Renewable and Sustainable Energy Reviews 67 (2017) 51–61

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Examining the driving factors of energy related carbon emissions using the extended STIRPAT model based on IPAT identity in Xinjiang

Changjian Wang [a,*], Fei Wang [b], Xinlin Zhang [c], Yu Yang [d], Yongxian Su [a], Yuyao Ye [a], Hongou Zhang [a]

[a] Guangzhou Institute of Geography, Guangdong Open Laboratory of Geospatial Information Technology and Application, Guangzhou 510070, China
[b] School of Geography Science and Tourism, Xinjiang Normal University, Urumqi 830054, China
[c] School of Geographical Science, Nanjing Normal University, Nanjing 210046, China
[d] Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing 100101, China

ARTICLE INFO

Article history:
Received 16 September 2015
Received in revised form
7 July 2016
Accepted 3 September 2016

Keywords:
Carbon emissions
Xinjiang
STIRPAT model
Driving factors

ABSTRACT

Analysis of driving factors of energy related carbon emissions from the regional perspective is necessary and helpful for China to achieve its reduction targets. An extended STIRPAT model based on the classical IPAT identity was used to determine the main driving factors for energy related carbon emissions in Xinjiang. In order to get the best understanding of driving factors on carbon emissions during 1952–2012, we divided the process into 3 stages, such as "Before Reform and Opening up" (1952–1978), "After Reform and Opening up" (1978–2000), and "Western Development" (2000–2012). Research results show that the impacts and influences of various factors on carbon emissions are different in the three different development stages. Before the Reform and Opening up (1952–1977), carbon intensity and population size are the two dominant contributors to the carbon emissions increments, while energy consumption structure is the important influencing factor in curbing carbon emissions. After the Reform and Opening up (1978–2000), economic growth and population size are the two dominant contributors to the carbon emissions increments, while carbon intensity plays the important negative effect on carbon emissions. During the Western Development (2001–2012), fixed assets investment and economic growth are the two dominant contributors to the carbon emissions increments, while carbon intensity plays the important negative effect on carbon emissions. Solving these problems effectively will be of great help for Xinjiang to harmonize economic growth and carbon emissions reduction, even environmental damage reduction.

Contents

* Corresponding author.
E-mail addresses: elephant1987.kevin@gmail.com, wwwangcj@126.com (C. Wang).

http://dx.doi.org/10.1016/j.rser.2016.09.006
1364-0321/

1. Introduction

Climate change with the typical characteristic of global warming associated with fossil energy use has garnered widespread attention. Curbing carbon emissions has become a priority in dealing with global climate change, and the need for a low carbon economic transition has become the consensus of the international community. China has become one of the world's largest energy consuming countries, as well as one of the biggest emitters of greenhouse gases, due to its high-speed economic growth, urbanization, and industrialization [1–3]. Under such a circumstance, Chinese government made promises to address climate change to reduce the carbon dioxide emissions per unit GDP by 40–45% in 2010 compared with the 2005 level, while the consumption proportion of non-fossil energy would reach 15% by 2020 [4]. In the "Twelfth Five Year Plan (2011–2015)", it was proposed that the proportion of the non-fossil energy would be 11.4% by 2015, while the energy consumption per unit GDP would decrease by 16% and the carbon dioxide emissions per unit GDP will decrease by 17% by 2015 [5]. In 2013, China was also seeking to cap the total energy consumption at four billion tons of coal equivalent by 2015 [6]. In 2014, China promised to stabilize carbon emissions by 2030 in a joint announcement with the United States, while at least 20% of its power will come from sources other than fossil energy by 2030 [7,8]. Questions like whether China can fulfill the most restrictive emissions reduction commitments while maintaining rapid and stable socio-economic development further highlight the importance and urgency of research on carbon emissions.

