The use of indirect expansion solar assisted heat pump with latent heat storage in community heating

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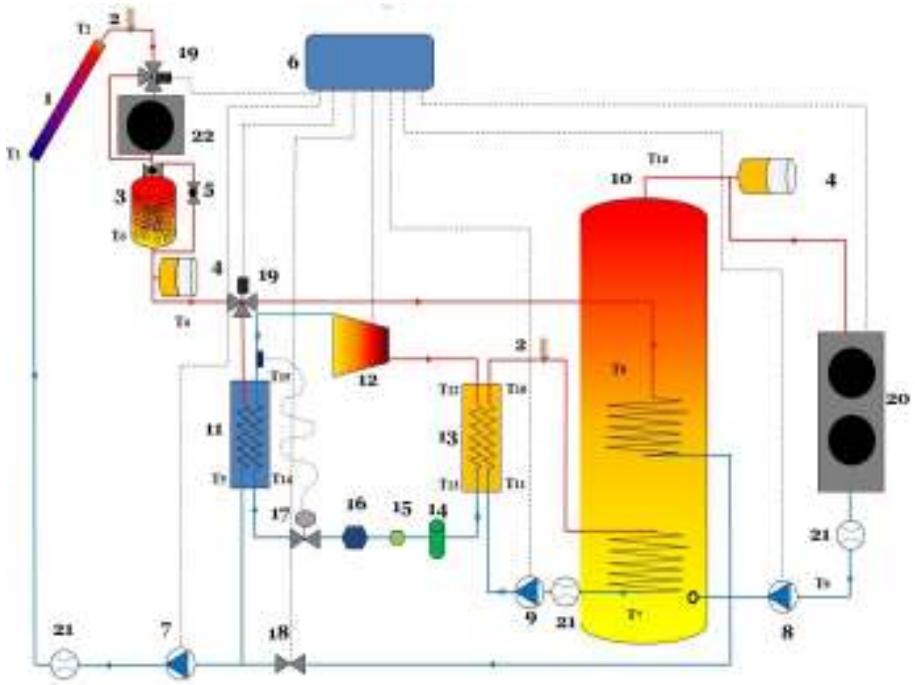
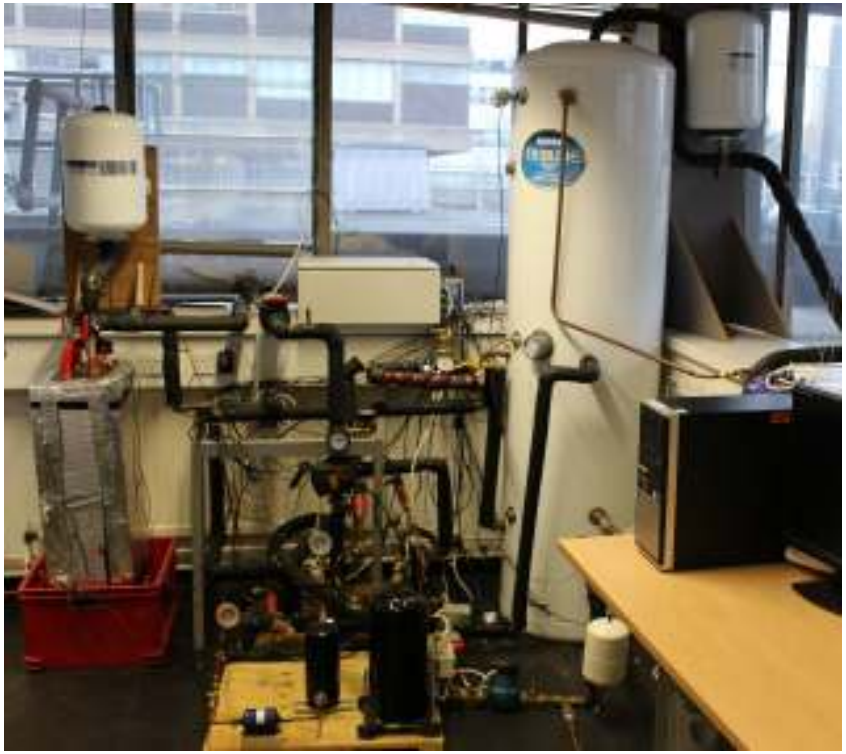
- Test rig description
- PCM Tank
- Study findings
- Challenges
- Conclusion

Community heating and SAHP

Test Rig schematic diagram



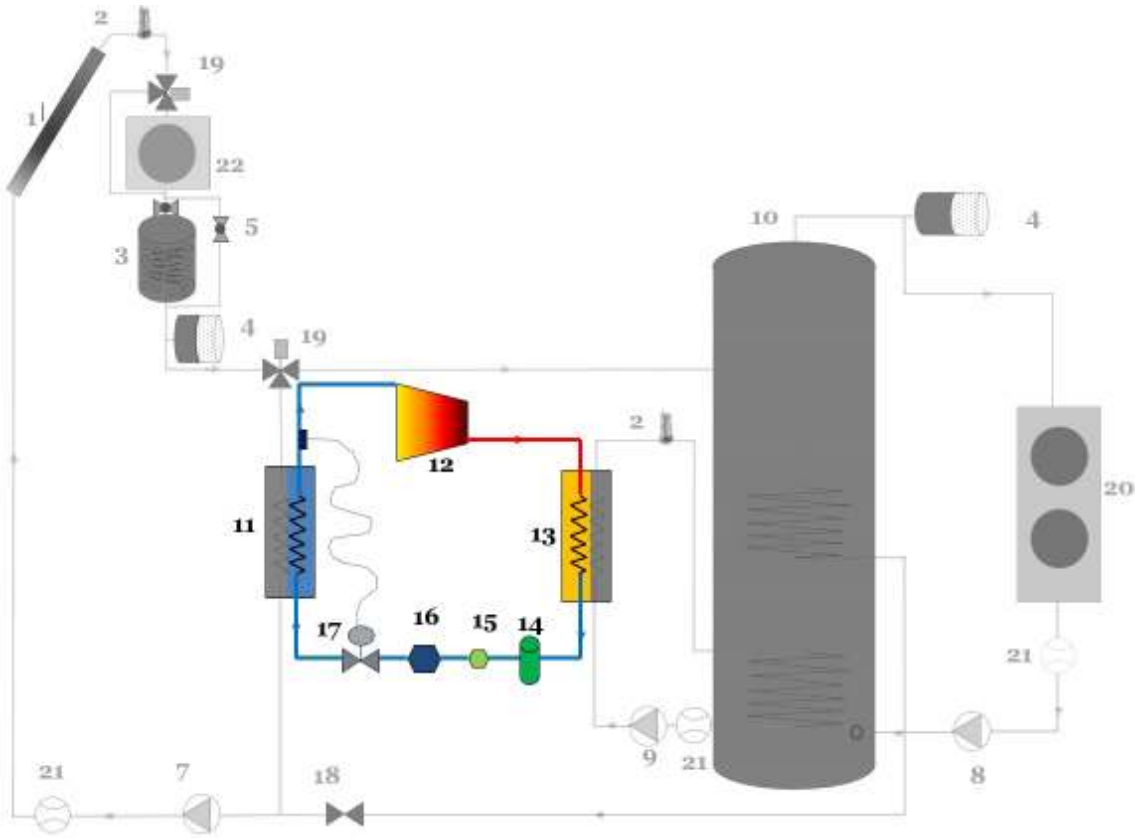


Experimental Test Rig

Heat Pump Loop

Function:

- Primary heating element for the system

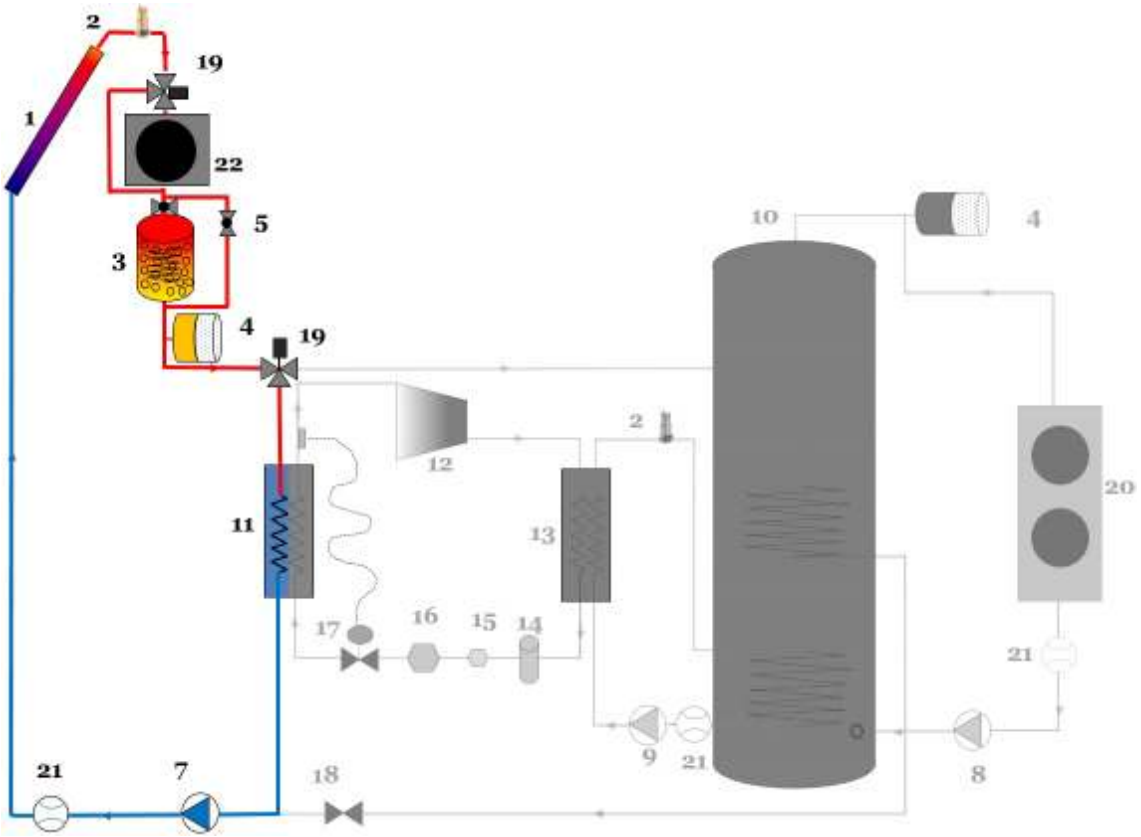


Heat Source Loop

Function:

- Heating source to the HP via:

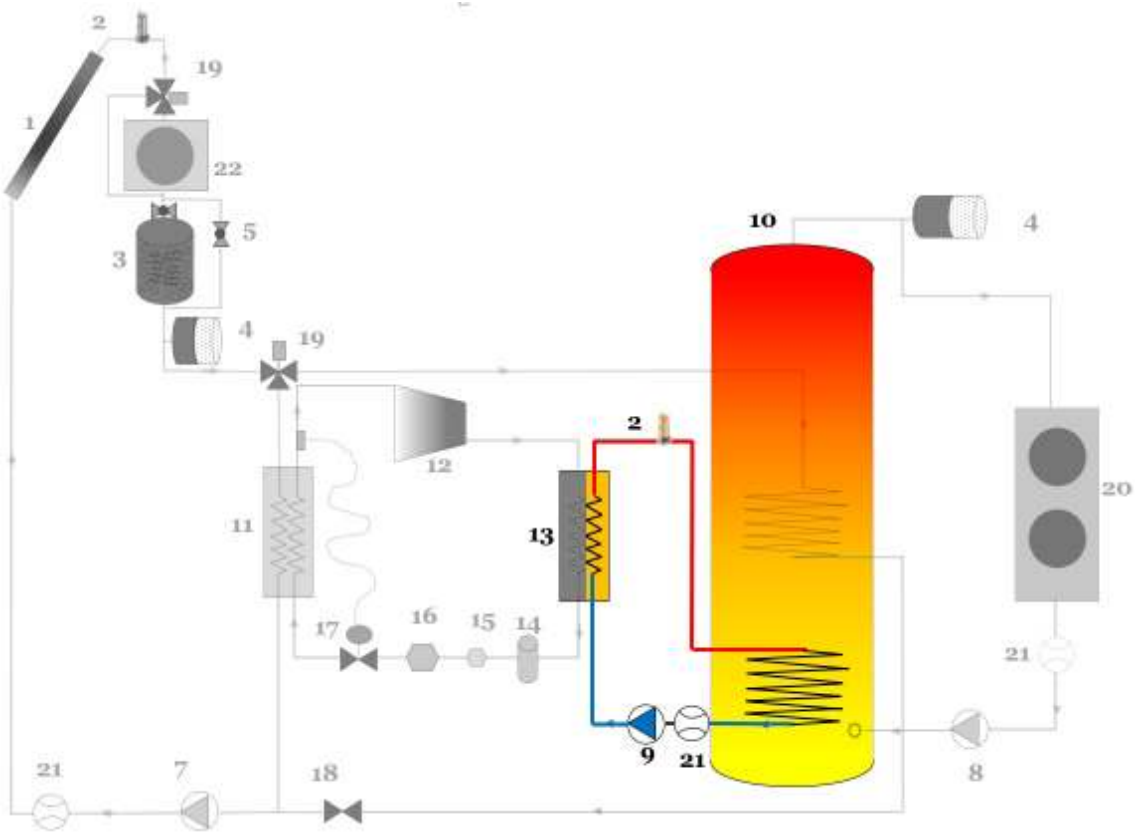
1. Solar Collector
2. PCM HX
3. AWHX



Heat Sink Loop

Function:

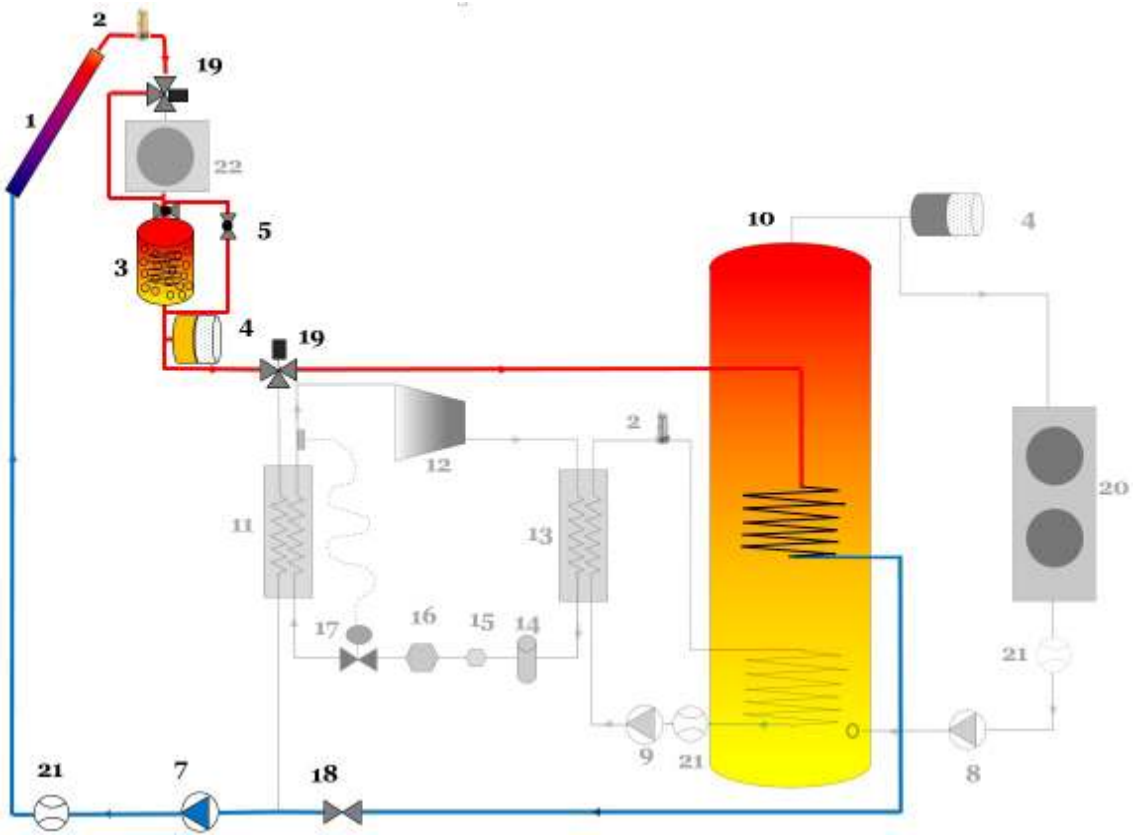
- Transfers the heat from the heat pump to the storage tank



Direct Solar Loop

Function:

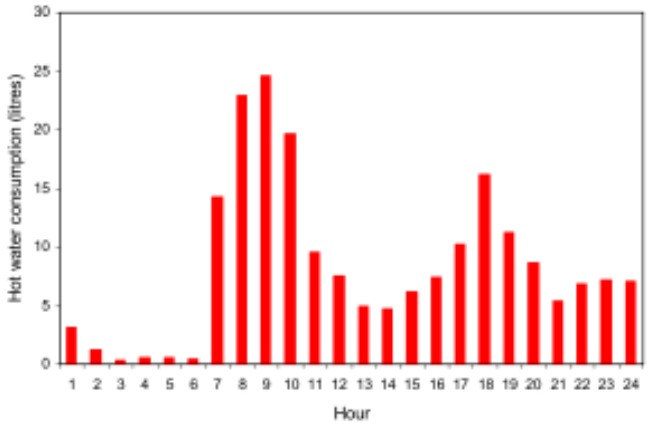
- Works as traditional thermal solar system

