# PCM storage systems for air temperature control and hot water to increase building energy autonomy

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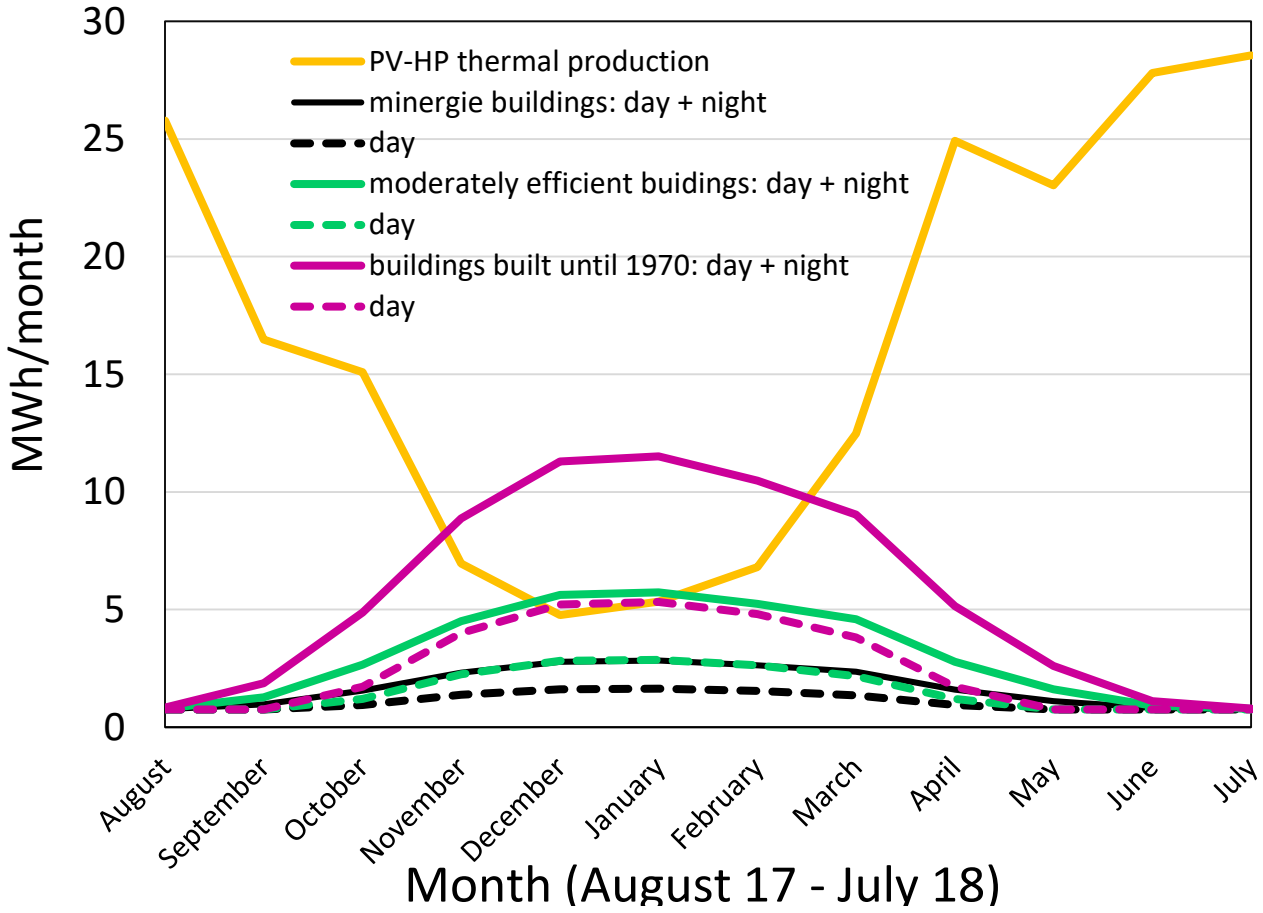
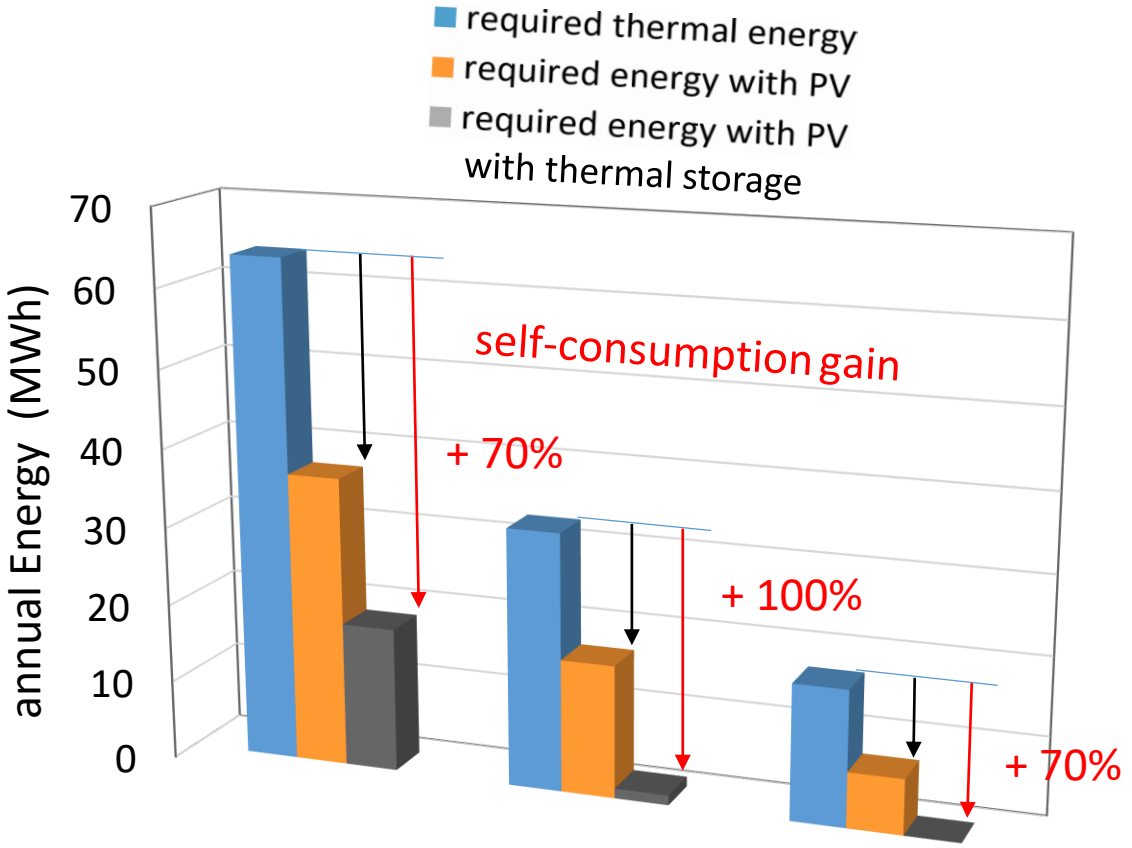
# Introduction

- In Switzerland, 1/3 of the total energy consumption corresponds to buildings heating.
- Renewable energy in particular photovoltaic is growing fast. The production peak corresponds however to periods of low heating requirements.

Thermal storage is advantageous
and PCM is one solution

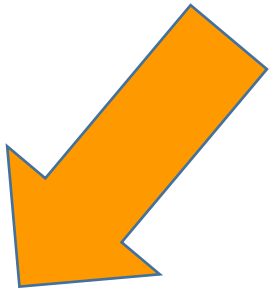
# PV thermal power and energy consumption

