Resources, Conservation and Recycling 117 (2017) 66–73

Contents lists available at ScienceDirect

Resources, Conservation and Recycling

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

Full length article

The consequence of energy policies in China: A case study of the iron and steel sector

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ARTICLE INFO

Article history:
Received 21 October 2014
Received in revised form 27 June 2015
Accepted 9 July 2015
Available online 8 August 2015

Keywords:
Iron and steel sector
Energy efficiency policies
Policy assessment

ABSTRACT

As a key energy-intensive sector, the iron and steel sector play an important role of achieving China's national energy efficiency target. This paper reviewed China's energy management system and industrial energy saving policies. Since the 11th Five Year Plan (FYP), China have set explicit energy saving targets for major industrial enterprises by target responsibility system (TRS), while "the Top-1000 program" during the 11th FYP and "the Top-10,000 enterprises project" during the 12th FYP are the most important actions saving energy in industry sectors. Industrial enterprises mainly implement energy saving policies by closing outdated facilities, applying advanced energy efficiency technologies and improving product structure.

This paper also evaluates the energy saving performance of the iron and steel sector from 2006 to 2011 with 2005 as reference year. During this period, the iron and steel sector saved energy of 195.1 million tce based on the "value-added method", and 167.1 million tce based on the "production output method". The gap between the two methods comes from the contributor of production structure improvement, which resulted in the change of value-added per unit production output. Closing outdated facilities and applying advanced technology contribute 33% and 67% of the energy saving based on production output, which reflects the change of energy efficiency technologies.

China has approved the new target of "achieving the peak of CO_2 emissions around 2030", as a response, future energy policy should be transformed from "energy saving amount" into "total amount control". Increasingly economic-market policy tools should be encouraged, and energy efficiency and produce quality should be continually improved. In addition, in the 11th and 12th FYP, energy policies are mainly implemented in large-scaled enterprises, however, in the future they should be given sufficient attention to middle and small sized enterprises (SMEs).

1. Introduction

China has become the largest CO_2 emitter in the world, and in order to cope with climate change, it has set ambitious energy reduction or CO_2 reduction targets as a response. The nation plans to reduce its CO_2 emission per unit GDP by 40–45% in 2020 compared to the 2005 level, and control its CO_2 emissions to a stable level around 2030. China has taken a series of actions to reduce its CO_2 emissions since 2005. China's policy and action related to emission reduction include reducing energy intensity, increasing the ratio of non-fossil energy, and increasing carbon sinks, while reducing energy intensity is overwhelming one.

The Five Year Plan (FYP) is an important perspective to understanding China's policy system since it establish core targets and policy framework for China's economic and social development in coming five years. Since the 11th FYP (2006–2010), China has set a binding target to reduce the national energy intensity per Gross Domestic Product (GDP). The target is reducing 20% during the 11th FYP and 16% during the 12th FYP, respectively (The State Council, 2012). In order to reduce the energy intensity the central government implemented a target responsibility system (TRS) to disaggregate national energy-saving targets into regional or sector targets (Qi, 2013). TRS has become the basic policy mechanism of the energy policy implementation in China.

Industry is the key energy saving sector in China as it consumes more than 70% energy of the country (National Bureau of Statistics (NBS), 2012). The energy efficiency performance of industrial enterprises impacts the national energy intensity target achievement to

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http://dx.doi.org/10.1016/j.resconrec.2015.07.007
0921-3449/

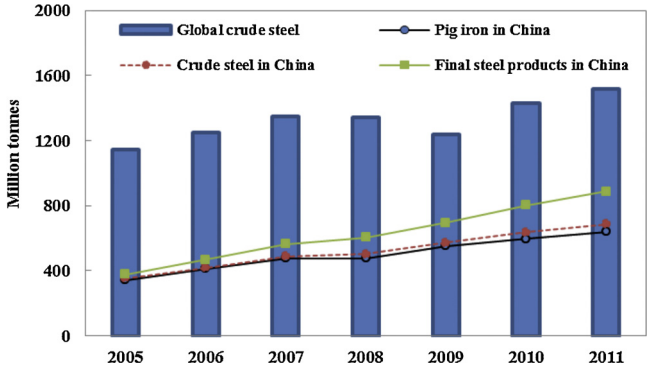

Fig. 1. Pig iron and finished steel products in China (2005–2011). (*Sources:* The Editorial Board of China Steel Yearbook (EBCSY), 2012; World Steel Association (WSA), 2012)

a large degree. The iron and steel sector plays a significant role in decreasing energy intensity since it is one of the most energy-intensive sub-industries (Sun et al., 2011; OECD/IEA, 2007). On average, the iron and steel sector accounts for 17.9% of China's national energy consumption and its industrial value-added makes up 14.9% of the country's GDP in the 11th FYP (The Editorial Board of China Steel Yearbook(EBCSY), 2012). Fig. 1 shows the change of the output of pig iron and crude steel in China. As important index of the iron and steel sector, the output of pig iron and crude steel increased dramatically in 2005–2011, while finished steel products had doubled more, increased from 377.7 million tons to 886.2 million tons. China has been the largest producer of iron and steel in the world, and in 2011, the crude iron production shares 45.5% of the world (World Steel Association (WSA), 2015). However, in China, energy intensity in iron and steel sector reduced the most among all industry sectors.

