Valuation of Pumped-Storage Power Plants under Uncertainty based on a Real–Option Approach

Ed Zuur (Time-steps AG), Max Scheidt (ProCom GmbH)

Abstract

Given today's competitive electricity markets, the owner of any production facility has to optimize the income from plant operation in order to maximize its expected value and to control the risk in face of hourly, daily and seasonal uncertainties. With the increase in renewable capacity fluctuating production exacerbates the volatility on the physical side of the market. Storages are a probable mean to cope with this behavior. Hence, investments in pump-storage plants promise to be an economically valuable idea. Yet, such investments will be done only if the investor can expect a sufficient return on investment. Given the volatility in prices, inflow and renewable generation such investment appraisals cannot be performed based on deterministic contribution accounting. Instead one should directly account for the uncertainty by using stochastic valuation approachs, like e.g. a real-options approach.

In the workshop we will present a stochastic approach to the plant valuation problem based on a realistic investment decision for a hydro-power plant.

In order to optimize plant operation and to perform a risk analysis, two tasks are accounted for. The first task consists of obtaining an action-grid for the plant operator. It is accomplished by means of a dynamic programming approach through backward induction and makes use of correlated stochastic processes. In order to avoid an a priori constraint on the number of time-steps, the method is not based on a tree method, but a regular function space is spanned. As a result, the calculation time is linear with the number of time intervals. For each future time period the resulting grid holds the information about the best operation mode of the plant, given the market state, such as the electricity price, and the internal state of the facility, such as the amount of water in a hydro power plant reservoir. For a simple financial derivative like an American option that has no internal state, the information contained in the action-grid would be at what moment to hold and at what moment to exercise the option given the value of the underlying asset.

The second task consists of considering a set of scenarios of the uncertain factors such as electricity prices and natural inflows. By following the individual scenarios and by performing the operations dictated by the action-grid, the value distribution of the plant is obtained. From this distribution key risk numbers such as value at risk are derived.

The above approach and its application to hydro power plants will be discussed.