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Nexus water energy for hotel sector efficiency

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Abstract

Five and four stars' hotels to guarantee high comfort and quality of their services lead to high energy and water consumption per user. A great part of it is for the guests´ baths which include a great energy expenditure for hot water production, pumping and distribution. Efficient showers installation entail at the building level to the decrease of water use and of the energy for its heating and distribution. At the urban level the decrease of the water consumption implies also the energy reduction needed for its abstraction, treatment, pumping and distribution and also for sewage pumping and treatment. This study encompass the measurement of the energy consumption associated with the water use (including pressurization, recirculation, storage and heating), and the laboratory assessment of the hydric efficiency of different showers from the hotels under study and a simplified methodology to assess the nexus between water and energy. It also includes the study of the relation between the consumption and the installation's features depicting the respective models. It was concluded: 1) is essential to increase the showers' hydric efficiency to decrease the energy consumption by each hotel user; 2) there is no linear relation between the water and energy consumption; 3) in the pumping and in the thermal insulation pipes there is a potential of improvement of the energy efficiency to effectively diminish the carbon footprint and the building vulnerabilities under climate changes.

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1. Introduction

Water and energy are essential resources for the Communities. However, water is under increasing pressure from the continuous growth in demand for all purposes, being imperative it's sustainable use [1]. The increasing use of

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fossil energy lead to unsustainable Green House Gas emissions, being building sector currently considered a high energy consumer and consequently producer of great amount of CO_2. Nevertheless, the importance of the building sector in achieving carbon savings is amply illustrated by the analysis of the Intergovernmental Panel on Climate Changes [2]. Currently energy and water are considered scares resources being imperative to promote its efficient use as a strategy of adaptation and mitigation to climate changes, assuring a sustainable quality of the population life and the normal development of economic activities. This strategy is depicted in the Portuguese Policy for the efficient use of water [3], in the national and European plan of energy efficiency promotion [4, 5], and in the National Strategy to Adaptation and Mitigation to Climatic Changes [6]. At the environmental level the higher water consumption lead to higher waste water production and consequently to more energy needs for its transport and treatment could be avoided.

In Portugal, during 2000 the water demand was about $7500\times10^6 m^3$/year. By sector, agriculture appears as the biggest user (representing 87% of total consumption), while the supply to the urban usage represents 8% of total consumption. The sector with the lowest water consumption is the industry, which corresponds to 5% of total consumption [3]. In 2012 the Final Energy Consumption in Portugal achieved 15.591 ktep (239 ktep in electricity), being 32.5% consumed in the industry sector, 35.7% in transports, 17% in the domestic sector, 12% in the services sector and 2.6% in agriculture and fishery [7]. However, not all water abstracted is effectively applied, because there is a significant portion associated with losses and inefficient use. It is estimated that losses could represent approximately 40% of abstracted water, which also imply that there is an important fraction of energy that is consumed without need representing both great losses and cost [8].

In the hotel sector buildings are high energy and water consumers per capita, namely the four and five stars' hotels due to the required high comfort standards. In Lisbon and Algarve they could have energy consumption of 10 to 100 kWhpe/(guest.night) and water consumption of 50 to 2000 l/(guest.night), compared with 3 to 4 kWhpe/(person.night) and 100 to 150 l/(person.night) at homes [9]. However, hotels present a great potential of water and energy conservation.

National policies and building's energy legal regulations include few synergies to maximize both the water and energy efficiency. For instance, Portuguese technical regulations deal water and energy efficiency independently [10, 11, 12]. Only recently, buildings energy certification scheme [11, 13] encouraged the use of efficient showers with hydric label A, A+ or A++ [14], reducing hot water needs. International environmental certification systems of buildings (e.g. BREEAM and LEED) usually gives incentives for the efficient use of those resources even so considering them inserted in different fields (energy and water), also without any synergy between them. So, in spite of the consciousness of the real nexus between water and energy consumption it is not really considered neither in the technical rules neither in the sustainability assessment systems. This paper is outlined in more 4 sections and in section 2 it is explained the methodology that is applied to identify the nexus between water, energy and the efficient use of resources. This methodology is applied to a sample of 4 and 5 stars' [15] hotels aiming to show the relevance of that relation for the critical factors of those buildings' performance.

2. Methodology

2.1. Relation between water and energy consumption in the hotel sector

Water supply in hotels are required for personal and sanitary hygiene, cooking and washing activities, laundries, swimming pools, spas, sport areas, drinking water, interior and exterior irrigation, etc. Beyond this, water also can be used as a heat transfer mean (heat or cold) in air conditioning systems and in heating plants, in which the water consumption is minimum.

At the building level the domestic water network is usually composed by a cold and a hot water branches, were those circuits are in almost all the cases open circuits with hot water recirculation. In the air conditioning systems and in the heating plants or other heat distribution systems the circuit is closed.

Applying the conservation principle of mass and energy to a permanent flow of incompressible liquid between two sections of the water system the Bernoulli equation is obtained (1) [16], that relates the pressure, kinematic energy, potential energy, friction losses (h_f and h_m) and pump energy (h_p). The loss of water pressure along the pipe system (h_f) can be determined by expression (2). The Darcy coefficient (f) for a completely rough turbulent flow, typical in such networks, depends on the systems' relative roughness (ε/D in expression 3), while in the transition zone depends