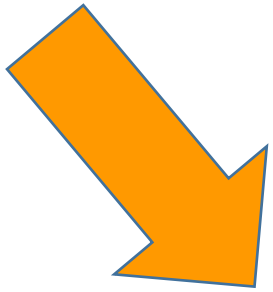


# Thermal storage

**PCM**

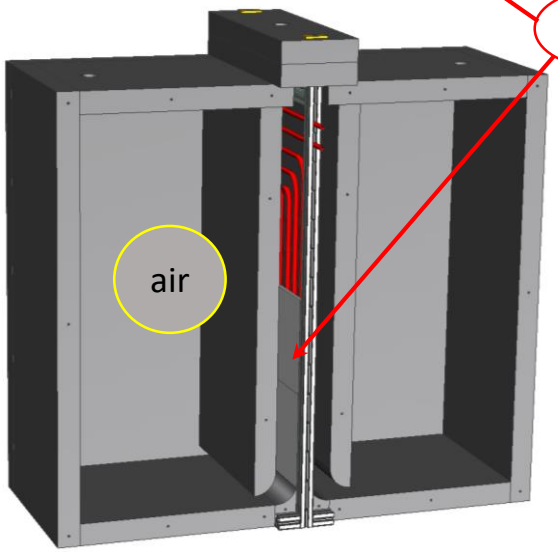




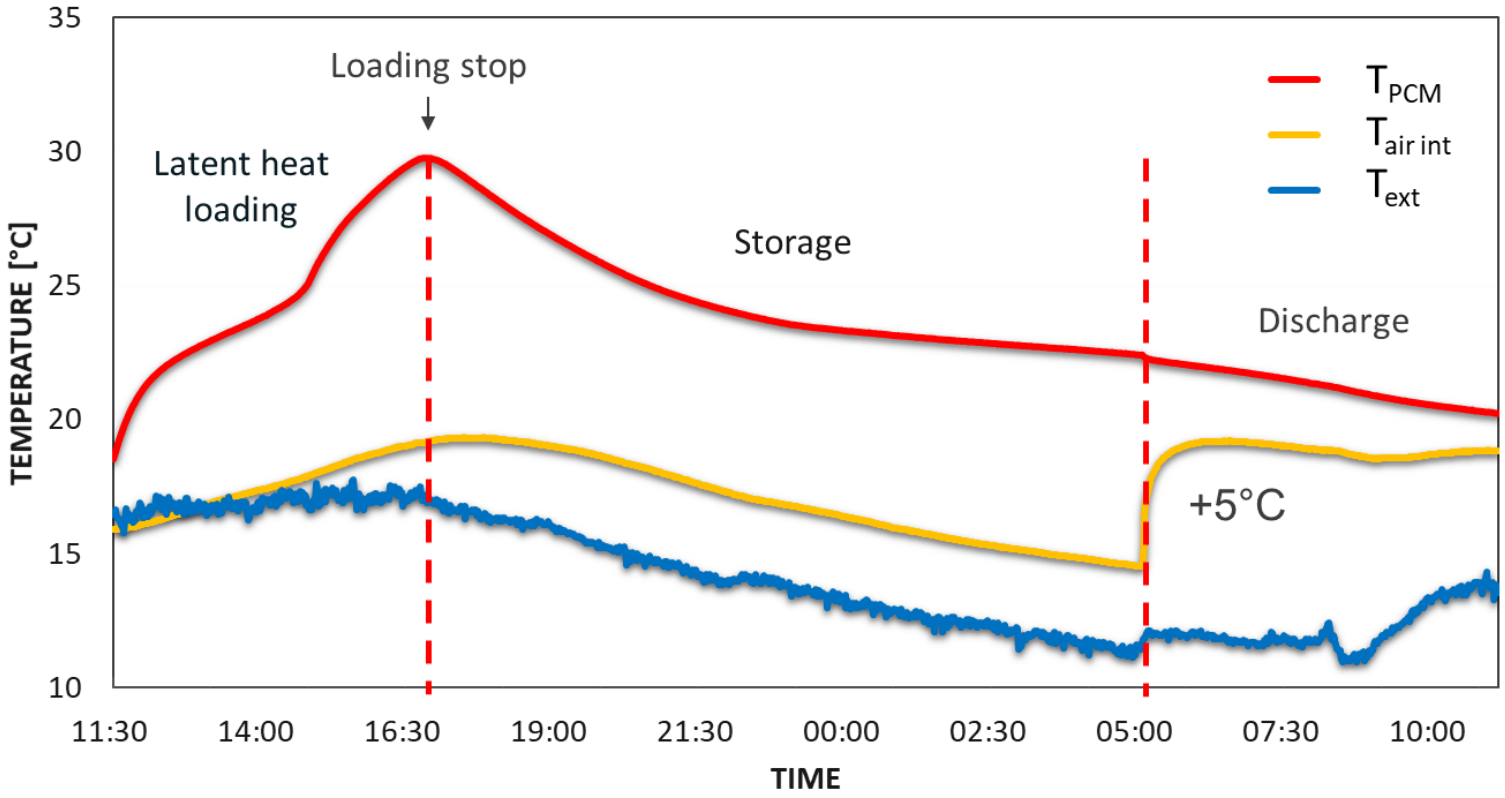
**Air temperature control**

**Hot water**

# PCM Walls : measurements results

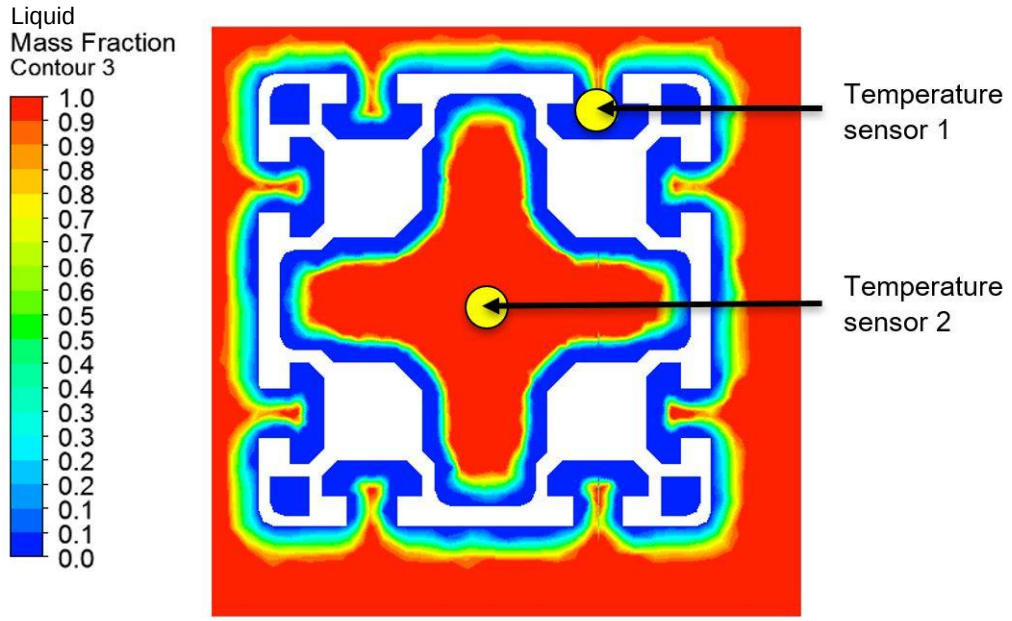


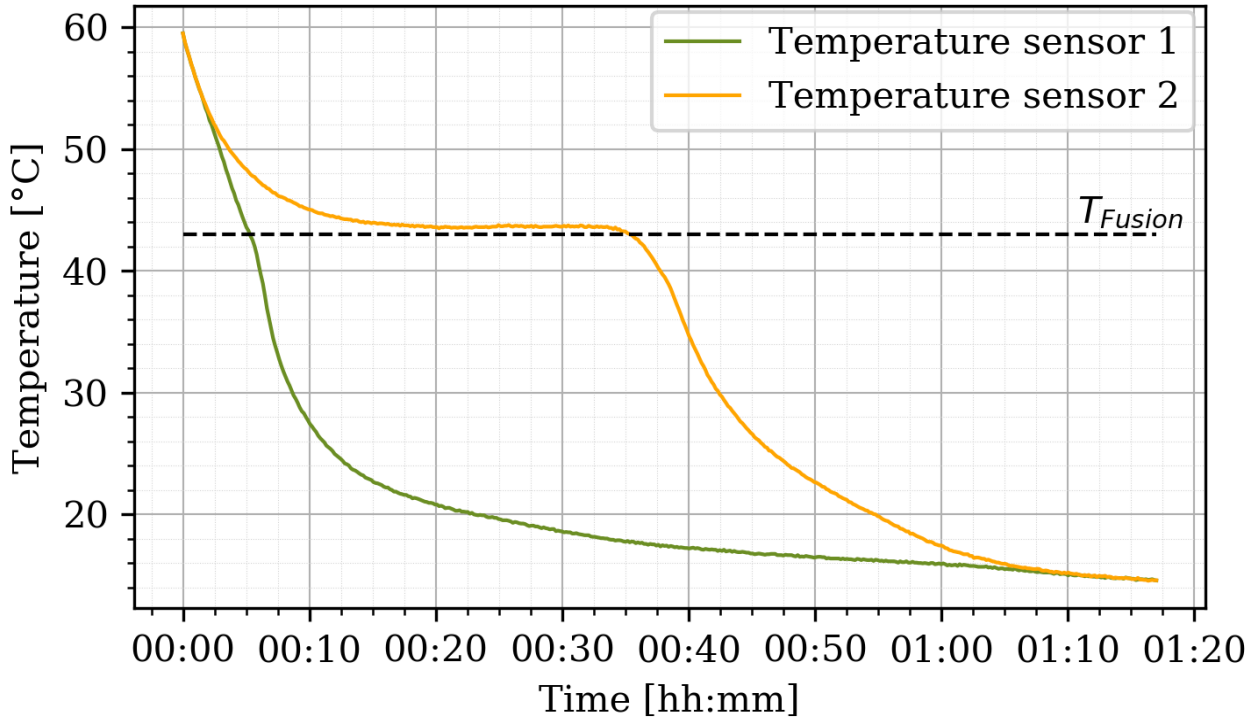

## PCM, external and internal air temperatures



# Hot water storage system: simulations and measurements

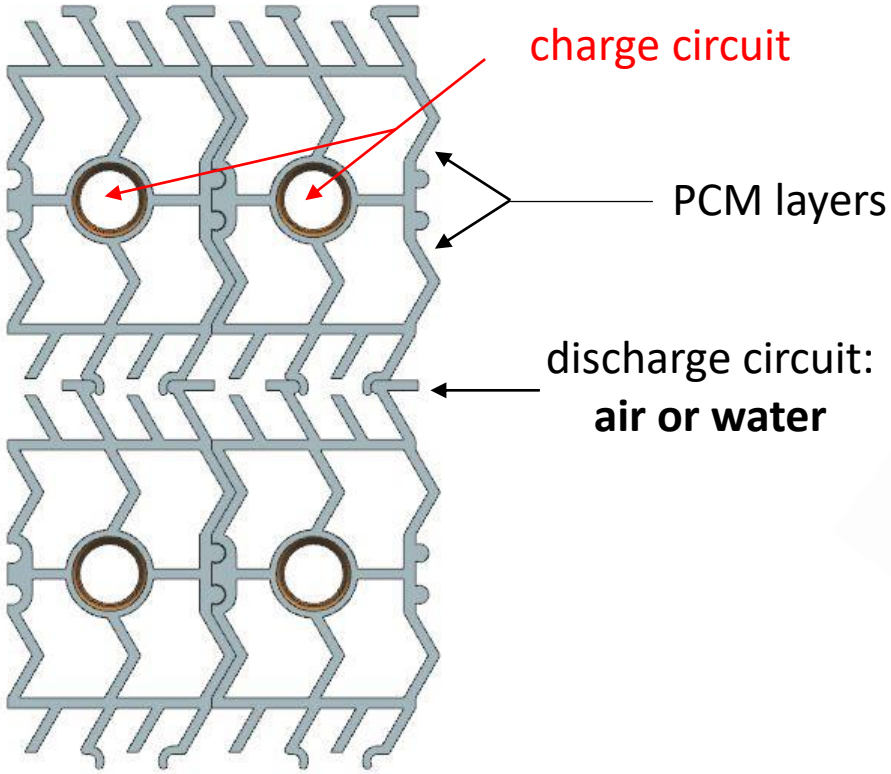
30x30 cm cross-section of a 2m high PCM Heat-Exchanger

