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Introducing the emissions trading system to China's electricity sector: Challenges and opportunities

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HIGHLIGHTS

- We assess the institutional barriers of electricity market to ETS in China.
- Major challenges to ETS come from equal share dispatching an regulated pricing policies.
- Several options are examined to reconcile the ETS and electricity market in China.

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ABSTRACT

We examine the challenges and opportunities to introduce emissions trading (ETS) in China's electricity sector, in which the interaction between ETS and electricity market reform plays a major role. China's electricity sector is currently in a slow progress towards a more competitive and market-based system. Both equal share dispatching policy and regulated wholesale and retail pricing policies pose significant challenges for implementation of ETS in China's electricity sector. One of the important points of ETS is to give a price for carbon emissions and establish a cost pass-through mechanism (reminded that the essential of carbon pricing is to put a price on carbon emissions that is equal to discounted value of the external damages). It should be regarded as a part of broader policy package for energy and resources price reform. This will require that any low-carbon power policy should be considered as a part of whole policy package aiming at further liberalizing the electricity sector in China. Three policy options are identified to incorporate ETS with electricity reform under different circumstances. A combination of those three options is also proposed to break the lock and reinforce the positive interaction between ETS and the transition towards a competitive electricity system, in link with current pilot ETS designs. A roadmap to introduce ETS in a stepwise manner is suggested.

1. Introduction

China is so far the biggest CO_2 emitter which is unlikely to reach to its CO_2 emissions peak in the short term. Electricity sector is the major contributing sector of CO_2 emissions in China, accounting for about 44% of total national CO_2 emissions in 2010. Despite a number of effective policies implemented and the increasing installation of clean electricity generation units, CO_2 emissions in the electricity sector are still expected to double in the next decade due to increasing electricity demand from industrial and household sectors (Kahrl et al., 2011). Whether China can decarbonize its electricity sector will have important implication on its contribution to reducing global warming (Baron et al., 2012).

Among policy instruments, market-based policies start to draw increasing political attention since they ensure cost-effective CO_2 emissions reduction (Tietenberg, 2006). Five cities (Beijing, Tianjin, Shanghai and Chongqing as four municipalities which have equivalent administrative position to provinces and Shenzhen as a local city in Guangdong province) and two provinces (Hubei and Guangdong) have been selected to conduct pilot carbon emissions trading systems (ETS) with a national wide ETS to follow from 2016. Electricity sector is included directly and indirectly in the seven pilot ETS and will be a major factor to ensure good performance of ETS. Theoretically, in a pure market mechanism, carbon costs can be passed through in electricity price to downstream users and generates cost-efficient CO_2 emissions reduction. Cost increase is not necessarily an ensured outcome since large

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generators may have better condition by reducing the stand-by hours and entail scale effect of environmental management. However, pure market mechanisms in electricity sectors are not even the truth in many mature economies. The degree of carbon cost pass-through depends on supply and demand elasticities and is not necessarily 100% (Alexeeva-Talebi, 2011). And CCPT is not necessarily a condition for effective and efficient ETS. However, China's electricity market has experienced a number of unsuccessful reforms of liberalization and there exist today two major obstacles that could reduce the cost-efficiency and cost-effectiveness of electricity sector CO_2 emissions reduction under ETS. First, both the wholesale and retail prices of electricity in China are still regulated, although competition has been partially introduced into the wholesale market. Without governmental intervention, the regulated electricity price will not ensure carbon cost pass-through (CCPT) in electricity price thus reducing the cost-efficiency and cost-effectiveness of ETS in the electricity sector. Second, the dispatching system of China's electricity sector is dominated by long-term contracts and a flexible dispatch system is not established to be conforming to ETS.

Certainly, the introduction of a carbon price could reduce the incentive of using carbon-intensive fuels such as coal. However, both obstacles constrain the CCPT mechanism in China's electricity sector that is essential for a meaningful ETS, in particular, to stimulate investments in low-carbon technology. Such CCPT mechanism can reduce emissions in the electricity sector in two ways: first, on the supply side, the increased wholesale electricity price can incentivize the shift from carbon-intensive generation technologies to less or zero emission generation technologies; second, on the demand side, the increased retail electricity price can drive behavior changes in both industrial and household consumers.

