, i.e. smart contracts and a distributed ledger, to integrate CDR futures with time and volume-matched SRM orders, to address emissions contractually before release. This provides an economically and environmentally proportionate solution to CO₂ emissions at the wellhead, with robust contractual transparency, and minimal overhead cost.

In the paper "Comprehensive analysis on China's National Climate Change Assessment Reports: Action and emphasis," Bing WANG et al. investigate China's National Climate Change Assessment Reports of 2007, 2011, and 2015. They compare three reports with other climate change assessment reports by data mining, and analyze the necessity of national climate change assessment with the requirements at home and abroad. They also propose an outlook for China's fourth assessment report.

In the paper "Solvability and thermal response of cellulose with different crystal configurations" from Qian CHEN et al., cellulose polymorphs are prepared from natural cellulose, and their solvability and thermal response are investigated. Using liquid- and solid-state NMR signals, the distinct types and dissolving states of cellulose polymorphs are identified. The thermal behavior of the polymorphic forms of cellulose-d is also evaluated, and cellulose II exhibited the poorest thermal stability and a unique exothermic reaction.

In the paper "Characteristics of flow and heat transfer of shell-and-tube heat exchangers with overlapped helical baffles" from Tingting DU and Wenjing DU, the characteristics of flow and heat transfer of shell-and-tube heat exchangers with overlapped helical baffles (STHXsHB) are illustrated through theoretical analysis and numerical simulation. The ideal helical flow model is constructed to demonstrate parts of the flow characteristics of the STHXsHB, providing theoretical evidence of short-circuit and back flows in a triangular zone. The numerical simulation is adopted to describe the characteristics of helical, leakage, and bypass streams.

In the paper "Adaptive policy-based framework for China's carbon capture and storage development," Xiaoliang YANG et al. review and analyze Chinese carbon capture and storage (CCS) support policies from the perspective of an adaptive policymaking framework, recognizing uncertainty as an inherent element of the policymaking process and drawing general lessons for responding to changing circumstances. They point out that the political support for CCS in China remains fragmented with uncoordinated government leadership, undecided industry players, and even with opposing voices from some leading scientists. A scope for expanding the framework to provide much more granularity, particularly in terms of the development of a CCS infrastructure and storage-focused CO₂-enhanced oil recovery, exists. They conclude that given the role CCS can play to decarbonize China's power and other industrial sectors, a commitment to CCS from top policymakers and major stakeholders is needed.

In the paper "Internal incentives and operations strategies for the water-saving supply chain with cap-and-trade regulation," Zhisong CHEN et al. develop, analyze and compare the supply chain equilibrium and coordination models under the benchmark scenario without water saving and cap-and-trade regulation, water-saving supply chain equilibrium and coordination models under the scenario without/with cap-and-trade regulation. They conduct and compare the corresponding numerical and sensitivity analyses for all models and summarize the managerial insights and policy recommendations.

In the paper "Security of solar radiation management geoengineering," Andrew LOCKLEY points out that Solar Radiation Management (SRM) geoengineering is a proposed response to anthropogenic global warming, and there may be profound disagreement on preferred temperature. SRM disruption risks dangerous temperature rise (termination shock). Concentrating on aircraft-delivered Stratospheric Aerosol Injection, he appraises threats to SRM and defense methodologies.

In the paper "Financing climate-resilient infrastructure: Determining risk, reward, and return on investment," Peter

MEYER and Reimund SCHWARZE develop a generic framework to identify what are the necessary and sufficient factors to economically favor climate-change resilient infrastructure in private investment decisions. They specifically demonstrate that carbon pricing alone will not generate the needed will, because market prices at present systematically fail to account for climate change risks such as the costs of stranded assets and the national and local co-benefits of investments in climate resiliency. They emphasize that carbon pricing is necessary, but not sufficient for enhanced private financing of climate-resilient infrastructure. The Paris Agreement and other supra-local policies and actors including city networks can concretely help to generate the sufficient social and political will for investments into climate change mitigation and resiliency at the city level.

