

Urban Energy Systems and Their Increasing Importance in Global Long-term Energy Strategies

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1. Introduction

Major news stories about energy and climate change recently have mainly focused on the national or global scale. However, cities are likely to play a growingly significant role to improve energy efficiency and decrease emissions. To identify the influence of urban form on energy, this research set three research questions: 1) What are the key driving forces influencing a shaping urban form? 2) How has the pattern of urbanization and urban density been changing over time in different regions? 3) What is the relationship between urban density, urban residential energy consumption, and income level in select regions?

2. Methodology

In a first step a literature review was carried out to understand possible urban patterns and identify the relationship between urban forms and energy use, as well as policy options for improving the efficiency of urban energy use. In a second step, trends in urbanization patterns and urban density across regions and over time were analyzed. Finally, quantitative analysis, exploring broad trends and relationships, was undertaken to identify how urban population density relates to urban residential final energy consumption, and to investigate the relationship between those two factors and urban income levels.

3. Literature Review

Urban forms and functions are changing over time. In major developing regions in Asia new urban forms are emerging in which key driving forces are more social activities rather than simple economic activities, which was the case in the past. Key driving forces: in terms of urban scale and land use, a) Travel time budget, b) Income, c) Technology (Public transport, Car, High speed train, IT system).

In these studies, compact urban form and high density represent the more efficient urban form. However, relationship between residential places and job locations have strong influences on the diving forces. Studies analyzing urban form in relationship to energy have focused specifically on the transport sector. Little research was done on urban form and energy consumption in other sectors.

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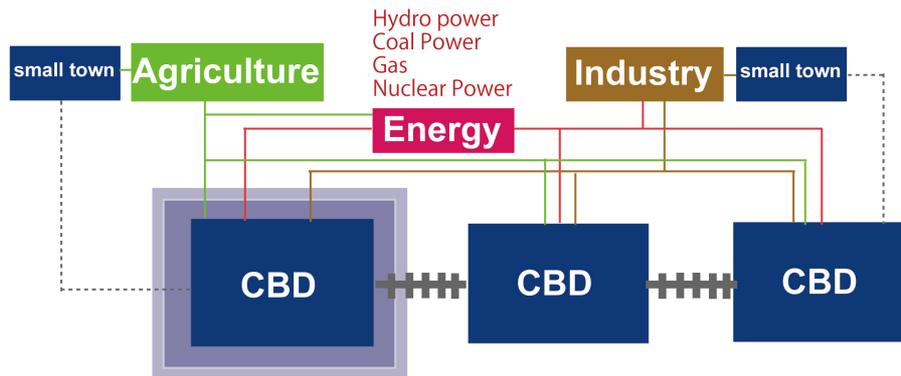


Figure 1: Urban growth pattern in 1960's – 1980's (author made)

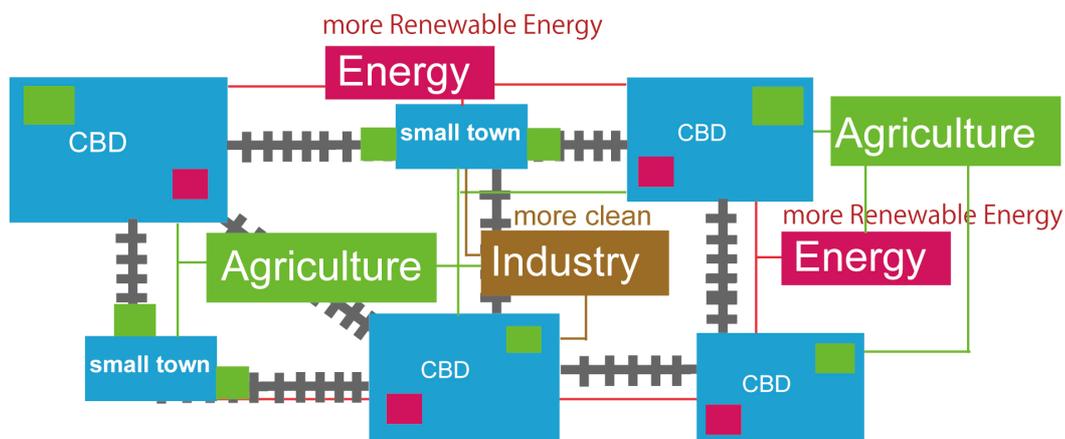


Figure 2: Urban growth pattern of new emerging urban form (author made)

