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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.

Keywords: Hidric; energy;decrease; four and five stars'; hotels

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 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 on the Reynolds number ($Re_D=v.D/\upsilon$) and from pipes' relative roughness. Beyond the pressure losses in pipes other local pressure losses in pipe connections, changes of directions, valves and sections changes (h_m) can occur, that could be overcame by work applied by pumps (h_p). Applying the energy conservation principle, the energy variation in the system (dE/dt) is equal to the sum of the heat gains ($\dot{Q}$) with the work realized ($\dot{W}$, 5). The mechanical work done by the pump in the fluid is obtained by (6). The electrical energy consumption by the pump is equal to the value of work affected by the efficiency of the group pump and engine (η_p). When there is a temperature difference between the fluid and the ambient a heat transfer occurs that can be obtained by (7) for circular pipes and by (8) for flat surfaces. Due to health reasons, acoustic comfort and corrosion prevention, the average water velocity in pipes is limited between 0.5 and 2 m/s [17] and the pressure losses are usually limited to 100-400 Pa/m.

$$\left(\frac{P}{\rho g}+\frac{v^2}{2g}+z\right)_1=\left(\frac{P}{\rho g}+\frac{v^2}{2g}+z\right)_2+h_f+h_m-h_p \tag{1}$$

$$h_f=f\frac{L}{D}\frac{v^2}{2g}=\frac{\Delta p}{\rho g} \tag{2}$$

$$\frac{1}{f^{1/2}}=-2.0log\frac{\epsilon/D}{3.7} \tag{3}$$

$$h_m=k\frac{v^2}{2g}=\frac{\Delta p}{\rho g} \tag{4}$$

$$\frac{dE}{dt}=\dot{Q}-\dot{W} \tag{5}$$

$$\dot{W}_p=\rho g\dot{V}h_p \tag{6}$$

$$\dot{Q}=L\frac{(T_{env}-T_{fluid})}{\frac{1}{\pi D h_i}+\frac{ln\left(\frac{D+2e_{pipe}}{D}\right)}{2\pi\lambda_{pipe}}+\frac{ln\left(\frac{D+2e_{pipe}+2e_{iso}}{D+2e_{pipe}}\right)}{2\pi\lambda_{iso}}+\frac{1}{\pi\left(D+2e_{pipe}+2e_{iso}\right)h_e}} \tag{7}$$

$$\dot{Q}=L.h\frac{(T_{env}-T_{fluid})}{\frac{1}{h_i}+\sum_i\frac{e_i}{\lambda_i}+\frac{1}{h_e}} \tag{8}$$

In buildings with high water consumption like hotels, a water reservoir exists in the base of the building from which the water is supplied. In the cold water network (Figure 1), to assure a pressure between 0.5 - 3 bar in the devices at the higher level, according to the principle of energy conservation (1), is necessary to provide a pressure no lower than the hydrostatic pressure ($\Delta P=\rho g(z_2-z_1)$) plus the pressure losses due to friction of the water flow. The nexus of booster energy consumption and building water consumption could be obtained by (9). In this expression, was adopted k equal to 350 Pa/m, according to the characteristics of the water piping systems of the hotels under study. The performance of the booster system (η_p) changes with its running point (about 65%).

To assure hot water temperature at devices and reduce the supply time of hot water in each device a recirculation system is installed (Figure 2). The required mechanical energy for this recirculation pump can be calculated by (10).

To heat the water for sanitary purposes it is required thermal energy (11). Due to the extensive pipe length in hotels, it is also required heat to balance the thermal losses in the supply system (12) in which linear heat loss Ψ=0.30 W/(mºC) for piping systems with thermal insulation according to the Portuguese regulation [10] (insulation thickness of 20 mm for pipes with no more than ∅60 mm and water temperature until 65ºC, and insulation thickness of 30 mm for larger diameters); Ψ=0.45 W/(mºC) for pipes insulation with half of that thickness, and Ψ=0.22 W/(mºC) for the double of that value. The total hot water piping length (supply and return) for pressure losses calculation (L_{DHWt}) takes the value of 2x(H+Lx(n.º of floors+1)) in this study, while for the pressure losses (L_{DHWf}) it is adopted the value 2x(H+L) (see Figure 2). The water heating can be done by different systems: renewable energies (as solar panels, biomass boilers), with heat recover systems, with combustion systems (natural gas, propane gas, etc.), heat pumps, being the energy of the support system determined by (13).