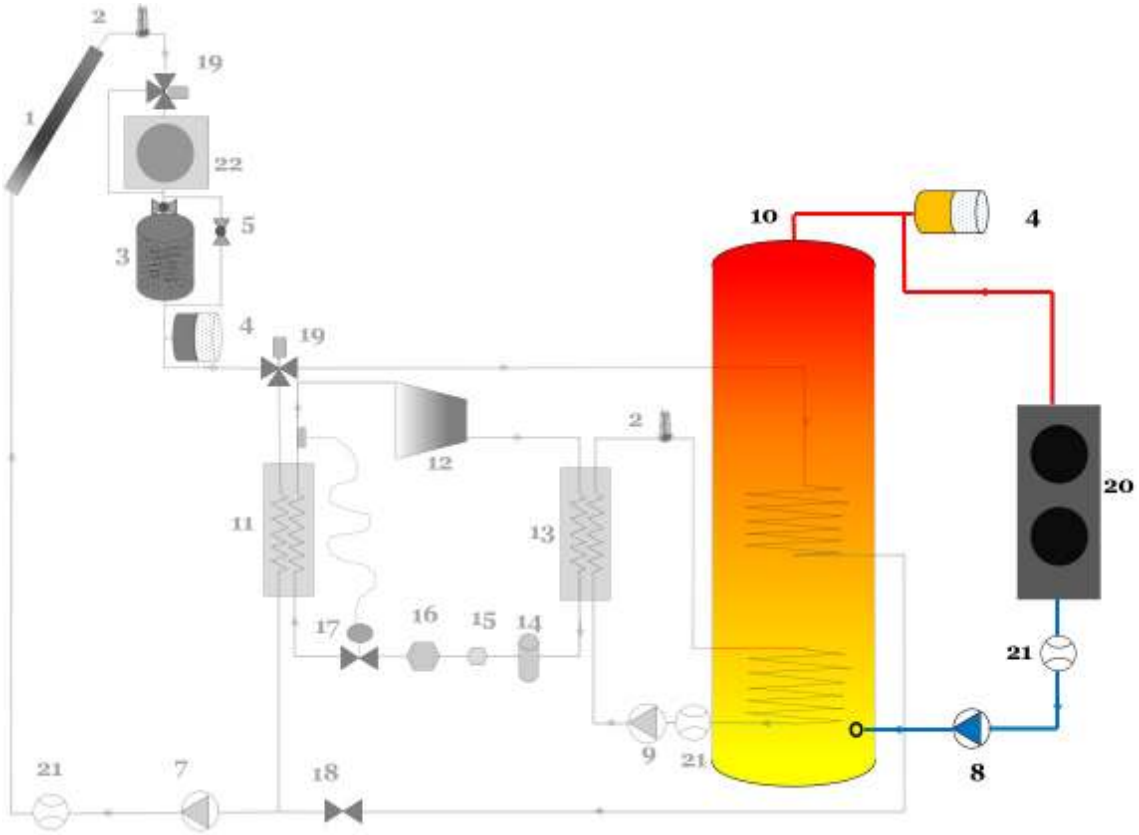


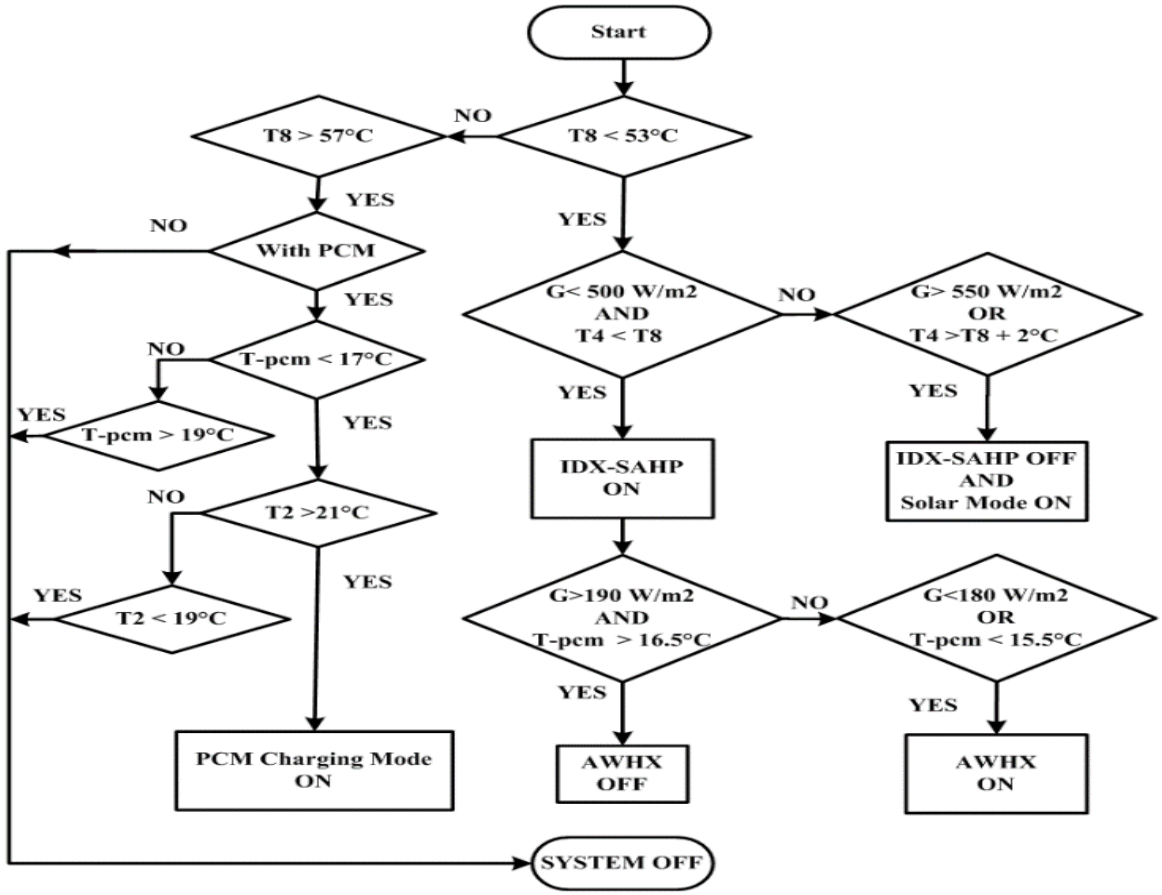
Load Simulation Loop

Function:

- Simulates the DHW consumption for typical dwelling





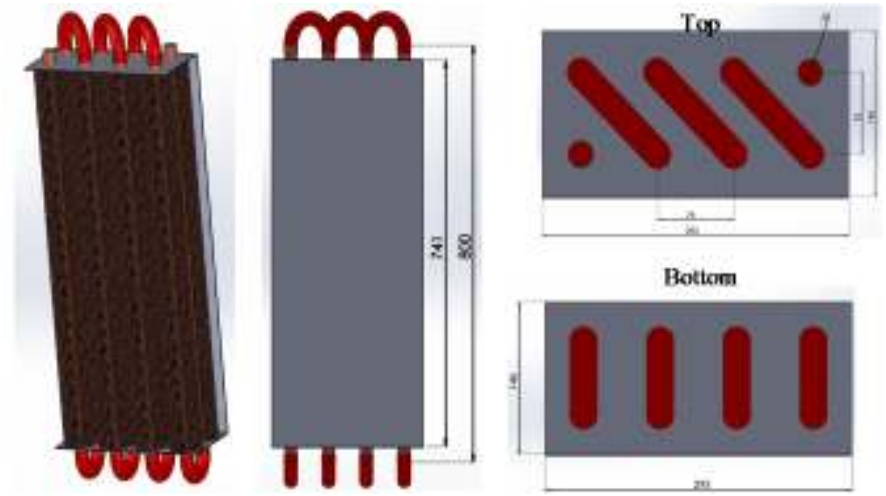


Flow chart of the system control strategy

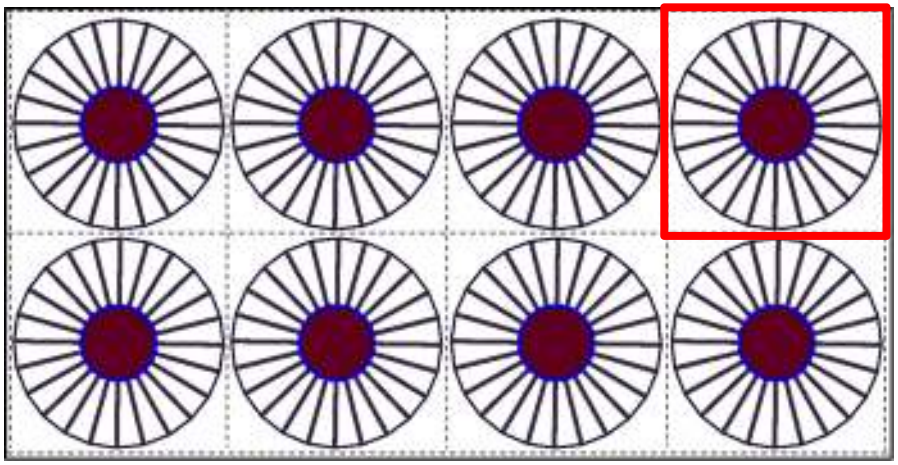
Approach

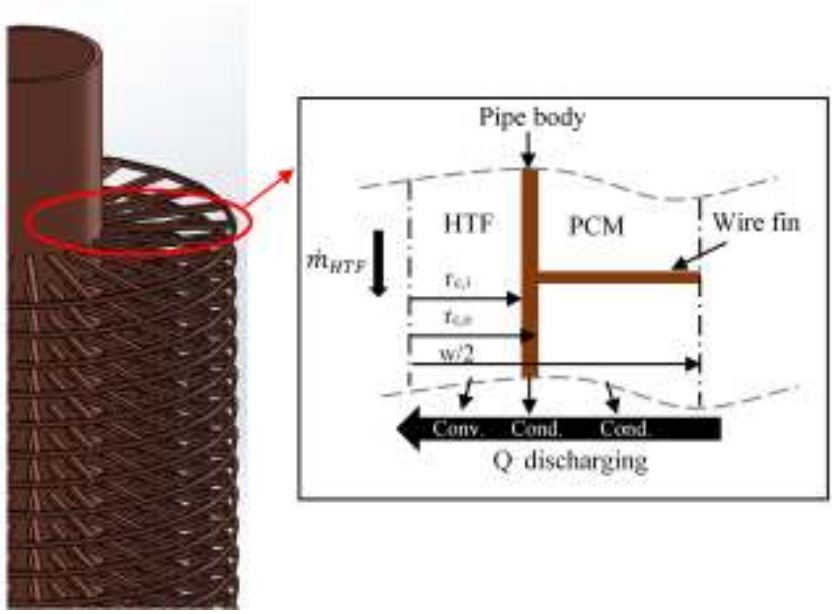
Manufacture

Design

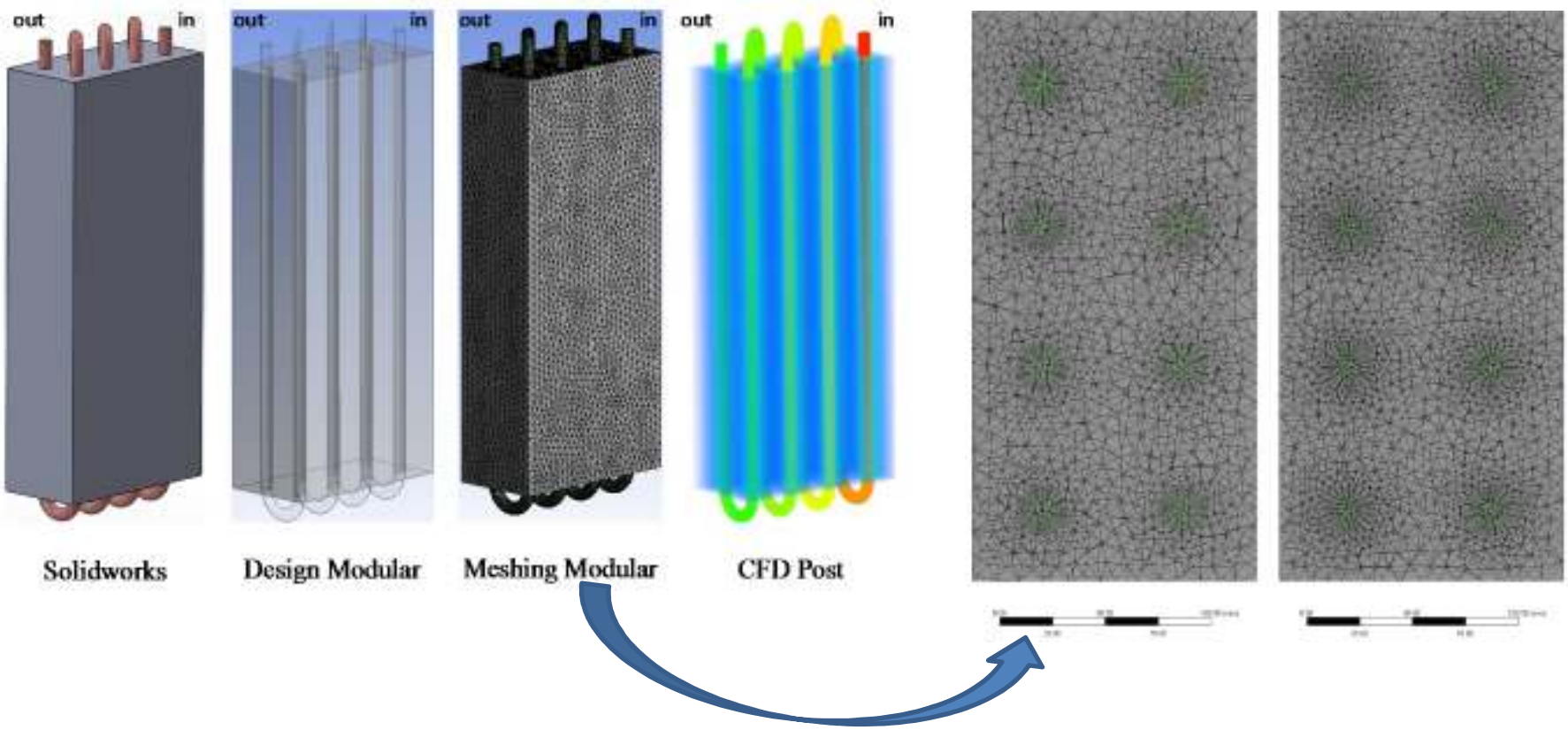


PCM enhanced thermal conductivity coefficient



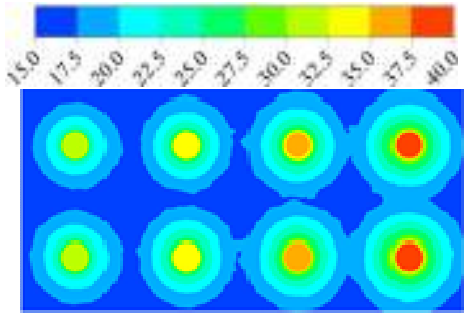


$$Q = \underbrace{[\dot{m}_{wf} C_p (T_{in} - T_{out})]}_{main\ heat\ transfer} = \underbrace{[\bar{h} A_s \Delta T_{lm}]}_{Convection} = \underbrace{\left[\frac{2\pi k_c L}{\ln\left(\frac{r_{c,o}}{r_{c,i}}\right)}\left(T_{s,i} - T_{s,o}\right)\right]}_{Pipe\ Conduction} = \underbrace{[Sk_{pcm}(T_{s,o} - T_{pcm})]}_{PCM\ conduction}$$



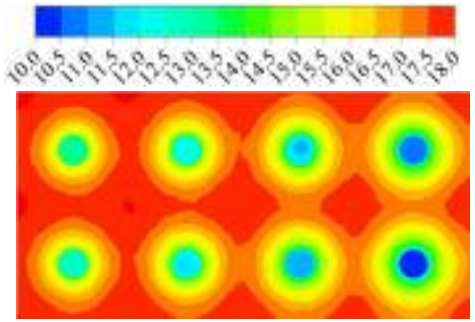
Level	No of elements	No of nodes	Skewness	Time per iter.
Coarse	920703	244452	Av: 0.23%, stdev: 0.12%	6-11 s
Fine	1981116	514875	Av: 0.22%, stdev: 0.12%	9-13 s

