



**Ulster
University**



The Role of Thermal Storage and Heat Pumps (EPSRC HP-FITS EP/T025581/1)

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Heat Pump Integration

Some of the Challenges

“Approximately 10% of existing homes in the UK will need to be heated by a heat pump, compared to only approximately 1% today.”

“Action needs to extend beyond electricity, with rapid progress needed on electric cars, heat pumps and tree planting”.

“UK’s heat pump rollout is considerably behind many comparable countries.”

Recommendations

“Make Electricity Cheaper”

“Reverse recent policy rollbacks.”

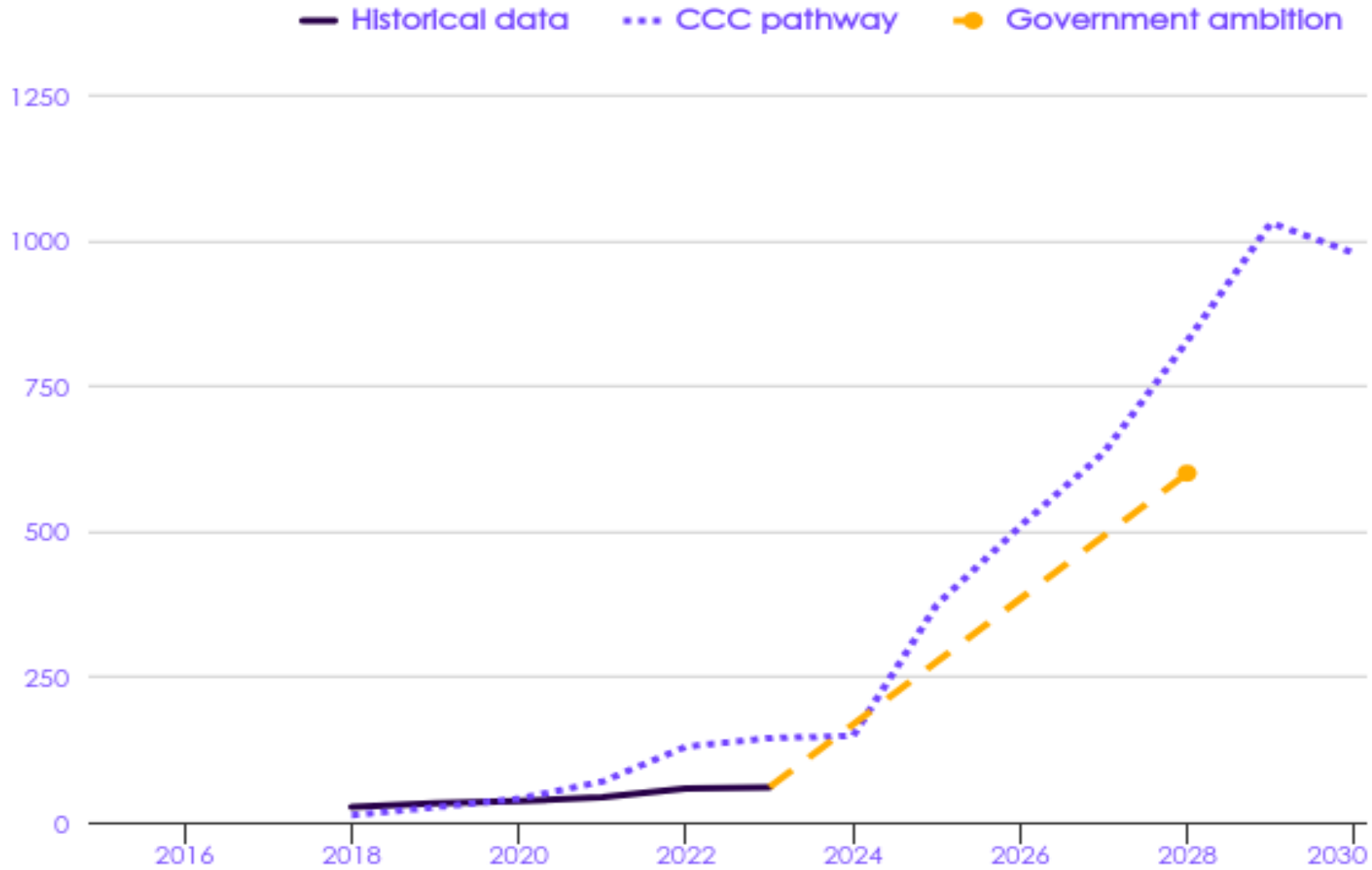
July 2024

Progress in reducing emissions
2024 Report to Parliament



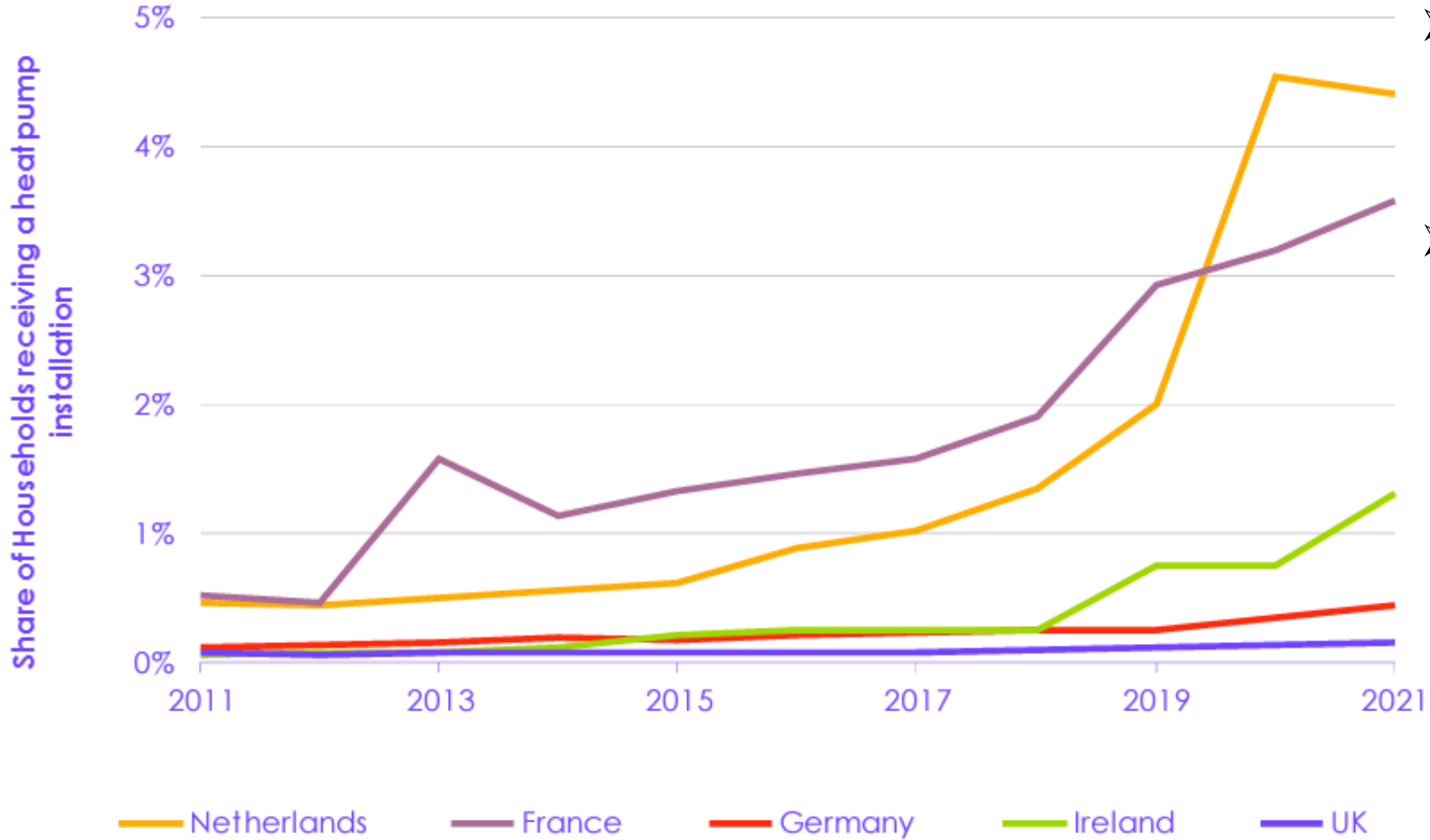
Progress in reducing emissions, 2024 Report to Parliament, Climate Change Committee, July 2024.

Residential heat pump installations (thousands) Significantly off track



Progress in reducing emissions, 2024 Report to Parliament, Climate Change Committee, July 2024.