In terms of urban growth and pattern trends, The most of population growth will occur in Asian regions, specifically in China and India. The urbanization pattern in these regions differs, as much as urban population growth in these regions is in larger cities (more than 10 millions) compared to other regions.

4. Results

The initial literature review identified that most previous studies focused on the relationship between urban form and energy demand in the transport sector. In terms of urban scale and land use, the driving forces for growing energy use explored in the literature include 1) travel time budget, 2) income, 3) technologies. In the second stage of the study, quantitative analysis focused on regional urban population growth patterns and identified that most of population growth will occur in Asian region, specifically in China and India. The urbanization pattern in these regions differs significantly, as much of urban population growth in these regions is in larger cities (more than 10 millions) compared to other regions. In the third stage, further analysis suggests that the higher population density has accompanied higher income growth in these regions. As a result, growing urban population density has occurred alongside decreasing or relatively unchanging urban residential energy consumption per capita in these countries.

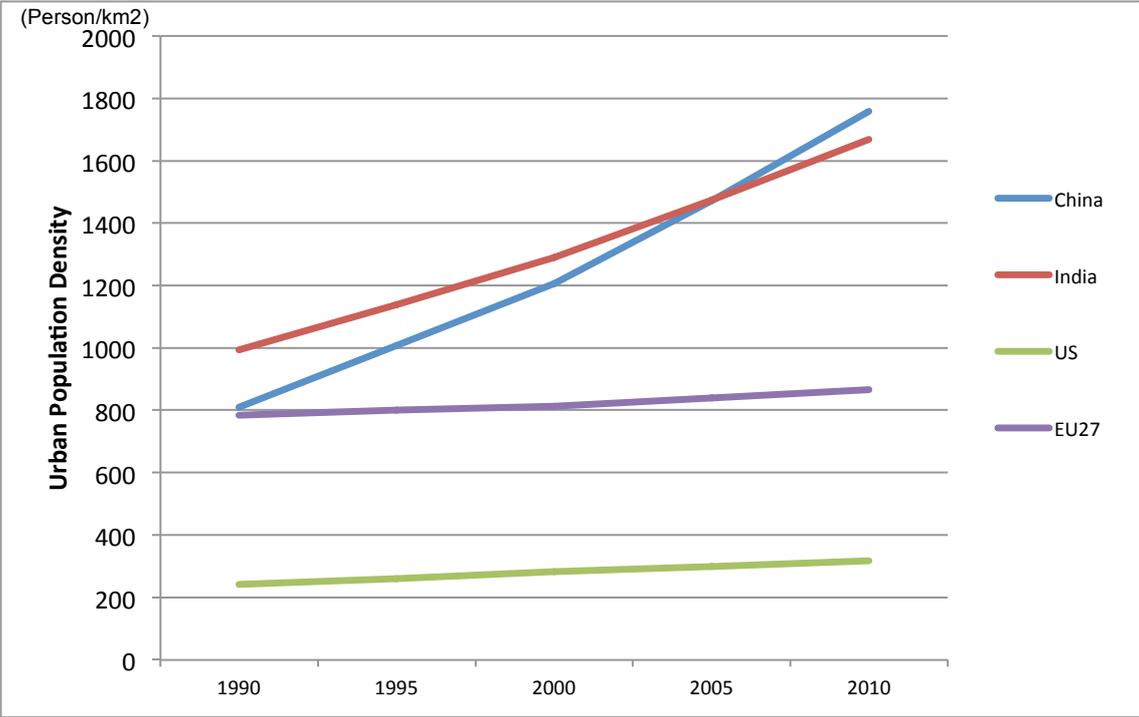


Figure 3: Urban Population Density (Date source: UN World Urbanization Prospects 2014 revision and Euro State, SEDAC, CIESIN)