The current research on carbon emissions can be classified as, for example, total carbon emissions accounting [9,10], influencing factors and influencing mechanisms of carbon emissions [4–6,11], scenario analysis on carbon emissions [12,13], technology application and policy simulation for carbon emission reduction and mitigation potentials [14–16]. Furthermore, analyzing the influencing factors of carbon emissions is the key to make polices and conduct scenario analysis for emission reduction. Researches on the influencing factors of carbon emissions mainly concentrated on the following fields, namely, energy consumption and economic growth [17–19], energy structure optimization and economic structure change [20–22], technological progress [23,24], import and export trades [25,26] etc. As one of the biggest emitters of greenhouse gases, an increasing number of studies have been conducted to uncover the main driving forces for carbon emissions growth in China. Economic growth and population scale were confirmed as important contributors to China's increased carbon emissions, while the decrease of energy intensity was highlighted for curbing carbon emissions. Liu et al. found that urbanization does have a causal effect on carbon emissions growth in the long run in China [27]. Xu et al. indicated that there is an inverted U-shaped nonlinear relationship between industrialization and carbon emissions in China [28]. Zhang et al. indicated that financial developments and foreign direct investments (FDI) had significant effects on carbon emissions growth in China [29]. Carbon emissions embodied in China-U.S. trade [30], China-UK trade [31], China-Japan trade [32], and China-Australia trade [33] has been analyzed, results showed that China's international trades played significant effects on national and global carbon dioxide emissions.

In particular, there are pronounced differences in physical geography, economic development model, population density, economic structure, consumption levels, infrastructure construction, available technology, and resource endowment across the different provinces within China [4,5,34,35]. National "energy saving and emission reduction" policies and strategies cannot be effectively and efficiently implemented without sufficient understanding of China's emissions status at the regional level [5,8,36]. Based on perspectives of regional analysis and comparative analysis, Tian et al. found that the disparity in regional industrial structure impacted regional carbon emissions substantially in China [37]. Liu et al. found that the impact of urbanization on carbon emissions in the western China was larger than that in the eastern and central China, while economic growth had a larger impact on carbon emissions in the eastern China than that in the central and western China [27]. Feng et al. found that considerable disparities in technological improvements and household lifestyles had different effects on regional carbon emissions in different provinces in China [38]. As a consequence, there is an urgent need to have a deeper understanding on the national experience-based learning as well as provincial case-based empirical studies to inform itself of the best route to low carbon economy [4,6].

Xinjiang, an important Chinese energy production base, as well as a less developed area in western China, is currently going through a period of strategic opportunities for rapid development. Energy resources utilization has made great contribution to Xinjiang's regional development. Meanwhile, such rapid economic development mode has brought serious environmental challenges to the arid ecosystem, especially the energy-related carbon emissions [5,6]. Presently, the biggest challenge faced by the local government is to slow down the carbon emissions, at the same time ensuring that it does not come at the expense of social-economic development. This case study aimed to find out the most important contributors to carbon emissions and to analyze the energy-related carbon emissions in Xinjiang. Wang et al. used LMDI (Logarithmic Mean Divisia Index) technique based on an extended Kaya identity to uncover the main driving forces (i. e. affluence effect, population effect, energy intensity effect and energy structure effect) for energy-related carbon emissions in Xinjiang [5]. Then, Wang et al. found that the inter-provincial exports, inter-provincial imports, and fixed capital formation had significant influence on the changes in carbon emissions in Xinjiang from the viewpoint of final demands from 1997 to 2007 [6]. As an important Chinese energy production base, the total fixed assets investment of Xinjiang increased from 1.29 billion Yuan in 1978 to 61.04 billion Yuan in 2000, then to 625.84 billion Yuan in 2012. After the Reform and Opening-up, total value of imports and exports increased from 23.46 million U.S. Dollar in 1978 to 226.39 million U.S. Dollar in 2000, then to 2517.07 million U.S. Dollar in 2012. The development of second industry and tertiary industry performed differently due to the industrial structure adjustment under the context of different policies. In accompany with the fixed assets investment, trade openness, and industrialization etc.,