HP installations in UK vs Neighbours

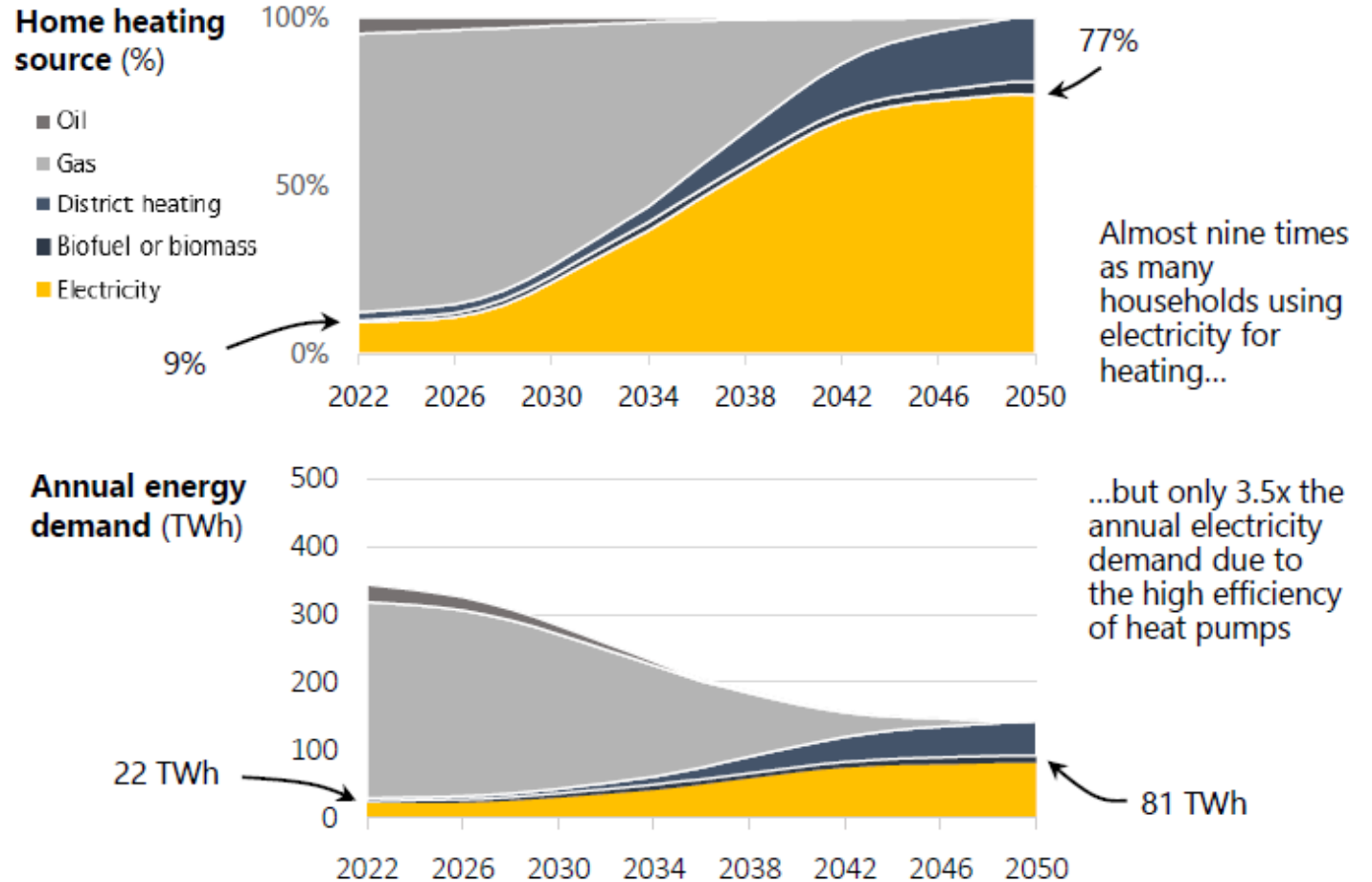


- In Germany, electricity costs between 2.5 and 3.5 times more than gas
- while in the UK, it is more than 3.5 times as expensive.

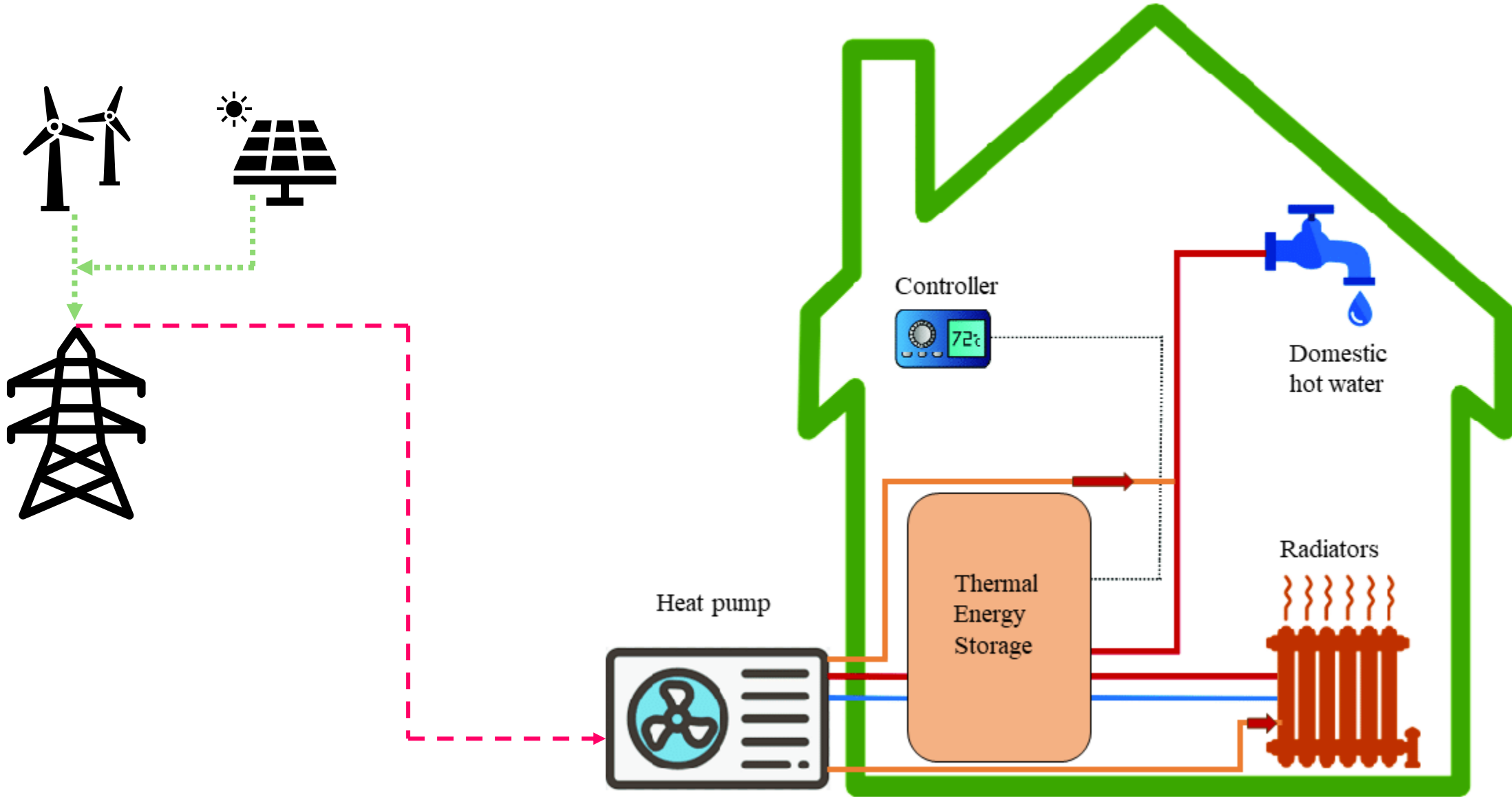
National Grid's Future Energy Scenarios (2022)

note:

