Swapping hot water tank with PCM thermal battery to cut gas consumption: NYSERDA house

New York house swaps an indirect tank heated by a gas boiler with a Phase Change Material (PCM) thermal battery for cleaner and more efficient domestic hot water

Introduction:

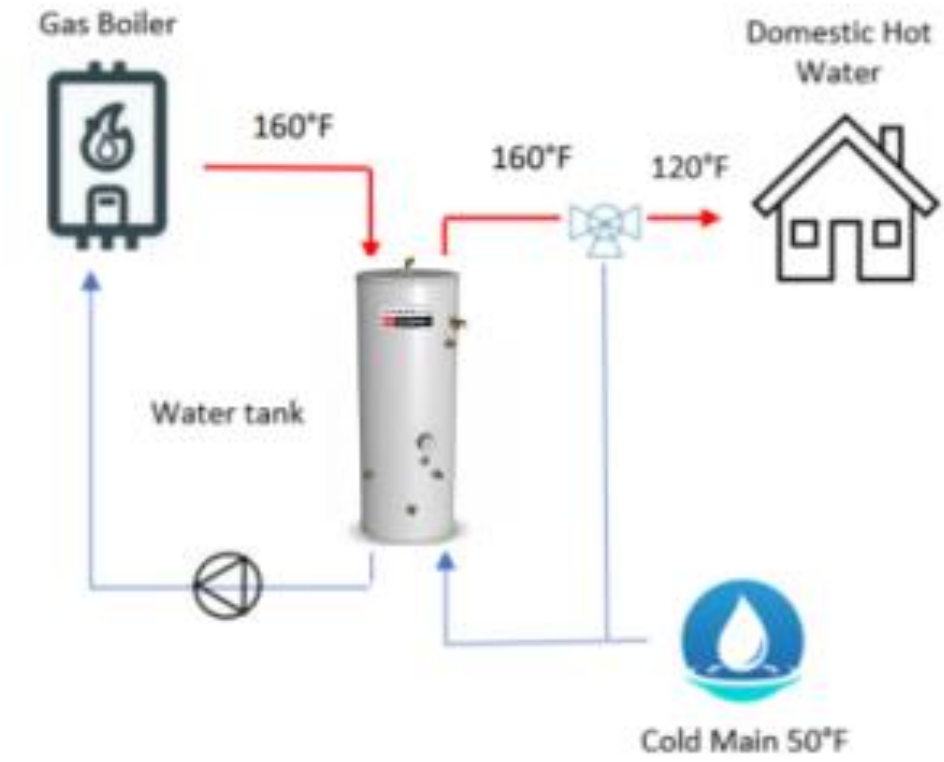
New York State Energy Research & Development Authority's (NYSERDA) Next Gen Buildings program seeks to accelerate the development and commercialization of innovative solutions that enable electrification and decarbonisation of building stock in the state of New York.

The Challenge:

Albany homeowner wanted to replace their indirect tank in their single 3 person occupancy house, which was heated by a gas boiler, to reduce gas consumption as well as improve boiler efficiency. They needed a solution to be as reliable as their hot water tank but also a lot more sustainable and kinder to the planet.

