Climate Policies and the Power Sector: Challenges and Issues

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Climate change is an unprecedented challenge faced by our society today. Numerous resources and policies have been devoted to controlling greenhouse gas emissions (GHGs) from the power sector and other energy-intensive sectors.

Implementation of CO_2 emissions policies such as emissions trading schemes (EU ETS) in the European Union and the Regional Greenhouse Gas Initiative (RGGI) in the United States has altered power-sector economics. Recent dialogues among Western U.S. states highlight the need to design policies offering companies incentives for emissions reduction.

Climate policies affect the power sector in both the short and long run. In the short run, these policies rearrange production merit order by forcing generators to take emissions costs into consideration. In the long run, they are expected to drive the generation mix toward less carbon-intensive technologies. One of the main mechanisms underlying these polices is the cap-and-trade approach, where a fixed amount of tradable emissions allowances is allocated to affected facilities, and these facilities are required to hold or buy sufficient allowances to cover their emissions.

Experience with the Clean Air Act (CAA) Title IV SO_2 emissions-trading program in the United States has indicated that cap-and-trade programs could be an effective means for controlling air pollution. However, the impact of CO_2 emissions policies on the power sector is expected to be far more profound than that of the SO_2 program because it affects power generation not only from coal-fired baseload units, but also from other fossil-fired units, and the costs are anticipated to be much higher.

Although the experience of emissions trading programs so far is encouraging, policy makers are still seeking answers for several challenging questions in designing emissions trading programs. In particular, while allocating allowances to incumbents and new entries by means of grandfathering is a necessary political comprise, little is known about the economic inefficiencies incurred by distorting firms' investment incentives. Another issue is which regulatory instruments can be used to manage GHG inventory uncertainty, which presumably varies by country and sector. If the problem of inventory uncertainty is unsolved or overlooked, the policy effectiveness of the ETS, RGGI, and other trading programs might be difficult to evaluate.

In parallel with emissions trading, other energy policies that promote the use of renewable energy (e.g., renewable portfolio standard or RPS) are also expected to play an important role in combatting global warming. However, one ongoing debate among the scientific communities is to what extent the various renewable technologies are actually environmentally beneficial, if evaluated over their entire life-cycle. Another related issue is which renewable technologies can be melded into the existing power system and deliver tangible environmental benefits without impairing the system's reliability. Finally, the Kyoto Protocol Clean Development Mechanism (CDM) provides compliance flexibility for developed countries to meet their reduction target at lower costs. However, two emerging questions are (1) how domestic renewable policies (e.g., taxes, subsidies) and CO_2 control policies will interact with each other under the presence of CDM projects; and (2) whether a preexisting renewable tax or subsidy will lead to underinvestment in CDM projects.

For this special issue, Implications of CO_2 Emissions Policies on the Electric Power Sector, the *Journal of Energy Engineering* selected seven high-quality papers that address a wide array of the questions concerning CO_2 policies and the power sector. Each paper was reviewed externally by at least two researchers in the field. These papers are further grouped into two areas.

Analysis of Emissions Trading Programs

In the first area discussed, Bartels and Müsens examine the distortions of long-run economic efficiencies resulting from free allocation of the ETS allowances to new entries based on uniform and fuel-specific benchmarks. They find firms' investment decisions are significantly distorted under these two approaches, compared to allocating allowances by auctions. In particular, considerable coal capacity will be built because of the economic rents of free allowances. In both cases, economic rents associated with free allowances are equivalent to a lump-sum subsidy for capacity costs.

In the short run, when technological capital stock is fixed and generators cannot retrofit air pollution devices, the power system relies on fuel switching or expanding output from low-carbon-intensive generators. Delarue et al. study generators' fuel-switching decisions in the first and second phases of the EU ETS. They first calculate the price level at which natural gas-fired plants would become more economical than coal-fired units, and estimate that fuel switching accounts for roughly 88 Mtons of emissions reductions in 2005. For the EU ETS second phase, they derive emissions reductions as a function of allowance prices and conclude that more than 300 megatons per year of emissions reductions can be attributed to fuel switching if the allowance price is sufficiently high.

In the final paper in this section, Nahorski and Horabik explicitly derive an operational rule to calculate *effective permits* for a given level of risk of noncompliance. The effective permits take into account the uncertainty associated with the industrial activities that create these permits. Thus, the value of permits can be more accurately reflected. These rules are crucial steps for ensuring individuals' compliance, and for maintaining the integrity of the emissions trading program.

Renewables Technology

In the second area discussed, Lee and Tzeng develop a life-cycle assessment of wind energy in Taiwan, from turbine manufacturing, foundation construction, and system operation through disposal of systems. Their results provide a basis for comparing the environmental burdens that wind energy places on other conventional technologies.

Fukushima and Kuo examine the GHG emissions reduction potential of different scales of penetration of photovoltaic (PV) generation introduced to a power system. Their research shows that correct assessment of emissions reduction potential should consider changes of the generation mix on an hourly basis. This is because emissions reduction potential varies considerably at different levels of electricity demand and with the hourly generation mix.

Su et al. perform an integrated assessment of renewable and CO_2 control policies by using a recursive model to consider the possibility of CDM projects in China. They conclude that local policies (e.g., subsidies, emissions trading) may conflict with CO_2 control policies and impair the development of these projects, and therefore, careful consideration needs to be given to synchronize renewable policies, CO_2 policies, and CDM opportunities in China.

In the final paper of this special issue, Simms et al. review and analyze the requirements of a 10% offset of carbon emissions in new buildings in London. Eligible sources include onset renewables and carbon-saving sources. They propose an index, expressed as carbon saving per dollar, that allows for comparison across different eligible technologies.

While the selected papers may address only a subset of issues on this challenging topic, their relevance and in-depth analyses into climate change and the power sector is important, at least for lessening society and power sector dependence on CO_2-intensive energy resources. We hope that these papers cover a variety of topics of your interest.