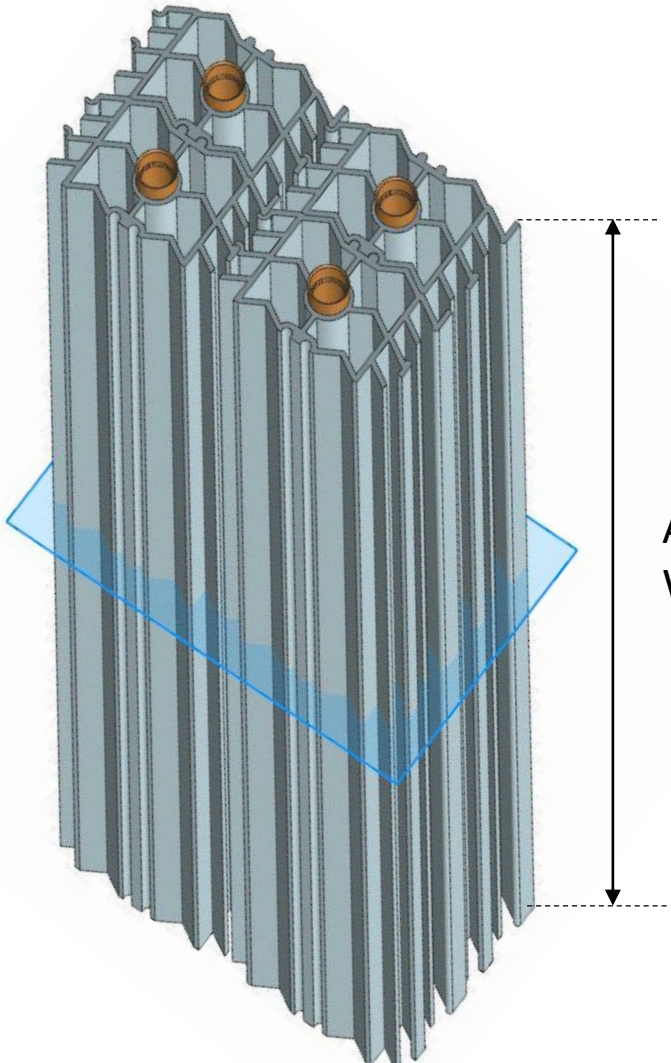


# Wich PCM Module is optimal for water or air heating ?

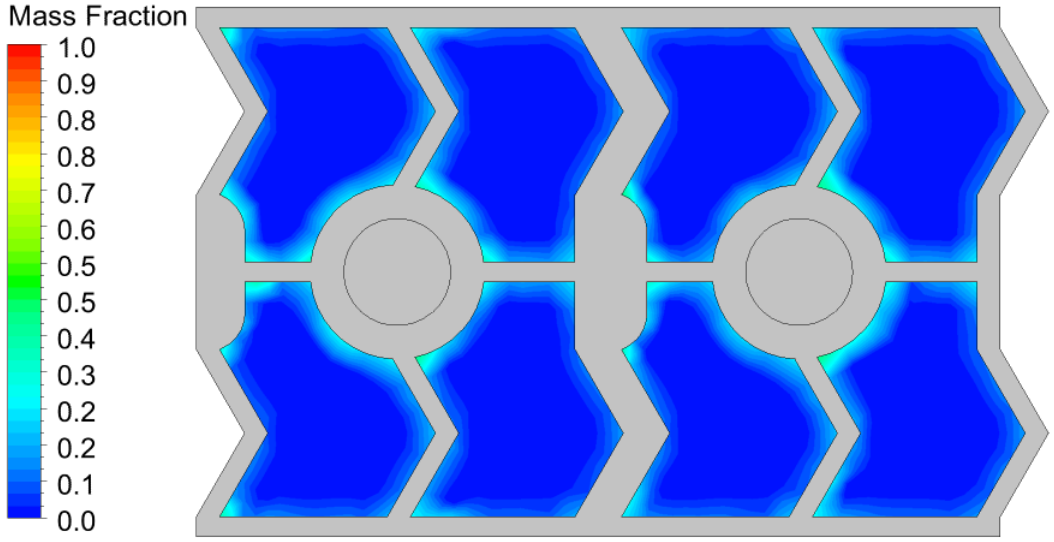
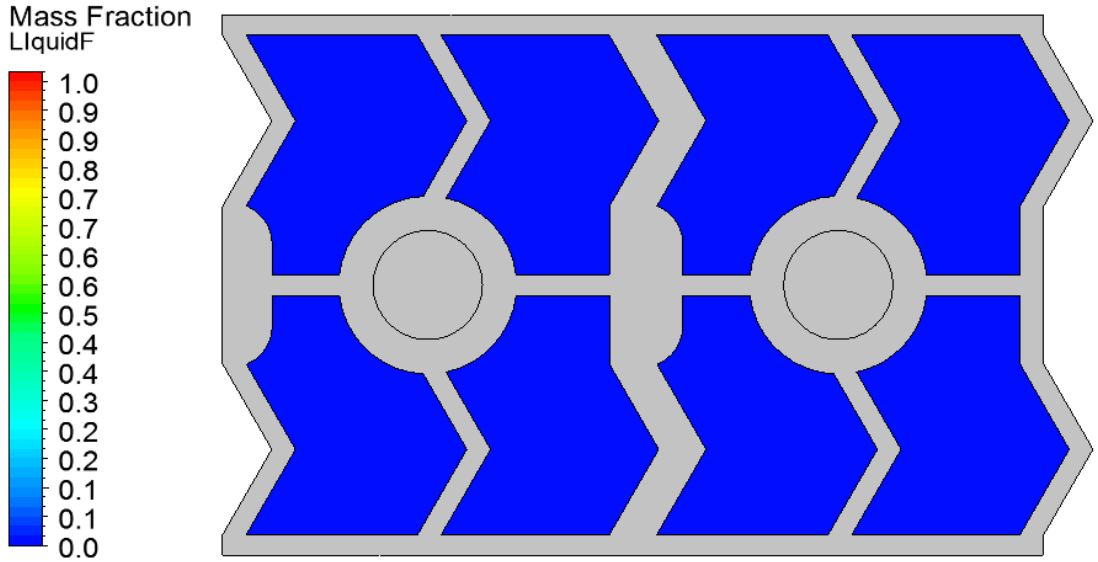
One structure → water-PCM-water or air-PCM-water heat exchanger



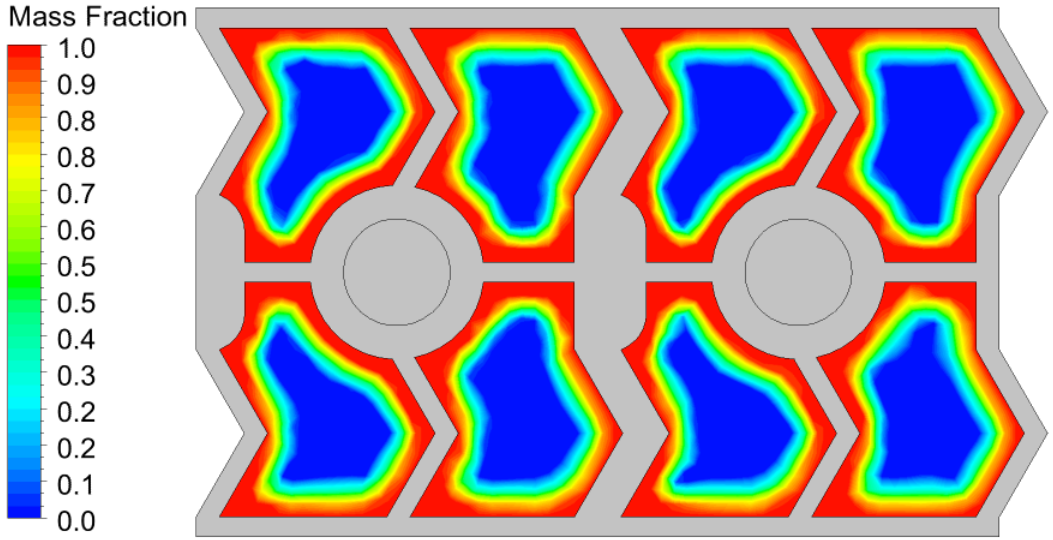
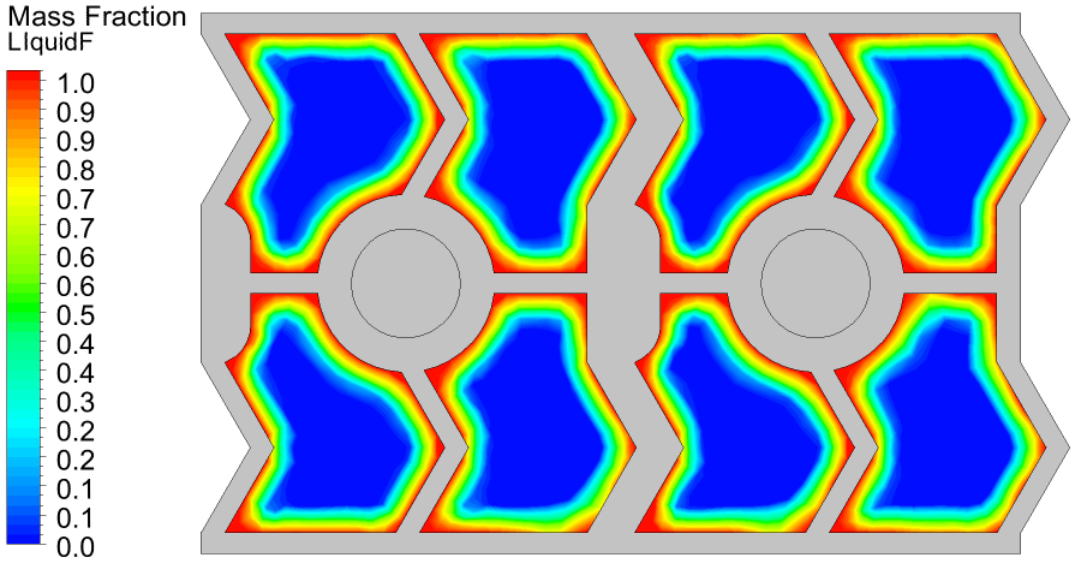



