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Regional disaggregation of China's national carbon intensity reduction target by reduction pathway analysis

Li Zhou *, Xiliang Zhang, Tianyu Qi *, Jiankun He, Xiaohu Luo

Institute of Energy, Environment and Economy, Tsinghua University, Beijing 100084, China

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ABSTRACT

Chinese government announced it is going to reduce carbon intensity in 2020 by 40 to 45% when compared with 2005 levels. One question for how to accomplish this is how to disaggregate national target to provincial level. This study employed a regional disaggregation approach based on a series of principles. Analysis of the carbon intensity revealed three main approaches to reduce CO_2 are energy structure adjustment, technical improvement and energy substitution. We proposed a disaggregation model from the view of reduction approaches. Through the data collection and analysis of provinces from 2005 to 2010, a regional disaggregation scheme is carried out in which the national carbon intensity reduction target during the 12th Five-Year Plan was set at 17%. The calculated regional targets were then compared with official published data. The results showed that this method could be useful for disaggregation of the target to the provincial level.

Introduction

The rapid growth of China's economy and energy has caused tremendous environmental cost to the society and made China the largest source of the global green-house-gas emissions (International Energy Agency, 2011). An evaluation from the World Bank reveals that the environmental pollutions cost over 4% of China's GDP each year (The World Bank and China Ministry of Environmental Protection, 2007), threatening the long-term development of the country's economy. Growing intentions to reduce the serious environmental pollutions and control the growing CO_2 emission have been signaled in policies in China recently. One important action taken by the government is that in China's Twelfth Five-Year Plan (2-11-2015), a 17% target for national CO_2 intensity reduction has been introduced for the first time (The State Council of China, 2011). This will work as a legally binding target in line with the nation's commitment at the Copenhagen conference to reduce its CO_2 emission intensity by 40–45% over the period 2005 to 2020 in 2009 (Xinhua, 2009).

It is learned from the 11th Five-Year Plan period that decomposing national energy-saving targets to local areas and implementing a local governor target responsibility system are effective energy-saving institutional arrangement means in China. It should be persevered and continuously improved in achieving the carbon dioxide emission reduction targets by 2020. Taking the advantage of a centralized political system, China's national emission reduction target is allocated to provincial level to facilitate the achievement of this target. The first allocation trial is implemented during the 11th Five-Year Plan period (2006–2010) for a 20% energy intensity (energy consumption per unit of GDP) reduction. In this trial, a "declaration and negotiation" approach is adopted for the target disaggregation. The provinces first report a volunteer reduction target and the central government negotiates with the provinces to adjust their target to match the national target. One key problem in this aggregation trial is that most of the reduction target raised by provinces is based on a rough evaluation and short of effective and scientific assessment (Haibing, 2011; Xiao, 2012). This shortage is mainly due to the lack of experience and capacity of the impact evaluation. As soon as the provincial target has been set, it works as an administrative instruction and has almost been achieved by all the provinces at the end of the 11th Five-Year Plan period (National Development and Reform Commission of China, 2010; The State Council of China, 2011), as shown in Fig. 1. Although energy efficiency is well improved (Kostka and Hobbs, 2012), some extreme measures such as power rationing have been implemented; and, a significant loss of social welfare is the cost to achieve the absolute and not-well-evaluated target in provinces (steelorbis, 2010).

A best sample of emission permit allocation that China can learn from may be the emission allowance allocation in the EU Emissions Trading System (EU-ETS) market. Launched in 2005, the EU-ETS is a cornerstone of the European Union's policy to combat climate change and its key tool for reducing industrial greenhouse gas emissions cost-effectively. The EU-ETS is the largest emission

* Corresponding authors.
E-mail addresses: zhoulizl@tsinghua.edu.cn (L. Zhou), apollo110110@gmail.com (T. Qi).

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trading scheme to date, covering around 11,000 power stations and industrial plants in 30 countries (European Union, 2003, 2012). In its first phase (2005–2007), the allocation of allowances in Phase I was determined by the Member States which submitted the so called National Allocation Plans (NAPs) to the Commission for review and approval (The European Commission, 2013; Zhang and Wei, 2010). The NAPs set the overall cap for the country and allocated allowances to every participating installation (Zhang and Wei, 2010). The allocations are determined for each trading period at a time to account for the fact that annual GHG emissions fluctuate depending on the economic conditions (Ellerman and Joskow, 2008). Similarly as in China, due the lack of experience and capacity in emission projection, the allowance in Phase I of the EU ETS is over-allocated causing the permit price to decline considerably (European Environment Agency, 2011).

Following the identification of the limitations experienced in Phase I, the commission acquired the authority to impose a formula to assess the allocation plans of Member States and emission projections were objectively based on the verified emissions of 2005. Based on the assessment, the NAPs adjusted its allowance in the second round and were more ambitious. Though due to the unexpected financial crisis, the permit price declined again. This allocation approach delivers a more compelling price signal to the industries.

