Optimization in Energy Systems and Markets

4th Laboratory Assignment

Optimal Generation Bid and Risk Management

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Contents

Description of the study

Let's consider the stochastic optimal day-ahead generation bid problem associated to the data defined in the Annex: input data. This problem represents a simplified version of an electricity generation company bid model considering only their thermal units. By means of AMPL codes developed during the course, we want to perform the following exercises.

Exercise 1. Scenario generation.

Define 100 equiprobable scenarios for Monday 30 June 2014 using the series in file `pricesDM_1407041Mo-140627Fr-WD_students.xlsx` and the methodology outlined in the topic *Scenario generation with Time Series Forecasting models*. Explain which is the TSF model that best fits the data. You can use the MATLAB implementation TSFA as described in class or any other TSF software.

Exercise 2. The effect of bilateral contracts on the optimal bid, risk-neutral model.

Solve the $(DMGB)$ and the $(DMGB - RB)$ with the data in the annex[1] and:

a) Perform a general description of the solution: BC load covering, participation in the DM, unit commitment, etc.

b) Based on the optimal bid curves analyse how the bilateral contracts affects the optimal generation bid.

c) Check is the current price λ^B is convenient for the GenCo. Propose a general procedure to find the minimum price λ^B_{min} for the BC to be worth for the GenCo (*BC negotiation strategy)*. Find the value of λ^B_{min} corresponding to your data.

Exercise 3. The effect of risk-management on the optimal bid with and bilateral contracts, risk-averse model.

Now, take the value λ^B_{min} in the previous exercise. We would like to assess the impact in the optimal bid of the consideration of the $CVaR$ risk measure with probability level $\alpha = 0.9$. To simplify the executions, we are going to linearize the quadratic objective function. A good possibility is to take the linear functions associated to the secant to the quadratic costs associated to P^{min}, and P^{max}. In order to evaluate the impact of this risk measure, compare the risk-neutral versus the risk-averse solutions following the methodology explained in class, that is:

a) First, plot the efficient frontier

b) Second, compare the probability distribution of the random variable *total profit* for the *risk-neutral* ($\beta = 0$) *risk-averse* ($\beta = 1$) and some representative *risk-seeking* strategy ($0 < \beta < 1$) models: expectation, Var, $CVaR$, and histogram.

c) Finally, analyse the differences in the optimal bid functions of the three strategies (risk-neutral/seeking/averse).

d) Analyse what are the advantages (if any) of the BC for the GenCo from the point of view of the risk-seeking strategy.

[1] The thermal units of this data set has $R^D_G < P^{min}_G$. With the formulation of the ramp constraints provided in the slides these units will never be shut down. You must modify the ramp limit constraints to avoid this flaw.

Report

You should elaborate and upload to the intranet a report with the answers to the different sections of Exercise 1 and Exercise 2, taking into account that:

1) The assignment must be undertaken by groups of maximum two students.
2) The report must follow the IEEE template published at Atenea and should include the different parts of the studies proposed in exercises 1 and 2, presented in a comprehensive way following the usual structure of a IEEE paper[2]:
   - I. Introduction
     - A. Brief description of the problem.
     - B. Objectives of the study and main results.
     - C. Structure of the report.
   - II. Mathematical formulation of the models $(DMGB - R)$ and $(DMGB - RB)$:
     - A. Risk-neutral model.
     - B. Negotiation strategy for λ_{min}^{B}.
     - C. Risk-seeking/averse model.
   - III. Numerical results.
     - A. Description of the computational test: data, software, computational resources.
     - B. Description of the scenario generation procedure (Exercise 1).
     - C. Numerical results and analysis for the risk-neutral (Exercise 2).
     - D. Numerical results and analysis of the risk-averse (Exercise 3).
   - IV. Conclusions of the study.
3) The grading criteria to be applied is :
   - 10% : answers to exercise 1.
   - 35% : answers to exercise 2.
   - 35% : answers to exercise 3.
   - 20% : quality of the report.

[2] An example of how to arrange a IEEE paper can be found at http://hdl.handle.net/2117/20642

Annex: input data

Data for generation units (file `dmgb_units4_2014_v3.dat`)

```
set G := ALL1 ROB1 NRC2 NRC3;

param  loadBC := 700;
param priceBC := 50;

param : cq   cl     cb      csu     csd     pgmin  pgmax  ru    rd     tU   tD   pg0    u0:=
ALL1    0.01 38.28  1432.50 1241.29 1241.29 160.00 350.00 63.33 95.00  3.00 2.00 160.00 1
ROB1    0.02 39.17  870.92  1308.87 1308.87 160.00 370.70 70.23 105.35 3.00 2.00 160.00 1
NRC2    0.08 26.76  3599.94 1246.67 1246.67 160.00 364.10 68.03 102.05 3.00 2.00 160.00 1
NRC3    0.01 38.35  1946.43 1958.97 1958.97 90.00  350.00 86.67 130.00 3.00 2.00 90.00  1
;
```