

**Master-Thesis Energy and Environment**

# Cold storage with glycerol

Efficient building cooling with thermal energy storage in extreme climates such as Texas

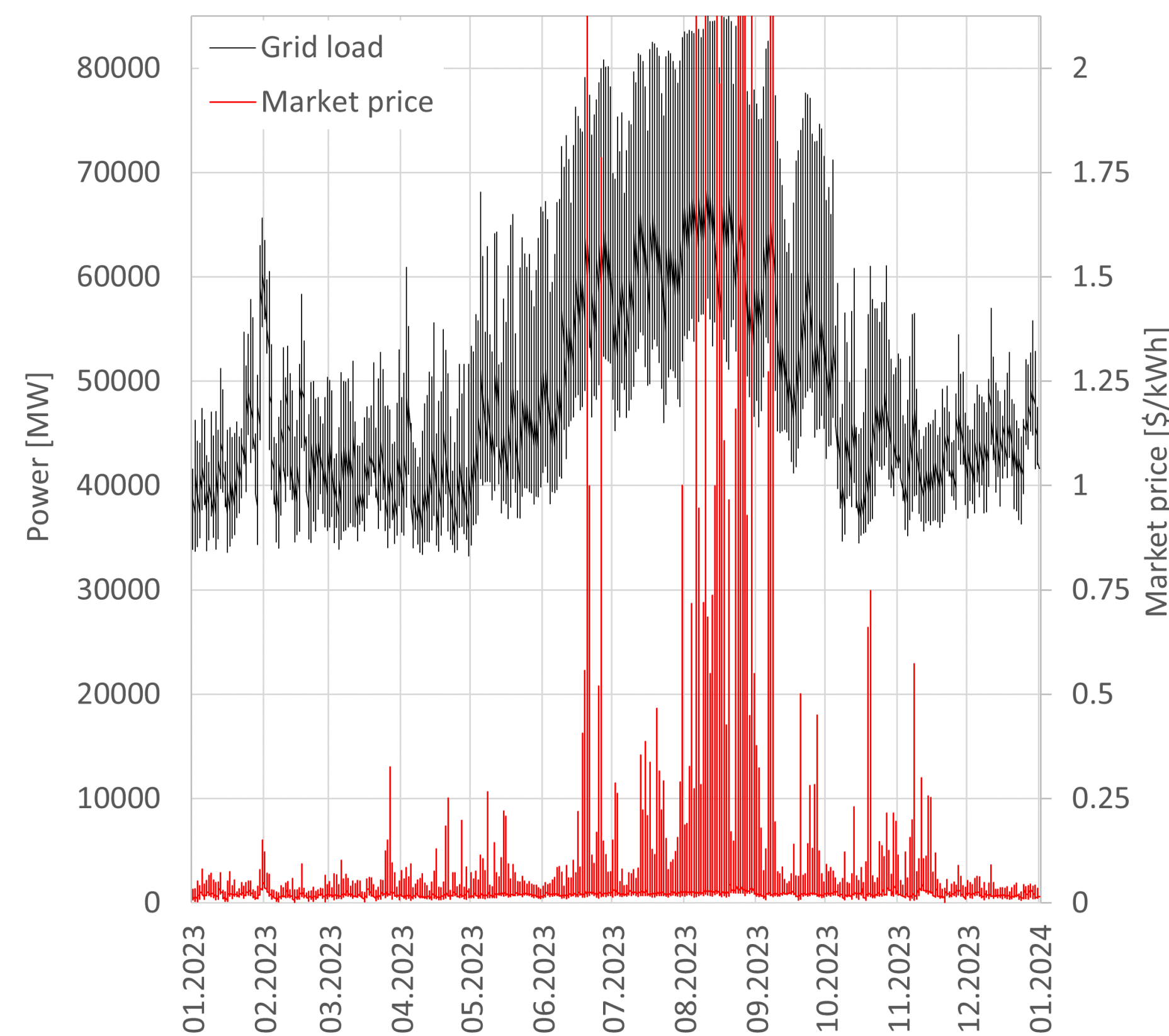


