# Pump away: Estação Viana's experiment reveals a more efficient strategy for chilled water distribution

Estação Viana Shopping

92 shops

Viana do Castelo, Portugal

Energy efficiency

## KEY HIGHLIGHTS

- Sonae Sierra shopping centres mainly rely on primary-secondary hydronic systems for their chilled water distribution. In these arrangements, secondary pumps account for around 70 percent of the total energy requirement for chilled water distribution, and represent up to six percent of total building electricity use.
- Through a detailed analysis, Estação Viana Shopping's team found that energy savings of 30 to 50 percent in these systems could be achieved, giving rise to cost savings ranging from €2,000 to €34,000 a year (with results varying according to the shopping centre's location and size).

## SOLUTION

- Optimize the chilled water distribution system switching from a secondary pumps control based on maintaining a constant differential pressure near or across pumps, to one which uses several pressure transducers located near the most remote heat exchangers.
- Evaluate the viability of replicating this to other shopping centres in different locations and with different sizes.

## KEY NUMBERS

**From 30% to 50%**
achievable energy savings in chilled water systems

**From €2,000 to €34,000**
costs savings per year

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## Abstract

Chilled water distribution demands a significant amount of energy use and typically accounts for around five to ten percent of a shopping centre's total electricity costs. Identifying and implementing strategies to maximise the efficiency of chilled water pumps can therefore generate important cost savings whilst increasing assets' resource resilience.

At **Estação Viana Shopping** in Portugal, the shopping centre management team jointly with corporate operations department piloted a new water pump control strategy and monitored the associated energy use and costs. Through a detailed analysis, they found that energy savings of 30 to 50 percent in these systems could be achieved, giving rise to cost savings ranging from €2,000 to €34,000 a year (with results varying according to the shopping centre's location and size).

The team has now put forward the business case for all large and medium sized Sonae Sierra shopping centres to invest in optimized chilled water pump control.

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## Introduction

Variable speed pumping is nowadays a mature technology in the chilled water distribution systems, allowing significant savings over constant speed pumping and it is a common practice in Sonae Sierra's shopping centres as an effective means of achieving high levels of energy performance.

However, could efficiency be enhanced even further?

**Estação Viana Shopping** jointly with corporate operations department decided to tackle this challenge and improve energy efficiency in the chilled water distribution system, a process that typically accounts for 5% to 10% of shopping centres total electricity consumption. It was also evaluated the methodology applied to assess the viability in other assets with different sizes and climate conditions.

## Background

Sonae Sierra shopping centres mainly rely on primary-secondary hydronic systems for their chilled water distribution.

In these arrangements, secondary pumps account for around 70 percent of the total energy requirement for chilled water distribution, and represent up to six percent of total building electricity use [1].

As a means to increase their efficiency, Sonae Sierra's shopping centres commonly practice variable speed pumping, maintaining a constant differential pressure near or across pumps. However, this approach is sub-optimal because it leads to a higher than necessary pressure, and hence energy wastage.

## Challenge

The team wanted to increase corporate knowledge about variable speed pumping control optimisation, and undertake an experimental study to enable Sonae Sierra to effectively compare the performance of the "conventional control strategy" (based on maintaining a constant differential pressure across pumps) with the "optimised control strategy" (based on maintain a constant differential pressure set-points at the most remote heat exchangers of each branch). The team knew that such an analysis could ultimately bring real benefits to the company and they wanted to evaluate the costs and benefits in terms of investment, energy use, impact on thermal comfort and maintenance issues, and consider the potential implications for Sonae Sierra's wider shopping centre portfolio, including centres with very different physical and geographical profiles compared to that of **Estação Viana Shopping**.

## Solution

The team found a solution by pursuing a two-fold study based on theoretical and experimental analysis.

First of all, they applied a theoretical analysis in order to estimate the annual energy use associated with each control strategy. They investigated chilled water flow requirements on an hourly basis, using the Standard Shopping Centre from Bright ® energy simulation tool. This enabled them to determine the needs for several locations where Sonae Sierra operates. The team then explored the relationships between flow, pressure and absorbed power at different valve position scenarios. For this purpose, a hydronic model of **Estação Viana Shopping** was created using Pipeflo (a hydraulic simulation software).

Secondly, they performed an experimental analysis by monitoring energy use as well as pressure and flow rates over the course of three months using portable energy analysers and data on differential pressure and flow rates supplied by sensors connected to the shopping centre's Building Management System (BMS).