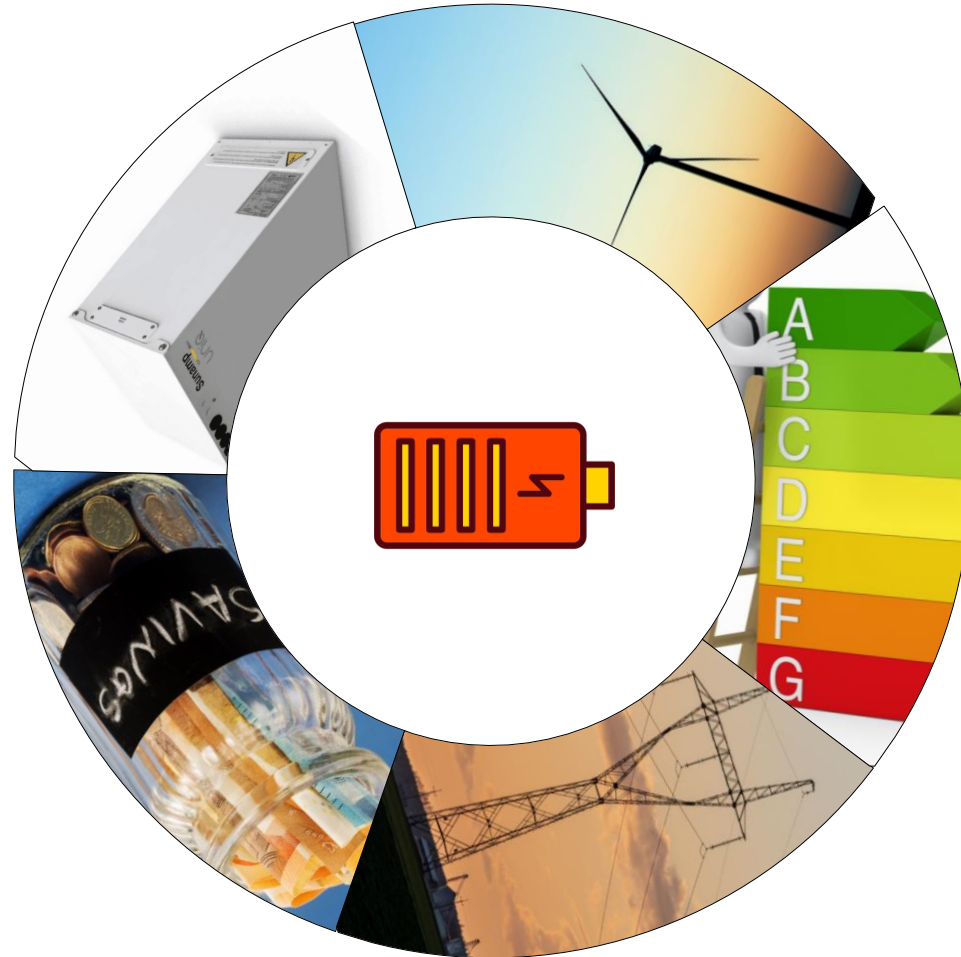
- ***“By 2035, 41% of household could use electricity as energy source for heating”***
- ***“The annual electricity demand for domestic heating will only increase by a factor of 3.5 (Due to higher energy conversion efficiency of low carbon technologies).”***



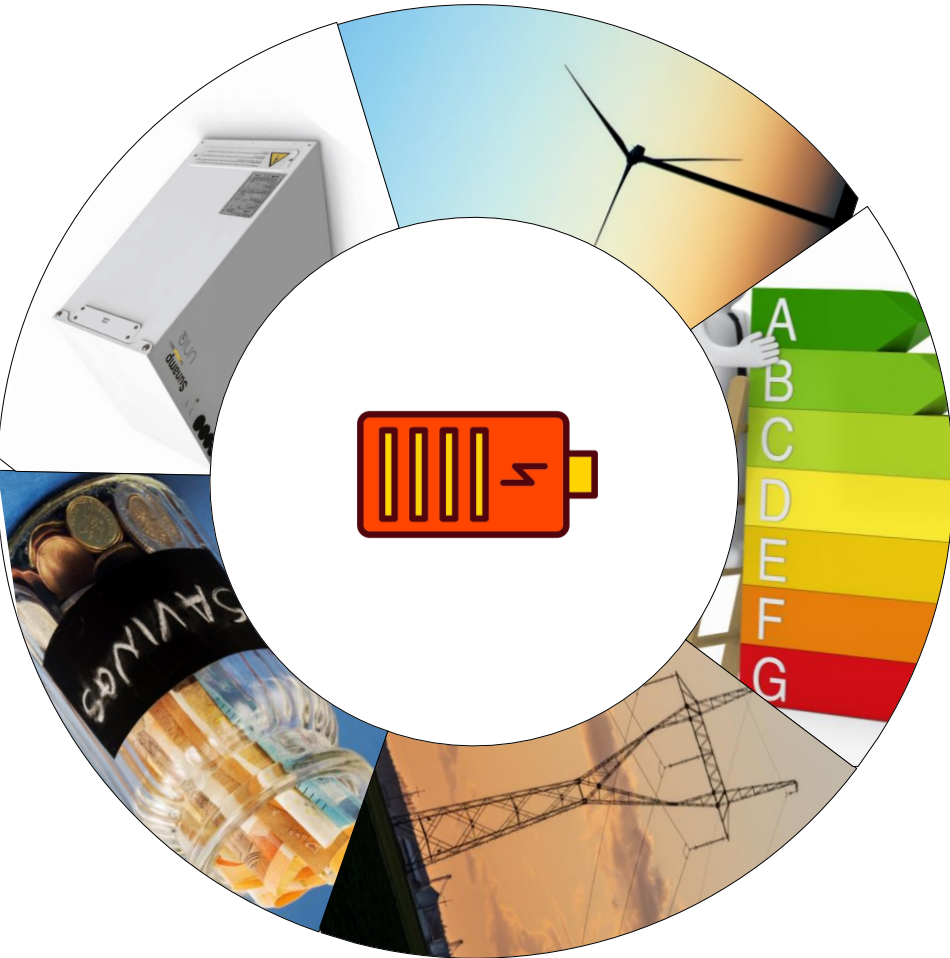
Why HP integration with Heat battery?



Why HP integration with Heat battery?



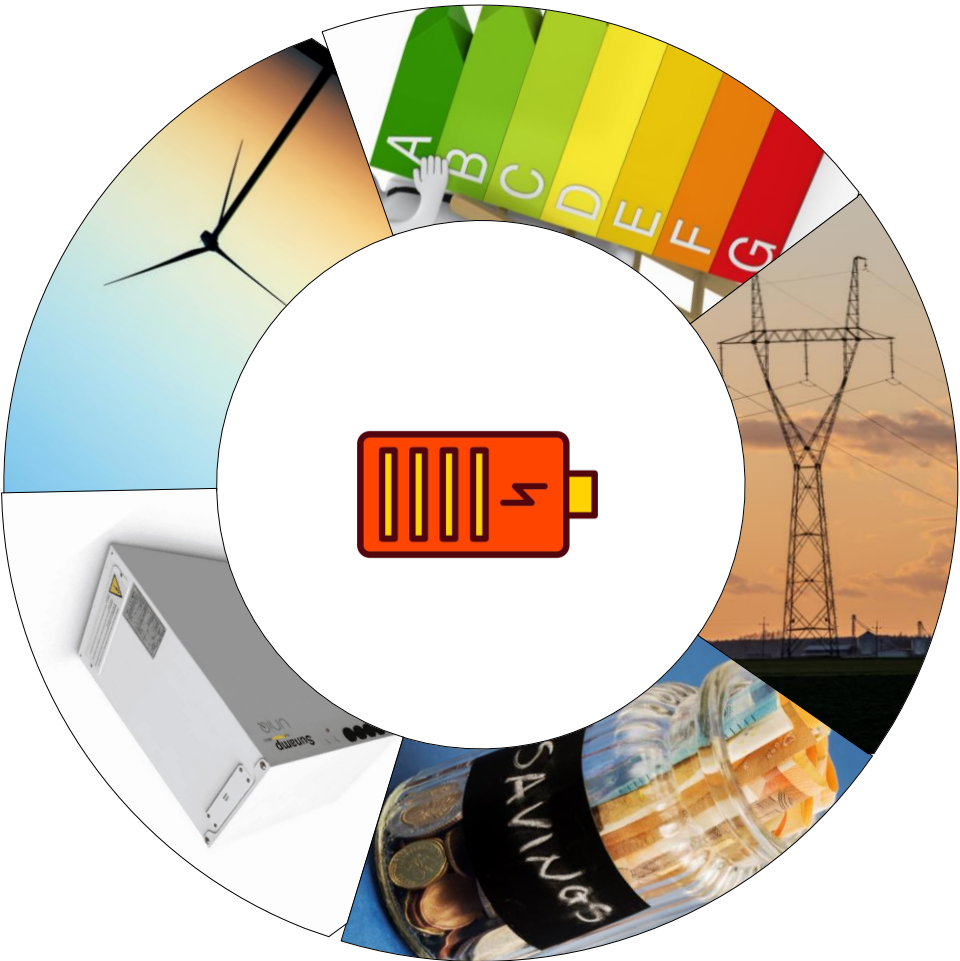
Why HP integration with Heat battery?



