Nexus of energy saving and air quality in China’s energy industries during the 12th Five Year Period

Wenhuan Wang\textsuperscript{a}, Qiming Li\textsuperscript{a}, Yiping Lou\textsuperscript{a}, Xiaoguang Yang\textsuperscript{a,b,*}

\textsuperscript{a}School of Business Administration, China University of Petroleum, No.18 Fuxue Road, Changping District, Beijing, 102249, China
\textsuperscript{b}Academic of Mathematic and System Science, CAS, No.55 Zhongguancun East Road, Haidian District, Beijing, 100190, China

Abstract

Energy consumption and air quality have become two major factors limiting the sustainable development in China. Energy efficiency and air quality improvement are critical for the healthy growth of China’s economy. Few studies have investigated the relationship between energy-saving and air quality. This study analyzes the nexus of energy-saving and air quality in three Chinese energy sectors. Coefficients that characterize the relationship between energy consumption and waste gas emission are estimated by input-output method. Then, the air quality-improving effects associated with the enforcement of energy-saving policies in energy sectors are calculated for each year in the 12th Five Year Plan, namely from 2010 to 2014. The results show: (1) Only the power sector has achieved reducing waste gas emission, while coal sector and oil sector haven’t. (2) For coal sector and oil sector, most of the waste gas emission is due to using the intermediate products which produced by high emitting sectors, while in power sector, waste gas emission is due to the direct emission during electricity generation.

Keywords: energy saving, air quality, input-output, complete emission reduction, direction emission reduction

1. Introduction

Energy and air quality have become two major factors limiting sustainable development in China. China is making consecutive effort to save energy and improve air quality. In the 12th Five Year Plan, China sets goals to reduce energy consumption per unit of GDP by 16%, and to reduce SO\textsubscript{2} and NO\textsubscript{x} by

* Corresponding author. Tel.: +86-10-89733124; fax: +86-10-89733742
E-mail address: xgyang@iss.ac.cn.
thi8% and 10% respectively. Energy industries are major industries for energy consumption and waste air emission. It is time to evaluate the synergy effect of energy-saving on air quality in the industries.

But the existing studies in this area mainly focus on air pollution issue and energy consumption related to the air pollution influence factors\cite{1-5}. Some studies focus on energy synergy effect\cite{6-8}, but few of them can quantize the nexus between energy saving and the air quality improving.

In this study, we quantitatively analyze the relationship between the energy consumption and air quality using input-output method. We try to figure out the performance of energy production sectors on energy saving and waste gas emission reduction.

2. Analytical Framework

2.1. Methodology

The input-output model which is useful for analysing the economic relationship of linkages among sectors of an economy was developed by Wassily Leonif\cite{10} in the 1930s. The direct consumption coefficient stands for producing one unit of product in sector $j$ will consume the quantity of products made by sector $i$, which can be calculated in Equation (1):

$$a_{ij} = \frac{x_{ij}}{x_j} \quad (i, j = 1, 2, ..., n)$$

(1)

So, assuming $e_i$ is the direct waste gas emission coefficient per sector $i$ output, this coefficient is expressed by Eq. (2)

$$e_i = \frac{E_i}{X_i}$$

(2)

Where $E_i$ is the direct waste gas emission emitted by sector $i$, $X_i$ is the total output of sector $i$, and the direct waste gas emission coefficient $e_i$ consists of the direct waste gas emission $1 \times n$ matrix $E$.

The complete consumption coefficient is expressed in matrix form by (3)

$$B = A(I - A)^{-1}$$

(3)

Where, $(I-A)^{-1}$ is called Leontief inverse matrix (key matrix).

Bring direct waste gas emission coefficient bring into Eq. (3)

$$C = E(I - A)^{-1}$$

(4)

And the quantity of energy saving $P$ can be expressed as follow:

$$P_i = (EI_i - EI_{i-1})Y_i$$

(5)

Where, $EI_i$ means energy intensity, $Y_i$ is the yield of energy production sector, and $P_i$ is the quantity of energy saving, and $i$ stands for 2010, 2011, 2012, 2013, 2014.

Finally, the embodied waste gas emission reduction\cite{9} is expressed by Eq. (6)

$$S = CP$$

(6)

Where $P$ is the final demand and $E(I - A)^{-1}$ is the complete waste gas emission coefficient matrix.

2.2 Data
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