Figure 1: Grid load and electricity market prices in Houston, 2023

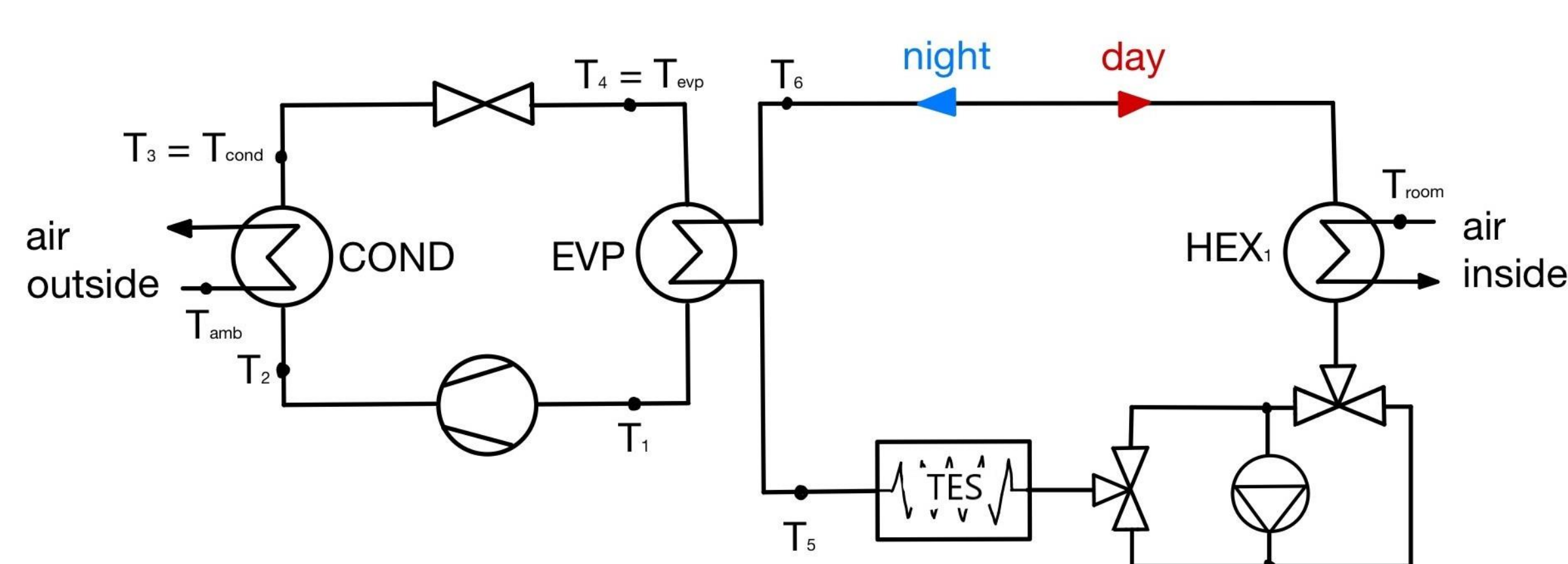


Figure 2: Integration of the thermal energy storage (TES) into the cooling circuit