Air structure: 0.5m
Water structure: 2m

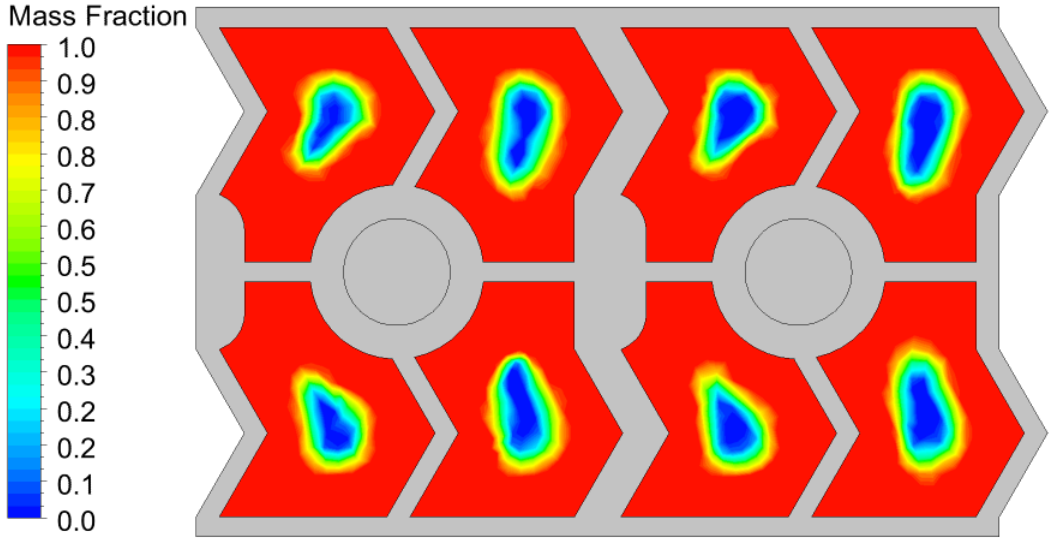
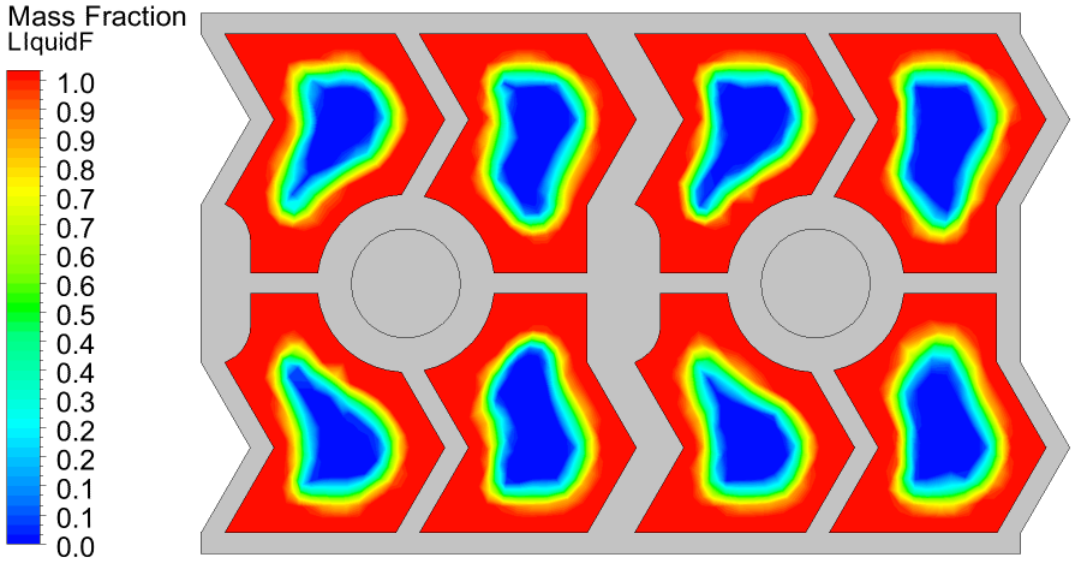
# PCM charge – after 1 minute

| | Air-PCM-Water | Water-PCM-Water |
|---|---|---|
| Fraction of liquid PCM |  |  |
| | $T_{fusion}$ = 23°C<br>Heating flow at 35°C | $T_{fusion}$ = 43°C<br>Heating flow at 50°C |

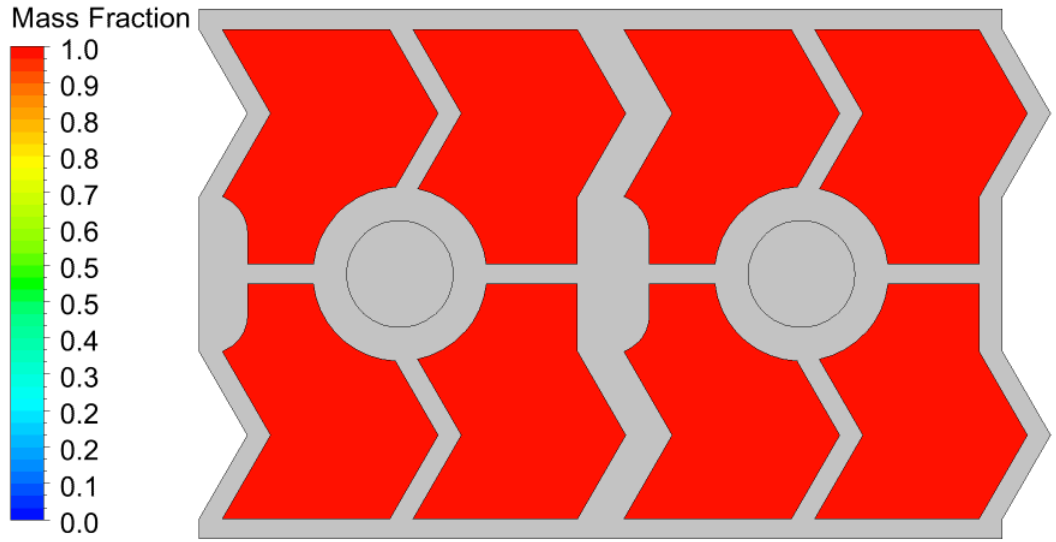
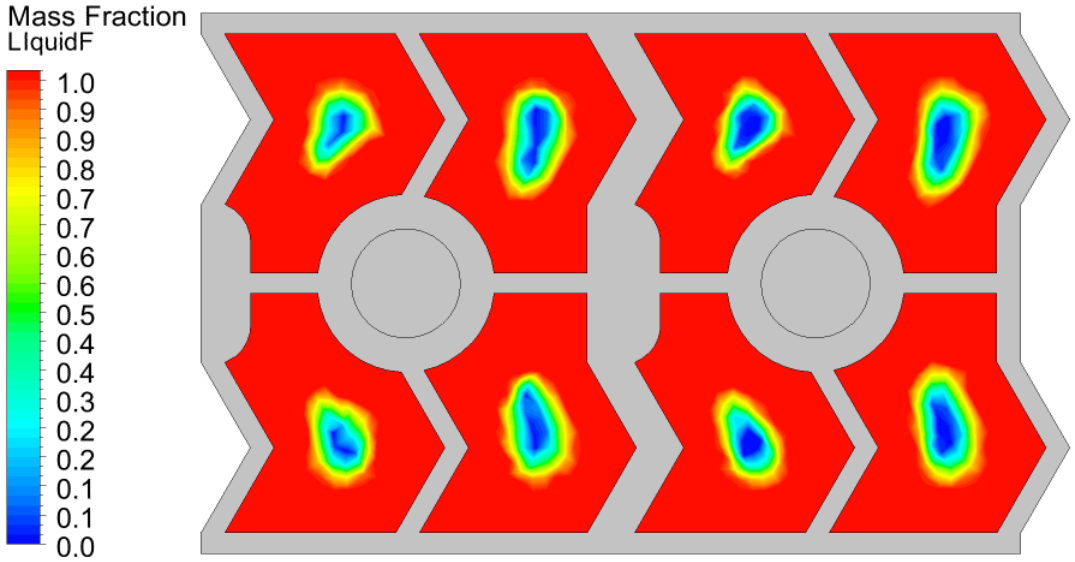
# PCM charge – after 10 minutes

| | Air-PCM-Water | Water-PCM-Water |
|---|---|---|
| Fraction of liquid PCM |  |  |
| | $T_{fusion}$ = 23°C<br>Heating flow at 35°C | $T_{fusion}$ = 43°C<br>Heating flow at 50°C |