$$\dot{W}_{cold}(W)=\left((z_2-z_1)\rho g+1.5kL_{cold}\right)\dot{V}_{cold}/\eta_{p\,cold} \tag{9}$$

$$\dot{W}_{DHW}(W) = 1.5kL_{DHWf} \times \dot{V}_{DHW\,return}/\eta_{p\,DHW} \tag{10}$$

$$\dot{Q}_{DHW\,consumption}(W) = 4.186 \times 10^6 \times \dot{V}_{DHW}(T_{DHW} - T_{cold}) \tag{11}$$

$$\dot{Q}_{DHW\,losses}(W) = \Psi . L_{DHWt}(T_{DHW} - \overline{T_{env}}) + U \times A_{tank}(T_{DHW} - \overline{T_{env}}) \tag{12}$$

$$\dot{Q}_{DHW\,supply}(W) = (\dot{Q}_{DHW\,consumption} + \dot{Q}_{DHW\,losses} - \dot{Q}_{renewable} - \dot{Q}_{recovery})/\eta_{heat} \tag{13}$$

The thermal energy distribution for large buildings usually is done through closed water circuits. In those circuits the water consumption is almost zero, excluding the losses or ruptures situations. According to this, this water consumption will not be considered in this study. In two of the hotels under study there are open cooling towers and its respective consumptions were taken into account.

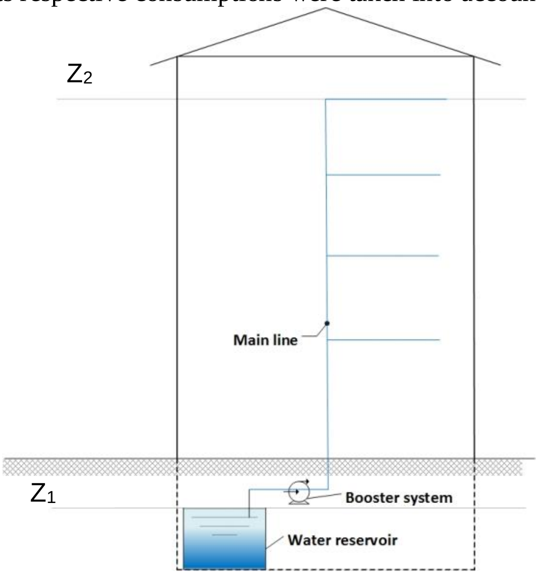


Fig. 1. Cold water supply system with reservoir and booster

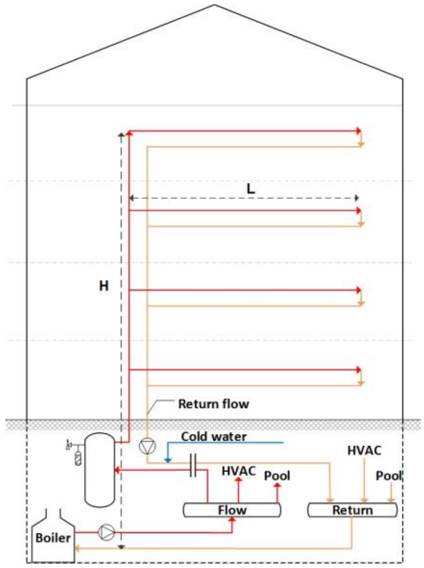


Fig.2. Hot water supply and distribution system

2.2. Water and energy efficiency

The energy balance highlights the relation between the water and energy consumption (eq. 9 and 13). The analysis of the nexus water and energy of hotels (figure 3) is centered in the 15 days' measurement period carried out during the audits that took place in the 2015 summer. Taking into account that great part of water and energy consumption in hotels is due to guests' baths, in section 3 it will be presented the laboratorial analysis of the hydric efficiency of the showers installed in the hotels. In section 4 is detailed the characteristics of each hotel and the respective energy consumption associated with the water consumption. In section 5 the analysis of the nexus water and energy, supported by the systems' assessment and in the relation between the water and energy is done.

3. Water Efficiency in Showers

3.1. Test Methods

In Portugal exists a scheme of water efficiency labelling for products (Figure 4), based on Technical Specifications that define categories of water efficiency and test methods [18]. The scheme was created and is managed by ANQIP (Portuguese Association for Quality in Building Installations).