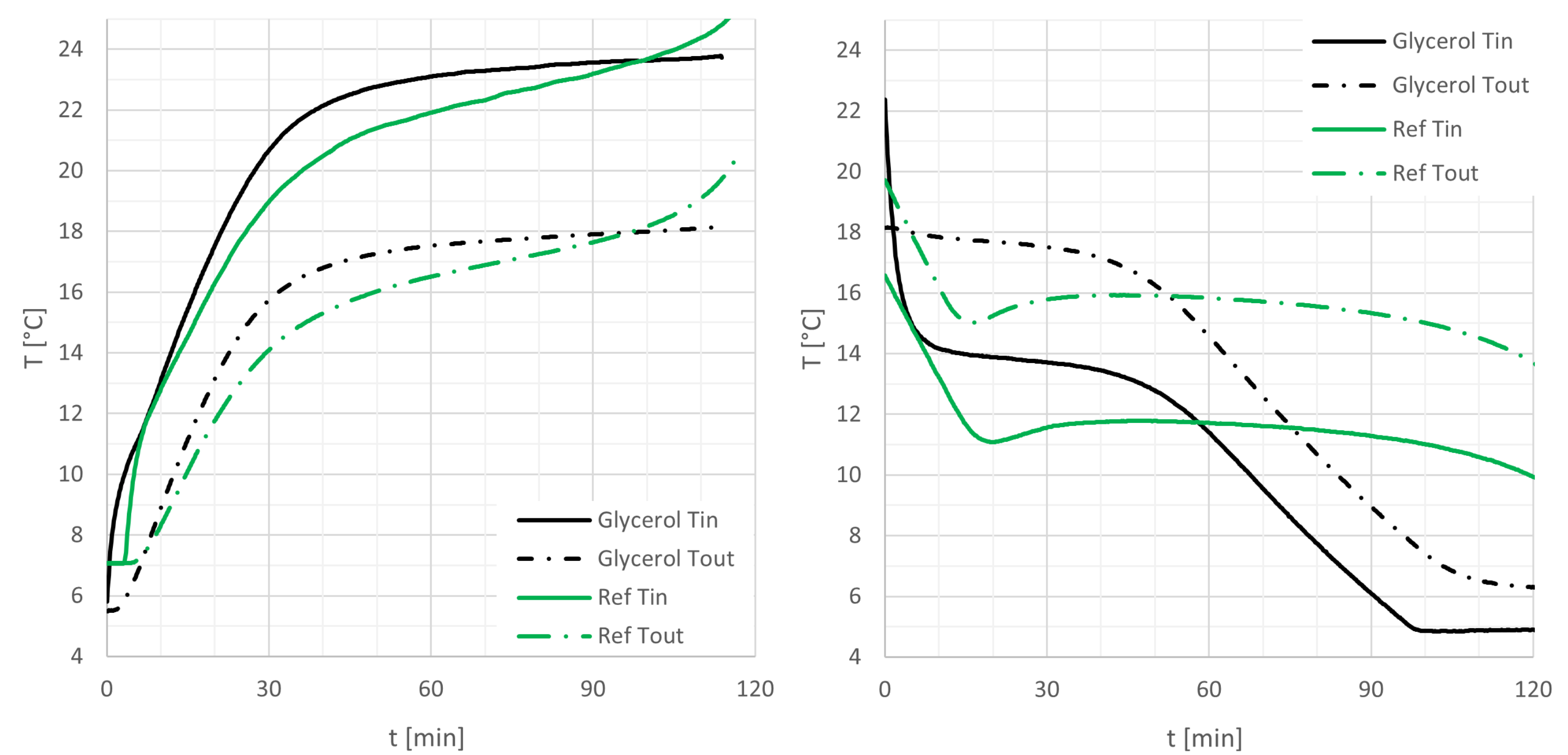


Figure 4: Measured values of the inlet and outlet temperature of the heat transfer fluid of both storage tanks. Melting left, freezing right.