The theoretical analysis at **Estação Viana Shopping** revealed that energy savings ranging from 20 percent in summer to 50 percent in winter could be generated using the optimised control strategy, with an annual average energy efficiency gain of around 35 percent. Energy savings tended to be higher during colder months because when cooling needs (flowrate) are lower, the difference between the two control strategies is higher (Figure 1). Experimental analysis showed that energy savings at the centre were

[1] Average figures based on extensive shopping centre energy audits

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much higher in practice, ranging from 45% to 80%. This difference was thought to be influenced by changes in operational routines between 2016 and 2017, which increased the extent of energy savings (Figure 2).

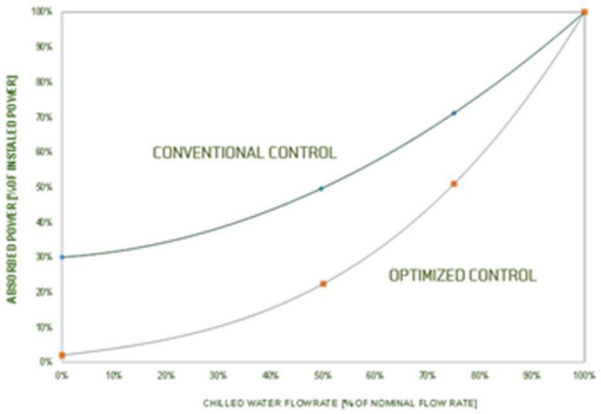


Figure 1- **Power vs. flowrate relationships** associated with each control strategy (source: hydronic simulation)

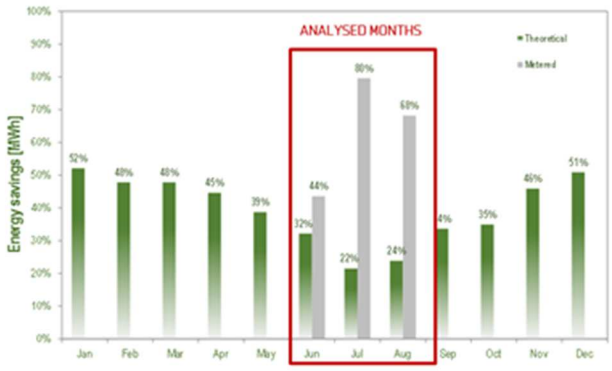


Figure 2- **Theoretical vs Real (metered) energy savings** associated with each control strategy (source: hydronic simulation)

A further positive finding was that thermal comfort was not affected by the control upgrade. Nonetheless, owing to some specific operational factors in **Estação Viana Shopping**, the payback associated with the intervention was not very attractive due to:

- Installed control hardware was not able to accommodate the needs and new controllers were needed (will not be the case for all assets, as it is dependent on the existing hardware)
- There was no BMS maintenance contract prior to this intervention which aggravated the service fees associated with the BMS provider.
- Pressure transducers were initially overestimated, elevating the investment needed.

However the team's analysis of other Sonae Sierra shopping centres proved more exciting in this regard.

Indeed, the **Estação Viana Shopping** team found that theoretical energy savings across the portfolio ranged from 30 percent to 50 percent, with higher potential for energy savings in colder climatic zones. Cost savings could be generated ranging from €2,000 to €34,000 a year, depending on the shopping centre size and location. The level of investment required to upgrade to the optimised control strategy would vary according to the characteristics of the shopping centre's existing control hardware and software, with payback ranging from a couple of weeks in larger centres to a maximum of ten years in smaller centres presenting adverse investment conditions.

## Closure

**Estação Viana Shopping's** management team found that within shopping centre chilled water distribution systems, the energy performance of secondary pumps can be significantly improved by controlling differential pressure at most remote heat exchangers rather than by using differential pressure located at or near the pumps. This can lead to energy savings from 30 to 50 percent in shopping centres, and cost savings of up to €34,000 per annum, with payback times varying from a couple of weeks to a maximum of ten years depending on operational factors.

Their study provides Sonae Sierra with new intelligence on the subject, and enables us to put forward the recommendation that all large shopping centres – and all medium shopping centres with favourable investment conditions – upgrade their secondary pumps control strategy, with smaller centres evaluating the cost benefit on a case-by-case basis.