

# Excessive Energy Consumption in Pool Heating Systems: Optimization Using Solar-Powered Piping

Leandro M. Ludi<sup>1</sup>

*Electromechanical Engineering Department, Facultad Regional Paraná, Universidad Tecnológica Nacional  
1033 Almafuerite Av, Paraná Entre Ríos, Argentina*

<sup>1</sup> leandroluditecnica@gmail.com

**Summary**— Viale is a small town located 57 kilometres to the east of Paraná, Entre Ríos. The problem this work addresses is the inefficiency in heating Viale's sport center pool. The system to heat the pool water has a high monetary cost due to the large amount of gas used, which also causes air pollution. The purpose of this work is to address the problem of the excessive energy consumption in pool heating systems. It also describes and analyses a solution by means of a piping system that operates with solar energy. To achieve this aim, this work is organized as follows. First, the city of Viale is going to be described. Next, the problem of excessive energy consumption in pool heating systems is going to be described. Then, the causes and consequences are going to be analysed. After this, a discussion on solutions to address the problem is going to be take place. Finally, the strengths and weaknesses of the proposal are going to be presented. This project is expected to contribute to the analysis of sustainable solutions to heating systems.

**Key words:** Excessive energy consumption, Solar-powered piping system, Energy efficiency.

**Resumen**— Viale es una pequeña ciudad ubicada a 57 kilómetros al este de Paraná, Entre Ríos. El problema que aborda este trabajo es la ineficiencia en la calefacción de la piscina del centro deportivo de Viale. El sistema para calentar el agua de la piscina tiene un alto costo monetario debido a la gran cantidad de gas que se utiliza, lo cual también causa contaminación del aire. El propósito de este trabajo es abordar el problema del consumo excesivo de energía en los sistemas de calefacción de piscinas. También describe y analiza una solución mediante un sistema de tuberías que opera con energía solar. Para lograr este objetivo, este trabajo se organiza de la siguiente manera. Primero, se describirá la ciudad de Viale. Luego, se describirá el problema del consumo excesivo de energía en los sistemas de calefacción de piscinas. Después, se analizarán las causas y consecuencias. A continuación, se realizará una discusión sobre las soluciones para abordar el problema. Finalmente, se presentarán las fortalezas y debilidades de la propuesta. Se espera que este proyecto contribuya al análisis de soluciones sostenibles para sistemas de calefacción.

**Palabras clave:** Consumo excesivo de energía, Sistema de tubería solar, Eficiencia energética.

## I. INTRODUCTION

Viale is a small town with approximately 12,000 inhabitants. It is located 57 kilometres to the east of Paraná, which is the capital city of Entre Ríos, in Argentina, according to [1].

This city of Viale has a few problems such as streets in bad conditions, neighbourhoods without properly designed

streets and parks with damaged park games. However, the problem this work addresses is the inefficiency in heating Viale's sport center pool. The system to heat the pool water has a high monetary cost due to the large amount of gas used, which also causes air pollution.

The purpose of this work is to address the problem of the excessive energy consumption in pool heating systems in Viale sports center. It also describes and analyses a solution by means of a piping system that operates with solar energy.

To achieve this aim, this work is organized as follows. First, the city of Viale is going to be described. Next, the problem of excessive energy consumption in pool heating systems is going to be described. Then, the causes and consequences are going to be analysed. After this, a discussion on a solution to address the problem is going to be take place. Finally, the strengths and weaknesses of the proposal are going to be presented. This project is expected to contribute to the analysis of sustainable solutions to heating systems.

## II. PROBLEM DEFINITION AND ANALYSIS: EXCESSIVE ENERGY CONSUMPTION IN POOL HEATING SYSTEMS IN VIALE

This section analyses the problem of excessive energy consumption in pool heating systems in Viale, Entre Ríos. To understand this problem, first, it is necessary to describe its context.

### A. Description of the Context

Viale is a city located 57 kilometres away from Paraná. It is a small and beautiful town. There are 12,000 inhabitants living there, as [1] shows.

Fig. 1 indicates where Viale is in relation to Paraná, and Fig. 2 shows a map of the city. The size difference of both places can be recognized and in the distance between them can be seen as well in Fig. 1.



Fig. 1. Location of Viale in relation to Paraná.

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Fig. 2. Map of Viale, Entre Ríos.

As mentioned before, Viale is a small town, but it has five primary schools, three secondary schools, two banks and a bus station. As well as this, it has many stores and local businesses.

Viale also has a sports center. The sports center includes a volleyball court, playgrounds for children, and two pools, one of which is heated. Various water sports are practiced there. Fig. 3 shows a satellite imagen of the sports center.



Fig. 3. Viale sports center.

### B. Problem Statement

In Viale, a city with infrastructure problems, the pool at the sports center is heated inefficiently because it uses a lot of natural gas, as stated in [2]. To heat a pool like this, about 5,853 kW of power are needed, which means it uses around 4,815 cubic meters of natural gas per day.