Increased Efficiency and Reduced Energy Consumption

PCMs allow heat pumps to operate more efficiently when the outside temperature is high, and store heat for use when it's cooler (Optimized Heat Pump Operation).

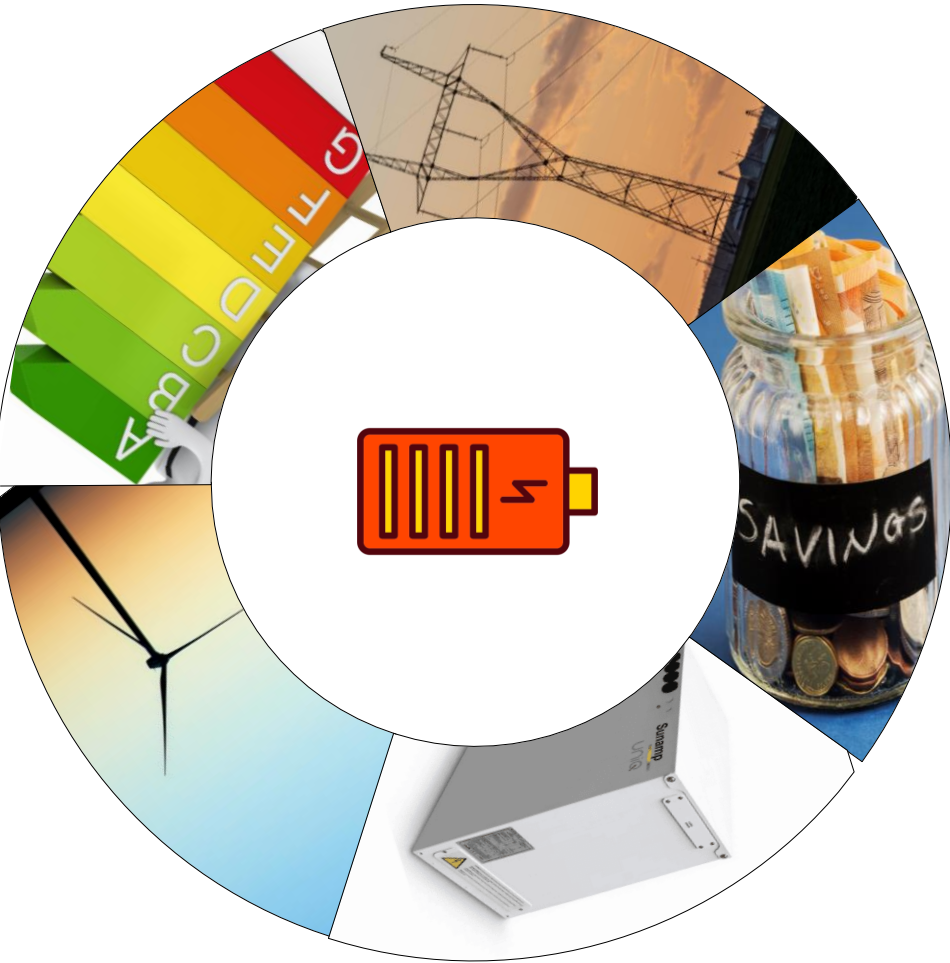
Why HP integration with Heat battery?



Load shifting and Grid demand management

- Off-Peak Energy Storage
- Demand Response Capability

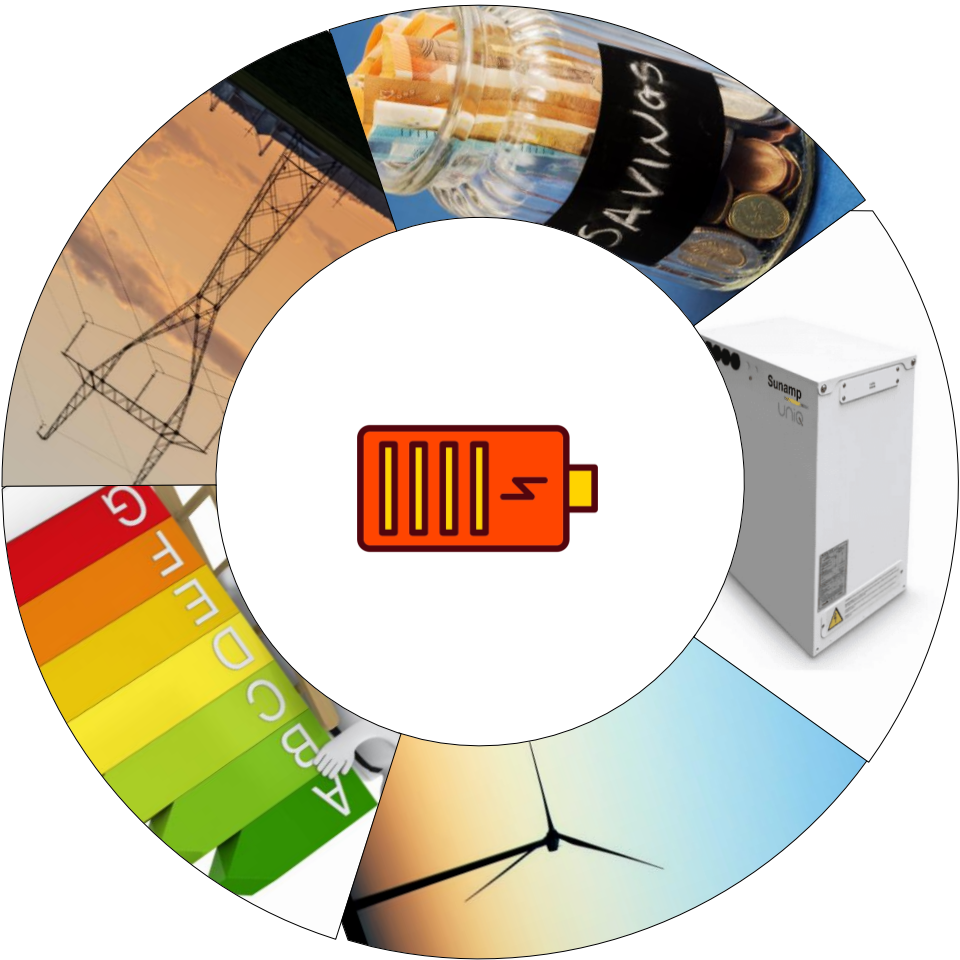
Why HP integration with Heat battery?



Cost savings

- Reduced Oversizing Needs of HP
- Reducing energy use during grid peak periods

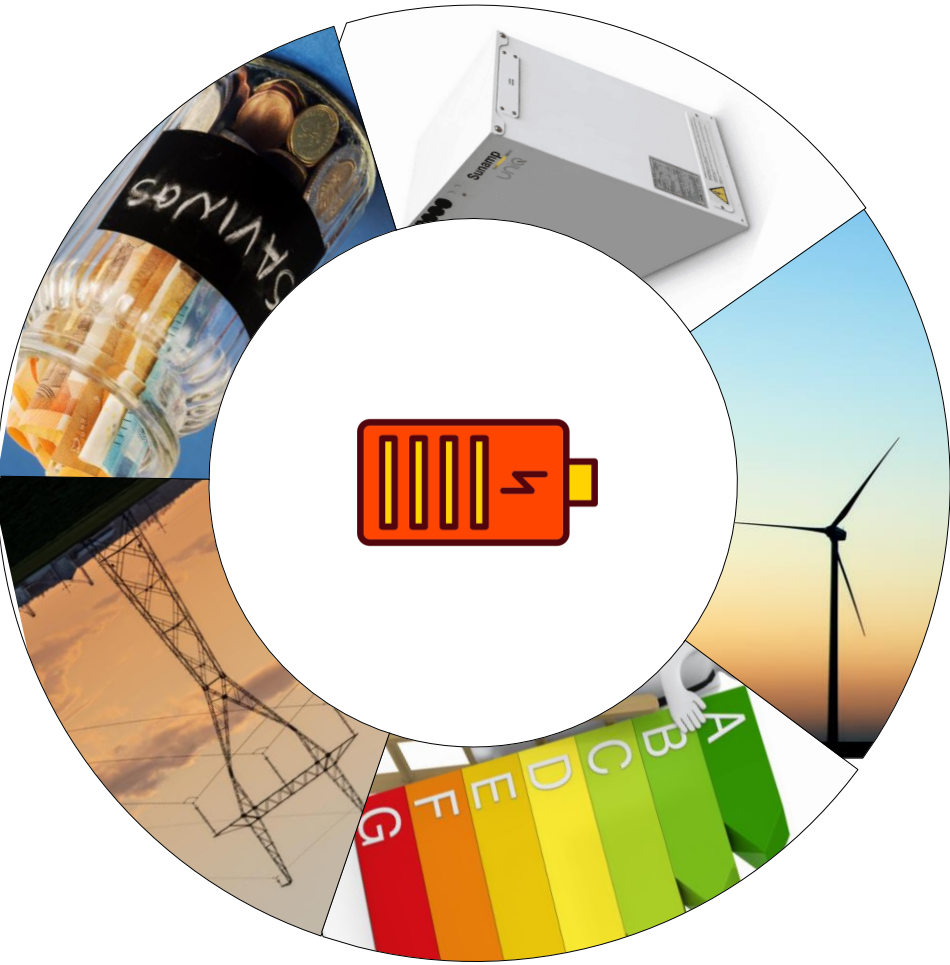
Why HP integration with Heat battery?



