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Energy Policy Seminar Series

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Generation Expansion Planning Considering Health Damages – A Simulation-Based Optimization Approach

Abstract*: In this research, we provide an analytical framework to solve electricity generation expansion planning (GEP) problems that minimize total system-wide costs, including health damages. Typical generation expansion planning models leverage mathematical optimization methods to determine the optimal technology investment strategy to grow capacity in the electric power grid while minimizing market costs such as investment costs, fixed and variable operating & maintenance costs, and fuel costs over a long-term planning horizon. While fossil fuels (such as coal, oil, and natural gas) are among the most economical sources of electricity, and thus are the primary sources of energy for electricity, using these energy sources to generate electricity creates by-products that contribute to ground-level ozone, particulates, and acid rain, which have harmful health effects. More specifically, per research from the Environmental Protection Agency (EPA), exposure to these elements causes various respiratory-related illnesses leading to lost days at school or work on a daily basis. In this research, we present a simulation-based approach to quantify health damages associated with power grid expansion decisions by linking the outputs of GEP simulations with an EPA screening tool that determines the human health externalities from the electricity sector. We then use a statistical prediction model to approximate these health damages to develop a closed form relationship as a function of GEP capacity investments. This serves as a surrogate mathematical function, or metamodel, for health damages to be incorporated in the objective function of a GEP model in addition to market costs and the social cost of carbon and methane leakage. This research is the first comprehensive attempt to estimate health damages in the context of GEP capacity investment decisions. Additionally, this research leads to contributions for developing GEP models where health damages are included in the objective function to thus influence the investment strategy. Furthermore, the application of a rigorous search algorithm to determine candidate data points to enhance prediction capabilities of the metamodel is a contribution to the field of large scale simulation-based optimization models, as this ultimately leads to more accurate and realistic optimization solutions.*

—Coffee/tea will be served prior to the lecture—

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