Existing system

A gas-fired boiler and a 40 gallons tank

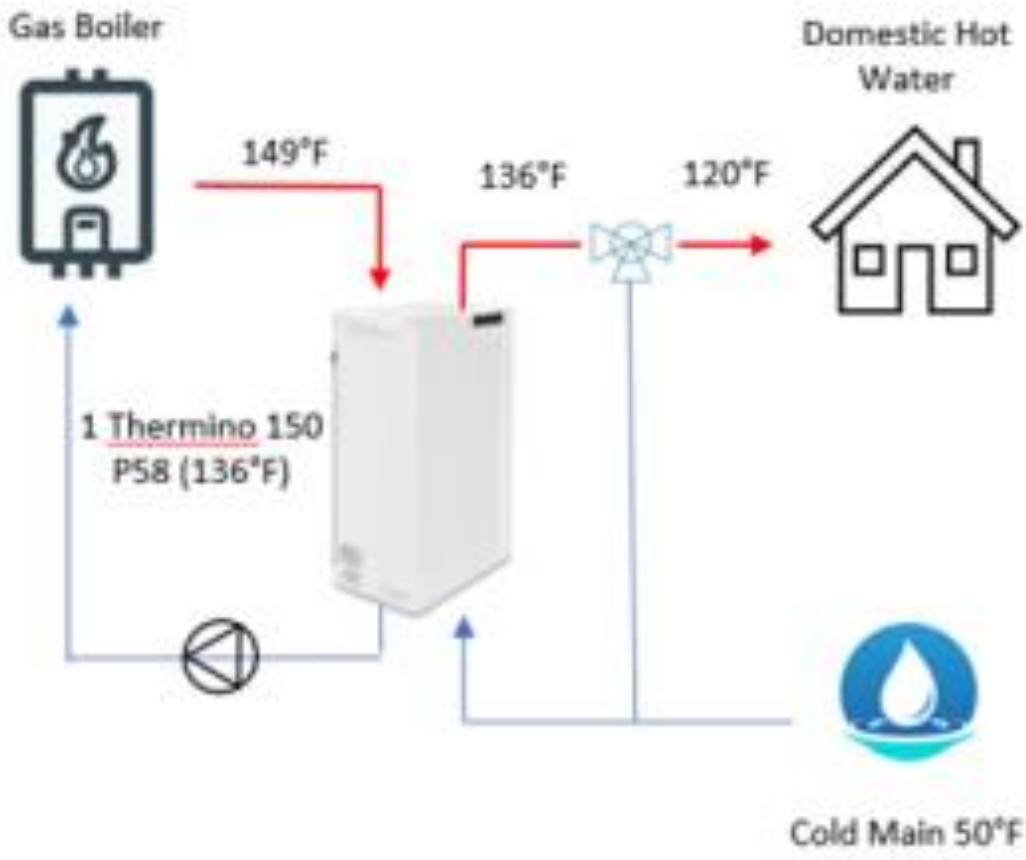


The Solution:

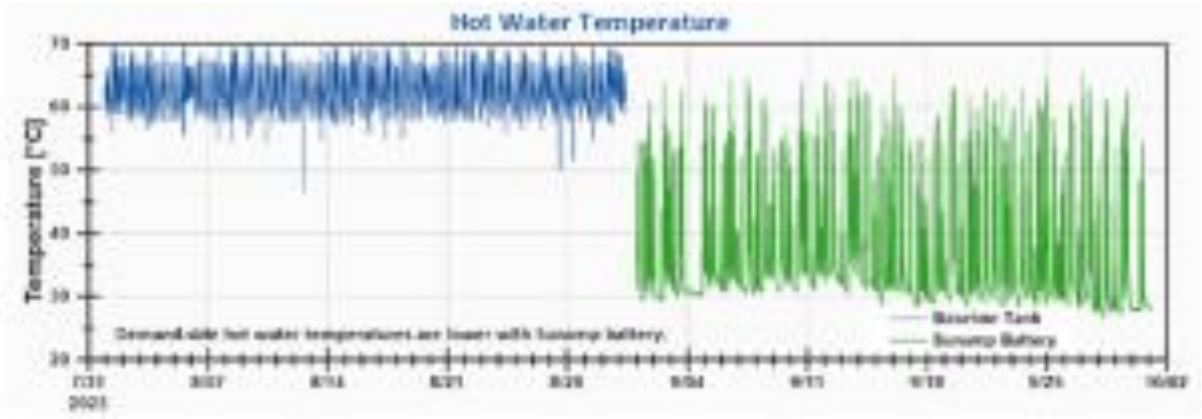
The homeowner paired up with NYSERDA and joined the Next Gen Buildings program which aims to help New York State achieve a carbon neutral economy by supporting building innovations that enable buildings to be cleaner, more energy efficient, load flexible, and resilient. The goal is to achieve at least an 85% reduction of greenhouse gases (from a 1990 baseline) by 2050.

The indirect tank was replaced with a PCM heat battery coupled with a variety of existing and new system parts to provide domestic hot water and heating in a more efficient and clean way. The boiler charges the PCM thermal battery – which is 40 gallons (150 litres) equivalent – at a minimum temperature of 149F (65C). The battery stores that heat and releases it for hot water, preventing the boiler from firing up every time there is demand for hot water.

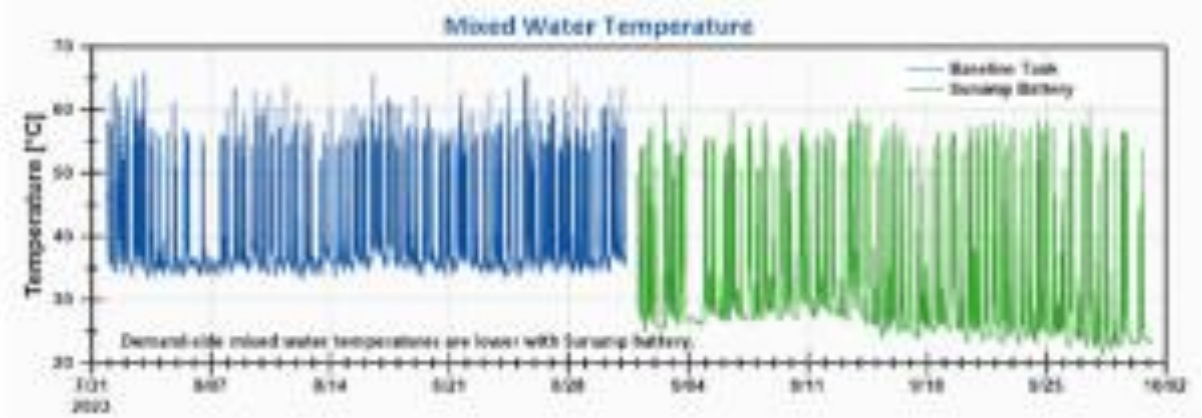
The PCM thermal battery solution



The hot water tank had required a temperature between 140F (60C) and 160F (70C) to keep the water hot (see in blue below); however, the PCM thermal battery only requires a maximum temperature of (140F) to melt the phase change material inside and store the heat to deliver hot water (see in green).