Charging

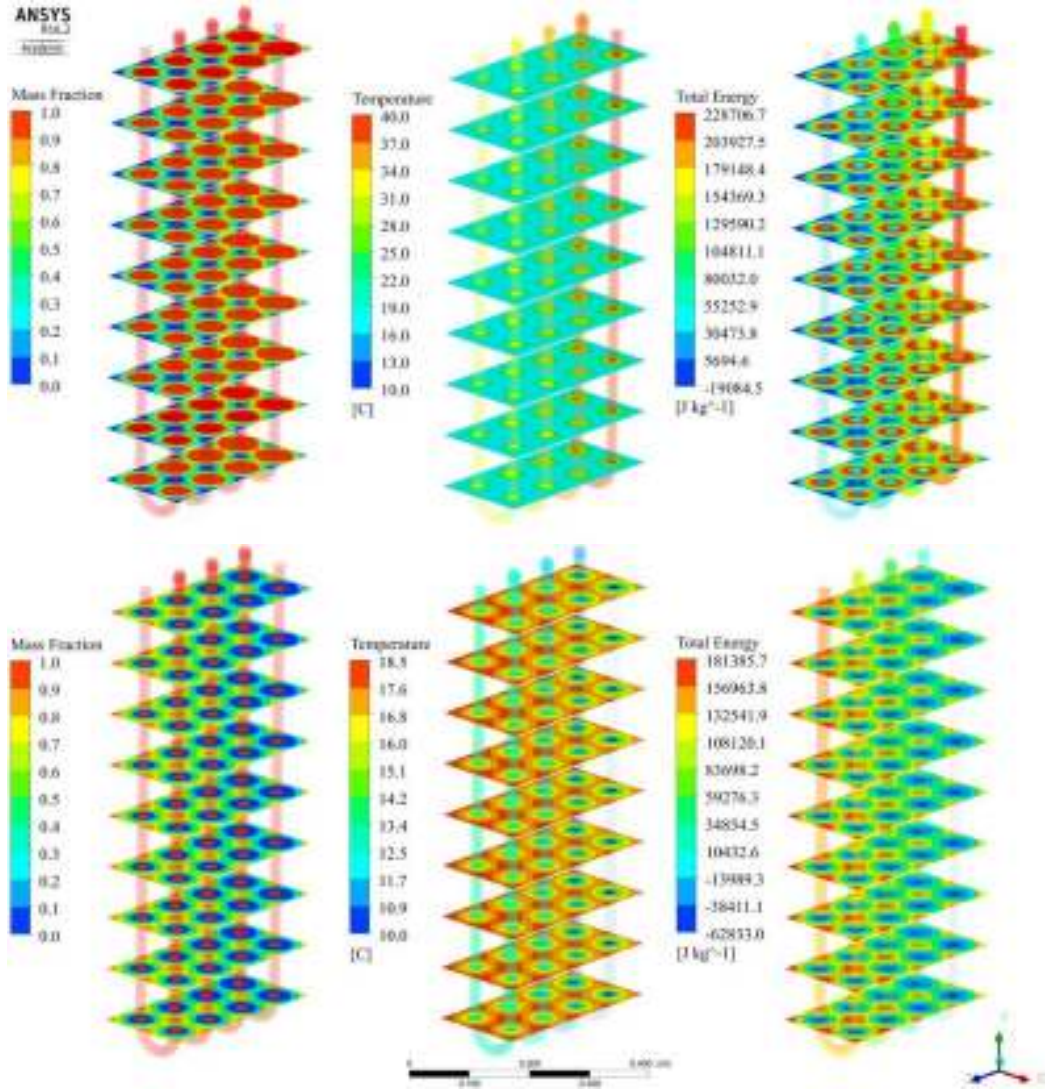


Temperature distribution at middle of the PCM HX at 1050s

Discharging

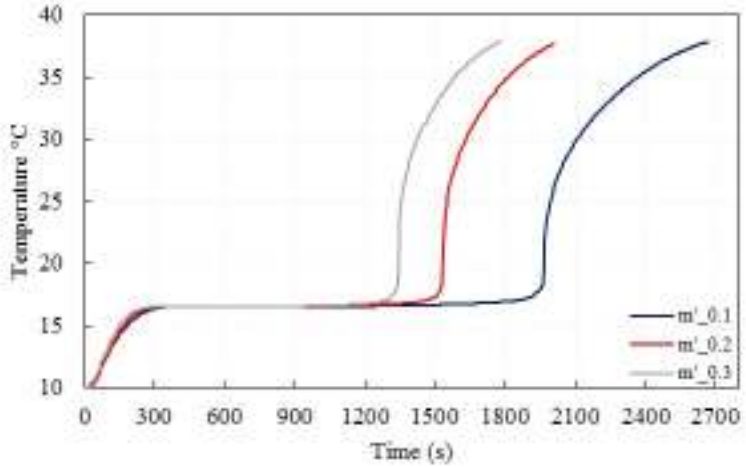


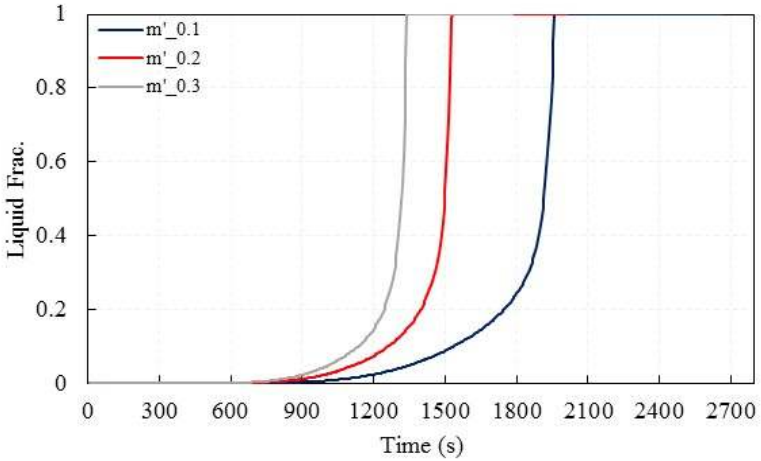
Temperature distribution at middle of the PCM HX at 3050s



