

# China's energy demand and its characteristics in the industrialization and urbanization process

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## H I G H L I G H T S

- ▶ China's energy demand will maintain high growth in mid-term.
- ▶ Urbanization always goes along with industrialization.
- ▶ Higher economic growth needs more energy.
- ▶ The energy intensity presents as an "inverted U" curve.

## A R T I C L E I N F O

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## A B S T R A C T

China is currently in the process of industrialization and urbanization, which is the key stage of transition from a low-income country to a middle-income country and requires large amount of energy. The process will not end until 2020, so China's primary energy demand will keep high growth in the mid-term. Although each country is unique considering its particular history and background, all countries are sharing some common rules in energy demand for economic development. Based on the comparison with developed countries, here, we report some rules in the process of industrialization and urbanization as follows: (1) urbanization always goes along with industrialization; (2) the higher economic growth is, the higher energy demand is; (3) economic globalization makes it possible to shorten the time of industrialization, but the shorter the transition phase is, the faster energy demand grows; (4) the change of energy intensity presents as an "inverted U" curve, but whose shape can be changed for different energy policy. The above rules are very important for the Chinese government in framing its energy policy.

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## 1. Introduction

Energy resource, use, and its economic, environmental and social impacts have a critical influence on development in general, and on sustainable development in particular (Jin et al., 2010). It is especially true for China, which is currently in the process of industrialization and urbanization and has topped the world in population, energy consumption (since 2010)<sup>1</sup> and CO<sub>2</sub> emissions (since 2008). Since 2002, China's high economic growth (at an annual growth rate of 10.2%), which is mainly pushed by the expansion of heavy industry, has resulted in consecutive high energy demand, at an annual growth

rate of 9.98% (2002–2010) as shown in Fig. 1, one of the highest growth rates in the world in energy consumption and economy. Yuan et al. (2010) applying gray incidence analysis to examine the relation between Chinese energy consumption and economic growth, found the relative and synthetic degree of gray incidences of GDP and total energy consumption in China to be the highest in the period IV (2001–present),<sup>2</sup> which indicated that energy consumption and GDP were closely related.

The expansion of the heavy industry and the acceleration of urbanization process are the salient characteristics of Chinese economy recently, and are also the main factors that engender the rapid

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<sup>1</sup> According to the statistical review of world energy full report 2011, in 2010, China has exceeded US, and becomes the largest energy consumption country in the world. China's primary energy consumption amounts to 2432.2 Mtoe, with the growth rate of 11.2%. US's energy consumption is 2285.7 Mtoe.

<sup>2</sup> Yuan et al. (2010) divided the process of China's economic development into four periods: Period I: 1980s–1992; Period II: 1993–1996; Period III: 1997–2000; period IV: 2001–present.

The relative degree of gray incidences shows the relationship between growth rates of total energy consumption and GDP; the synthetic degree of gray incidences shows the overall relationship between total energy consumption and GDP.

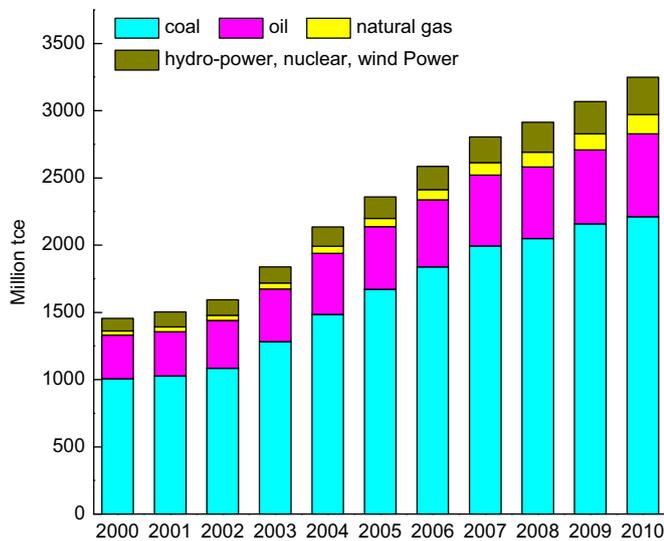


Fig. 1. Energy consumption and structure in China.  
Source: China Statistical Yearbook 2011.

increase in energy demand. China's urbanization level (expressed by the ratio of urban population to total population) was 51.3% in 2011, which is far lower than 61% in the middle-income country and 78% in the high-income country in the homologous phase, which means that China will fasten its urbanization process.