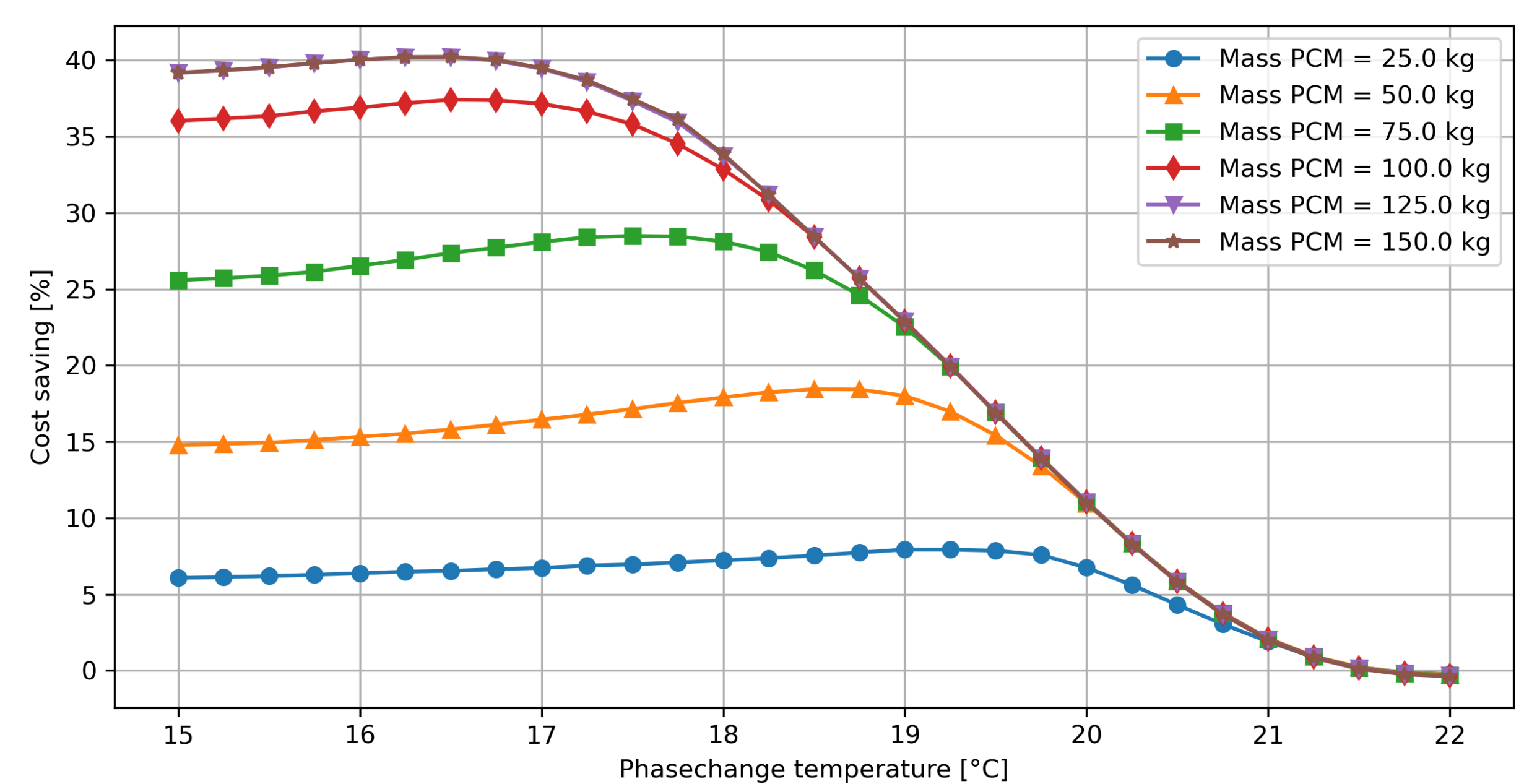


Figure 3: Influence of the phase change temperature and the mass of glycerol on operating cost

## Introduction

In extreme climate zones such as Texas, air conditioning (AC) is indispensable. However, this leads to high electricity consumption, with AC accounting for around half of electricity consumption in buildings in Texas during the summer months. The fluctuating demand, with a peak in the afternoon, puts a heavy load on the electricity grid, which also has an impact on electricity market prices as shown in Fig. 1. The grid operator ERCOT, which is responsible for 90 % of the electricity load in Texas, has been responding since 2019 by integrating battery storage into the electricity grid.

## Proposed solution

In this work, the integration of a thermal energy storage (TES) into the cooling system is proposed (Fig. 2). The storage unit is charged during the night when outside temperatures and electricity prices are low and supports the chiller in the afternoon. On one hand, this reduces the load on the electricity grid and, on the other, increases the efficiency of the chiller as the temperature lift is reduced.

In order to achieve a high energy density, a latent heat storage with glycerine as storage material is proposed. Glycerine is a by-product of biodiesel production, making it cheap and available in large quantities. It is harmless to humans and the environment and has excellent thermal properties. However, the material is very difficult to crystallise, which is why no energy storage using glycerine has yet been realised anywhere in the world.

## Procedure

The integration of a thermal energy storage (TES) for a small building in Houston during the summer months of June, July and August is simulated using Python. The optimal design of the storage system is determined. In addition, two prototypes of the storage tanks are built and filled with different materials, including glycerine. The storage units are then tested with a cycling setup to analyse their performance and efficiency.

## Result

The simulation shows that the use of a storage 80 litres of glycerine can reduce energy consumption by 5 % and operating costs by 30 % during the summer months, see Fig. 3. Both prototypes were successfully tested in the laboratory, including for the first time a storage tank with glycerine as a phase change material. The measurements show the potential of glycerine, but the charging power still drops relatively quickly compared to the reference storage, as shown in Fig. 4. Progress in materials research can minimise this effect.

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