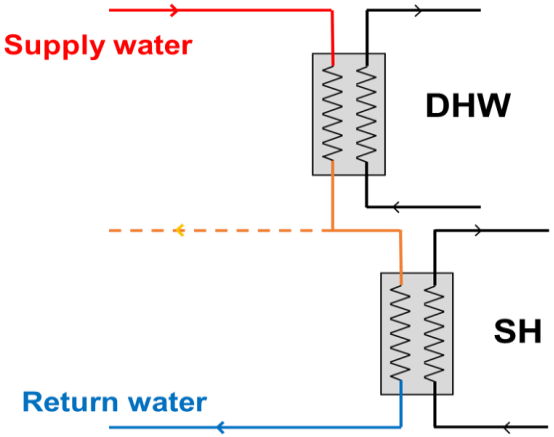
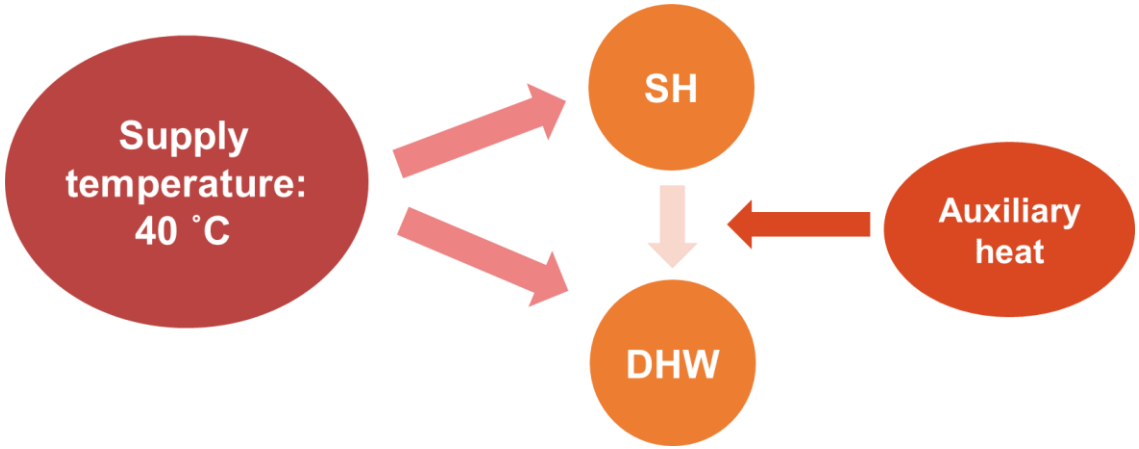
INTRODUCTION

Cascaded Heat Supply

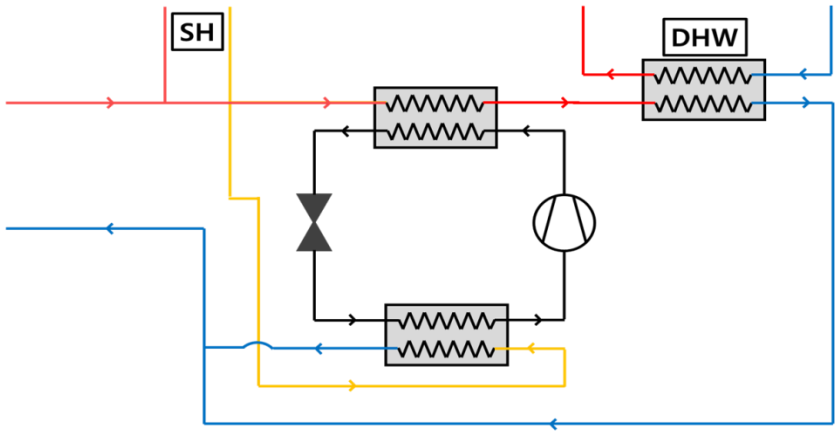


- More energy-efficient way
- Low return temperature
- Auxiliary heat supplier is needed
- However if the system is poorly designed, cascaded heat supply would cause more energy use