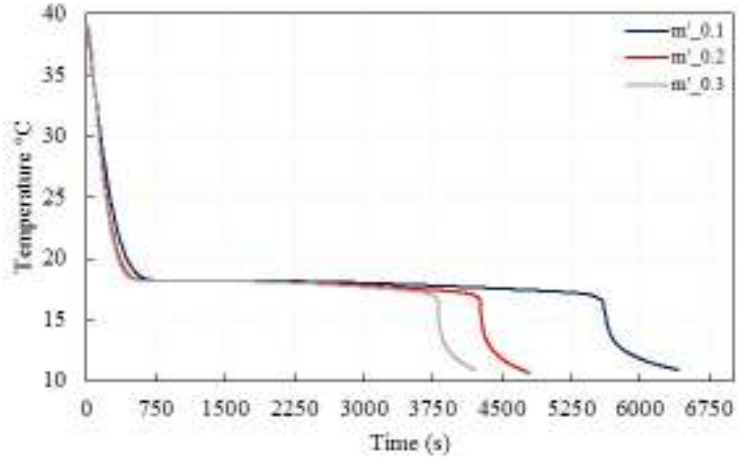
Effect of HTF Flow rate variation

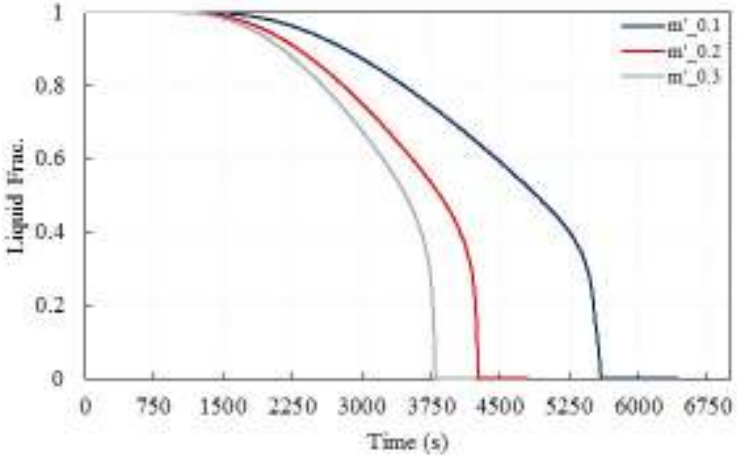
Charging





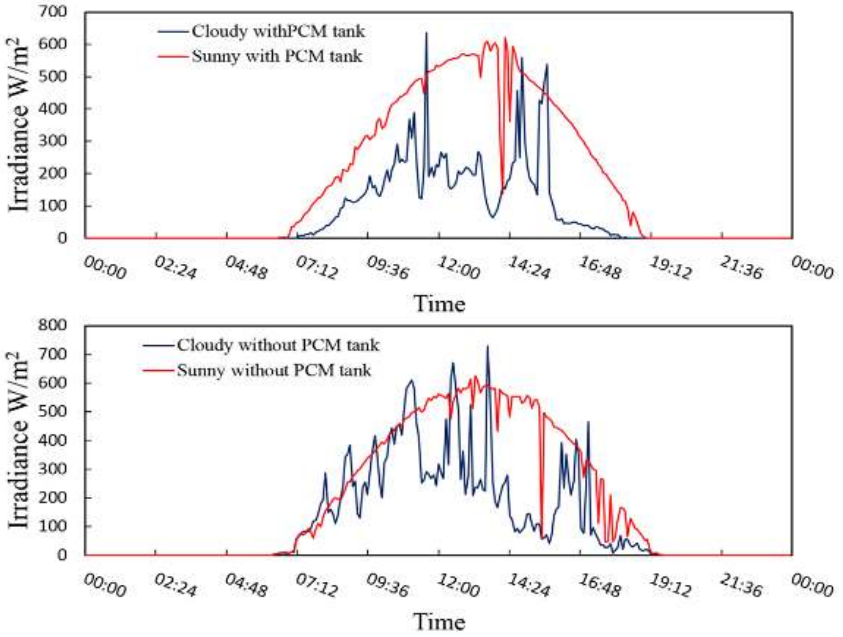
Discharging



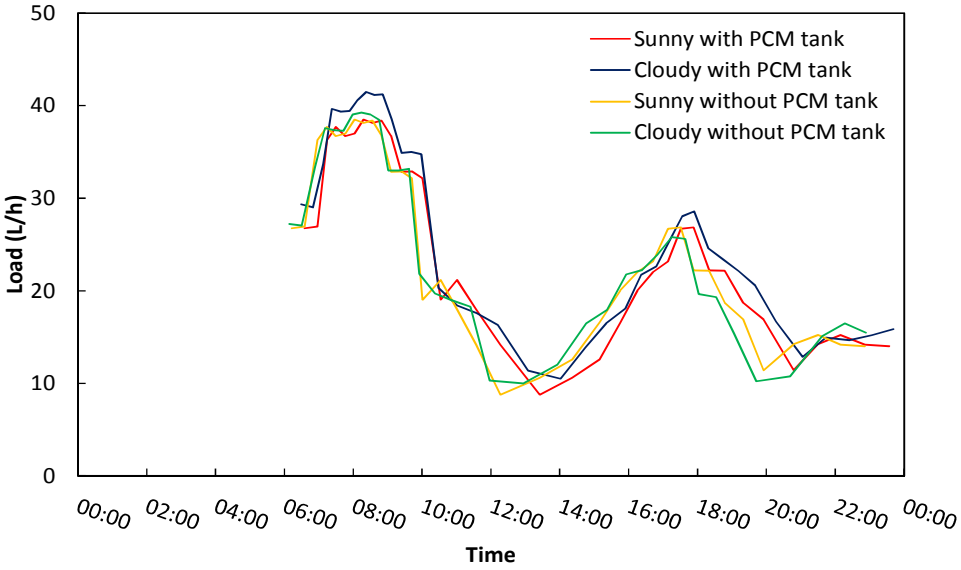


HTF: heat transfer fluid

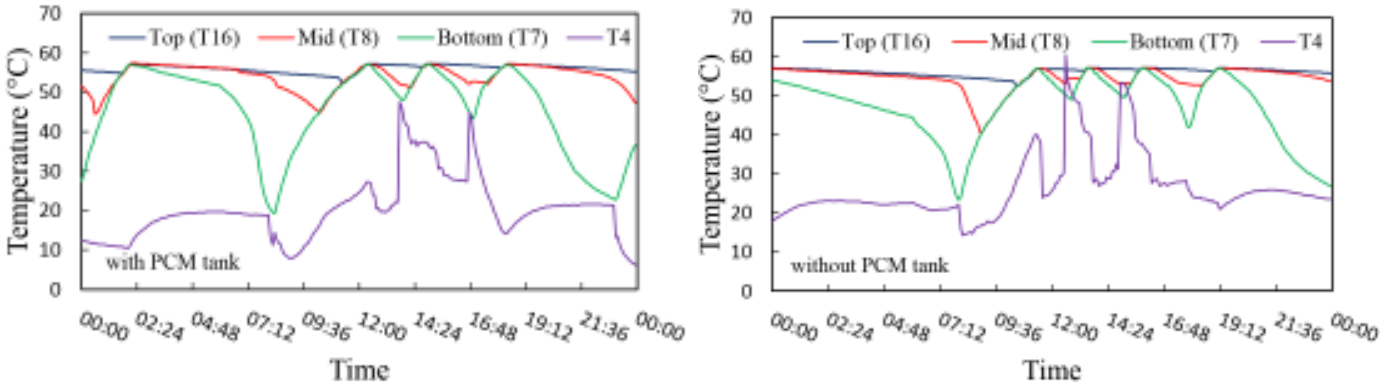
Experimental procedure



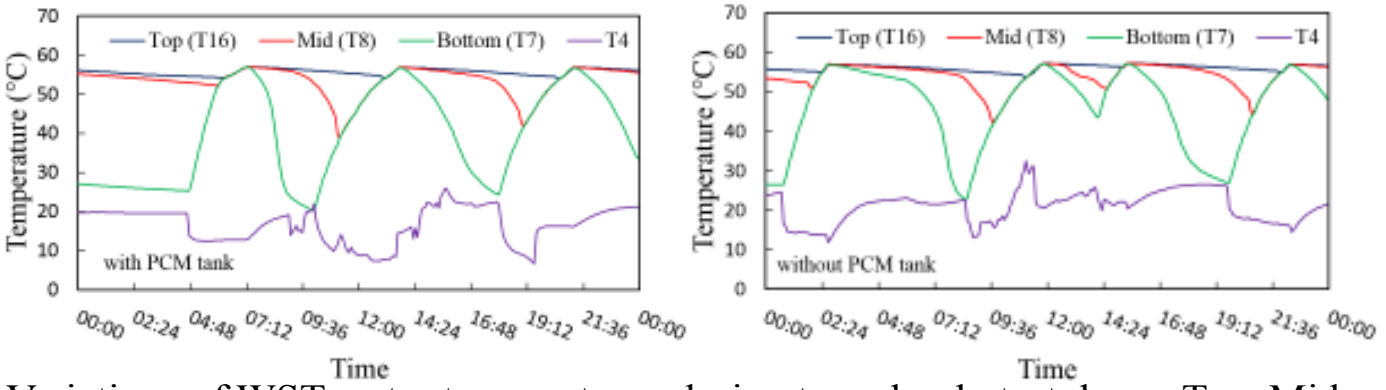
Variations of solar irradiance during four test days



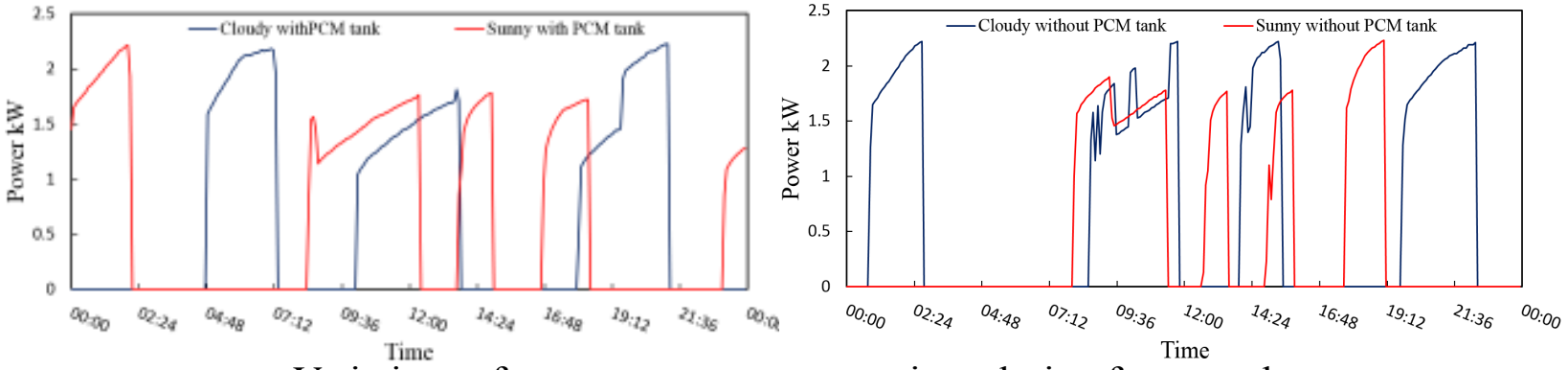
Variations of load profiles during four test days