In Comments “Low-carbon technology calls for comprehensive electricity-market redesign,” Yang YU shows that the energy transition also calls for electricity market redesign. Low-carbon technologies will fundamentally reshape the electricity sector. The electricity generation and demand will be significantly unpredictable and uncontrollable, thus require a more sophisticated system operation to guarantee the grid stability and reliability. The higher difficulty induced by the green-technology penetration exposes the electricity market to a higher market-failure risk. Thus, he argues that the future low-carbon electricity market and associated regulation scheme require a comprehensive new design.

In SuperEngineering, Xiaobo WANG provides a brief but comprehensive introduction of the engineering technology and green innovation in Tianrun Xia County Phase III 99.5 MW Wind Power project which is one of the typical representatives of wind power development in China nowadays.

Finally, we are very glad to become guest editors for the special issue of Low-carbon management in *Frontiers of Engineering Management*. Now is our privilege to provide this special issue which, we do hope will be of interest to academic and industrial communities, as well as government policy makers for helping them to understand and promote the performance of low-carbon management. We acknowledge the financial support from the National Natural Science Foundation of China under Grant Nos. 71871022, 71471018, 71521002, and the National Key R&D Program under Grant No. 2016YFA0602603.

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Wenrui HU, a famous expert in the exploration and development of oil and gas and engineering management, is an Academician at the Chinese Academy of Engineering (CAE). He has served as director of the Changqing Petroleum Exploration Bureau, vice president of PetroChina, and president of China Petroleum Enterprise Association. He is currently a member of the Presidium of the CAE and director of the Department of Engineering Management at the CAE. He has long been engaged in the exploration, development, and engineering management of unconventional low-permeability fields of oil and gas. He was responsible for the completion of China's first large-scale low-permeability oil field, the Ansai oil field. He also presided over the discovery of China's largest gas field, the Sulige gas field, where the gas reserve exceeds 1000 billion m³. Mr. Wenrui HU won one first prize and one second prize of National Science and Technology Progress Award,

respectively. He has also won four special accolades from the Award of the Scientific and Technological Progress at the provincial and ministerial levels. He has published seven monographs, including “A New Understanding of Petroleum.”



An WANG, a famous expert in modern coal mining engineering, is an Academician at Chinese Academy of Engineering. Prior to China International Engineering Consulting Corporation, he was chief engineer of Wuda Mining Bureau, deputy general manager of Shenhua Group, general manager of China National Coal Group Corporation. He has engaged in technology research and project management of coal exploitation. During the construction of national key project “Shenfu Dongsheng Mining Area,” he put forward the idea of “Large-scale production, modernization of technology and equipment, informatization of management means, and team specialization” for the development of the large-scale modern mining area. He established mining technical system, safety management system and integrated environment management system as the core of modern mining production mode, and made significant contributions on the first hundred million tons of modern mining area. He won the first prize of National Science and Technology Progress Award.



Yi-Ming WEI is a Distinguished University Professor and Dean of the School of Management and Economics, Beijing Institute of Technology (BIT). He is the Founding Director of the Center for Energy and Environmental Policy Research at BIT. Prof. Yi-Ming WEI has more than 25 years of experience in Climate Change Economics and Policy, including academia, research, and consulting. He has made remarkable achievements in integrating climate economic theory and policy practice by improving the integrated assessment methods, building the China’s Climate Change Integrated Assessment Model (C3IAM), developing new emission accounting methods, establishing a low-carbon development assessment system, researching systematically on the global climate change policy, and promoting climate change economics development in China. He has performed over 50 research projects for various China governmental agencies including NDRC, MOST, NEA, NSFC, CNPC, SGCC and CAS, and such international organizations as the World Bank, EU-FP7. He has published 20 books and over 300 papers in peer reviewed journals including *Nature-Climate Change*, *Nature-Energy*, *Climatic Change*, *Mitigation and Adaptation Strategies for Global Change*, *Global Environmental Change*, etc., with 17563 citations and a high H-index of 62 (Google Scholar). In his publications, 21 papers are listed in the ESI highly cited papers. He has been awarded as “Global Highly Cited Scientist” by Clarivate Analytics, and invited as a “Coordinating Lead Author” in IPCC Sixth Annual Report Workgroup III Chapter 6. He also served as the editorial member of several journals.