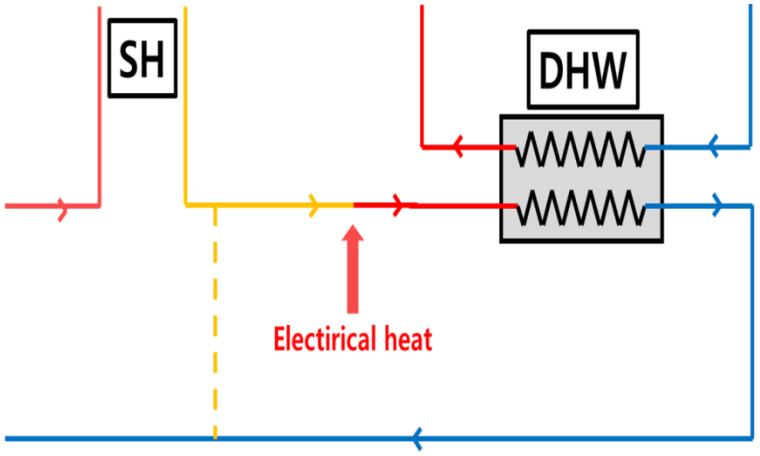
→ It is important to determine how to design the cascaded heat supply and how to control the auxiliary heat supply



