Optimization with Variable Energy Prices

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Abstract. The global energy market is undergoing major changes, in many countries market-based mechanisms are used to determine a real-time price for electricity. This is driven by volatile prices for fossil fuels, an increasing market share of renewable, but hard to predict, energy sources like solar PV (photo-voltaic) and wind energy, and a need to reduce CO_2 emissions by penalizing inefficient and polluting energy generators. While whole-sale prices can vary widely during a day, most residential and industrial consumers are still using fixed-price energy tariffs, as they can not easily exploit the advantages of variable prices.
We consider the role that optimization can play in helping users to plan their energy consumption over time, which reduces their energy bill, helps utility companies to reduce peak demands, and thus improve the overall environmental impact. For this we introduce a family of energy cost aware resource constraints, which can model time and volume dependent energy consumption. We show how a generalization of existing LP relaxations for the cumulative constraint can be used to perform strong propagation for these constraints.
In order to plan the energy consumption into the future we also have to be able to predict the real-time price hours or even days ahead. Experiments based on data from the Irish energy market indicate that high quality schedules can be found, even if the future price is not known very accurately, but also that improving the accuracy of the forecast based on standard quality measures is not enough to guarantee even better schedule costs.
We conclude with presenting some ongoing work on energy management in residential homes and public spaces like university campuses, which extends our optimization models with thermal models for heating and air conditioning and energy storage.