### C. Description of Scenes that Help Picture the Problematic Situation

Fig. 4 shows a picture of Viale sports center. In the background of the photo there is a lot of vegetation, a soccer field and a cold-water pool. In the middle of the picture is the pool heating system that runs on natural gas.



Fig. 4. Pool heating system.

### D. Identification and analysis of causes or factors that give rise to the problem

There are several causes of the excessive energy consumption in the water heating system of the hot water pool in Viale sports center. This work addresses the main three causes.

Old boilers are not efficient in converting energy into heat. This means they use more energy to heat the pool.

Poor insulation also causes significant heat loss. On the other hand, good insulation helps keep the heat in the water and reduces energy consumption.

Lack of maintenance of the boiler makes it inefficient. This can cause gas or water leaks, and it is very dangerous because there is a risk of explosions.

### E. Identification and Description of the Consequences

There are several consequences of the excessive energy consumption in the water heating system of the hot water pool in Viale sports center. This work addresses only three of them.

The boiler uses too much natural gas to heat the pool. This makes the water heating process expensive.

The operation of the boiler also increases the emissions of greenhouse gases. These gases, contribute to climate change.

Apart from this, when heat is lost, the boiler has to work harder to keep the water hot. This uses more energy than necessary.

## III. THE WAY FORWARD: OPTIMIZATION USING SOLAR ENERGY

The problem of excessive energy consumption in pool heating systems in the city of Viale is especially important because there is a lot of loss of resources, in this case, gas. For this reason, the next section shows the steps to address this problem.

### A. Problem Approach

The system uses solar energy to heat the water and keep the pool at a comfortable temperature without excessive use of gas. This type of system is ideal for areas with good sun exposure because it significantly reduces energy costs.

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Black PVC (polyvinyl chloride) pipes are installed because they can absorb the sun's heat more effectively, as [3] shows. These pipes are exposed to the sun on the roof to maximize solar capture. Black PVC is especially efficient because it absorbs sunlight, heating up the material. Fig. 5 shows the piping system, in this case, they are in the form of coils.



Fig. 5. Piping system

As for the operation of this system, it has a pump that takes cold water from the pool and sends it through pipes on the roof, as stated in [4]. As the water flows through these sun exposed pipes, the heat absorbed by the PVC pipes transfers to the water. At the end of this pipe section, a sensor measures the water temperature. If the water temperature is already in the desired range, it goes directly back to the pool, bypassing the boiler. If the water has not reached the target temperature after passing through the pipes, it is directed to the boiler for extra heating. Once the water has gone through the boiler (because it is needed) and reaches the ideal temperature, it is sent back to the pool through a return pipe. This process repeats continuously while the system is on. Fig. 6. shows the path that water takes as described before.

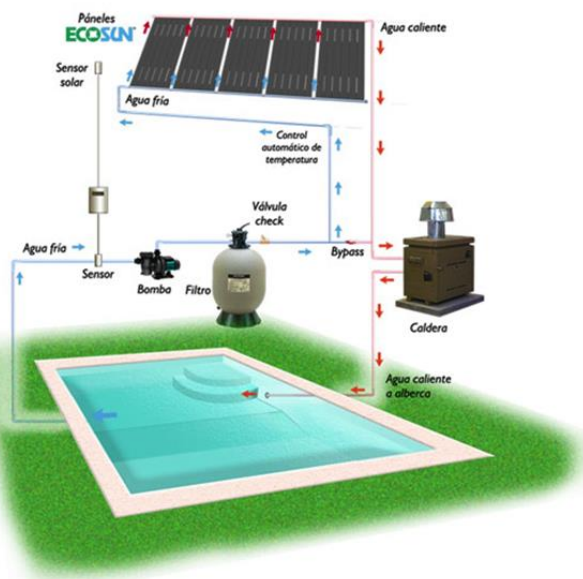


Fig. 6. Water route [4]

### B. Strengths and Weaknesses of the Proposal

This proposal offers several strengths and weaknesses. They are mentioned below.

Using solar energy reduces gas use and heating costs. However, on cloudy or rainy days, the system does not work effectively, according to [2].

The durability of PVC pipes means they need little maintenance, which is a benefit for installing them on roofs. However, for large amounts of water, many pipes are needed, and they require a lot of room on the roof.

The system can be expanded by adding more meters of pipes to increase its heating capacity. However, this expansion can mean extra costs and requires that the roof can support the extra weight.

## IV. CONCLUSION

The system proposed to heat the pool at the sports center in Viale using solar energy is a sustainable and efficient solution. It reduces gas consumption and lowers greenhouse gas emissions. By using PVC pipes, the system takes advantage of solar heat, cutting costs and reducing environmental impact. Although it depends on the weather and needs a large space for installation, it is practical and brings both economic and ecological benefits to the community.

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Leandro Ludi is an Electromechanical Engineering student at UTN FRP: [leandroluditecnica@gmail.com](mailto:leandroluditecnica@gmail.com). Mariana Acebedo is a Civil Engineering student at UTN FRP: [marianaacebedo@alu.frp.utn.edu.ar](mailto:marianaacebedo@alu.frp.utn.edu.ar).

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