Impacts of Climate Change on Regional Air Pollution: A Short- and Long-Term Analysis of Mid-Atlantic Region

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Abstract Submitted to the IAEE 2005 Summer Taipei Meeting

Power sector is an important source for regional air pollution. The effects of climate change on power sector have significant implications to the regional air quality and public health. In general, climate change affects power sector in various ways. In the short-run, it results in an increase in the electricity demand, a change in the load shape, and the degradations in generation efficiency. In the long-run, it influences the generation mixture and the marginal pollution emission rate.

In this study, the least-cost models are developed to investigate the impact of climate change on regional power generation and its pollution emission. We simulate a climate change scenario characterized by a uniform increase in temperature. The models account for two sources of efficiency degradations in the power generation: (a) an increase in heat rate and (b) a de-rate of available generation capacity. Meanwhile, the increase in load and the change in load shape of the given climate change scenario are estimated by time series techniques considering variables, such as day of the week, heating & cooling degree days and etc. In the long-run, the screening-curve technique is applied to get an abstract estimation of generation mixture. A least-cost capacity expansion model is subsequently used to estimate the capacity addition and power generation.

The application is to Pennsylvania – New Jersey – Maryland (PJM) Interconnection in Mid-Atlantic region for years 2000 and 2025. The PJM power system is represented by a network with fourteen nodes and eighteen arcs. The year load is approximated by eighty-two blocks. In the simulations, we assume that an explicit NOx emission cap is imposed during ozone season and the cost of CO2 and SO2 emission is incorporated in the production costs with exogenous allowance prices. We stimulate cases with- and without climate change. In addition to the yearly emission impact, we also report the hourly emission profile during hypothetical three-day ozone episodes.

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