Compact energy storage

- PCMs can store more energy per unit mass than water, which can improve the heat storage capacity of a tank.

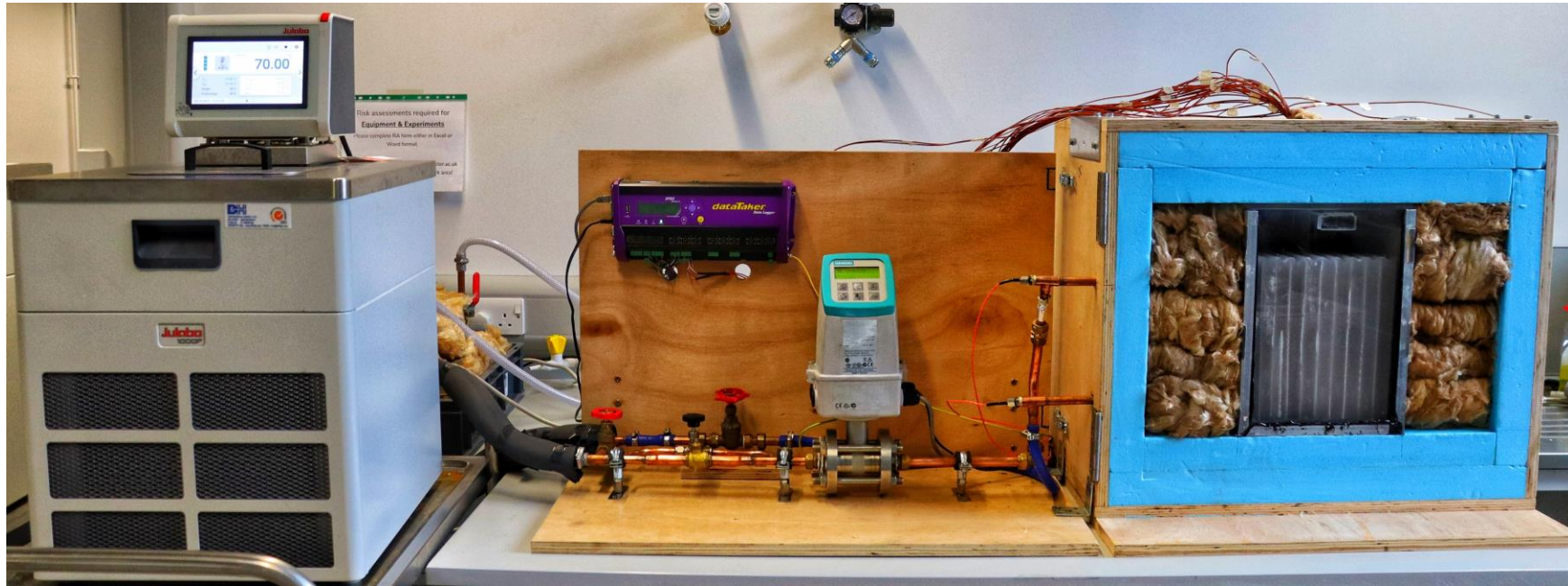
Why HP integration with Heat battery?



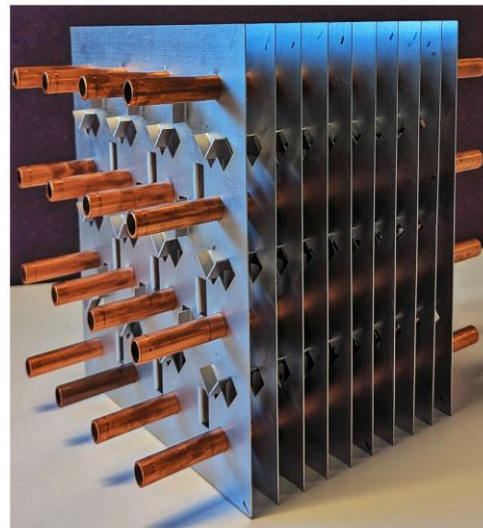
Enhanced Use of Renewable Energy Sources

- **Renewable Energy Integration:** Only paired with renewable energy sources
- **Decarbonization Potential**

Current project status (Experimental Test Rig)



Fractal (Branched) Plate

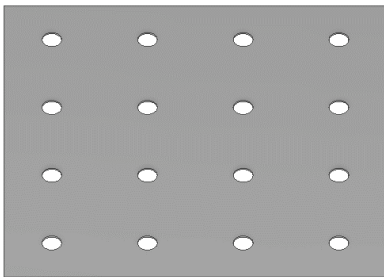
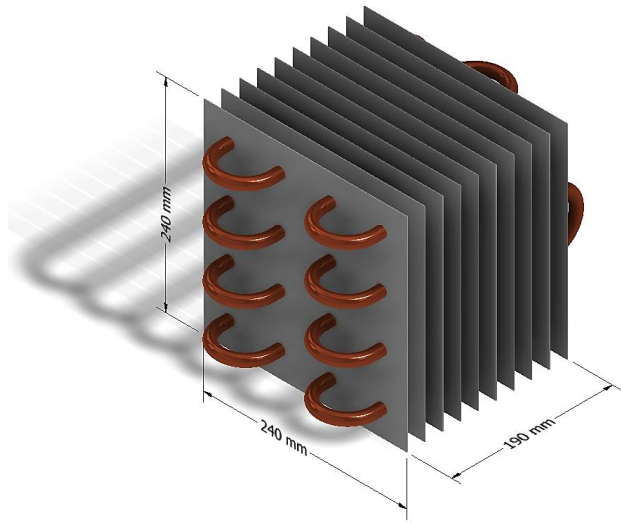


Winglet Plate

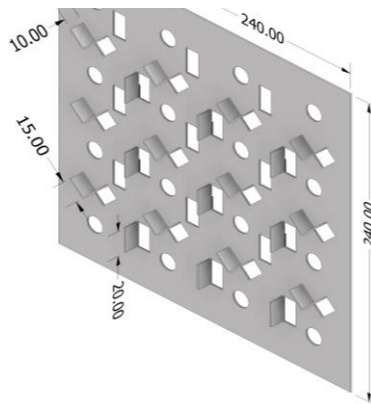
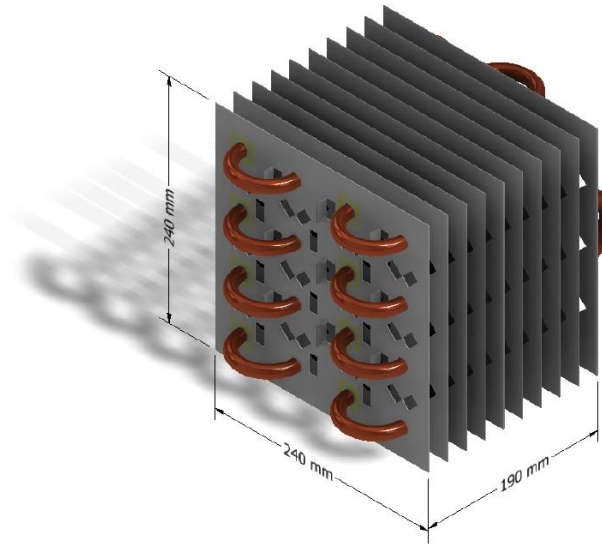