To further control the growing CO_2 emissions, China has set up a clear target of 17% CO_2 intensity (CO_2 emissions per unit of GDP) reduction in its 12th Five-Year Plan over the period 2011 to 2015 (Joana Lewis, 2011; State Council of China, 2011). However, this target will be a great challenge for a developing country. It is urgent and important to determine how to accomplish this challenging task. One aspect that must be addressed is determination of how to disaggregate the national target to the provincial level. A second round of the allocation of this national target to provincial level is ongoing. To avoid repeating the limitations in the first round, it is necessary to establish scientific and reasonable decomposition principles and methodologies to disaggregate target decomposition to the provincial level and implement a target responsibility system. This paper designs a method to allocate the target in the 12th Five Year Period based on a group of decomposition principles and methodologies in the consideration of equity and efficiency.

The paper is organized as follows: the Basic assumptions and analysis section describes the principles used in disaggregation, the Regional disaggregation method based on mitigation pathway analysis of carbon intensity section briefly introduces the methodology and formulas, the Results and discussion section presents the results, and the last section gives a conclusion.

Basic assumptions and analysis

Basic disaggregation principles

To disaggregate China's carbon intensity reduction target scientifically and reasonably to the local level, it is necessary to deal with different relationships properly, such as international and domestic, central and local, short-term and long-term, potential and ability, and efficiency and equity. In addition, it is necessary to build scientific and reasonable principles and methodology for disaggregation.

Discussions on the principles of reduction commitments allocations for greenhouse gas emissions are drawing increasing attention because of the difficulty in International Climate Change Negotiation. Topics of such discussions primarily include the role of responsibility, capability and efficiency and their balance on the target delegations (Bhatti et al., 2010; Harris and Symons, 2010; Kanie et al., 2010; Zetterberg et al., 2012). Based on these discussions, we developed the principles of target disaggregation from the following aspects. (1) Effect, e.g., whether the disaggregation scheme could ensure or advance realization of the national target. (2) Efficiency, which considers whether the implementation of disaggregation leads to less economic and social cost. (3) Equity, different situations among provinces such as the social and economic development stage, natural resources endowment, energy import and export amount, and energy conservation effort should be considered. (4) Transparency, which specifies that the disaggregation method and supporting data should be transparent and easily repeated. (5) Feasibility, e.g., the approach, ability and potential to realize the carbon intensity reduction target of each province should be considered. (6) Continuity, the efforts made by each province for energy conservation and carbon reduction in the 12th Five Year Plan period should be continuous with the energy conservation goal in the 11th Five Year Plan period, and dramatic increases and decreases should be avoided unless there are special circumstances. (7) Consistency, the results of local disaggregation schemes should be connected with the national target to ensure realization of the target.

Factors affecting the reduction of CO_2 emissions per unit GDP

The main component of greenhouse gases is CO_2, which is mainly produced by fossil fuel combustion. Numerically, the CO_2 emissions per GDP (usually referred to as carbon intensity) are equal to the amount of energy consumed per GDP (usually referred to as energy

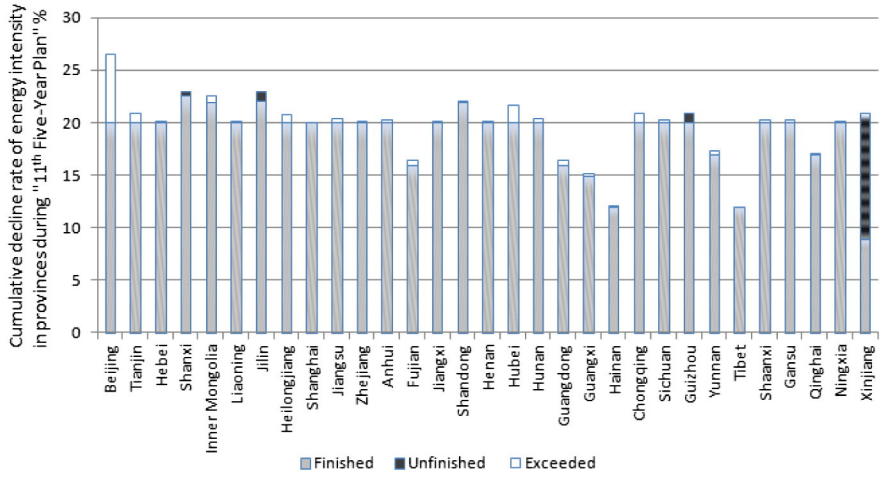

Fig. 1. Completion of energy consumption per GDP reduction target of provinces during the 11th Five-Year Plan.