Two-Level, Mixed-Integer Programming Models for Energy Conservation Measures

The federal, state, and local governments, agencies and authorities have been issued directives and mandates that require, among many other things, a percentage reduction in energy consumption. Many private institutions and commercial entities adopt these standards and adhere to these requirements to save operating cost, demonstrate leadership, market to prospective and existing building tenants and prepare for impending legislation to which they must comply. The first phase in the process of meeting these objectives is conducting an American Society of Heating and Refrigeration and Air-Conditioning Engineers (ASHRAE) level 2 or 3 energy audit, which will undoubtedly generate a suite of potential savings opportunities. Energy Conservation Measure (project) selection is made difficult given real-world constraints, limited resources to implement savings retrofits, various suppliers in the market and project financing alternatives. The most common method of implementation planning consists of sorting opportunities by simple payback and selecting projects until the agency's budget is exhausted. Additional projects are then financed until the reduction requirement is met. Optimization is not mandatory but necessary to determine the best way to meet these objectives in the least costly manner. This optimization must evaluate and select projects in a single model regardless of the implementing body. This presentation will demonstrate how two-level mixed integer programming is used to optimize the selection of energy conservation measures. The practical application of the Karush-Kuhn-Tucker conditions allows for the agencies to make the most cost effective selection while considering opportunities for self-performance, financing, the impact of life cycle costing and lower level firm competencies.