Plain Plate

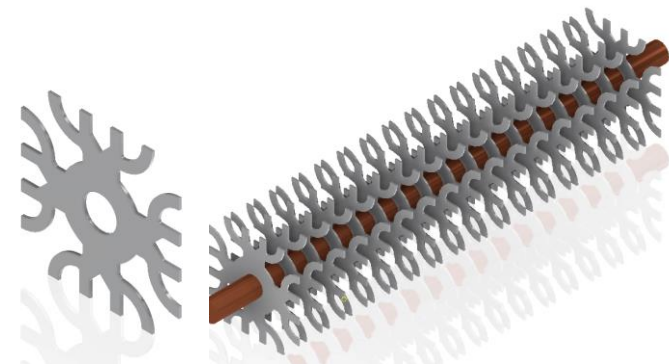
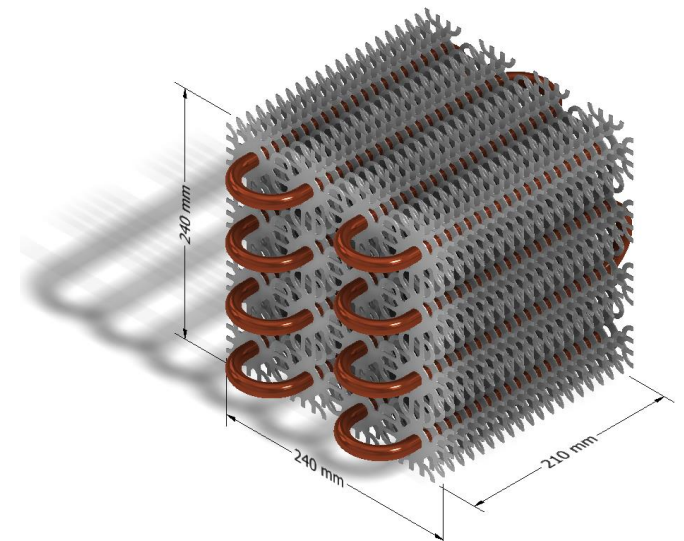
Plain Plate (Reference)



Winglet Plate



Fractal (Branched) Plate



Heat exchanger: Aluminium fin Copper tube

Fins: 10 plain fin, 10 Winglet fins and 20 branched fin (All with same mass)

Phase Change Material (PCM)

Rubitherm 55 (RT55)

Melting point: 55 °C, Phase change enthalpy : 170 kJ/kg

	Temperature (°C)	Flow rate (l/min)
Charging	65, 70 & 75	1.0, 1.5 & 2.0
Discharging	10, 15 & 20	1.0, 1.5 & 2.0

Experimental Results

Plain Plate



Winglet Plate



Fractal (Branched) Plate



Charging & Discharging 



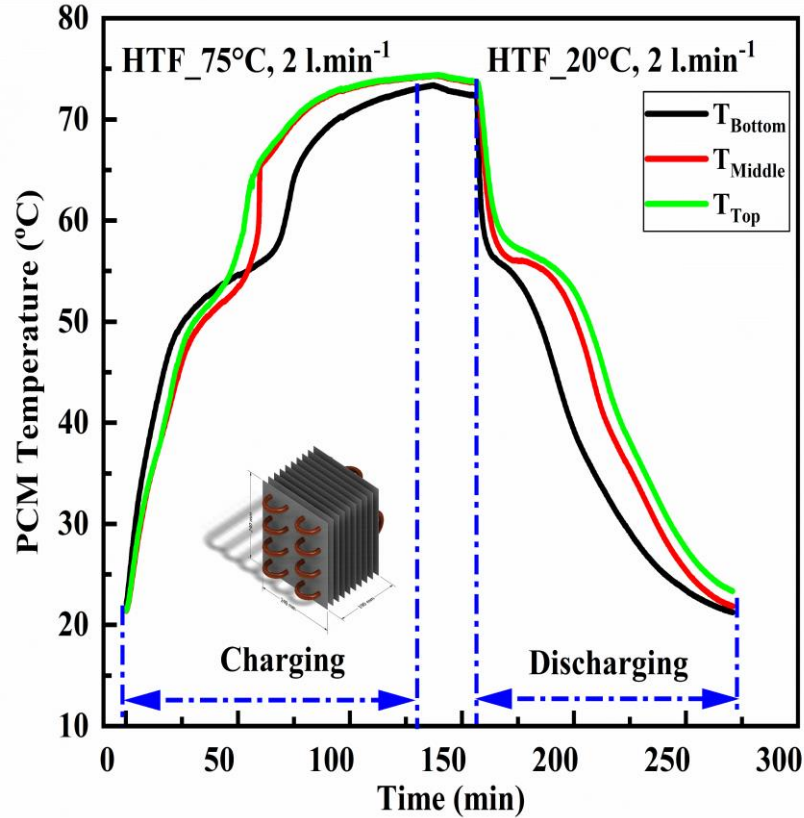
Charging & Discharging 



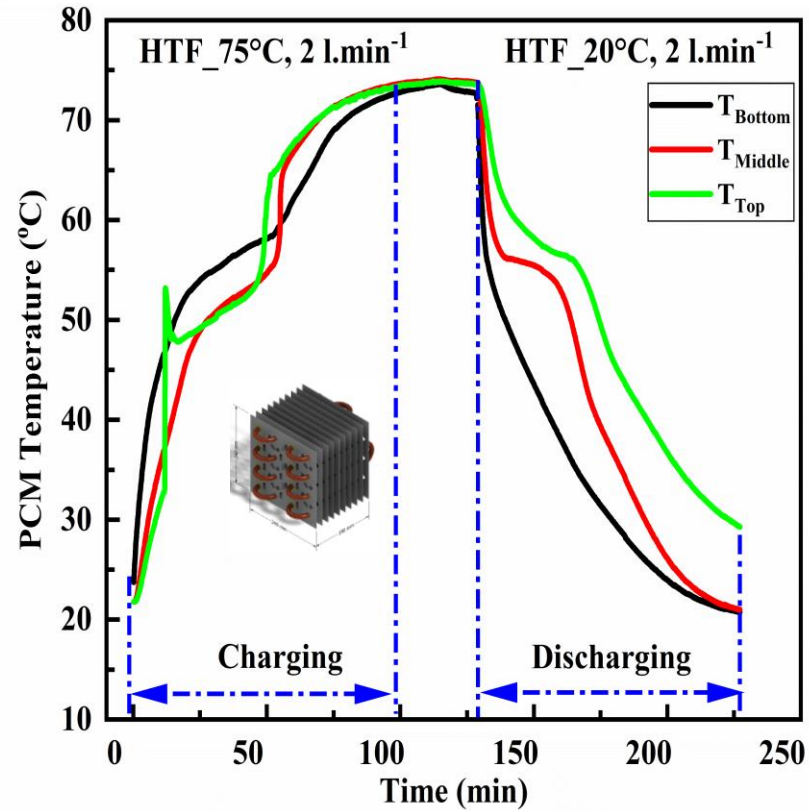
Charging & Discharging 

Experimental Results

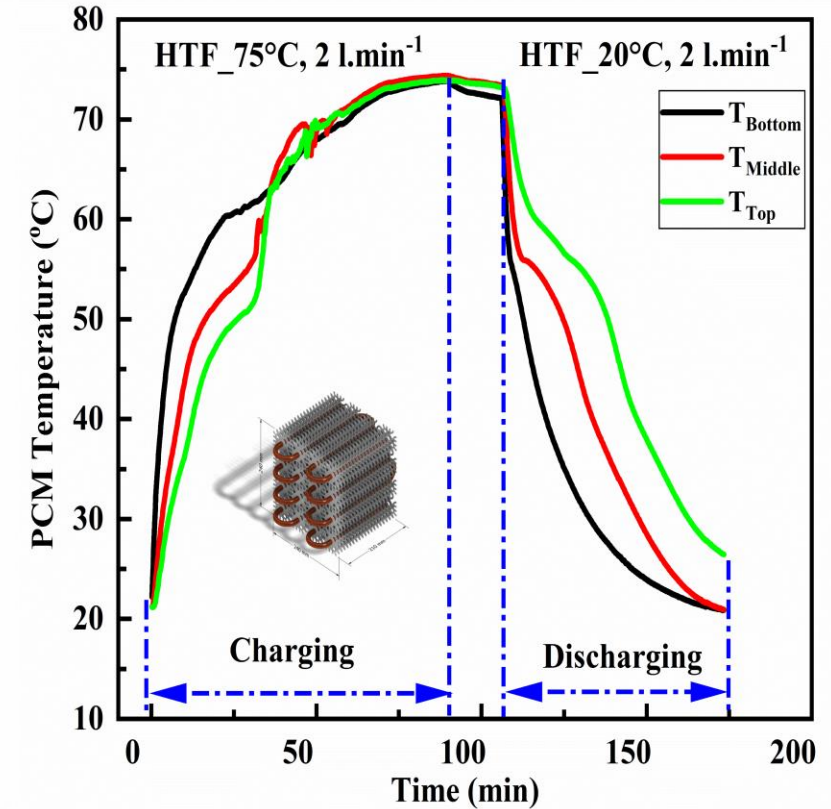
Plain Plate (Reference)



