China's "energy revolution": measuring the status quo, modelling regional dynamics and assessing global impacts - DTU Orbit (04/08/2019)

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As the world's largest economy in transition, China plays a growing role in global energy markets, clean technology deployment and climate change negotiations. The Chinese president Xi Jinping called in June 2014 for an "energy revolution" of the country's "energy production and consumption habits in light of changing dynamics in global energy markets" [Xinhua, 2014]. This highlights the strategic importance of China's energy sector in the country's national economic planning and its associated global impacts. China furthermore has a growing research and development budget and plays an increasing role in global scientific collaboration networks. A wide range of Chinese national and provincial statistics builds the foundation of this China energy sector research and allows measuring and modelling its main regional dynamics. As the quality, reliability, and availability of China's official statistics continues to be critically debated in the scientific community, additional complexity gets introduced to many China-specific research areas, such as the ones discussed here.

This research takes thus place in a fascinating, highly complex and fast-paced research environment. The overall aim of this PhD thesis is to describe and discuss the main characteristics China's "energy revolution" by means of (i) measuring and quantifying the status quo of China's energy sector with a focus on major regional characteristics, (ii) modelling selected future scenarios for different regions of China, and (iii) benchmarking and visualizing associated global impacts of China's "energy revolution". The general framework of investigation was chosen as a cross-disciplinary and highly collaborative approach. Different quantitative-based, economic, technical, and financial planning tools are developed, expanded and applied in this regard. The theories underlying this research are stemming from various scientific disciplines, such as energy and power engineering, macro- and energy-economics, and power project finance. Cross-cutting aspects are the harmonization of Chinese and international energy statistics and the communication of complex scientific results for a broad scientific and public audience.

Novel scientific approaches and results of this research include: (i) a pragmatic methodology development to construct regional energy balances for China in the format of a commonly used international energy balance; (ii) a review and benchmarking exercise of 18 Chinese energy modelling tools followed by a discussion of the Chinese perspective towards a low-carbon economy; (iii) an energy system wide mapping of regional energy flows in China to evaluate main disparities; (iv) a coupling of two complex top-down and bottom-up global energy planning tools to model future regional dynamics of China's energy sector; and (v) an assessment of electricity generation costs of the first operational concentrated solar power technologies in China. The results of this thesis are relevant for a broad scientific and public audience interested in an overview of China's ongoing energy and power system transition. The transparent, collaborative, and cross-disciplinary approach of this research allows gaining a deeper understanding of China's "energy revolution" from various economic, technical and financial perspectives, while highlighting associated complexities, such as data challenges.

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