So far, there are only a few studies that focus on China's electricity sector under ETS. IEA and ERI (Baron et al., 2012) conducted a sectoral study of China's electricity sector and discussed the challenges of current electricity pricing and dispatching systems in China as well as the relevant design of ETS in the electricity sector. Based on this study, this paper provides an analysis of the institutional barriers in China's electricity pricing and dispatching systems that may reduce the performance of ETS and discusses different options to align ETS design with electricity market reform. Part Two elaborates the relation of ETS and electricity market and presents its application to the Chinese context; Part Three shows the challenge of China's electricity pricing system to a performing ETS; Part Four shows the challenge of dispatching system to a performing ETS; Part Five discusses feasible solutions and compare options of ensuring cost-effective and efficient CO_2 emissions reduction with an application to current pilot ETS before concluding.

2. Implication of ETS to electricity sector

2.1. Electricity sector and ETS

Most of the existing ETS cover electricity sector. For example, the EU ETS covers about 12,000 installations which count around 2 billion tonnes of CO_2 emissions and the electricity sector dominates the total CO_2 emissions covered by EU ETS: it received nearly 55% of total CO_2 allowances allocation in the pilot phase of the EU ETS (Kirat and Ahamada, 2011). Since 1998, the European electricity market has been opened up for competition. Most western European countries have deregulated their electricity sector and introduced competition in both the wholesale and retail markets, although state-owned vertically integrated companies still exist in south east European regions (Karova, 2011). The liberalized electricity market allows power producers to add carbon costs to their marginal production cost. The CCPT increases both electricity prices in the wholesale and retail markets and can create an important incentive for low-carbon electricity generation investments in the long run. In a competitive electricity market, it has been shown by many studies that the CCPT rate can be 100% (Bonacina and Gulli, 2007). In reality, the real CCPT rate may be lower as a result of imperfect competition (Sijm et al., 2012), the demand elasticity and the change in merit order, etc., while this rate remains in general high according to empirical studies (Jouvet and Solier, 2013).

2.2. Electricity sector in China

Different to existing liberalized electricity markets in the EU, the regulatory reform in China's electricity sector is still very much in progress. Historically, China's electricity sector was operated by the former State Power which is a state-owned vertically integrated company. The recent reform in 2002 divided the monopoly State Power into five regional power generation companies and two transmission companies (Xu and Chen, 2006). The government also created a specific regulator: State Electricity Regulatory Commission (SERC) as the main regulator over electricity. However, the SERC has never been given the right for planning and project approval. Key decision-making power is still hold by the National Development and Reform Committee (NDRC), a powerful ministry in charge of planning in China. In 2013, the Chinese government announced a reform plan which merged SERC into the National Energy Administration (the latter being mandated by NDRC) with a hope to strengthen the regulatory reform of the electricity sector. As a result, the electricity pricing and dispatching policies are now majorly under the mandate of NDRC. However, the centralization of the regulatory reform has entailed so far negligible impacts on the reform of electricity pricing and dispatching toward a competitive electricity market in China given the short time of institutional adjustment.

2.3. Cap setting and cost increase in electricity sector

In a competitive electricity market, there are two factors to determine the cost increase of power generation. The first one is the carbon price which is determined by the stringency of the cap on total emissions and the market structure. The second one is the carbon intensity of the electricity sector, especially the marginal generation technologies which set the marginal wholesale price in the market.

Gao and Li (2010) investigated an Institute of Electrical and Electronics Engineers (IEEE) 138-bus system and the contribution of energy saving dispatch to CO_2 emissions reduction. Chen et al. (2012) used a provincial case study with carbon capture and storage (CCS) and showed the short-term relationship between emissions constraint and carbon price. Key messages from these case studies include: first, the stringency of the cap has huge implication on cost increase, a more stringent cap will be translated into a higher carbon price which can entail higher electricity price for both wholesale and retail prices in a competitive market. Second, in the short term, the introduction of ETS can induce emissions reduction of about 6% where 1% of emissions reduction in the electricity sector can roughly cause 1% of cost increase. Third, the cost increases are mainly due to substitution between large generation units and small generation units. Existing small generation units always have higher variable cost but lower fixed cost as they have less loan pressure than large-scale units.

Based on these results, the introduction of ETS and emissions cap in electricity sectors could lead to a significant cost increase in the short term. Despite the fact that most of the pilot ETS have