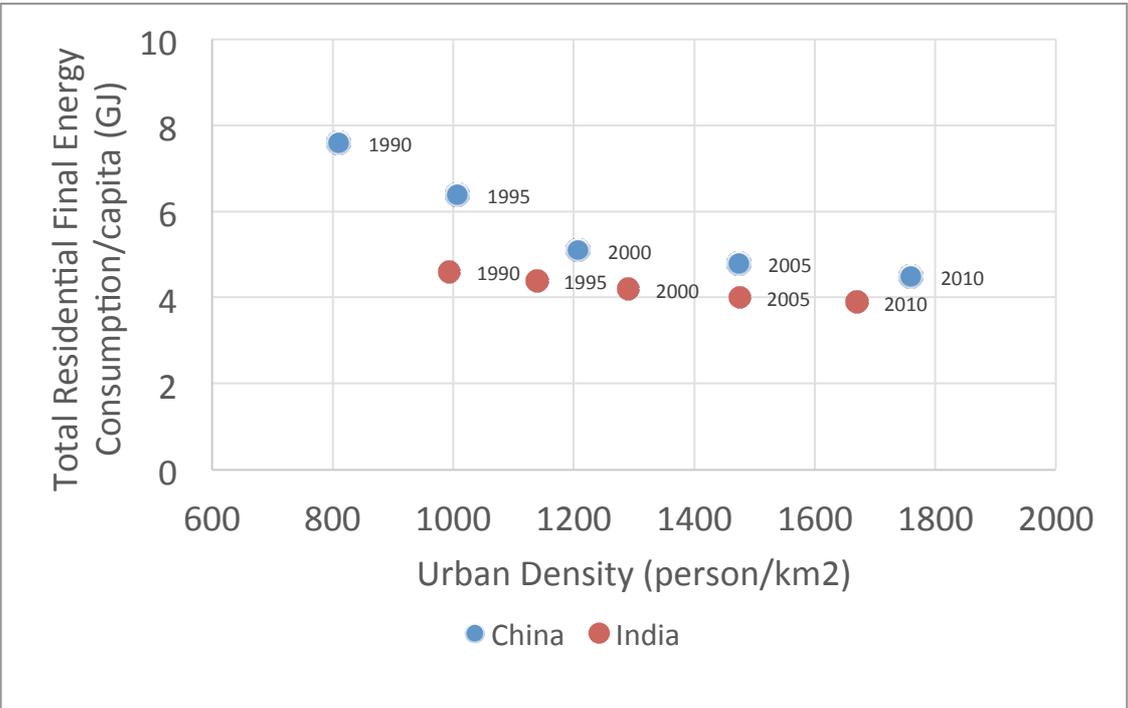


Figure 4: Urban Residential Final Energy Consumption per capita (GJ) vs Urban Density (person/km²) (Date source: UN World Urbanization Prospects 2014 revision and Euro State, IEA and SEDAC, CIESIN)

5. Conclusions

Urban populations in Asia, specifically China and India, are rising significantly. The driving force of new urbanization patterns in these regions is a growing focus on more social activities rather than simple economic activities, which was the case in the past. Growing urban population density in China and India has been accompanied by a transition to the use of more efficient energy technologies and infrastructures, which is in part a result of higher income levels. Therefore, the preliminary findings of this work suggest that higher urban density encourages technological transition and tends to lead to a more energy efficient urban residential sector in developing regions.

Keywords: *Climate Change, Megacity region, Urban Energy System, Urban Sustainability*

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