Renewable and Sustainable Energy Reviews 15 (2011) 4334–4347

Contents lists available at SciVerse ScienceDirect

Renewable and Sustainable Energy Reviews

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

Energy conservation and emissions reduction in China—Progress and prospective

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ARTICLE INFO

Article history:
Received 6 April 2011
Accepted 5 July 2011
Available online 1 October 2011

Keywords:
Energy conservation
Emission Reduction
China
Energy policy

ABSTRACT

Energy conservation (EC) has been taken as basic state policy in China for more than 20 years and China achieves 3.9% annual energy saving from 1980 to 2005. In 2006 China Central Government firstly set up a binding target of reducing GDP energy intensity by 20% in its 11th Five-Year-Plan (FYP). At the end of 2010, 19.1% reduction in energy intensity has been achieved, which is 95% of the target and means 608 million tons stand coal equivalence (sce) saved, 1510 million tons CO_2 emission reduced, 300 billion RMB¥ saving in energy bill and vast saving in infrastructure investment. This paper is systematical review and prospective analysis on energy policy issue in China. Review on policy evolution and progress of EC and Emission Reduction (ER) in China during the 11th FYP periods is presented in detail. Outlook of energy demand and supply into 2050 is presented and the roadmap to realize sustainable energy development is drafted to set the framing constraints for China's energy policy options. Rationality and feasibility analysis on newly formulated 12th FYP EC and ER target is also addressed. Then lessons from the 11th FYP periods are drawn and factors underlying and limiting the policy formulation and implementation are discussed in details to probe the policy predicament and solutions. Finally policy suggestions are proposed for long-term successful implementation of EC and ER in China.

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doi:10.1016/j.rser.2011.07.117

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1. Introduction

Since launching its Reform and Opening-up policy in 1978, China has achieved a miracle of 9.8% annual GDP growth for more than consecutive three decades. However, the miracle is achieved at high environment and ecology cost with low energy and resource efficiency, which has been notoriously criticized for years. To address the persistent pressure on resource and environment, China Government officially took sustainable development as the basic state policy in the 16th Conference of Communist Party of China (CPC) in 2002. Then in the 17th conference of CPC, sustainable development was officially taken as one of the cores of "*scientific development perspective*", China's current summit development tenet. In fact, energy efficiency has long been on the policy agenda in China. With continuous efforts, GDP energy intensity decreased by 50% from 1980 to 1995, which has been extensively probed in literature [1–5]. Then in the 9th Five-Year-Plan (FYP), annual saving energy by 5% and reducing main pollutants of SO_2 and COD was proposed by Central Government, which is the first energy saving and emission reducing goal among developing countries. Because of the massive economic restructuring, efficiency enhancing in energy intensive industries and the slow-down of GDP growth due to Asian Crisis, the actual performance is 6.1% and pollutant of SO_2 and COD is cut down significantly. Nonetheless, according to many experts China's experience during the periods was an exception. As argued by Lin et al. [6], in the early stage of economic development, industrialization and urbanization tend to lead to extensive infrastructure and housing development, which will in turn consume much energy resource. Accordingly, as far as China follows the "old way" that industrialized countries have experienced, energy intensity will reverse. Unfortunately, this is what happened in China during the 10th FYP periods. In 2001 inspired by the great success of the past 5 years, another EC target of 10% is set for the10th FYP. However, during the periods, China economy recovered from Asian Crisis and speeded up. Increased energy consumption incurred by the shift of output structure toward heavy industry, as well as the slow-down of efficiency enhancement in energy-intensive sectors ultimately resulted in a 7.5% rise in energy intensity in 2005 [7,8] (see Fig. 1 for energy, carbon and electricity intensity in China). Reported on energy consumption and carbon emission elasticity, from 2002 to 2004, elasticity greater than one for consecutive 3 years was witnessed. When examining electricity, because of rapid electrification during the periods, electricity consumption elasticity was greater than one from 1999 to 2007. As a result, a consecutive increase of GDP electricity intensity was witnessed from 1999 to 2006 (Figs. 1 and 2). Of course whether or not increase in electrification level will lead to decrease in energy intensity is an intriguing and important issue, which is beyond the scope of this paper.