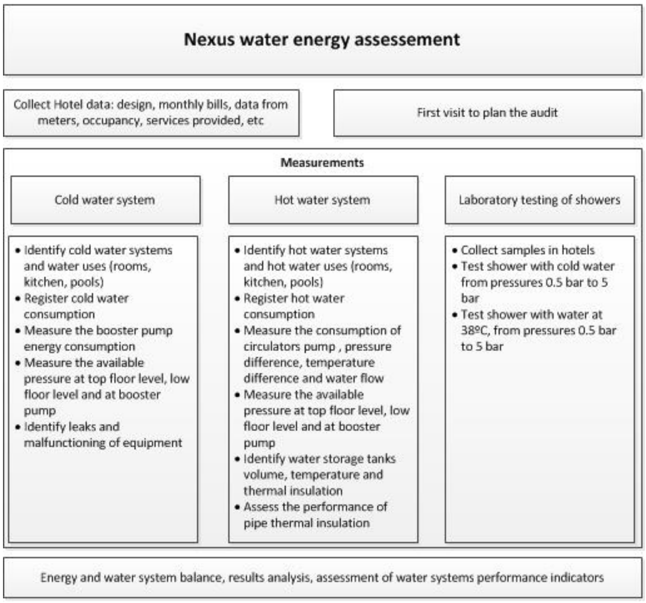
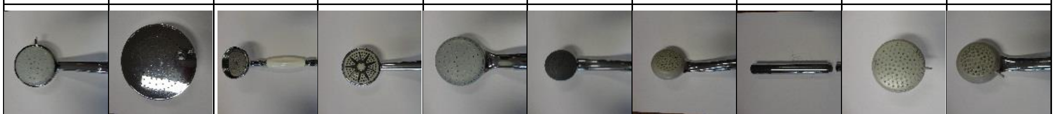


Fig.3. Methodology

Fig.4. Portuguese water efficiency label [18]

The methodology used for water efficiency tests of showers is described in the technical specification ETA 0807 [18], and according with this specification each shower was tested at least 3 times, with a flow meter with 5% of uncertainty. Although this technical specification establishes the measurements of water flow rates at normal temperature of the supply network (considered close to 12°C) and at a fixed residual pressure of 3 bar, the procedure was generalized in order to consider flow measurements with other values of temperatures (hot water temperature at 38°C) and pressures (between 1 and 5 bar), to consider the pressure and temperatures measured at hotels.

The tests involved one sample for each hotel and were conducted for hot and cold water (Figure 5). Beyond this tests each shower was also tested with one commercial reducer in order to evaluate the potential improvement of the water efficiency resulting from the possible application of these equipment.



Nominal values: Cold water/ /Hot water/ /Hydric efficiency class	Hotel A	Hotel B	Hotel C	Hotel D	Hotel D	Hotel E	Hotel F	Hotel G	Hotel I	Hotel I
Without reducer	12.5/11/C	13.5/10/C	17.5/-/B	13/11.5/C	8/8/B	22/17/D	15/13/C	13/11/C	8.1/8.1/B	13/10.5/C
With reducer	8.5/8.5/B	8/7.5/B	7.5/5.5/A	8/7.5/B	7/7/B	10/9.5/C	10/8.2/C	9.3/7.5/C	8.1/7.9/B	9.5/9/C

Fig. 5. Shower models tested (water flow in l/min)

3.2. Tests' results with cold water vs hot water

The analysis of the tests' results shows that, in general, a bit lower flow rates were observed when hot water was used (38ºC). In the case of the Hotel E model, with several plastic elements, the difference is 5 l/min to a pressure of 3 bar (Figure 6a). However, in some models of showers, the difference is not significant and is only visible for higher pressures (Figure 6b, model used in the Hotel I with metallic components). Theoretically, the hot water has a low viscosity which reduces the pressure losses, leading to a greater flow. However, the expansion of interior components of the device due to the temperature rise can cause a reduction in flow sections, reversing the beneficial effect of the reduction of water viscosity.