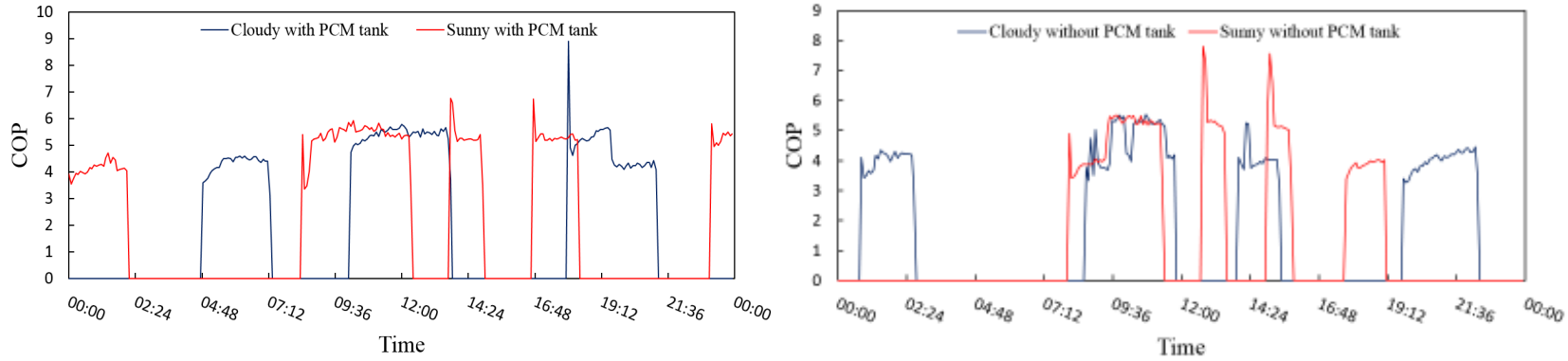
Variations of WST water temperatures during two sunny test days – Top, Mid and Bottom



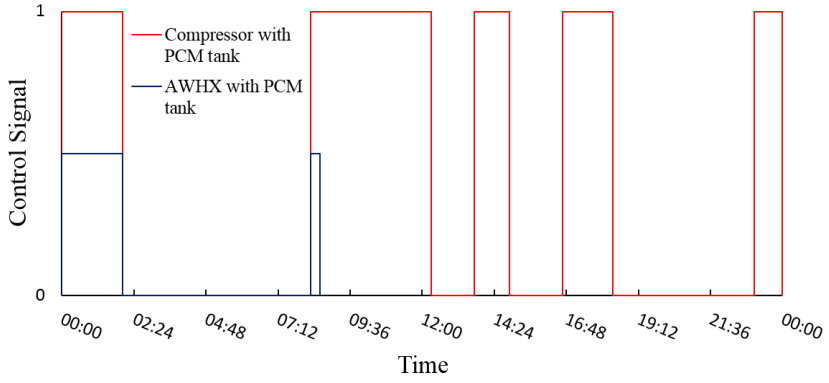
Variations of WST water temperatures during two cloudy test days - Top, Mid and Bottom

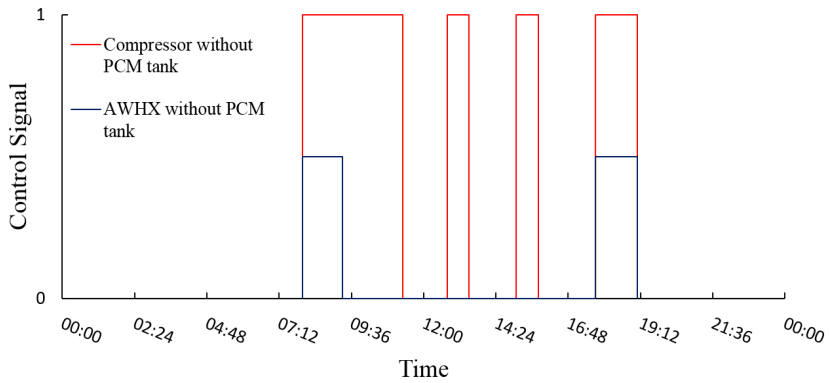


Variations of system power consumptions during four test days

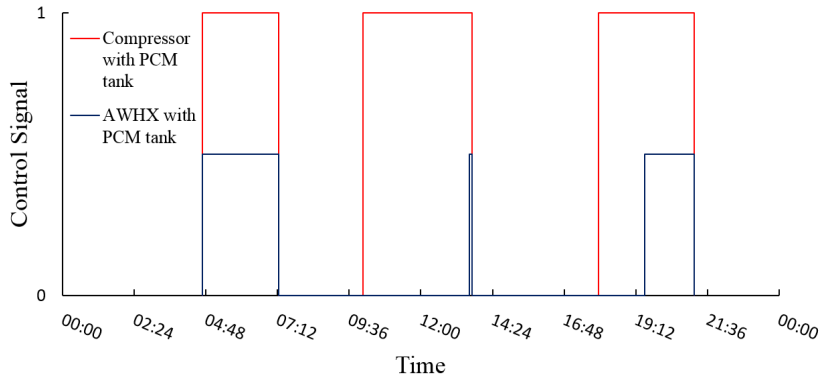


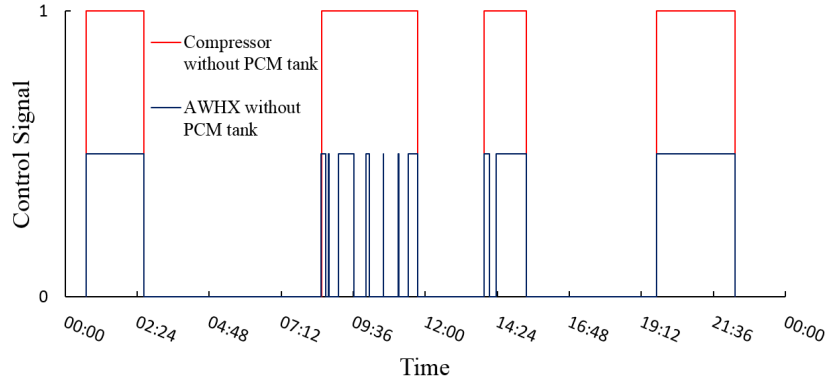
Variations of system COPs during four test days





Variations of compressor and AWHX fan control signals during two sunny test days





Variations of compressor and AWHX fan control signals during two cloudy test days

- Needs large space to install
- Initial cost is high
- PCM weight could be a barrier

- The proposed control showed economic and reliable operation.
- The PCM HX could increase the system COP by 6.1% and 14% during sunny and cloudy days respectively.
- The PCM HX improved the control of AWHX during cloudy days operation.
- Further study is required for the system compared with a conventional DHW system in large scale applications and community heating.
- The Modelling for the system is required to study the system performance in different location (hot climate).

Thank You

Any Questions?