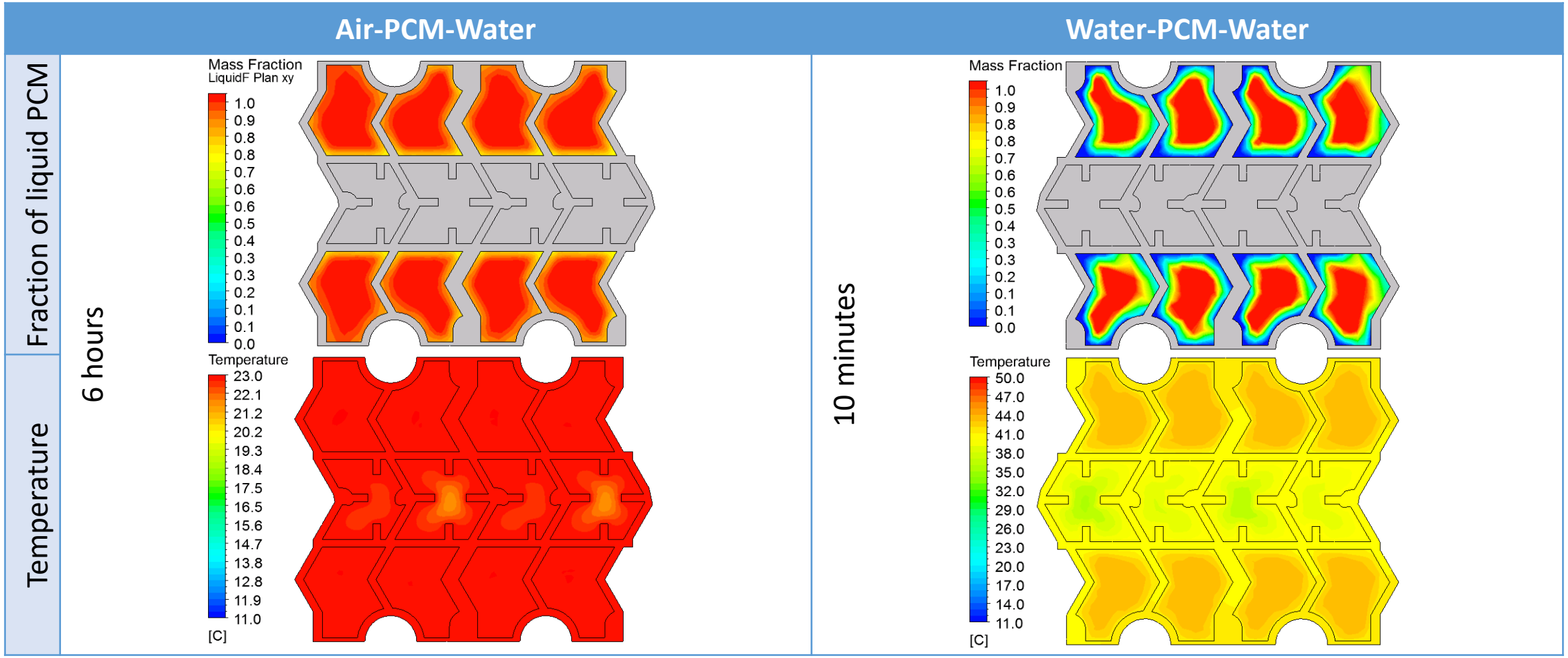
# PCM charge – after 25 minutes

| | Air-PCM-Water | Water-PCM-Water |
|---|---|---|
| Fraction of liquid PCM |  |  |
| | $T_{fusion}$ = 23°C<br>Heating flow at 35°C | $T_{fusion}$ = 43°C<br>Heating flow at 50°C |

# PCM charge – after 40 minutes

| | Air-PCM-Water | Water-PCM-Water |
|---|---|---|
| Fraction of liquid PCM |  |  |
| | $T_{fusion}$ = 23°C<br>Heating flow at 35°C | $T_{fusion}$ = 43°C<br>Heating flow at 50°C |

