Energy Policy 75 (2014) 84–90

Contents lists available at ScienceDirect

Energy Policy

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

An emissions trading scheme design for power industries facing price regulation

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HIGHLIGHTS

- A rate-based allocation induces power producers to minimize direct emissions.
- A cap-and-trade on indirect emission induces firms to reduce electricity consumption.
- These two can jointly achieve market efficiency even in the regulated power market.

ARTICLE INFO

Article history:
Received 26 June 2013
Received in revised form
25 June 2014
Accepted 8 July 2014
Available online 31 July 2014

Keywords:
Emissions trading
Power sector
Indirect emissions

ABSTRACT

The electricity market, monopolistic in nature, with government price regulation, poses a serious challenge for policy makers with respect to the cost-effectiveness of emissions trading, particularly in Asian countries. This paper argues that a cap-and-trade regulatory system for indirect emissions combined with a rate-based allocation system for direct emissions can achieve market efficiency even in the presence of price and quantity controls in the electricity market. This particular policy mix could provide appropriate incentives for industries to reduce their electricity consumption while inducing power producers to reduce their direct carbon emissions cost-effectively in conditions where there is strict government control of electricity prices. Another advantage of the suggested policy mix is that it allows carbon leakage in cross-border power trades to be effectively eliminated.

1. Introduction

Emissions trading schemes (ETS) have been playing a central role in mitigating greenhouse gas (GHG) emissions within many countries, as well as internationally. The EU, Norway, Switzerland, Australia and New Zealand are implementing national ETS, whereas other countries, such as the USA, Canada, and Japan, run ETS at the provincial level. Recently, Korea passed an ETS law setting a goal of implementing an ETS by 2015. China, the largest emitter in the world, also plans to introduce a national ETS starting in 2016. Seven provincial Chinese governments are already in the final preparatory stages for local pilot ETS.[1]

It is well known that a Pigouvian tax can correct market inefficiency caused by an environmental externality. Within the context of climate change, a fully functional cap-and-trade system with the carbon price set at the Pigouvian tax rate will also achieve the social optimum provided that market is under free competition.[2] The key is to make sure that the price of carbon is passed through to the final consumption stage so that equilibrium consumption will stay at the socially optimal level. In practice, however, market interventions such as government price control causes carbon price to be incompletely conveyed onto the final price, resulting in the allocative inefficiency of the market equilibrium.

The electricity industry requires special attention in this regard. Electricity production and use account for a large share of total emissions of greenhouse gases with the largest reduction potential.[3] Most countries intervene in their electricity markets through

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[1] Refer to International Emissions Trading Association (IETA)'s website for the recent status of emissions trading schemes in the East Asian countries and other regions (www.ieta.org/worldcarbonmarkets).

[2] Inefficiencies due to market imperfections and transaction cost were thoroughly investigated in, among others, Sijm et al. (2012), Boom and Dijkstra(2009), and Stavins (1995).

[3] According to the International Energy Agency, the electricity and heat production sector was responsible for 41.2% of global CO_2 emissions from fossil fuel consumption in 2010. The electricity sector will account for between two-thirds and three-quarters of emissions reductions in the next two decades in the USA (Burtraw, 2008).

http://dx.doi.org/10.1016/j.enpol.2014.07.011
0301-4215/

price interventions, resulting in serious market distortions. If the price of electricity cannot be adjusted to reflect the market price of carbon, the lack of the appropriate pass-through of carbon costs to the final consumers of electricity caused by malfunctioning price adjustment mechanisms creates a distortion in energy markets, i.e., non-uniform carbon prices between electric power and other types of energy.

The academic community has not reached a consensus on how the pass-through of carbon costs to the consumer price of electricity should be determined and when a certain ETS scheme produces efficient outcomes in the presence of market imperfections. Various ETS schemes have been tried around the world, although the systematic evaluation of their performance must still be conducted. Nelson et al. (2012) reviewed various modeling studies on the impact of carbon prices on electricity markets and found the studies to be entirely inconsistent in their estimation of carbon pass-through; the authors were unable to establish why the estimations vary so significantly.[4] Sijm et al. (2012) present a theoretical analysis of the impact of the structure of the power market on the pass-through of carbon costs to electricity prices and conclude that the pass-through rate is significantly affected by market structure, such as the number of firms and government regulations. The success of economic incentive measures crucially depends on the carbon cost pass-through rate because this is the barometer for the efficiency of market mechanisms.