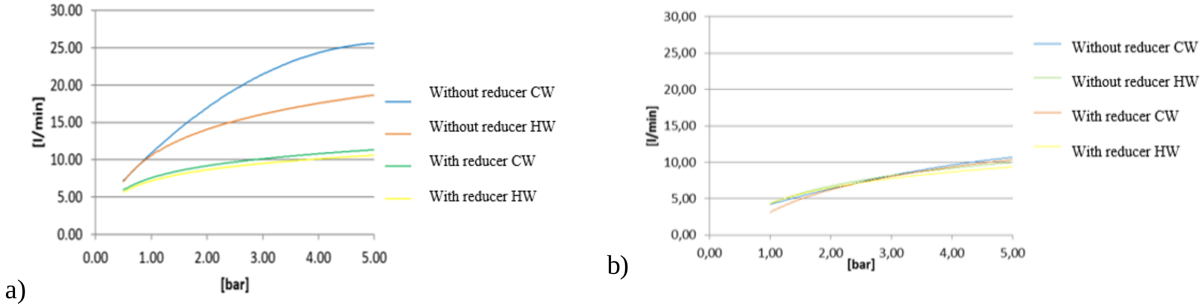


Fig. 6. Results for two showers. a) Model used in the Hotel E; b) Model used in the hotel I

3.3. Effect of reducers application

The effect of reducers application was sensible, either in hot and cold water, on devices with higher flow rates (typically over 10 l/min). In general, the flow rates did not fall below 5 l/min, which is important, since below this value there is a tendency for users to stay longer in the shower, which may reverse the trend of decrease consumption by reducing the flow rate [19]. In the case of the hotel E it is obtained an important reduction in flow rate of 12 l/min for cold water and 6 l/min for hot water with the application of the reducer (fig. 6a), showing the benefit of this devices.

3.4. Analysis of water efficiency

Observing the tests results, it can be concluded that the majority of tested devices have low hydric efficiency. According to the water efficiency labelling scheme of ANQIP, the model used in hotel E would be classified under category D (improving to C with reducer application). The models used in the hotels A, B, D, F, G and I would be classified under category C (keeping the models in the hotels F, G, I in this category even with the application of reducer, and improving the last three to the category B with the reducer). The models used in the hotels I and D belong to the category B (even after applying the proposed reducer) and only the shower model in the hotel C would be classified with the category A with application of the reducer (category B without the reducer). It should be noted that ANQIP considers that the category A is the ideal, even though admit that, in non-private uses, as for example in hotels, can be considered the category B for reasons of hygiene and comfort requirements.

Taking into account the characteristic curves of some devices, it should be noted that the in situ measurements, when there are variations in pressures between 2.5 and 7 bar, can lead to very different flow rates of those obtained with 3 bar, considered as reference values in the testing and certification of water efficiency of products.

4. Water and energy consumption

4.1. Buildings general characteristics

In the present study were analyzed nine hotels of 4 and 5 stars. The hotels A, B, C and D are located in Lisbon while the remaining are placed in Algarve. The hotels have 55 to 300 rooms (Figure 7), with water lift heights ranging from 15 to 55 m. The hotels have heated indoor pools and some also have exterior swimming pools, where the area of swimming pools per rooms ranges from 0.2 to 11 m^2/room, and for the Algarve's hotels this value is always greater than 2.7 m^2/room. The A, B, C and I hotels have laundries with a relevant production, while the remaining do outsourcing and have small laundries for occasional uses. The D, E, F, G, H and I hotels have exterior green spaces with irrigation, which is supplied by a separate line, not being the respective consumptions considered in this analysis. About 44% of the hotels have showers with low water efficiency (see section 3) and only one of them has rainwater recovery system, which during the audit period had no use due to the lack of rainfall. In the hotel I, each of the accommodation units has an electric heater to produce the sanitary hot water, while in the others hotels the water is heated centrally through gas boiler, with hot water storage and a distribution network with circulator pumps (Figure 2). The boilers also provide energy for space heating in winter.

4.2. Booster systems: pressure available and consumption

In the audit it was measured the energy consumption of the booster system (0.7% uncertainty) and the available pressure at fixtures (5% uncertainty), namely in showers in the highest floor, in the first floor and at the booster system level. At the highest floor the available pressure is larger than 3 bar (hotels A, C, E, F and H). Since it is acceptable to have pressures of 1.5 to 2.0 bar in the highest floor, there are potential to reduce the operating pressure of the pump, decreasing their energy consumption, reduce the risk of damage/leakage in pipes and also decrease the water consumption. At the first floor the pressures are normally greater than 4 bar and at the booster system level the pressure is high and consistent with the pressure value in the highest floor plus the reference height of the building (eq. 1). To avoid excessive pressure variation along the building height, could be beneficial to split the distribution system into two pressure zones (upper and lower zone), to ensure more constant and low pressures in taps, with the potential water and energy savings.