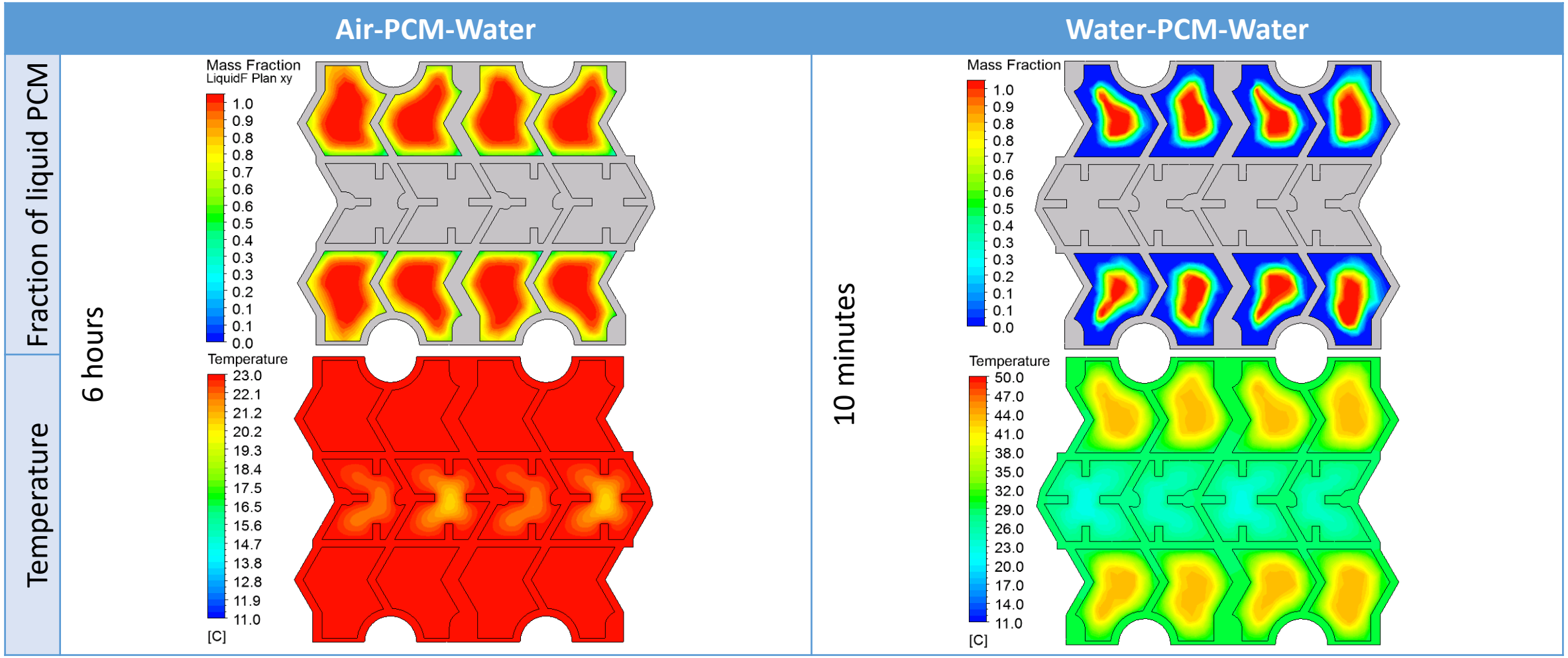
# PCM discharge




$T_{fusion}$ = 23°C

$T_{fusion}$ = 43°C

# PCM discharge




$T_{fusion}$ = 23°C

$T_{fusion}$ = 43°C

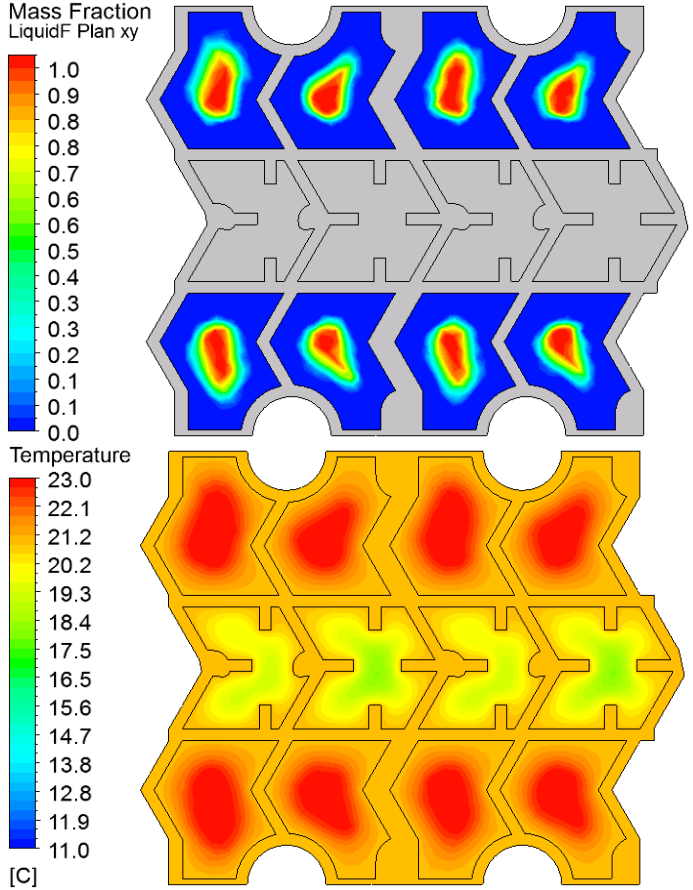
# PCM discharge

## Air-PCM-Water

Fraction of liquid PCM

Temperature

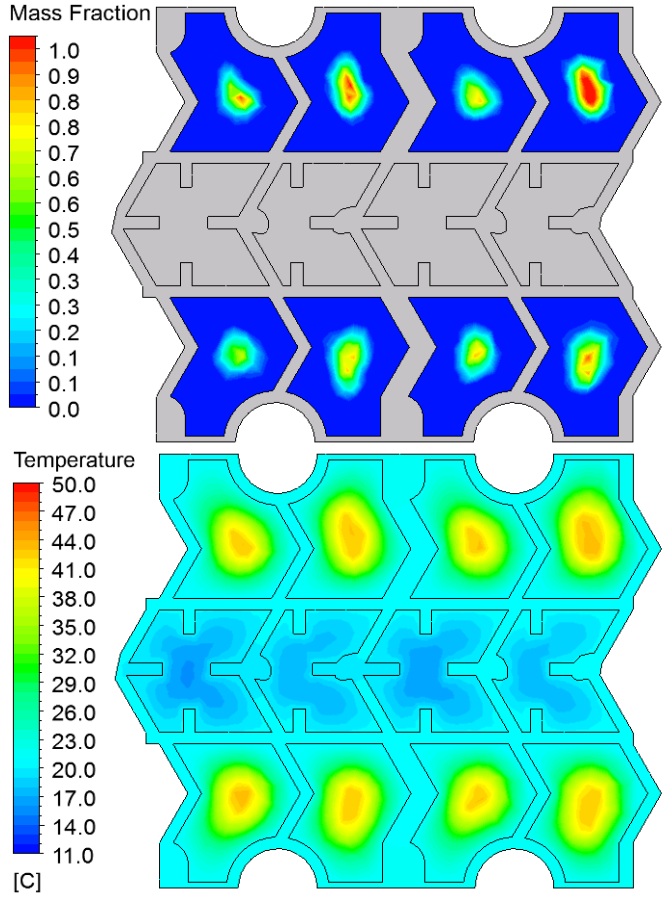
9 hours




$T_{fusion}$ = 23°C

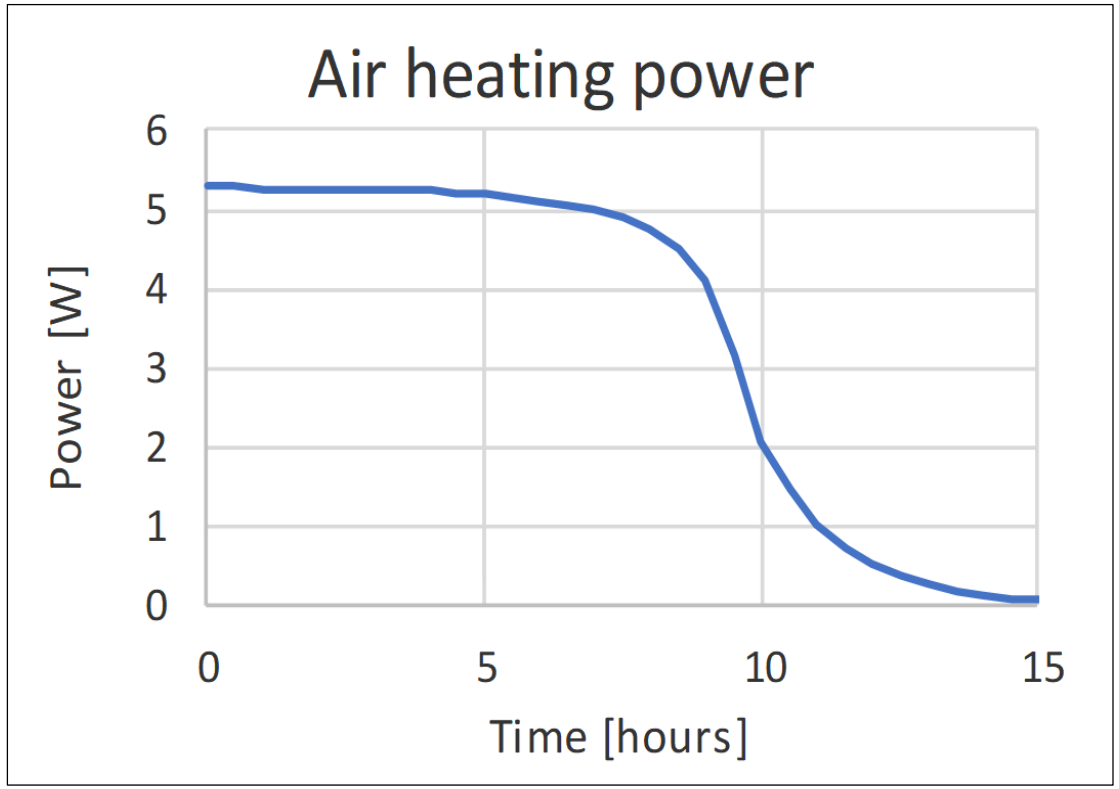
## Water-PCM-Water

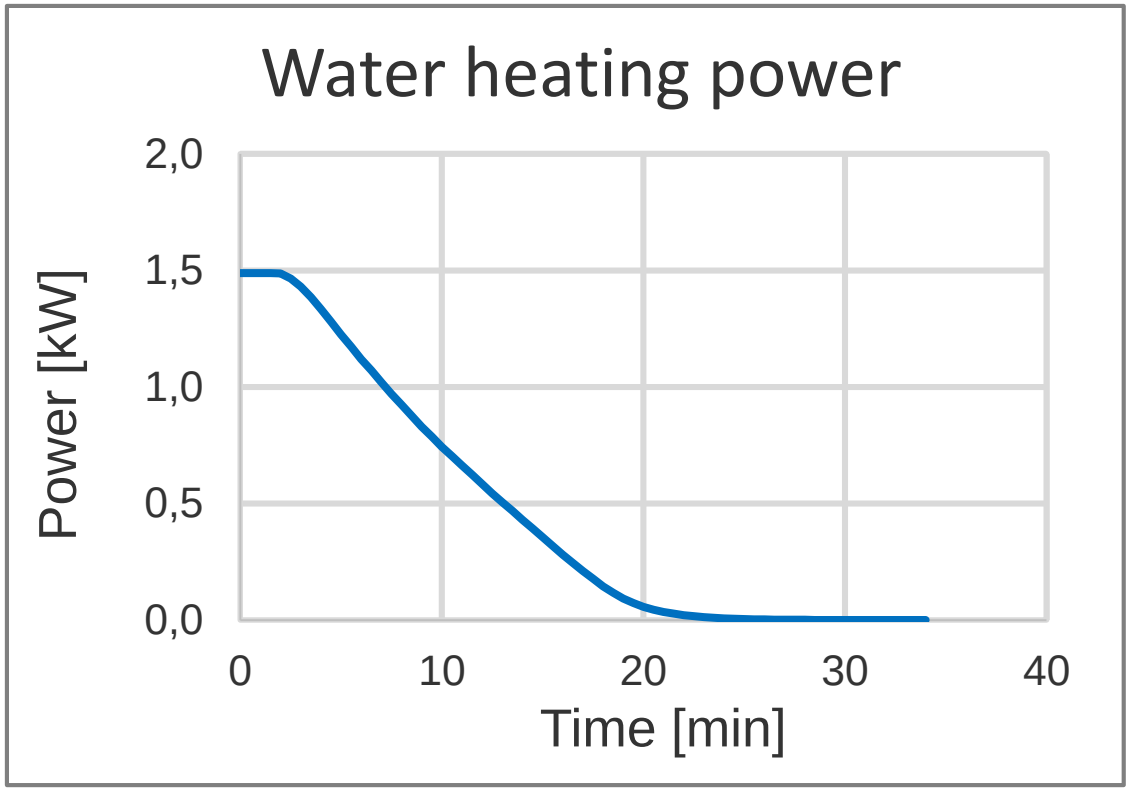
15 minutes




$T_{fusion}$ = 43°C

# Discharge power of a 6x6 cm cell



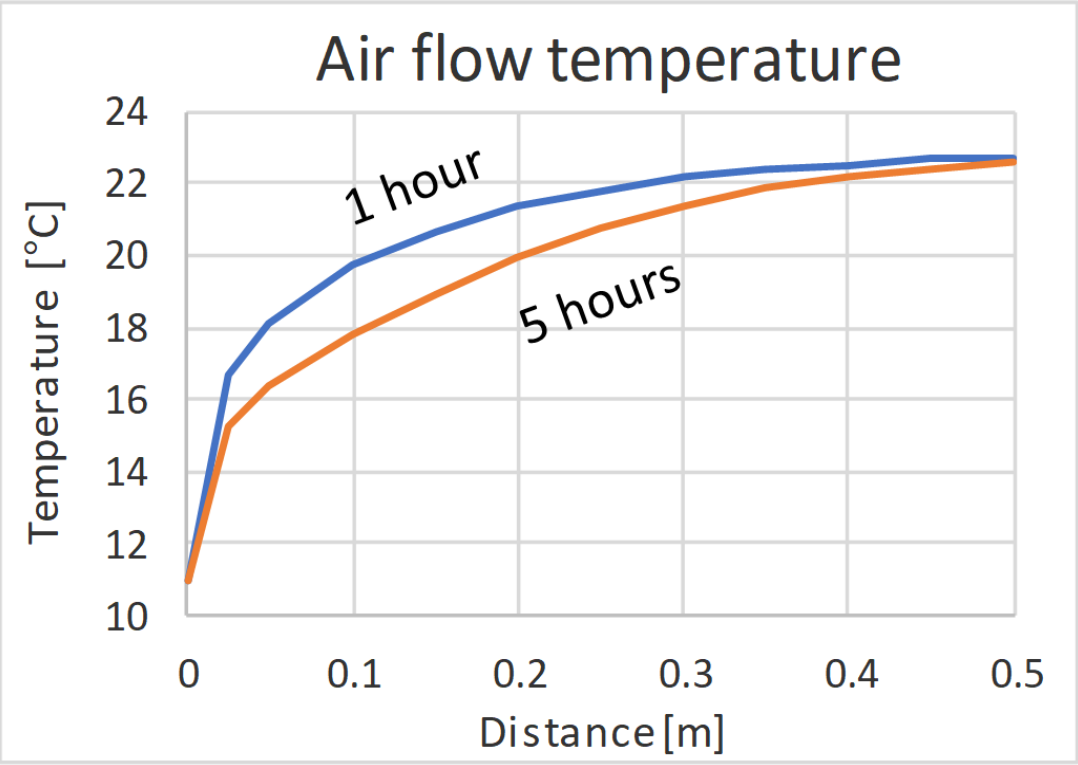



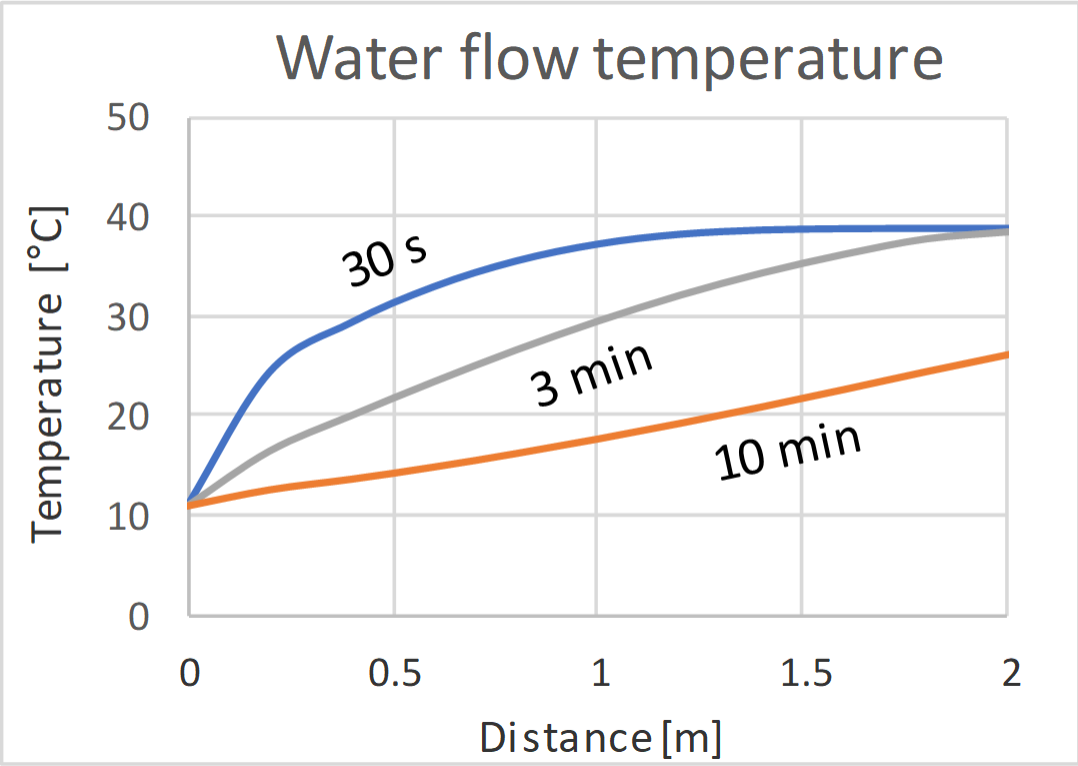

| Exchanger of 0.225 m³ | Discharge Power | Duration |
|---|---|---|
| air-PCM-water heat exchanger | 600 W | 8 hours |
| water-PCM-water heat exchanger | 15 kW | 13 minutes |