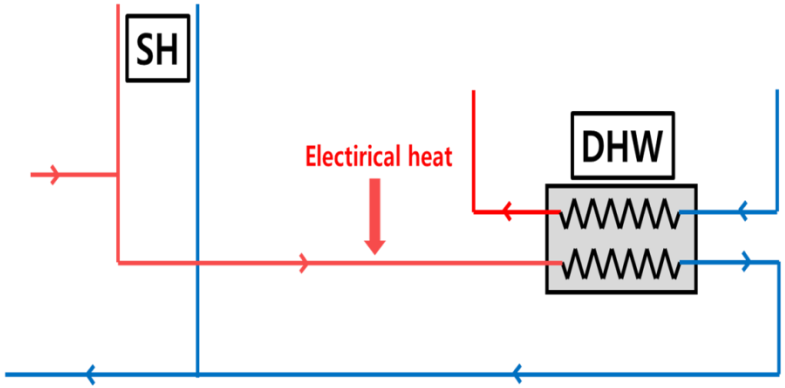
System Configurations



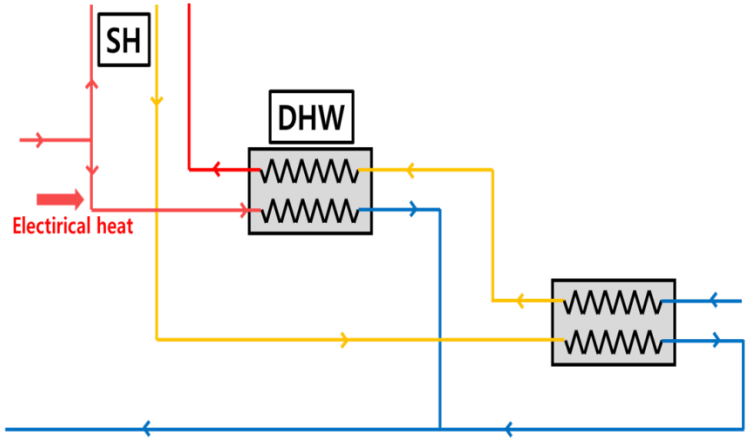
S1: heat pump with cascade



S2: electrical heater with cascade



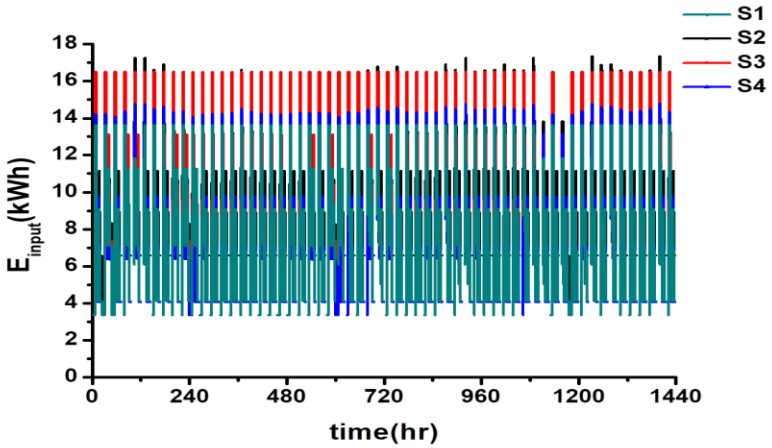
S3: electrical heater without cascade

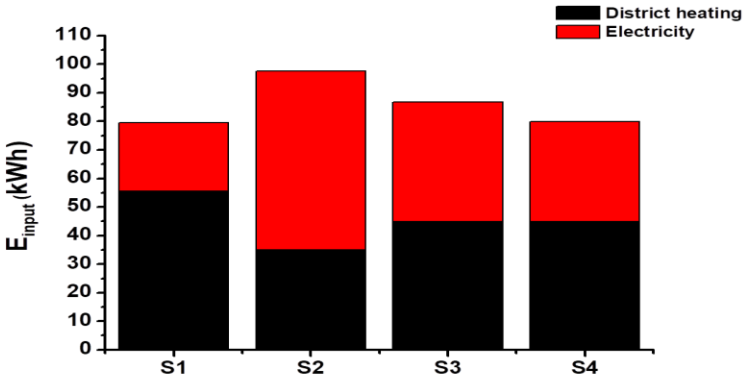


S4: electrical heater with cascade for preheat

Results

Primary energy use

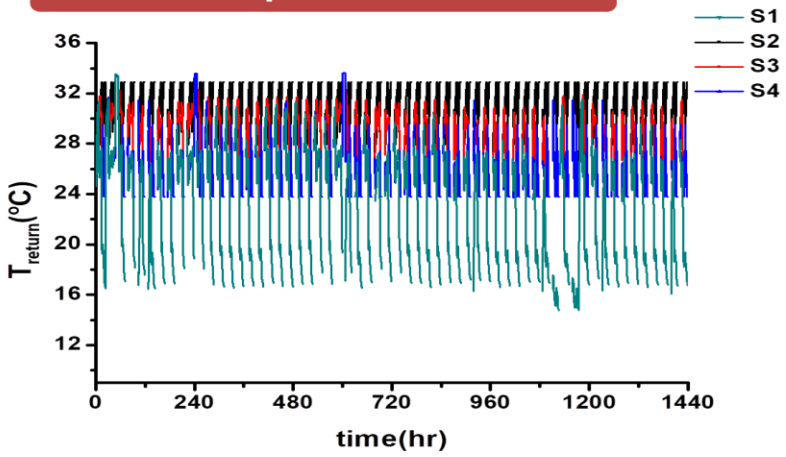




Scenario	Peak energy input(kWh)	Accumulated energy input(kWh)
S1	9.12	79.5
S2	17.3	97.5
S3	16.5	86.8
S4	14.7	79.8

- Although S1 needs more mass flow for heat source of heat pump, S1 shows the best system performance
- As shown in S3 and S4, the cascaded heat supply yields more benefit in the point of view of energy use

Return temperature



Scenario	Return temperature(°C)	Heat loss(W/m)
S1	22.6	8.77
S2	30.95	10.49
S3	27.78	9.84
S4	26.26	9.53

- S1 has the lowest return temperature because of heat pump and cascaded heat supply
- S4 has lower return temperature than S3 because of cascaded heat supply