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Integrating environmental considerations into economic regulation of China's electricity sector

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ABSTRACT

One of the key challenges for China's transition towards sustainable development is how to supply adequate and reliable electric power by an environmentally benign electricity sector. This paper examines to what extent environmental concerns have been integrated into economic regulation and the difficulties of doing so under the current regulatory framework. It finds that there has been a failure to adequately and systematically incorporate environmental considerations into the formulation and enforcement of electricity regulation. As a result, some of the potential gains of the adopted emission-control measures have not materialised and challenges remain for future adoption of other pollution-reduction initiatives.

1. Introduction

China's rapid economic growth over the last thirty years has created a strong appetite for electricity. Its further development and the objective of making electricity a universal service require major new investments in both generation capacity and grid networks. However, the country has to make it a policy priority to reduce environmental damage caused by rapid industrialisation and urbanisation in order to make a transition toward sustainable development. With coal's dominance in power generation, the electricity sector is and will remain the largest emitter of some of the most damaging pollutants in China. Environmental degradation and pollutant-induced human health problems induced by coal burning have now become a growing international concern (IEA, 2007), calling for China to reduce pollution in the context of the increasing electricity demand.

The key challenge centres on how to supply adequate energy to a prospering population and growing economy by a 'greener' electricity sector. The experience of various countries has shown that both supply- and demand-oriented measures are important (IEA, 2006). On the supply side, improvement in environmental performance can be achieved by controlling emissions from fossil-fuel-based power generation, replacing coal-fired electricity with alternative energy, and improving generation efficiency. On the demand side, solutions revolves on energy conservation and efficiency by end users. Apart from the adoption of off-the-shelf technologies, there has been increasing recognition of the importance of establishing an appropriate institutional structure by which environmental concerns can be integrated into economic regulation and the design of competitive markets, so as to realise the potential gains of supply- and demand-side solutions (Colburn et al., 2013; Jordan and Lenschow, 2008; Olsen, 2007).

There have been reforms in China's electricity industry over the last thirty years. Despite an increasing volume of literature on electricity reform in China, few studies have related the regulatory framework explicitly to environmental issues. Williams and Kahrl (2008) examine the impact of reforms on the environmental sustainability of the sector. Kahrl et al. (2011) look at the challenges arising from the institutional arrangements for China's transition to an electricity system which is capable of responding to conflicting pressures from demand growth and the need to decarbonise the sector. Zhang (2015) evaluates how regulatory governance of electricity has created barriers for effective deployment of supply- and demand-side solutions. Taking the energy sector as a whole, Andrews-Speed (2012) analyze the role of the institutions of energy governance in shaping China's path to a low-carbon economy. This paper adds to the existing literature by examining to what extent environmental concerns have been integrated into economic regulation of electricity and the difficulties of doing so under the current regulatory framework. The discussion on the regulatory

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framework is not confined to regulatory agencies and governmental departments at the central level. It also incorporates China's quasi-federalist structure of government administration in the analysis. It is hoped that this approach will help develop an understanding of the complexity of the institutional landscape and an appreciation of difficulties in finding explicit solutions to the problems faced by China's electricity industry.

The article is structured as follows. Section 2 discusses supply- and demand-side solutions and what is needed for their successful deployment, drawing on publications from international energy organisations. Section 3 examines the regulatory framework of China's electricity sector and Section 4 analyses how well environmental concerns have been integrated into economic regulation and its enforcement. Section 5 looks at the major pollution-control measures adopted thus far in the country, while the last section of the article draws conclusions.

2. Supply- and demand-side solutions to achieve a greener electricity industry

Guidelines on how to make the electricity sector greener have been provided by policy handbooks and professional reports published by energy organisations or associations, in which the importance of integrated consideration of both supply- and demand-side solutions has been highlighted. Demand-side measures have increasingly been viewed as complements or alternatives to supply-side investments (IEA, 2004, 2006).

2.1. Supply-side solutions

Supply-side solutions to environmental concerns in the electricity sector fall into three areas: emission control of coal-fired plants, fuel switching in generation, and improvement in generation efficiency. Pollution from coal-based plants can be reduced by replacing smaller, more polluting generating units with bigger, more efficient ones; using cleaner coal; and installing pollutant-capture equipments (Harmelink et al., 2003). There are environmental gains from switching to alternative generation options with zero or near-zero carbon emissions, such as renewable resources as well as nuclear power. Another source of pollution reduction lies in improvement in generation efficiency so that a given amount of electricity is produced with less fuel.