Note air and water PCM Heat exchanger have 0.5m and 2m height, respectively

# Flow Temperature profile

- Power remain constant as long as the flow reaches its maximal temperature within the heat exchanger.
- It continuously drops afterwards



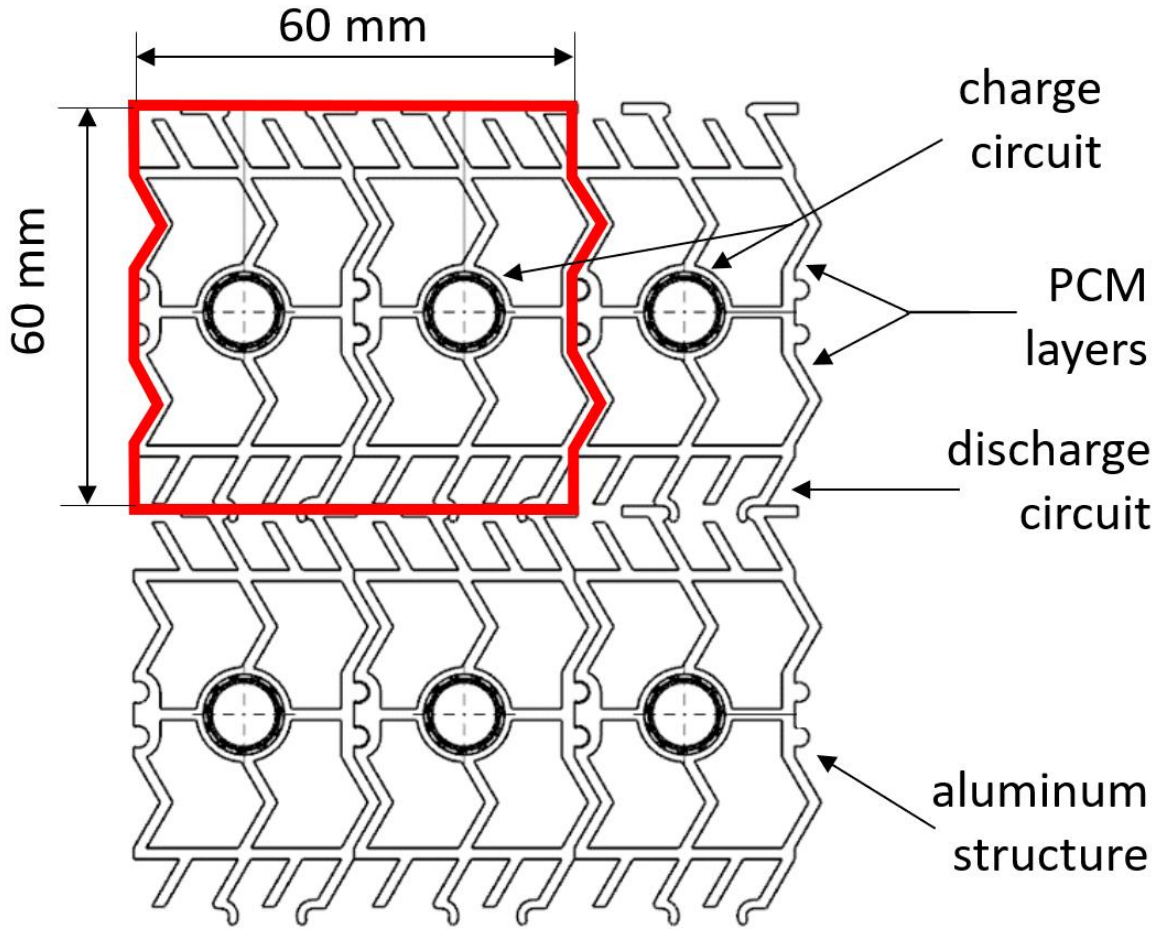



# Conclusion

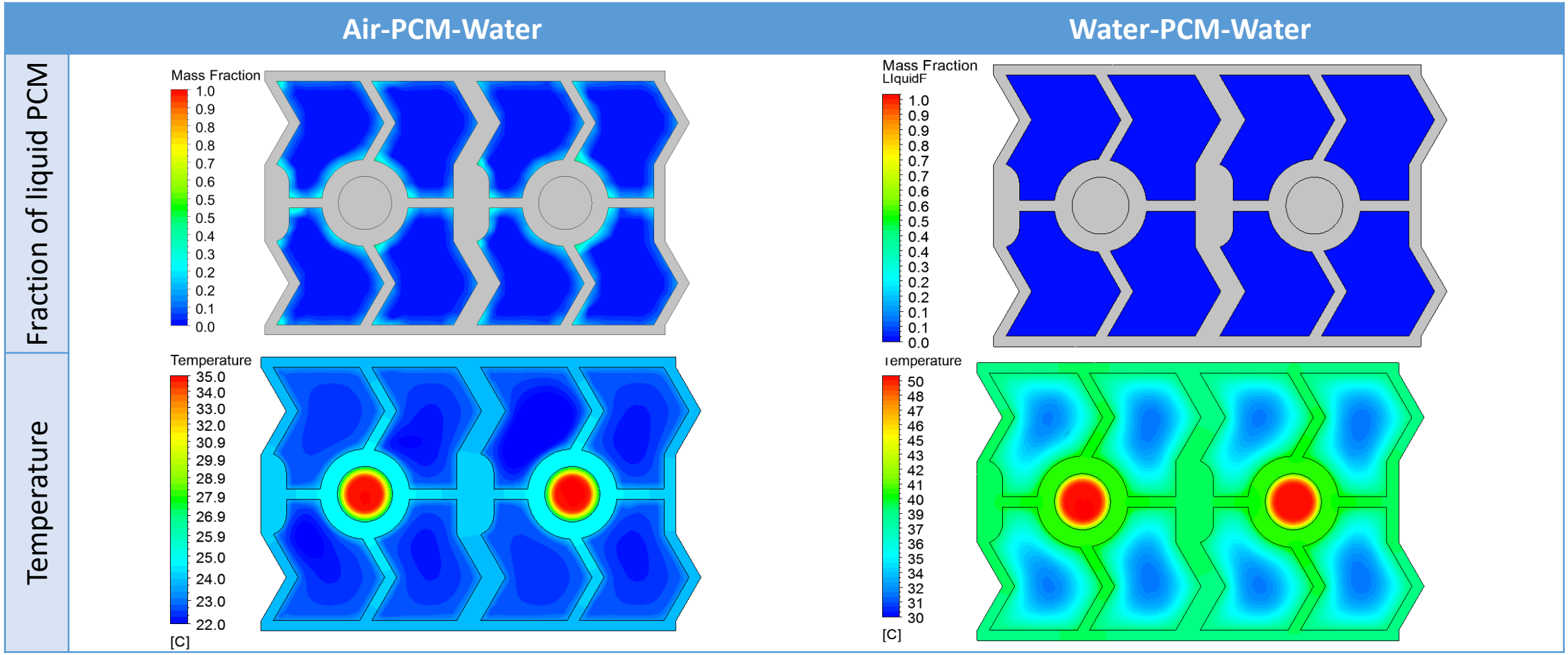
- Thermal storage is a key solution to increase the energy autonomy of buildings equipped with solar panels.
- PCM storage is one solution and it can be used for air heating/cooling and domestic hot water.
- ANSYS simulations of the proposed PCM structures show 2.6 kW/m$^3$ heating powers for air and 65 kW/m$^3$ for water and a storage capacity of 28 kWh/m$^3$ and 37 kWh/m$^3$, respectively.
- The efficiency predicted by the simulations must still be verified by in situ experiments.