This study aims to propose a desirable ETS structure that is suitable for Northeast Asia, including China, Japan and Korea, where electricity markets are strictly controlled by governments. In doing so, we compare various ETS schemes in terms of allocative efficiency and the ratio of carbon price that is passed through onto the final consumption stage under various policy options. Section 2 briefly describes the state of emissions trading schemes in Northeast Asia that involve the electric power industry. The current market situation of the Korean electric power industry is also briefly introduced. Section 3 examines how carbon price pass-through changes according to different choices in emissions trading schemes and provides graphical illustrations with discussions on efficiency implications. Policy recommendations for the design of emissions trading schemes for the electric power industry are provided in this section. Finally, Section 4 presents this study's conclusions.

2. Emissions trading initiatives in the Northeast Asia and Korean electricity markets

2.1. Current status of ETS in Northeast Asian region

Three major Northeast Asian economies, China, Japan, and Korea, plan to introduce ETS as part of their GHG mitigation policies, though at different stages. The electricity industry in all these countries creates serious challenges for the design of ETS systems.

Korea enacted a law that mandates the implementation of an ETS in 2015, the first in the region. Korea also implemented the Target Management Scheme (TMS), which is conceptualized as a transitional ETS policy tool, in 2012. Although it does not allow for trading, the TMS shares key elements with ETS: emissions targets for individual sources of emissions and MRV infrastructure. It is noteworthy that under the TMS, both direct emissions from electricity production and indirect emissions from electricity consumption are regulated by the authorities. Interestingly, rate-based intensity targets are applied to direct emissions whereas absolute targets are required for indirect emissions. It is not yet clear, however, whether the Korean government will maintain this structure in the forthcoming implementation of an ETS.

In China, emissions carbon trading schemes have made significant progress, with five out of the seven provinces having started operation of pilot schemes in 2013. Besides direct emissions, indirect emissions caused by the consumption of outsourced power or heat are covered by the pilot schemes.[5] Japan has also studied the possibility of an ETS for the electricity sector. An official document from the Japanese government (Japanese Government, 2010) describes three options for a Japanese cap-and-trade system. Two of these options propose the regulation of indirect emissions from electricity consumption combined with intensity regulation for the direct emissions of power producers. The emissions trading scheme of the Tokyo Metropolitan Area and other municipalities, which has been running since 2010, regulates indirect emissions from electricity consumption only, not direct emissions from electricity production (Table 1).

It is interesting to see that the regulation of indirect emissions is an important part of ETS in these three Northeast Asian countries to circumvent the incomplete pass-through of carbon prices due to government control of electricity prices. Intensity regulations for direct emissions are simultaneously regarded as being complementary in incentivizing power producers to reduce their direct emissions.

2.2. Structure of Korean electricity market

Industries emit greenhouse gases in the process of providing goods and services. Although they are not direct emitters, households are responsible for the emissions of industries because their demand is the ultimate cause of those emissions. However, an absolute majority of climate-change-related regulations falls on producers. Provided that price mechanisms properly reveal the cost structure, regulations on producers can alter economic consumption behavior toward the direction intended by policymakers.

We are concerned with cases in which the price mechanism does not work properly. When there are price controls, for example, cost hikes due to CO_2 regulations on the producers will not be properly conveyed onto the final purchase price. The policy goal of reducing the consumption of targeted products would be under-achieved. The Korean electricity market represents a typical example of this type of case.

The Korean electricity industry consists of four sub-industries: electricity generation, transmission, distribution, and sales. The Korean electricity industry was a vertically integrated monopoly until 2001. Since 2001, the upstream power generation monopoly has been divided into six companies. The downstream power transmission, distribution, and final sales supply chains are still monopolized by a public enterprise, KEPCO. The need for market connections between power-generating companies and KEPCO prompted the birth of the Korea Power Exchange (KPX) electricity marketplace.

The Korean electricity market is managed through a method known as the 'Cost-Based Pool'. In this system, the price and quantity of generated electricity are determined. The way in which they are decided is in stark contrast with a typical Walrasian tatonnemont process. The KPX-commissioned 'Cost Evaluation Committee' determines the price of electricity based on the cost

[4] Kim et al. (2010) showed that the pass-through of carbon costs can vary drastically across different systems through a comparative analysis of Australia and Korea.

[5] Refer to Duan et al. (2014) for the detail.