Planning of the maintenance outages for a set of hydroelectric turbogenerators

Rio Tinto Alcan (RTA) is a multinational company that owns many aluminum smelters throughout the world. In the Saguenay-Lac-St-Jean region (SLSJ), RTA operates four aluminum smelters that produce more than one million tons of aluminum per year. The Electrical Energy Division (EE) manages the production and distribution of energy. The six hydroelectric power plants owned by RTA (three on the Péribonka river and three on the Saguenay river) produce on average 2080 MW per year, that is, almost 90% of the energy required for its aluminum production. The reliability of generators is thus of utmost importance for the company.

In order to ensure the required level of reliability, EE plans many Switch-Off Events (abbreviated as SOE), consisting of switching off some turbogenerators (TG). These SOE are planned in order to repair broken parts or to carry out preventative maintenance or major repair work. All these SOE must be planned several months in advance, taking available resources into account. For the time being EE does not have any automated system for making an SOE schedule. The goal of this project is to formulate an optimization model for scheduling the SOE for the SLSJ region and to propose algorithms for solving this model.

While building an SOE schedule one must take several constraints into account. First, the resources that can be allocated to maintenance work are limited. Second, the required maintenance work must be carried out by various trades, each of which having a limited work force. Overtime may be used but in this case the labour costs will be higher. If a maintenance outage has a longer than average duration, it may be split into two parts when necessary. Finally, the main difficulty in building a schedule lies in the random nature of the production demand. Indeed, during certain periods (spring, summer, and autumn), there are large variations in the precipitations.

EE uses a model to forecast the precipitations on the catchment basin. This model generates several scenarios for the natural water supply stored in the reservoirs. The schedule building must take these scenarios into account and minimize losses due to the SOE and losses due to a lack of efficiency. SOE-related losses occur when the natural water supply (i.e., precipitations) is abundant and the reservoirs cannot store the excess water. In this case some extra TG must be switched on. If these TG are not available because of an SOE, the excess water must be evacuated and “SOE-related losses” will be recorded. The “lack-of-efficiency losses,” on the other hand, are due to the operation of TG in areas with a high flow rate, where the transformation of the flow into power is not efficient.

The solution to the optimization problem will produce a single schedule, which will minimize the expectation of the total losses (the sum of the SOE-related losses and the lack-of-efficiency losses), given a probability distribution on the set of available scenarios.