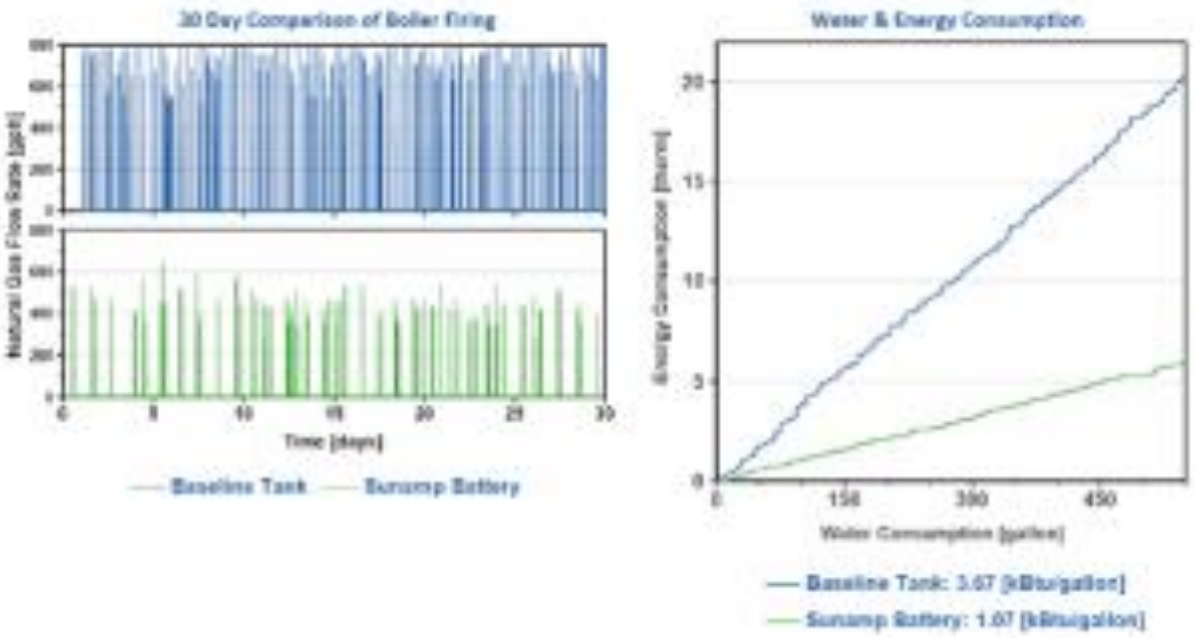


The temperature produced by the boiler was modulated to 140F (60C) after the installation. Domestic water is required at around 122F (50C). Since the PCM thermal battery requires less heat from the boiler to deliver the same temperature, significant energy wastage from the boiler is prevented.



The Benefits:

The homeowners monitored the previous system and the heat battery solution for one month to capture the boiler's activity and water usage profile. The results showed that the tank required the supply of heat every time the water temperature was below 140F (60C), making the boiler fire even when the hot water was not being used. The PCM thermal battery calls for heat only when is it 60% empty and keeps the heat stored in the PCM thermal battery with heat losses much smaller than the tank.



The energy required to heat a litre of water reduced by about 50%

Overall, the homeowners observed that the PCM thermal battery improves the boiler efficiency, reduces gas consumption and increases the boiler's lifespan. The battery also reduces the risk of Legionella because it delivers hot water without storing any water in the unit.

The Impact:

A staggering 50% reduction in gas consumption.

Previous system: National Grid, 2022: September and October, Average therms used: 23.5

Gas Usage

Month	Therms
May 22	55
Jun 22	32
Jul 22	20
Aug 22	20
Sep 22	24
Oct 22	23
Nov 22	38
Dec 22	136
Jan 23	173
Feb 23	198
Mar 23	182
Apr 23	105
May 23	39

Water Tank

The PCM thermal battery solution: National Grid 2023: September and October
Average therms used: 13

Gas Usage	
Month	**Therms**
Oct 22	23
Nov 22	38
Dec 22	136
Jan 23	173
Feb 23	198
Mar 23	182
Apr 23	105
May 23	39
Jun 23	30
Jul 23	19
Aug 23	20
Sep 23	15
Oct 23	11

Sunamp