Optimization under uncertainty.
Energy distribution.

1 Presentation

A national electricity provider collects the weather forecasts (sun and wind) every day to anticipate the amount of renewable energy it can expect and plan its energy production for the day accordingly. There are 6 Renewable Energy Production (REP) sites available and each of them always deliver the maximum possible power depending on weather conditions. Based on historical data, the network managers considers that the Renewable Energy Production on each site and in each hour is normally distributed, with a mean equal to the forecasted value and a coefficient of variation equal to 20%. For all sites $j = 1, \ldots, 6$, the forecasted REP values for the next 24 hours are indicated in the column "Avg REP j (MW)" in table "Demands and RE" of the file `data_energy.xlsx`.

The company owns 10 generators of different nature, each with specific startup and shutdown procedures. When the network manager decides to turn on a generator $i = 1, \ldots, 10$, it must produce electricity for at least the next UT_i hours (possibly more), including the hour during which it started. The maximum power produced during an activation period (i.e. when it is switched on) is given by the startup capability SU_i of the generator. Similarly when an active generator is turned off its power in the previous hour cannot be greater than a shutdown capability SD_i and the procedure takes DT_i hours during which the generator has to remain off in order to cool down. Whenever the genereator i is active, it delivers a power that is at least equal to $p_i^{\min}$, and below its maximum power $p_i^{\max}$. In addition, the increase (resp. decrease) in the power produced by generator i between two consecutive periods cannot exceed a ramp-up capability RU_i (resp. ramp-down capability RD_i). Each production site has a given efficiency: When plant i is turned on, it has a ramp-up rate RU_i (resp. ramp-down rate RD_i), i.e. the difference between the power generated on two consecutive days is in the interval $[-RD_i, RU_i]$. The generators specifications are available in table "Network data" of the file `data_energy.xlsx`

The goal of the network manager is to operate the different generators (switch on/off, power produced) in order to fulfil the energy demand in each hour given in column "Demand" in table "Demands and RE" of the file `data_energy.xlsx`. Any excess energy produced during a given hour is sold to the grid at price 15€/MW, while the company can also buy electricity from the grid for a cost

of 120€/MW. All the costs incurred when the company uses its generators are indicated in table "Network data" of the file `data_energy.xlsx`. They consist of:

- A per-hour utilization cost that must be paid whenever the generator is active, regardless of the power produced,
- A linear energy production cost for each MegaWatt produced in any given hour,
- A fixed startup cost that is incurred whenever the generator is switched on.

The goal is to fulfill the energy demands during the entire day at minimum cost.