SOLUTIONS

Technical University of Denmark

46750 - Optimization in Modern Energy Systems
Exercise 6

1. Optimal offering strategy of price-taker wind producer

We consider a **price-taker** wind producer (W_1) which aims at maximizing its own profit in the day-ahead electricity market. Its marginal production cost is $c^G_{W_1} = 15EUR/MWh$. Before deciding on the production to offer in the day-ahead market, the day-head electricity price λ and the available wind production $\overline{P}_{W_1}$ are still uncertain. However, once decided, the wind producer must supply all the production offered to the day-ahead market, regardless of its realized wind production in real-time. We consider that the wind producer only has access to (independent) forecasts of the realizations of the day-ahead price, such that:

- $\lambda = 10EUR/MWh$ with a probability 0.5 or $\lambda = 30EUR/MWh$ with a probability 0.5
- $\overline{P}_{W_1} = 125MWh$ with a probability 0.5 or $\overline{P}_{W_1} = 75EUR/MWh$ with a probability 0.5

(a) Formulate the scenarios on the uncertain input parameters to the optimal offering strategy problem of the wind producer, and their respective probabilities.

(b) When are the decisions of the wind producer made, compared to the realization of the uncertain parameters. Can they be changed afterwards?

(c) What is the objective of the wind producer? Formulate this objective function based on the scenarios of day-ahead prices.

(d) What constraints must the wind producer satisfy for each possible realization of the uncertain parameters? Formulate these constraints based on the scenarios of available wind production.

(e) Formulate and solve the optimization problem of the price-taker wind producer. What are the optimal decisions and profit of this producer (in expectation and for each realization of the uncertain parameters)?

(f) Compute the expected value of perfect information (EVPI) for this optimization problem.

(g) Discuss the limitations of the proposed approach, in terms of i) trade-off between computational complexity and accuracy of the solutions based on the number of scenarios; ii) limitations of the here-and-now decisions approach; iii) potential disappointment and losses for specific realizations of the uncertainty. How can these limitations be addressed?