Optimal Scheduling of CCHP (Combined Cooling Heat and Power) Engines for Powering and Cooling a Data Center

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Problem Description

We will consider the optimal operating configuration for a set of parallel CCHP engines. The CCHP engines are used to provide electricity and cooling, due a thermal conversion by means a absorber chiller, to a large-scale data center. The data center has a constant demand for electricity and cooling over the planning horizon. Electricity may be provided by the CCHP or from the electrical grid, while cooling demand can be satisfied by the CCHP or using an air-gas-water high efficiency chiller using part of the electricity demand. Electricity and cooling demand must be satisfied at all times. Moreover, electricity from the grid and electricity generated by the CCHP come at different costs and cooling capability. Multiple CCHP engines operating in parallel are available; however, a subset of the total machines may be chosen to be in operation at any given point in time so long as the engines in operation plus electricity from the grid is sufficient to meet demand. Furthermore, the machines are each subject to a scheduled maintenance/shutdown period after a fixed number of hours of operation and have a fixed operating lifetime. The objective is to determine the optimal configuration (schedule) of operating the CCHP engines over the planning horizon such that the electrical and cooling demand is met at all times, the maintenance/shutdown periods are taken into account, and the total cost is minimized over the planning horizon.

Tasks

1. Formulate a mathematical model for the problem (objective function and constraints)
2. Develop an appropriate input methodology for the CCHP engine and data center parameters and demand
3. Code an appropriate algorithm to determine the optimal operating schedule
4. Format the output (schedule) in a graphical and/or user-friendly manner.

Required knowledge: mathematical modeling, optimization/operations research, computer programming