In the nine hotels the booster system has an average consumption of 0.8 W/(l/min)/m of lift. An ideal system to ensure 2.0 bar at the highest levels would have a specific power of 0.4 W/(l/min)/m (eq. 9), showing that some booster systems are oversized and has a low average efficiency.

Since the pump energy consumption is proportional to water flow (eq. 9), the pump energy consumption gives also the outline of water use. Despite the variations between hotels, even for hotels of the same type and zone, the highest consumption takes place in the morning (7 am-10 am) in city hotel and in the evening (5 pm-7pm) for beach hotels.

In the audit period, the pumping energy and water consumption per accommodation unit has the values shown in Figure 8. The hotels A and C present a relatively low specific water consumption (less than 300 l/room), while the hotels H and I present consumptions above the average, mainly due to the large areas of swimming pools (see Figure 7). In hotel I the large water consumption per room, is affected by the fact that the accommodation units have 4 occupant's capacity.

4.3. Energy consumption for DHW and circulator pumps

In hotels the hot water for sanitary purposes (DHW) is required for several uses such as kitchens, laundries, rooms, bathrooms, public sanitary facilities, pools and showers.

In summer period, the gas consumption in hotels is mainly for DHW, pools and kitchen uses. Only in one hotel the gas is also used to generate steam for the laundry. According to measurements, the gas consumption in kitchens mainly equipped with gas ovens was 0.11 m^3/(room.day) and in kitchens mainly with electric ovens was 0.04 m^3/(room.day).

The remaining gas consumption (eq. 13) is for DHW use (hot water consumption eq 11, and heat loss, eq.12) that are proportional to hydric efficiency of devices and special uses (pool) as described in the following paragraphs.

In one hotel with a hot water meter the DHW consumption was 150 l/room, about 30% of the hotel total water consumption. In the assessment of water and energy consumption of pools it was made distinction between indoor pools (usually heated) and outdoor pools. The water consumption in pools is due to the compensation of losses by evaporation, the amount of water carried by swimmers and water renewal. In accordance with Directive 23 [20], it must be renewed 30l/person/day, with a minimum value of 2% of the pool volume. It was also included the filter cleaning (minimum of two weekly cycles with, 8 minutes' length), the water used in the pool cleaning and showers.

The hot water distribution system was assessed by visual inspection (pipe size, thermal insulation) and it was also measured the energy consumption and pressure differences of the circulator pumps. In general, the circulator pumps are of constant flow type and in one of the hotels with variable flow pumps the measurements showed also a constant flow operating regime. In the secondary circuit the simplified calculation method to assess the pump energy consumption is reasonable (eq. 10), while in the swimming pools and primary circuits the reliability of simplified method is low due to the singularities of those circuits. Circulator pumps of the secondary circuit have an energy consumption that is half of its nominal power (Figure 9).