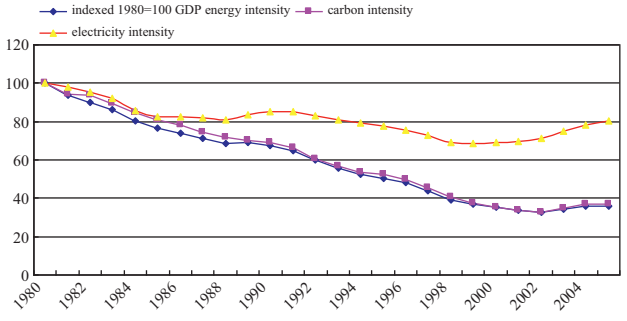

Fig. 1. China's energy, carbon and electricity GDP intensity index from 1980 to 2005.

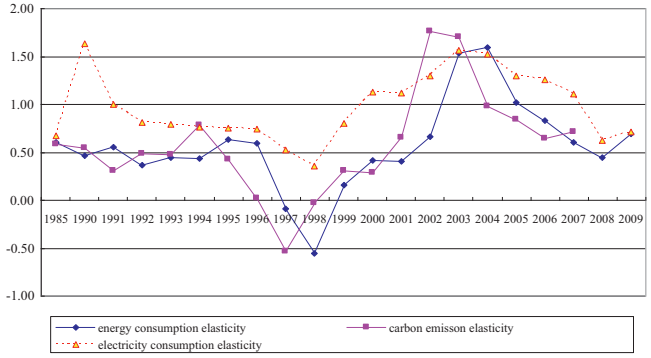

Fig. 2. Energy-electricity consumption and carbon emission elasticity in China. *Source*: Ref. [25] for carbon data and Refs. [28,29] for other data.

Though China set EC target for both its 9th and 10th FYP periods, it was in the 11th FYP that firstly a binding target, reducing GDP energy intensity by 20%, main pollutant of SO_2 and COD by 10% in 2010 as of 2005 was set. In China, targets included in the FYP are those viewed as the most important by Central Government, who should be responsible to achieve them. As noted by Lin et al. [6], this move signals a major shift in China's strategic thinking about its long-term economic and energy development and provides further evidence that the China government is serious in its call for a new "*scientific development perspective*". The target itself is of important policy implication considering its potential contribution to global efforts fighting against GHG emissions and thus catches intensive attention in literature. In an earlier study carried out by Lin et al. [6] at 2007, policy scenarios are provided to study the feasibility of target and it is concluded that with efficiency improvements in the industrial and buildings sectors, as well as structural changes in the economy, together with vigorous implementation of a host of policies, the 20% energy-intensity reduction target is feasible. In another study by Yang [9], the potential of different sectors or measurements to energy intensity reduction is appraised and seven policy actions and measures are proposed for achieving the target. In a later study by Zhou et al. [10], a comprehensive assessment of the policies and programs taken by China government is provided.

By the end of 2009, just before UN Copenhagen Climate Change Conference, China announced another ambitious target, promising to reduce GDP carbon intensity by 40–45% than that of 2005 and increase the share of non-fossil energy in primary energy to 15% by 2020 [11,12]. This move is another serious promise that China will pursue its way on EC and ER. To implement this target and extend the policy during the 11th FYP periods, 17% reduction in GDP carbon intensity (equaling 16% reduction in energy intensity), 8–10% reduction in main pollutant and increase the ratio of non-fossil over primary energy to 11.4% are included in the newly formulated 12th FYP, among which the targets of carbon intensity and the non-fossil ratio are firstly appeared in China's highest level planning.

Considering the target's potential impact on China as well the world as a whole, the issues of concern are naturally centered on the followings: What did China Government actually do during the 11th FYP periods? What progress and achievement has China made during the past 5 years? What are the problems and obstacles