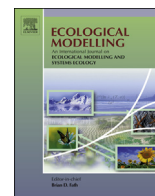




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Embodied energy uses by China's four municipalities: A study based on multi-regional input–output model

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ABSTRACT

Consumption demands in China's megacities not only cause energy resource extraction within their own jurisdictional boundaries, but also impose huge energy resource requirements to other regions via interregional supply chains. This paper presents a multi-regional input–output analysis of energy uses embodied in final demand and interregional trade of China's four direct-controlled municipalities, with the recently available Chinese 2007 multi-regional input–output table. The total embodied energy uses (EEUs) of Beijing, Tianjin, Shanghai and Chongqing are 59.1, 60.0, 136.7 and 50.4 Mtce in 2007, respectively. Shanghai has the highest per capita EEUs with an amount of 7.4 tce, followed by Tianjin (5.4 tce), Beijing (3.6 tce) and Chongqing (1.8 tce). Investment is the leading final demand category and accounts for respectively 53.1% and 55.8% of the total EEUs in Beijing and Chongqing. Meanwhile, the shares of energy uses embodied in exports are especially high in Tianjin and Shanghai, due to their location advantages and great economic openness. 98.9%, 92.1%, 51.2% and 35.6% of the EEUs in Shanghai, Beijing, Tianjin and Chongqing are imported from China's other regions, respectively. Shanxi, Inner Mongolia, Hebei, Shaanxi, Heilongjiang and Xinjiang are the important "energy-saving helpers" for these megacities. The largest interregional net embodied energy-import sector is construction for all the four municipalities. Considering the embodied energy uses in urban ecosystems is important for policy makers to recognize visible and hidden energy uses within city boundaries and along the entire supply chains and address cross-boundary potentials for energy saving at the regional, national and global supply chains.

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1. Introduction

China's urbanization process can be regarded as the great human-resettlement experiment in history (Bai et al., 2014). Mainland China had a total urban population of 712 million or 52.6% of the total population in 2012, rising from 17.9% in 1978 (CSY, 2013). Rapid urbanization provides an enormous opportunity to promote economic growth and regional development, but also poses a huge challenge in harmony with population, resources and environment in urban ecosystems (Liu et al., 2014).

China has become the largest energy consumer and CO₂ emitter in the world (BP, 2013), and urban production and consumption is regarded as one of the main drivers (Feng et al., 2014). More than 80%

of national total energy consumption is happened in China's cities (Liu et al., 2012c; Liu et al., 2012cc). Studies on city's energy problems of China have increased quickly over the past decade (e.g., Dhakal, 2009; Feng et al., 2013b; Zhang et al., 2010). The challenges of urban energy supply in megacities for the provision of adequate coal, electricity, natural gas and other energy sources for huge population have been emphasized in previous studies (Wang, 2014). However, accounts of territorial energy input/use within their jurisdictional boundaries are insufficient for depicting the true energy picture of the megacities (Feng et al., 2014; Lenzen et al., 2007c). Besides the direct energy inputs within territorial boundary, indirect energy demands or requirements associated with cross-boundary exchange of goods and services in cities are often neglected. It is necessary to undertake quantitative analysis on energy uses in cities and evaluate city's real energy status from different insights.

Since input–output model can capture the exact quantitative economic relationships among industrial sectors (Miller and Blair,

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