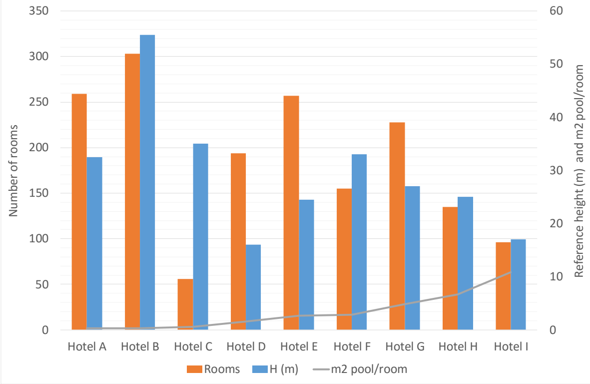


Fig. 7. Hotels features: height, number of hotel rooms and pool area per room

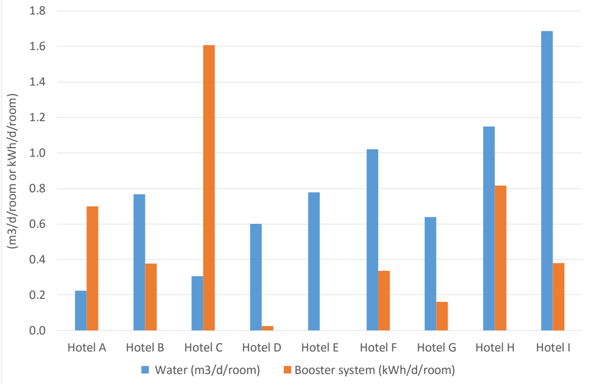


Fig. 8. Booster pumps average daily water and energy consumption

The DHW pipe heat loss was assessed with: i) the measurement of flow rate and temperature difference between supply and return; ii) the measurement of pipe thermal insulation thickness and temperature difference between water and environment (eq. 7). The two methods are consistent for hotels B, E and G (given the uncertainties involved) but result in significant differences in hotels D and H, due to the secondary circuit's length and the uncertainty in temperature difference measurements.

The gas boilers efficiency was measured and for the nine hotels the average efficiency was 94% ± 4%; that is acceptable, despite being lower than the performance of new condensing boilers. In three hotels are installed chiller with heat recovery systems and in one hotel is installed solar collectors. In the hotel I the hot water of the accommodation units is provided with standalone electric water heater, and there are no measurements of these energy consumptions and it is not reflected in the overall balance of this study.

Figures 10 show the primary energy consumption related with the production and distribution of hot water (10 to 30 kWhpe/room). In the hotels, the primary energy consumption related to water is due to the production of hot water (above 40%) and the thermal losses in the distribution network is 13% (20% of energy consumption for DHW) and that depends on the building architecture and system characteristics. In Algarve hotels, because the area of pools per room is quite high, comparing with the Lisbon hotels, energy consumption associated with pool system pumps is responsible for nearly 30% of primary energy consumption of water systems. In hotels F and G, during the measurements, the energy consumption of the heat recovery chiller pumps is higher than the avoided gas consumption, showing the need to improve the control of this subsystem. In the G hotel was proven the benefit of the use of solar radiation for water heating with solar collectors (0.77 m^2 collector/room), where the circulator pump consumption is residual compared with supplied heat.

The primary energy consumption associated with water uses is about 20% of primary energy requirements of buildings in summer. If the water system was improved with efficient pumping systems, condensation boilers, flow restrictors or replacement of fixtures with high water efficiency (showers, faucets, toilets, the equipment of kitchen and other equipment), increase the pipe thermal insulation (double the insulation thickness recommend in RECS-E) and also the improvement of room cleaning procedures, it would be possible to achieve a primary energy demand decrease of 35% and a water consumption decrease of 20% (35% in hot water).

In this energy and water balance, it was deduced the gas consumption for the production of steam to the laundry in the hotel B (1.8 m^3/day/night) and the water supply for cooling towers (30 and 50 l/room/night) in hotels B and F.

