Danmarks Tekniske Universitet

46750 Optimization in modern power systems

Assignment 2: Phase 2 - Consulting Proposal

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Phase 2 - Consulting Proposal

Key Challenge

The client wants a decision making tool to help them decide which and how much resources to buy, the timing of purchase on the market, and the desired storage levels for their power production units with the objective of minimizing their expected production costs. This becomes a challenging decision making problem due to different uncertainties such as future fuel prices, unknown regulatory and environmental policies, and their sequential decision making influencing future decisions.

Proposed Modeling Roadmap

Model 1: A simple deterministic model assuming frozen policy and perfect knowledge of future fuel and carbon permits prices to give a simple but insightful view of which fuels are most cost-effective to buy at what time and how the client might expect the storage of fuels to evolve.

Model 2: A stochastic model that accounts for the uncertainties inherent in the decision problem. The model generates different scenarios based on historical data, including policy changes affecting the EU Emissions Trading System (ETS) and fluctuations in fuel market prices. This enables the client to assess the objective value across scenarios, providing expected costs to make more informed strategic decisions.

Modeling Assumptions

For all proposed models, it is assumed that the client acts as a price taker in both the EU ETS market and the fuel markets, thus static competitor behavior is expected. The modeling horizon is limited to a single year, thereby excluding interannual effects such as the gradual reduction of the total ETS allowances cap. As input data, both models require forecasted data for fuel prices and the ETS market, the linear cost of storage, production requirements, power plant efficiencies, and CO_2 emission equivalents for each fuel type. The quantities of each fuel purchased, used for production, and stored are modeled as sets of decision variables in both models, along with the number of emission allowances (EUAs) purchased at auctions. As the time interval between each decision is not specified in the client brief and due to the nature of the fuel markets and the ETS auctions, it is assumed the client must make daily buying, storing and production decisions.

Anticipated Trade-offs for the models

The simple deterministic model is advantageous for conceptual understanding through transparent results. The complexity is low, computationally efficient and requires minimal input data. However, the model contains some crude assumptions and no uncertainties. In the real world, fuel markets are volatile, and environmental policies are hard to predict. In Model 2, it is possible to identify strategies across multiple possible scenarios and capture uncertainties and risk, but the optimization problem becomes more complex, and results are less transparent.

Expected Insight

Model 1 provides the optimal decision making outcome if all information is available and forecasting is perfect. It can be used as a model for comparison, and is useful for an overview of the deciding variables and constraints regarding dynamics of timing in the market and fuel storage levels. Model 2 deals with the stochastic and uncertain elements of the problem and allows the client to gain insight into the realistically expected outcomes by covering different scenarios with varying policies and market conditions. With this comprehensive insight, the client can adopt strategies that reflect their risk preferences when making strategic decisions.