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Water and energy saving in urban water systems: the ALADIN project

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Abstract

The ALADIN project was aimed at contributing to environmental and energy sustainability of the urban water system by means of a decision support tool able to allow an evaluation of the energy impact related to each different macro-sectors of urban water cycle highlighting the main energy flows and to assess the system energy balance and identify the possible energy-efficient solutions. Moreover the tool suggests the most efficient actions in reducing water losses. In the present paper the main features of the developed tool are presented.

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Keywords: energy saving; urban water systems; water saving; performance indicators; monitoring; decision support system

1. Introduction

Energy cost represents about the 35% of the operating costs for water utilities and this share is expected to increase due to population growth and tightening drinking water regulations. Energy is needed in every phase of water use, from extraction through conveyance, treatment, use, and disposal (Fig. 1) [1]. The amount of energy consumed is

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strictly related to water system location, resources availability and quality, area topography, supply network topology, and water and wastewater treatments. If freshwater resource is not available and desalination is considered as alternative [2, 3], the energy intensity, expressed as energy per cubic meter of water, can run up to 15 kWh/m^3, as reported in Nogueira Vilanova and Perrella Balestieri [4].

It is widely known that the presence of water losses affects the amount of energy required to supply water. Namely, the water volumes supplied to the network are greater respect to the actual users demand due to leakages, consequently pumps are oversized and a proportional energy waste occurs [5, 6]. Since the pumping cost is considered one of the major operational cost and even a small overall increase in pumping efficiency may result in significant cost savings [7-9], water losses reduction allows to achieve two goals: the water and energy saving.

The EU [10] as well as academia and water industries have shown interest in investigating water-energy interaction [11] as well as greenhouse gas (GHG) emissions [12-15] in the urban water system. Understanding such relationship is an important issue to reach a sustainable and cost effective water management. Several studies have been already carried out in Australia [16, 17] and United States [18-20], but still an integrated approach is needed to improve the energy management in such complex systems [1, 2].

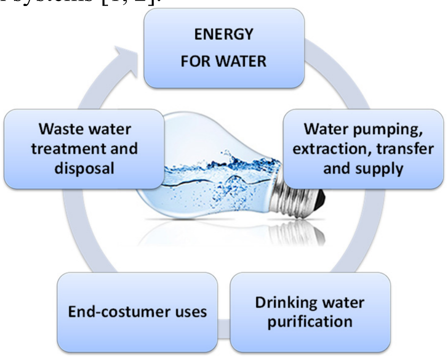

Fig. 1 Energy consumptions in integrated water systems

It is well-known that the urban water system management presents several problems due to the extension of the water supply networks, the difficulty in monitoring every point of the system, as well as the multiplicity and variety of water and wastewater treatment plants. Moreover, only overall energy consumption is usually available and its allocation to the system sections is hardly to accomplish. As consequence, the water service management focused on water and energy saving, is difficult to achieve. To overcome such difficulties, identifying the energy impacts associated to each macro-area of urban water system and analysing the potential interactions between them are essential requirements. Afterwards several water and energy saving strategies, in terms of system design, operation and maintenance, should be evaluated according to the existing interactions between water losses, energy consumptions and GHG emissions. Namely, the active control of water losses can lower the energy consumption [6], the use of renewable energy sources can cut the GHG emission amount [21-23] and the adoption of a suitable energy tariff can further reduce the energy cost [21].

In order to face with the water and energy saving issues in the urban water systems, the ALADIN project aimed to develop a decision support tool able to identify each contribution to the water and energy balance relating to the whole system and to suggest strategies finalized to the energy and water losses management improvement. The energy allocation contributes to find the most energy-intensive areas of the system for which several actions are proposed. Due to the existing interactions between water losses, energy and GHG emissions, the identification of reliable strategies requires a multi-criteria analysis able to outline the possible actions and energy conservation measures without negatively affecting the system hydraulic performance or water quality.

In the present paper the basic features of the abovementioned tool are provided in section 2 where the ALADIN prototype is described. Following the hydraulic modelling and monitoring data management into the prototype in section 3, and the decision support tool based on multi-criteria procedure in section 4 and finally conclusions are presented.

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