Energy applications of CPLEX

IBM ILOG CPLEX Optimizer provides flexible, high-performance mathematical programming solvers for linear programming, mixed integer programming, quadratic programming, and

quadratically constrained programming problems. For linear programming, the algorithms include primal simplex algorithm, the dual simplex algorithm, the network simplex algorithm, as well as a barrier method. For mixed integer programming models, CPLEX uses branch-and-cut algorithm. CPLEX can solve both convex and non-convex quadratic to global optimality. CPLEX has both barrier and simplex algorithms for solving convex quadratic programs and a barrier algorithm for solving non-convex problems.

Reference:

http://www-01.ibm.com/software/commerce/optimization/cplex-optimizer/

CPLEX has been applied to various problems arising in the energy sector:

Resource Planning Models address the supply and demand side investment decisions an energy supplier makes to ensure that it can satisfy customer demand. The objective is to minimize the total cost of building and operating production facilities to serve forecasted loads over a multiyear planning period.

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Unit Commitment/Economic Dispatch Models are used to schedule hourly production of thermal power stations for periods up to about a week in advance. The objective is to minimize the short-term costs of operating the generators to serve forecasted customer loads. The costs include both fuel costs and start-up costs. The constraints represent the requirement to serve hourly customer loads, various reserve requirements, minimum uptimes and downtimes for generators, and ramping limits for generators.

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Hydro/Thermal Scheduling Models are used to determine the use of water resources in power systems with a lot of hydroelectric generation. The objective is to minimize the short-term costs of operating the power plants to serve forecasted customer loads. The costs include thermal power plants'fuel costs, since hydro generation typically has negligible direct costs. The constraints represent the requirement to serve customer load per hour, the availability and flow of water through the supporting water network, various reserve requirements, various restrictions on water flows and reservoir volumes reflecting environmental regulations.

References:

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Optimal Power Flow/Security Constrained Dispatch Models are used to determine the flows of power along the various transmission paths in a power network for the purpose of evaluating the feasibility, reliability and security of the power system. The objective is to minimize the operating cost of serving the load. The constraints represent the requirement to serve instantaneous customer load at all nodes of the network, the generator capacity limits, conservation of power flow and voltage laws governing the physical power flows (which may be represented nonlinearly), and various reserve, security and reliability criteria.

References:

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Contract and Risk Management Models enable energy and power companies to implement profitable bidding strategies while limiting price and volume risks to acceptable levels. The objective is to determine volume and price for possible energy transactions and emission credits bought or sold in order to maximize expected net returns. The constraints represent forward price curve uncertainty and volatility, and impose limits on value at risk and conditional value at risk.

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Contingency Planning Models are used to determine the recourse in cases of outages. Sometimes, these involve transmission switching, load shedding, and controlled islanding.

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Pooling and Blending Models are bilinear network flow problem on an arbitrary directed graph. Given a list of available suppliers with raw materials containing known specifications, the objective is to minimize the cost of mixing these materials in intermediate pools so as to meet the demand and specifications requirements at multiple final blends.

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