Jones (1991) and Lin (2008) identified the mechanisms whereby urbanization affects energy consumption. First, food must be transported to urbanized populations and relatively smaller agricultural populations must modernize, entailing considerable increases in agricultural energy-use. Second, urbanization permits economies of scale in production but requires more transportation. Third, if the proportion of urban population in China reaches 60% in 2020, a net increment of 300 million rural people (approximately equal to current American population) will then move to cities and shift to the use of modern energy sources. In general, energy demand of urban residents is approximately 3.5–4 times higher than that of rural residents. Moreover, larger infrastructure requirements such as housing, transportation, must consequently be created, which require a large number of steel, cement and other energy intensive products. Consequently, more energy will be consumed.

Considering the current level of industrialization and urbanization, this process is unlikely to end until 2020, which means the continuation of high economic growth, high energy demand and emissions, with more challenges emerging. The increasing energy price and the high pressure of CO<sub>2</sub> reduction make the conflicts among economic growth, energy use and environmental protection more noticeable and sharp than ever before, and may threaten China's sustainable development, if they cannot be resolved and balanced. China confronts more formidable challenges than the developed countries in the same period.

In common sense, each economic period has its own characteristic. How to understand energy demand on this special development stage in China? Is there any commonness in energy demand for economic development with other countries? If yes, what is it? All these issues are very important for the design of energy policy and energy strategy, and the international experience on energy demand in economic development is also rather important for China to refer to. So, in this work, we pay special attention to China's energy demand and characteristics in different development periods, and then try to find out some rules of energy demand.

The remainder of the paper proceeds as follows: Section 2 briefly reviews the previous literatures in the area of relationship among energy, industrialization, and urbanization; Section 3 establishes a

cointegration model to analyze the relationship between energy demand and other economic variables; Section 4 forecasts China's primary energy demand; Section 5 analyzes the characteristics of energy demand in different countries in the process of urbanization and industrialization; Section 6 compares energy and electricity demand in different economic development stages, and followed by some conclusions and policy suggestions in Section 7.

## 2. Literature review

The relationship between economy and energy is always an interesting topic which has attracted much attention. The initial empirical analysis concerns the causality tests between economy and energy, but the findings are quite mixed. There are some cases where causality is found to run from GDP to energy use (Kraft and Kraft, 1978; Al-Irmani, 2006; Ozturk et al., 2010<sup>3</sup>). In other cases, however, causality is found to run from energy use to GDP (Stern, 1993; Lee, 2005; Narayan and Smyth, 2008; Apergis and Payne, 2009). Moreover, there are even cases showing both directions between energy use and GDP (Asafu-Adjaye, 2000; Mahadevan and Asafu-Adjaye, 2007; Lee and Chang, 2008) or non-causality (Yu and Choi, 1985; Cheng, 1995; Wolde-Rufael, 2006). Those results are generally inconclusive not only because of the different samples and the span of time, but also because of the methodologies used.

Urbanization is an important phenomenon in economic development. The relationship between urbanization and energy use and emissions, has been studied extensively in recent years. Many studies show urbanization may result in the increase of energy demand (Jones, 1989, 1991; Holtedahl and Joutz, 2004; York, 2007). Madlener and Sunak (2011) pointed out that various mechanisms of urbanization within the different sectors of the economy would lead to a substantial increase in urban energy demand and a change in the fuel mix. The relevance of these mechanisms differed considerably across countries. Poumanyong and Kaneko (2010) also showed that the impact of urbanization on energy use varied across the stages of the development. Urbanization decreased energy use in the low-income group, while it increased energy use in the middle- and high-income groups.

Studies related to urbanization in China are limited. Shen et al. (2005) testified that there were strong correlations between urbanization and energy demand. Liu (2009) found that urbanization positively influenced energy use, but the magnitude of the influence was declining. He attributed this decreasing influence to the improvements in industrial and technological structure and more efficient utilization of resources. These studies only analyze the relationship between urbanization and energy demand, but do not discuss the characteristics of energy demand in urbanization process. If there is, it will provide some hints for energy policy frame. Therefore, it is worthy of paying attention to this topic considering the stage China is in and the challenges it faces, which is what rest of the paper aims to achieve.

## 3. Methodology and results

### 3.1. Methodology

#### 3.1.1. Variable definitions

Firstly, this paper establishes an econometric model to analyze China's primary energy demand. The cointegration model is a

<sup>3</sup> Ozturk et al. (2010) revealed that there was long-run Granger causality running from GDP to energy consumption for low income countries, but was bidirectional causality between energy consumption and GDP for middle income countries.

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