Winglet Plate



Fractal (Branched) Plate



Charging

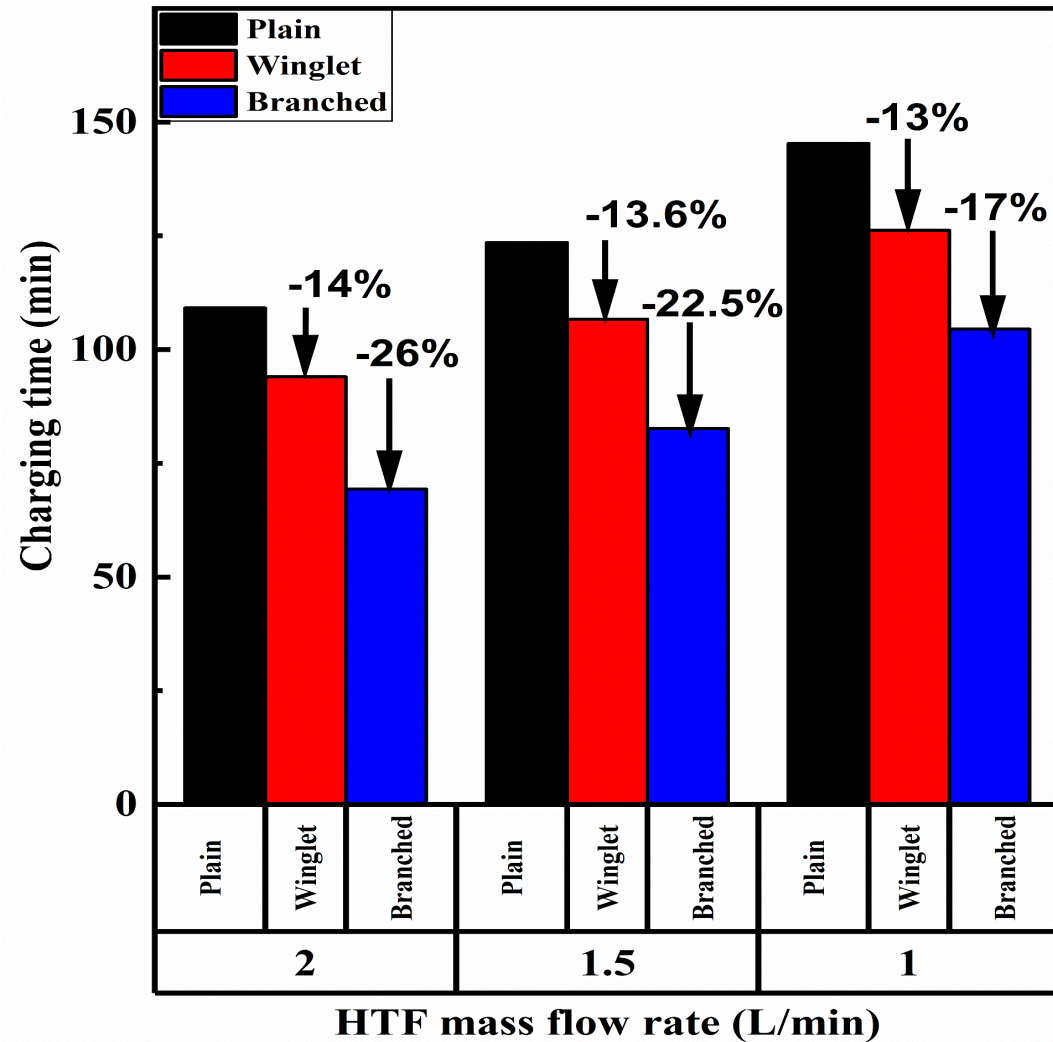
Conduction dominated at first
Convection dominated since melting