Without doubt, technology plays an important role in most of supply-side solutions. However, it has been widely recognised that the promise of technology is far from sufficient to ensure successful deployment (IEA, 2007). Replacing old, inefficient coal-fired plants with new, efficient ones, installing pollution-abatement equipment on fossil-fuel-based plants, and installing renewable generation capacity all require high initial investment and continuous injection of financial capital. Despite cost disadvantages, cleaner plants have substantial positive externalities, i.e. less pollution. It is therefore essential to consider policies that incentivise the adoption of beneficial technologies. In addition to providing power generators with sufficient financial support, it is important that on-grid electricity prices are set to allow for the recovery of the up-front investment and thus to improve cost-effectiveness of cleaner technologies. It's also crucial for electricity prices to internalise the externalities of different energy options in order to incentivise switching to cleaner generating technologies and to ensure power generation and dispatch from cleaner plants.

When it comes to renewable resources, additional obstacles to successful deployment need to been tackled. There may be insufficient demand for renewable energy due to high costs, and problems with connection and access to the grid. According to the World Bank (2008), quantity-based schemes can be adopted to set a desired quantity of generation or installed capacity in the form of, for instance, renewable portfolio standards (RPSs). Such schemes are more effective in combination with mandated access to the grid and well-enforced power purchase agreements (PPAs) (IREC, 2004).

In general, investment planning and project approval rules will affect what type of power plant will be built. To encourage investment in cleaner generating capacity and ensure that unauthorised (and likely dirtier) plants are not built, environmental costs and benefits should be appropriately integrated into the investment planning process, environmental standards should be used as one of the principal criteria in project approval, and licensing requirements should be strictly enforced (IEA, 2006).

With regard to generation efficiency, it is important that the pricing regime contains provisions for the adjustment of tariffs over time in order to incentivise power producers to adopt efficiency-enhancing practices (Cherni and Kentish, 2007). Competition can also play a role in compelling power producers to improve efficiency in generation. Many countries have implemented reforms in which the generation sub-sector is unbundled from transmission. Competition among power producers can be promoted by breaking up the dominance of incumbents and allowing entry by new participants. Independent power producers can be encouraged, not only for the purpose of imposing competitive pressure on state-owned incumbents, but also because, according to the World Bank (2008), they tend to be the main developers of renewable energy. This requires appropriate regulation to lower entry barriers and well-defined, transparent procedures for investment approval (Garcia, 2013).

In an unbundled electricity industry, grid companies remain as monopolies. It is therefore necessary to put them under effective regulation to ensure that they do not stand as an obstacle to competition among power producers (GWEC, 2005). This entails ensuring equal grid access for different types of investors and different generating technologies. In particular, grid companies should be regulated to guarantee grid connection and access to electricity generated from renewable resources and to respect PPAs. Imposing economic incentives and mandatory obligations on grid companies is important for this purpose (IEA, 2006).

Command-and-control measures can be combined with the use of market-based instruments. In addition to setting electricity prices (e.g. feed-in-tariffs) to internalise the externalities of different energy options and to incentivise power generation and dispatch from cleaner plants, other market-based approaches widely used around the world include emission taxes (also known as pollution taxes or levies) and emissions trading systems or schemes (ETS).[1] The idea is to provide incentives for emission reduction by pricing pollution. Emission taxes act as cost adders to internalise pollution damage that is not fully reflected in electricity prices (Green, 2008; IEA, 2008). The ETS, or cap-and-trade system, puts a limit on the amount of a pollutant that may be emitted and allocates allowances or permits to sources that can be traded on secondary markets. Generators can buy and sell the permits, but must surrender allowances matching their actual emissions.

Making pollution (relatively) more expensive, both emission levies and the ETS will in theory provide economic incentives to reduce pollution with the lowest-cost opportunities (Tietenberg and Johnstone, 2004). Achieving its aims by influencing generators' costs of production, the ETS provides incentives to reduce the

[1] Pollution taxes and the ETS can also be used to the demand side, but such application falls mostly outside the discussion of pollution and the regulatory framework in the electricity sector, except that end-users may choose to reduce polluting activities that consume electricity.