# Back up slides

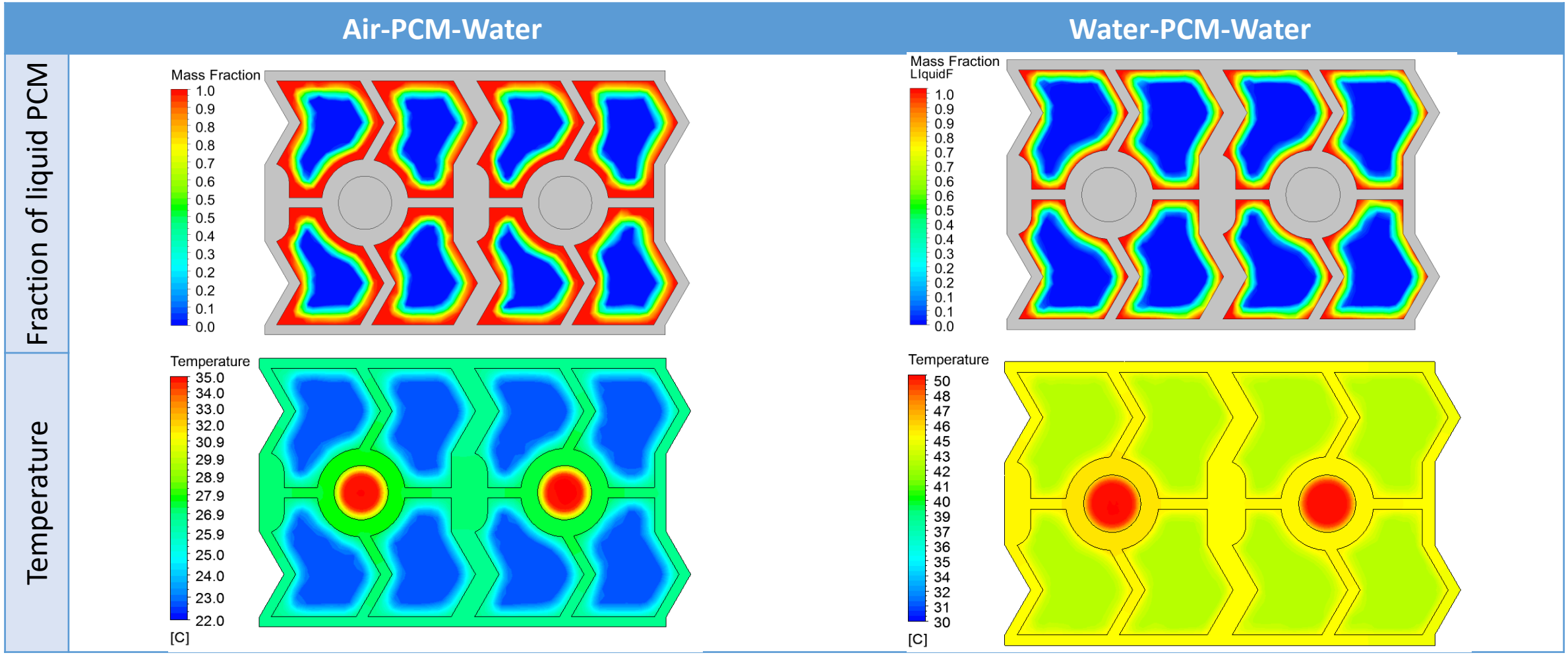
# PCM Cell Structure



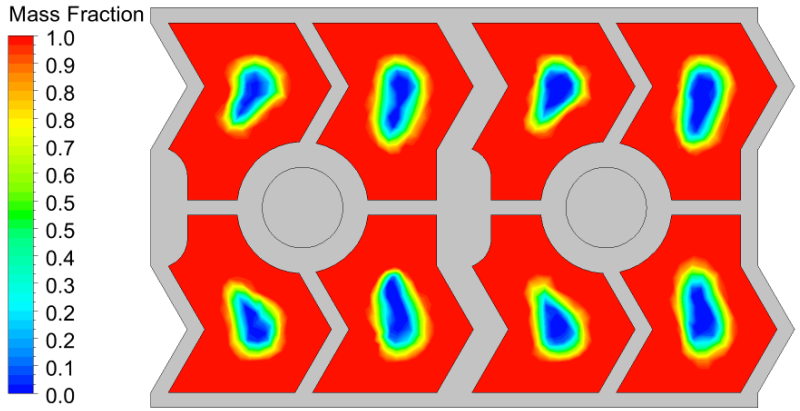
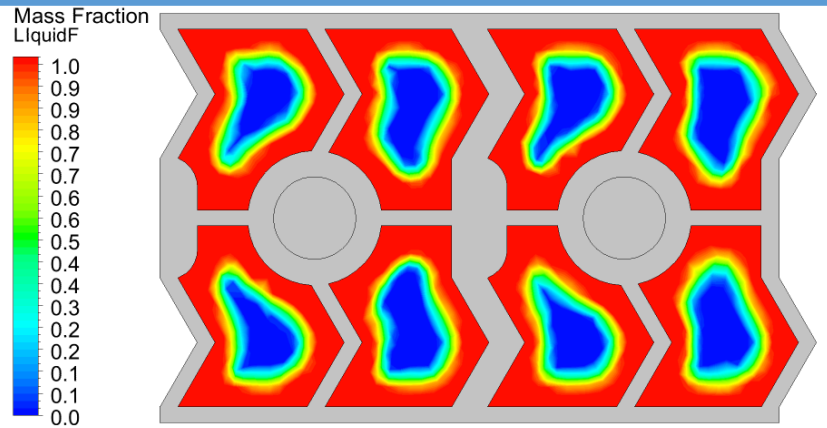
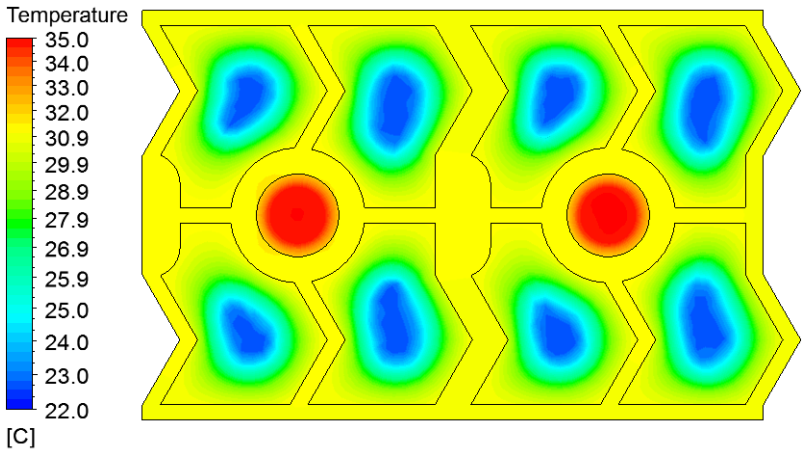
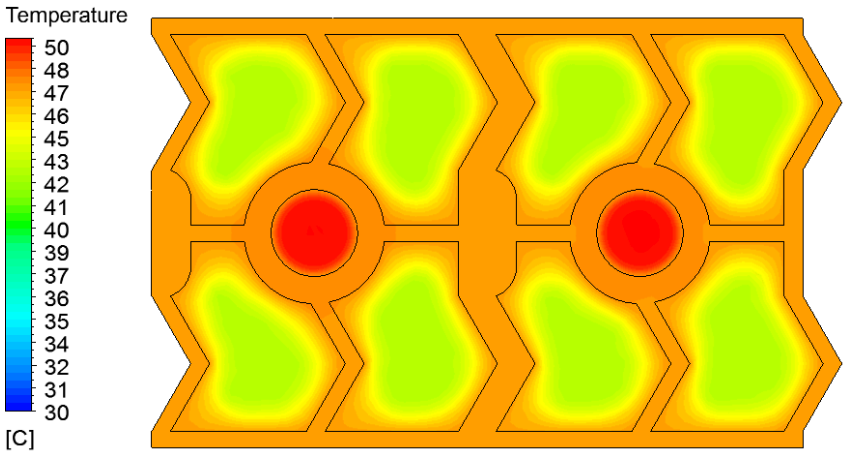
# PCM charge – after 1 minute



# PCM charge – after 10 minutes



# PCM charge – after 25 minutes

| | Air-PCM-Water | Water-PCM-Water |
|---|---|---|
| Fraction of liquid PCM |   |   |
| Temperature |   |   |

# PCM charge – after 40 minutes