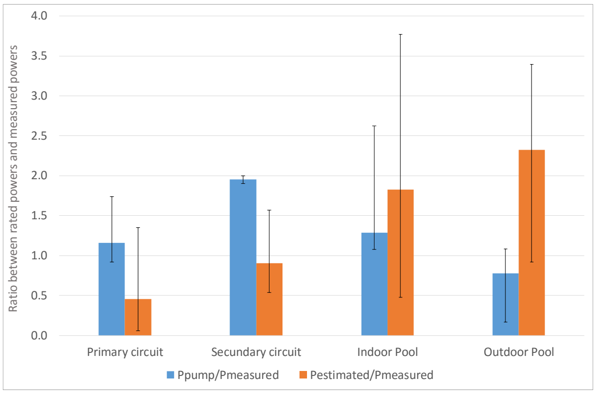


Fig. 9. Circulator pumps

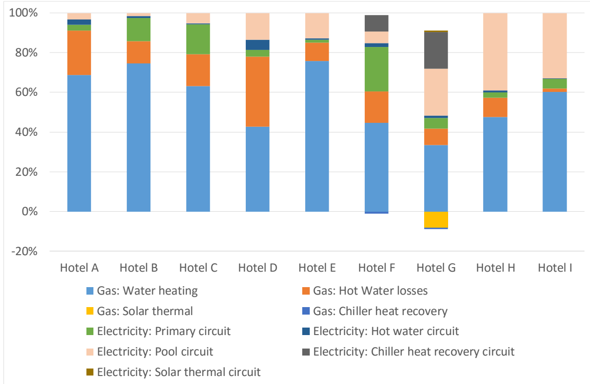
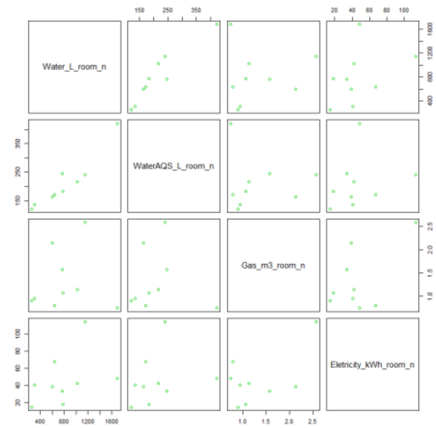


Fig. 10. Hot water production and distribution primary energy disaggregation

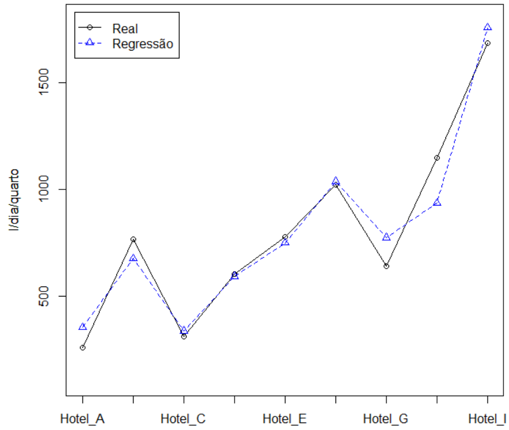
5. Results discussion: Nexus water energy

The measurements and the data that were collected during the hotels' audits permitted to check the estimate quality with the models of section 2. The measurements and the estimate allows the identification of energy and water inefficiencies, regarding the water and energy nexus, as detailed in section 4. Those measurements show that the energy consumption associated with the water use is almost 30% of the primary energy consumption in those buildings during the summer period, and the water consumption for showers is nearly 15% of the total, in the same period.

Given the specificity of each hotel in terms of use, equipment and architecture, a relation between water and energy use is non-linear (Figure 11a). Figure 11b shows the regression analysis of water consumption per room per day, with the independent variables: pools volume, number of occupants, nominal flow of the showers, covers and quantity of laundry, which results R^2 = 0.94, Pearson coefficient 0.97 for 95% confidence interval. Applying the same methodology to study the gas consumption and electricity consumption, also leads to a good regression.



a)



b)

Fig. 11. a) Water vs energy consumption; b) Relation water consumption with independent variables

It was highlighted that a linear relation between water and energy consumption does not exist due to the different architectonic solutions and of the equipment characteristics. However, through the regression analysis it is showed the importance of the hydric efficiency of showers in the water and energy consumption, as well as the other factors like: occupation, length of the hot water supply system, etc. The regression analysis is also a mean of assessment of the experimental analysis of the buildings performance as through the use of the independent variables of section 2 it was possible to estimate with a reasonable degree of correlation the water, gas and electricity consumption (R^2>0.82).

6. Conclusions

This work describes a methodology to assess the nexus water and energy consumption in 4 and 5 stars' hotels. This methodology was applied to the study of 9 Portuguese hotels in summer season when the occupation rates are higher and there is more demanding for the efficient use of resources.

The methodology allows the clear identification of some inefficiencies in booster and circulators pumps, pipe thermal insulation, and water fixtures. The impact of shower in water and energy consumption is large in hotels and it was shown the need to improve the test methodology to cover several pressures and temperatures to highlight the most efficient devices with almost a flat curve (self-regulated devices), that has a water consumption less dependent on user behavior. It was shown that the application of water reduction devices allows to reduce the nominal debts of showers, being a cost-effective measure to be considered in spite of not being so efficient as the most recent showers. Results emphasized that exist a great potential to decrease water and energy use in the hotel sector through the increase of the showers' hydric efficiency as an important measure to adapt to the climatic changes, which can lead to 35% of reduction of the current total consumptions.

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