In order to enforce the industry energy saving target, the central government published a series of key energy policies to reduce energy intensity in industry sectors, including the "Top-1000 programme" (11th FYP), and the "Top-10,000 programme" (12th FYP) aiming to energy-intensive industrial enterprises. In two programs, the central government set mandatory energy savings targets for these enterprises as the primary quantitative indicator of their energy saving performance (Zhao et al., 2014).

The iron and steel sector plays a crucial role in the "Top-1000 program". According to the "Announcement on Achieving Statues of the Top-1000 program" from the National Development and Reform Commission (NDRC), the iron and steel sector contribute about 37% of total amounts of energy savings in "the Top-10,000 program" during the 11th FYP, while the energy saving targets in the iron and steel sector were all overachieved (National Development Revolution Commission (NDRC), 2011).

"The Top-1000 program" enterprises consumed about 40% of the national energy in the 11th FYP. The programme aims to reduce the energy intensity per product, to increase the rate of energy use, and to save 100 million standard coal equivalents. Iron and steel sector plays a very significant role of the "Top-1000 program". In 2010, 37% of the total energy saved in the 'Top-1000 programme' came from the iron and steel sector (National Development Revolution Commission (NDRC), 2011). From 2008 to 2010, the energy saving targets in the iron and steel sector were all overachieved, based on the total amounts of the enterprises in the "Top-1000 programme" and calculated as the energy intensity per product.

Most studies on energy policies in China's iron and steel sector focus on four topics: (1) assessing the energy management experiences of key companies, such as Baogang (Zhang et al., 2012); (2) estimating future energy efficiency improvements and CO_2 reduction potential (Chen et al., in press; Hasanbeigi et al., 2013; Li and Zhu, 2014; Chen, 2012); (3) comparing China's situation to that in other countries or providing an overview of China's global or regional status (Xu et al., 2014; Hasanbeigi et al., 2011; Saygin et al., 2011; UNIDO, 2010); and (4) analysing the impact or affected elements of historical energy efficiency improvements or CO_2 emissions (Sun et al., 2011; Wei et al., 2007; Ma et al., 2002; Zhang and Wang, 2008; Lin et al., 2011; Qi, 2010). Regrettably, few studies evaluate the effectiveness of energy-saving policies, and some of these focus on the problems of putting these policies into practice. It is meaningful to do research on energy policy implementation in China at sector level from both theory and practice sides, and to find the energy saving experiences in the 11th FYP. It will help the policy-makers to find the most effective reduction measures and to improve energy saving in the future.

Focused on the iron and steel sector, this paper attempts to examine the effectiveness of China's industrial energy policies by decomposing the way of enterprises' energy saving at sector level. This paper is structured as followings. Section 2 overviewed China's energy policies and its implementation mechanism. Section 3 illustrates the methodology of decomposing energy saving performance for different policy measures. Based on it, Section4 evaluates the policy effectiveness, and Section 5 discusses the weakness of current policies and gives some policy recommendations.

2. Overview China's energy policies

2.1. China's energy management system

Energy management system is the basic energy policy implementation framework in China. The National People's Congress (NPC) is the highest legislative body, and the State Council (SC) is the highest executive branch of the government in China. The SC approve energy targets and make detailed energy policy complied with the energy laws approved by the NPC. Fig. 2 shows China's energy management system. As important components of the SC, The National Development and Reform Commission (NDRC) and Ministry of Industry and Information Technology (MIIT) are responsible to China's energy issues. Specifically, the National Energy Administration (NEA) of the NDRC takes charge of strategy, plan and operation management of energy industries, while the MITT is responsible to policymaking and implementation for energy saving at enterprise level. In addition, as a national wide industrial organization, the Iron and Steel Association (ISA) play an important intermediary role of linking national energy policy and enterprise's compliance.

These government agencies or enterprise bodies at the central and local levels work together by regulating responsibilities under the mechanism of the TRS. This is a system based on indicators, target responsibilities, and monitoring and accountability systems for energy. Energy policies interplay and interact from vertical and horizontal aspects. Vertically, the top-down methodology operates by the central government setting aims and objectives and providing blueprints that can be translated directly into actions at the sector and provincial levels. Energy saving statistics, monitoring, and evaluation systems were established to measure the performance at the local level. From the bottom to the top, energy reporting mechanisms contribute to the top-down control. Then, horizontal cooperation between ministries, provinces, and sectors helps to implement the policies. Support from the enterprises in the 'Top-1000 programme' and the 'Top-10,000 programme' is crucial to implementing the energy policies successfully.

2.2. China's industrial energy saving policies

Fig. 3 gives an overview of the structure of main energy policies at the national and industrial levels for the period 2005–2011. The