Discharging

Conduction dominated

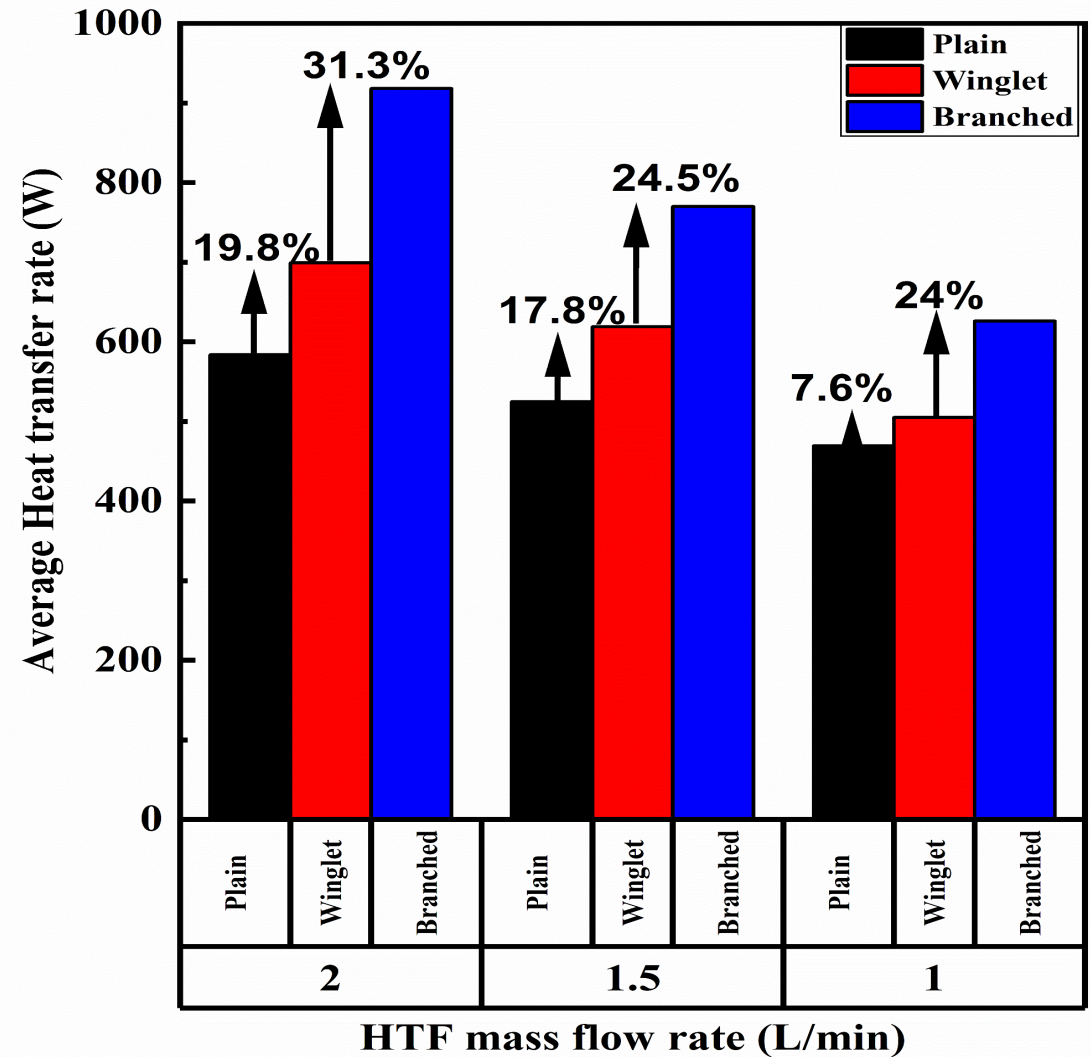
Charging time

$T_{HTF}: 75\text{ }^{\circ}\text{C}$



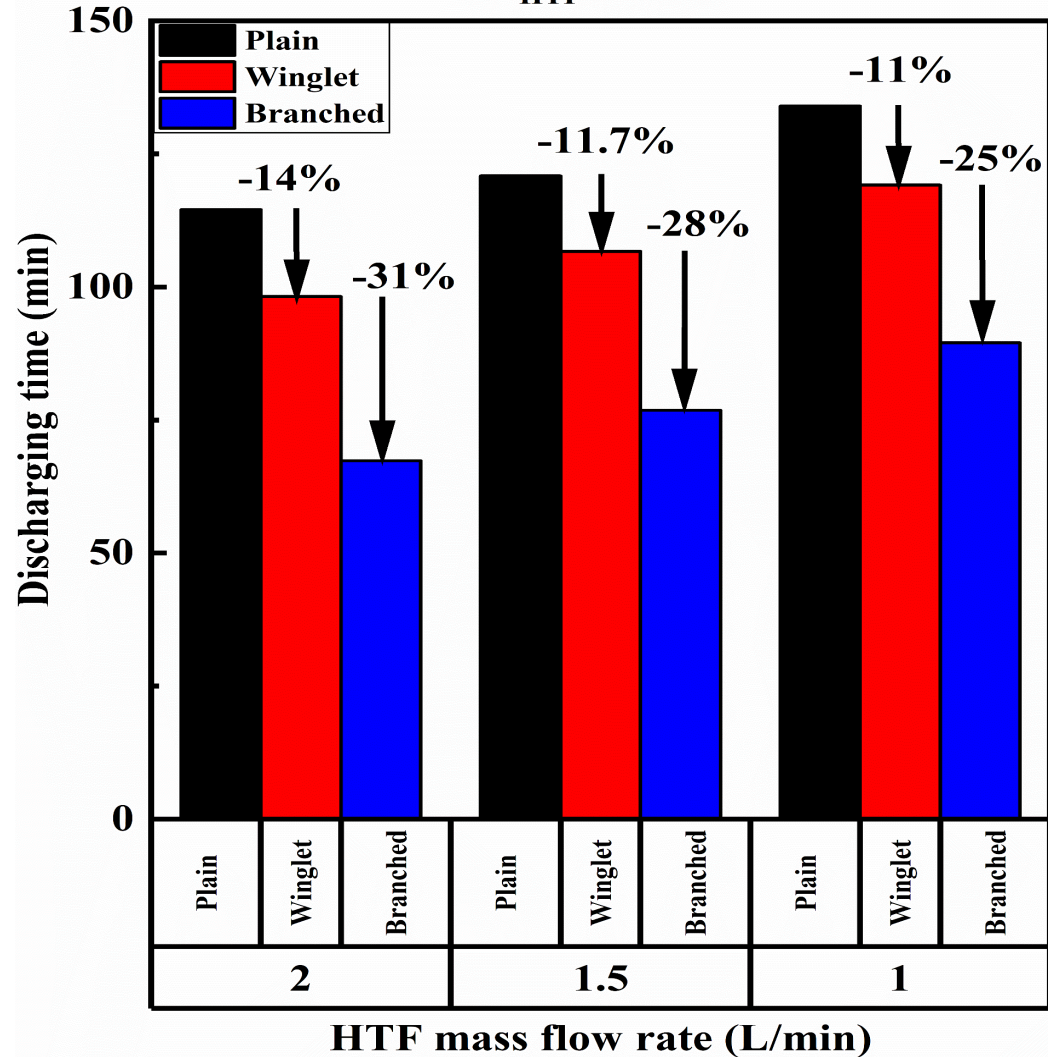
Time averaged heat transfer rate

$T_{HTF}: 75\text{ }^{\circ}\text{C}$



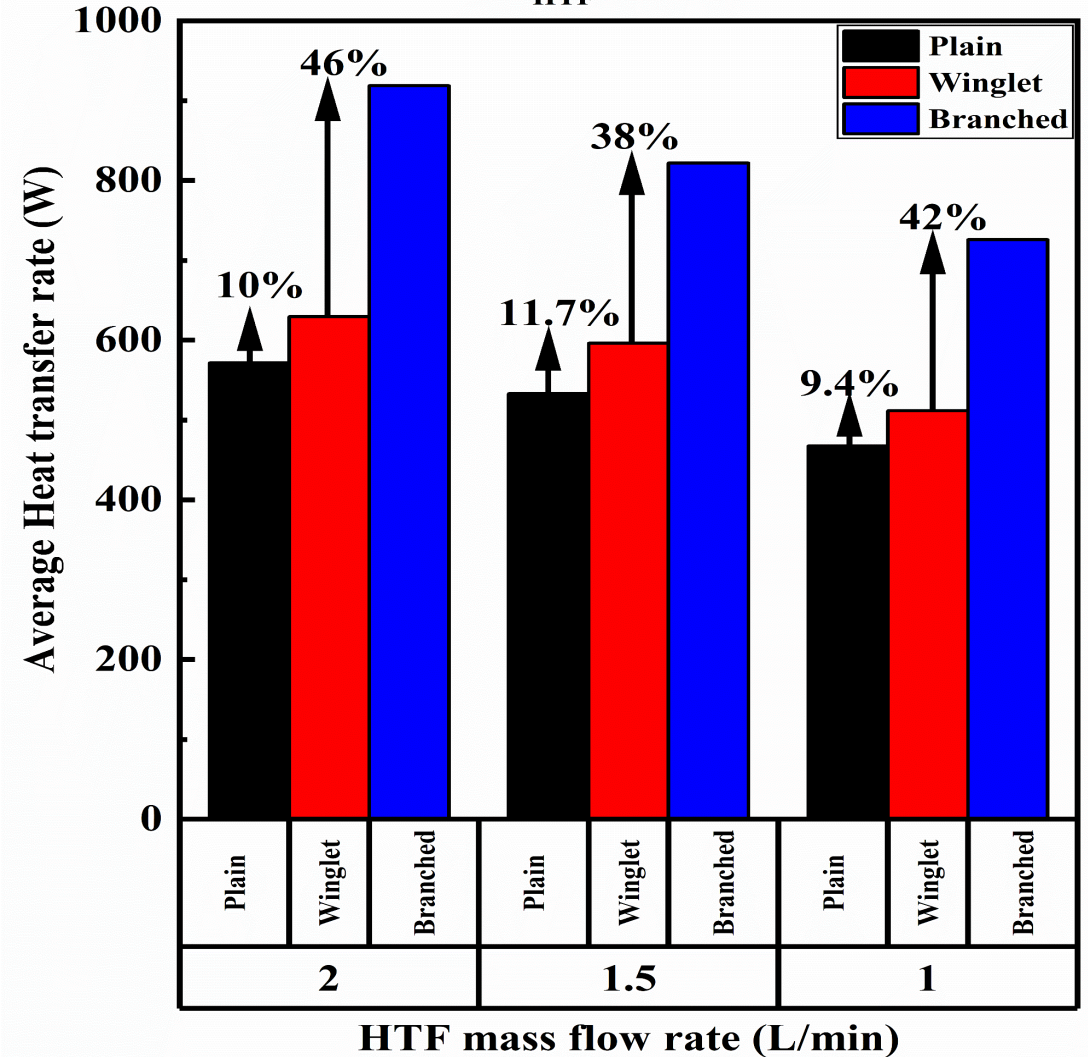
Discharging time

$T_{HTF}: 20\text{ }^{\circ}\text{C}$

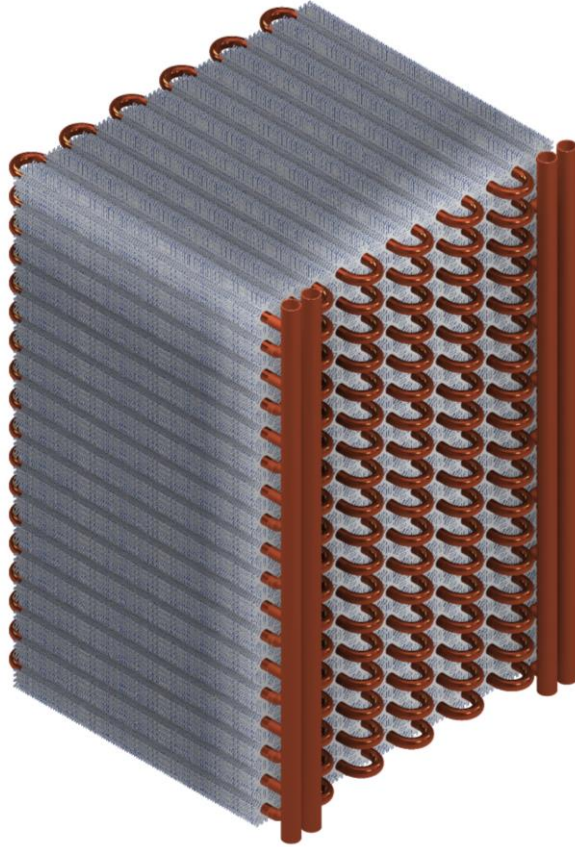


Time averaged heat transfer rate

$T_{HTF}: 20\text{ }^{\circ}\text{C}$



Future Research



**TES prototype
(under construction)**



Under counter Fridge

Small Form Factor

- Suitable for Smaller residences and flats where reduced space is an issue
- More Compact
- High Efficiency
- Low losses
- 9 kWh capacity

Thank you..

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