Daily storage management of hydroelectric facilities

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***Abstract*—This work presents a management procedure for hydroelectric facilities with daily storage. The water storage gives an additional degree of freedom allowing to shift in time power production when it is more convenient and to work at the maximum efficiency of hydraulic turbine. The management is optimized by coupling two different approaches: Mixed Integer Linear Programming for short period scheduling and Agent Based model for evaluation over long time. The approach has been applied to a small set of distributed hydroelectric power station assessing the yearly improvement of revenues due to the optimized management. First obtained results are encouraging and show the capability of the method.**

***Index Terms*—Agent Based model, Energy storage, Hydroelectric production, Mixed Integer Linear Programming**

I. Power production scheduling

Renewable energy production must seek the maximum in exploitation of primary source and in economical revenue coming from energy trading to the electrical grid. Hydroelectric plants with daily water reservoir can implement a strategy to fulfill both targets. The outline of the plant is reported in figure 1.

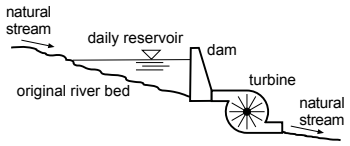

Fig. 1. Run of the river hydroelectric plant with daily reservoir.

The maximization of the economic revenue from the power plant can be obtained by: producing power in the time of the day when its price is more convenient and keeping the turbine working at its maximum efficiency point.

Under the assumption that river water flow is constant in each month, the following constraints are considered:

- maximum capacity of the storage reservoir;
- efficiency curve of the hydro-turbine which has its maximum point around 80% of the rated power;
- market price profile of energy sold to the network taken from the Italian energy market [1];

The optimization is performed by a hybrid approach: optimal daily schedule (short period) is performed by means of a Mixed-Integer-Linear-Programming (MILP) procedure maximizing production revenues under a time-varying energy price profile [2]. The optimal power production profile got from MILP is then used to form the interaction rules of agents which can be used inside an Agent-Based Model (ABM) [3] to simulate a long time period of the power production. In this way it is possible to get information about different periods of the years which could be virtually impossible by applying MILP approach to the whole year scheduling. The procedure has been applied on a set of small hydroelectric facilities working on alpine rivers of the North-Western part of Italy. It can be seen that:

- increase in production and revenues are small or null in the months of larger water flow, May and November, due to abundance of water flow for the whole day;
- in months of lower water flow, the optimal management of daily water can lead to increases of about 7% with respect to a conventional management;
- globally over the whole year the economical gain is of 5.46%.

Results, even if of limited validity, show the capabilities of the approach that will be applied to larger energy systems.

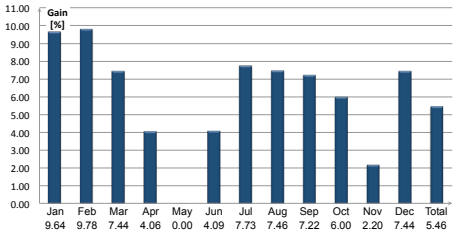

Fig. 2. Relative revenue gain (%) wrt conventional management.

References

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[3] Emile J. L. CHAPPIN, Simulating Energy Transitions, PhD Thesis, Delft University of Technology, 2011, Delft, the Netherlands.