Chapter 4

Hydropower Projects within a Municipal Water Supply System: Optimum Allocation and Management using Harmony Search

Ioannis Kougias  
Aristotle University of Thessaloniki, Greece

Thomas Patsialis  
Aristotle University of Thessaloniki, Greece

Nicolaos Theodossiou  
Aristotle University of Thessaloniki, Greece

Jacques Ganoulis  
Aristotle University of Thessaloniki, Greece

ABSTRACT

The interest of those involved in hydroelectricity has been attracted by mini-hydro projects due to their minimal environmental impact and low installation cost. Besides, mini hydros can cooperate with an impressively wide extent of water-related infrastructure, offering a broad potential for investment. In the present chapter, the integrated solution of hydro implementation in water supply systems is presented. Thus, the benefits of a water-supply installation (with constant Q) are extended to energy production. However, defining the optimum operation of such a project is a complicated task, which may involve environmental, hydraulic, technical, and economical parameters. In the present chapter a novel approach is presented, the optimum management of mini hydros in a water supply system with the use of an optimization algorithm (i.e. Harmony Search Algorithm [HAS]). This approach is applied at a site in Northern Greece and is used as a case study of the present chapter.

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INTRODUCTION

Increasing the non-polluting, renewable energy production is an important aim, for most of the countries, worldwide. European Union (Green Paper, 2001) policy is further emphasized in the “Green Paper” towards a European strategy for sustainable, secure energy supply. The “Green Paper” underlines the potential of hydroelectricity to play a much larger role in both the economy and the energy balance.

Fluctuations in hydroelectricity have a considerable impact on some countries, since they lead to increased coal consumption. The most susceptible to these fluctuations countries in EU are Austria, Sweden, Portugal, Finland, Italy, France and Spain. Large and medium – scale hydroelectric projects rely on hydrological regimes, depending on the seasonal fluctuation. The proposed method, the installation of mini – scale hydros in water networks with a constant flow, answers to the need for stabilization of the energy supply. Besides, recent studies have shown that small scale projects (mini, micro) are the only sector with any prospect in European Union. Furthermore, small hydro established in water systems, has the advantage to exploit the presence of an existing project, reducing construction costs, environmental costs and adds a new environmental and friendly use at the original project, which is the water supply system.

In the present chapter the definition of the optimum capacity and location of mini-scale hydroelectric projects in the presented area, is calculated with the use of Harmony Search Algorithm (HSA). At first glance placing the projects in the existing Break Pressure Tanks (BPT’s), as showed in Figure 1, reduces significantly the construction cost. Hydro units, as a rule, are installed where pressure is released from water lines. However, the created HSA algorithm will investigate the possibility of other alternatives as well. All the technical, economic and environmental data have been included in the created HSA-model in detail.

BACKGROUND

Hydroelectricity as a Renewable Energy Source

Large – scale hydroelectric plants have as a rule enormous size, having a generating capacity up to several hundreds of MW and supply 20% of the energy balance.

Figure 1. Hydropower generation in the break pressure tank (BPT)
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