D2EPC

Building performance assessment towards Next generation EPCs

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High capacity thermal storage solution to increase energy efficiency in residential settings

Carlos Ochoa

International Energy Research Centre (IERC), Ireland

Session 1: Smart buildings and energy efficiency

Brief Introduction

- System developed in the context of a Horizon 2020 call for residential thermal storage.
- Project is named “MiniStor”, led by IERC with participation of partners from the EU and Switzerland.

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 869821

Main objective of the system

- Develop a compact residential thermal storage system based on thermochemical materials

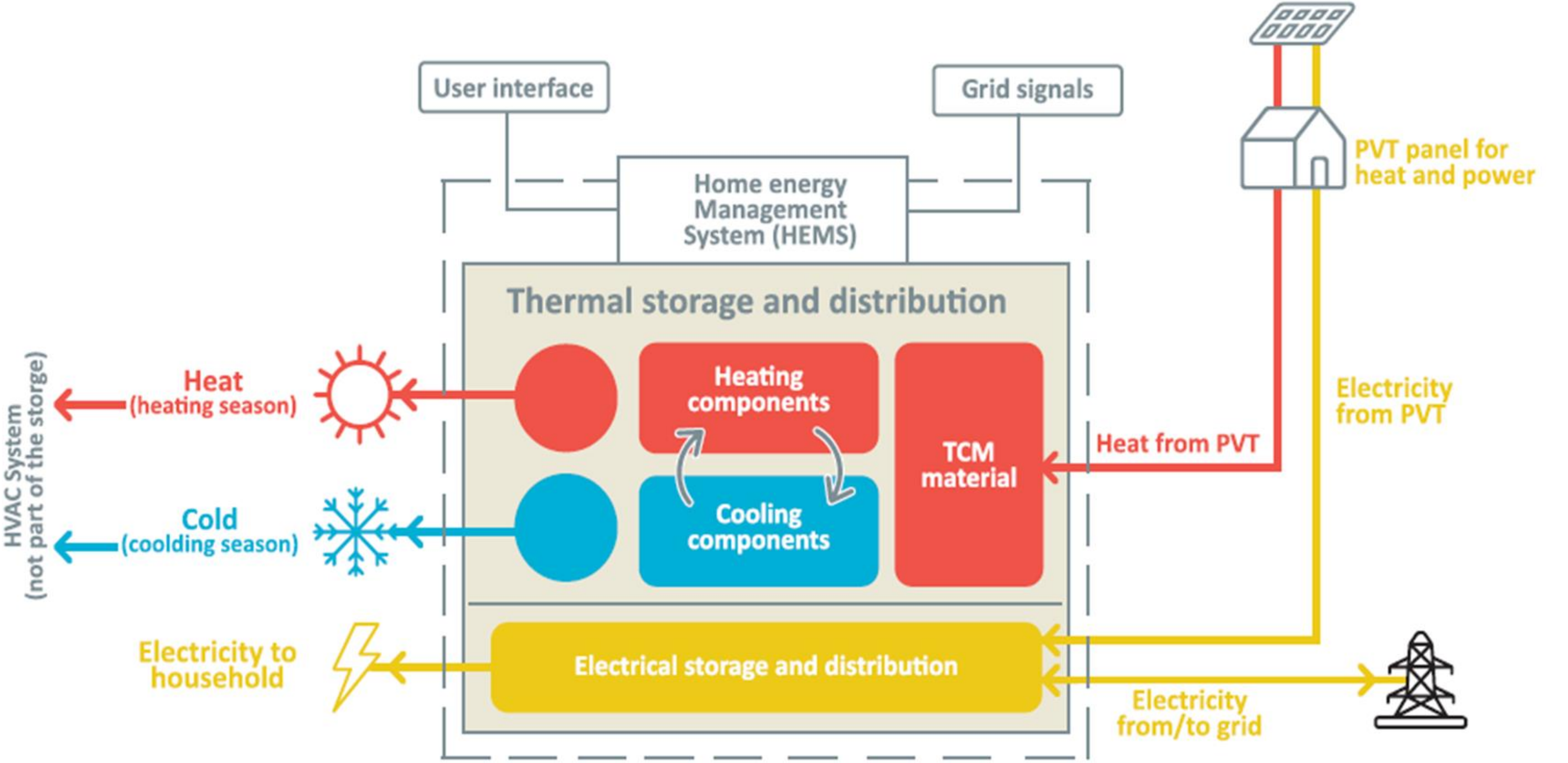
Other aims:

1. **10.6x storage capacity of water**
   Using PVT to power the process
2. **0.72m3 storage material**
   Flexibility with parallel use of TCM and PCM
3. **Payback period 6.7 years**
   Estimated net energy reduction of 44%
4. **Combine thermal & electric storage**
   Using a Home Energy Management System

System Overview

- ✓ **MiniStor** is a **compact, integrated system** capable of providing sustainable **heating, cooling and electricity storage**, while utilizing solar-based **renewable energy sources**.
- ✓ It combines two different storage technologies:
- **Thermochemical materials (TCM),** storing heat in the form of chemical energy. They are contained in a sealed vessel (TCM reactor) and used for daily and multi-day energy storage.
- **Phase Change Materials (PCM),** storing energy in the form of latent heat. They are used for supplementary heating and cooling storage.
- ✓ This configuration results in an overall system **energy storage density of over 180 kWh/m^3,** i.e. more than 10 times the energy storage density of water.
- ✓ The necessary **heat input** to the system is provided by a combination of **innovative PVTs** and solar thermal collectors.
- ✓ The PVTs produce also **electricity** that is stored in an electrical battery system (**BESS)**

The original concept



Main components

TCM reactor (typical capacity 30kWh)

- Ammoniated $CaCl_2$ salts are selected as the reactor sorbents. A two-step reversible reaction is utilized for thermochemical storage.

$$CaCl_2 \cdot 8NH_3 + Heat \leftrightarrow CaCl_2 \cdot 4NH_3 + 4NH_3$$

$$CaCl_2 \cdot 4NH_3 + Heat \leftrightarrow CaCl_2 \cdot 2NH_3 + 2NH_3$$

Ammonia cycle

- Includes all mechanical devices of a typical refrigeration cycle, i.e. compressor, condenser etc.

Heat Pump

- To upgrade heat released by the ammonia condensation

PCM vessels

- Vessels for heating and cooling storage are considered

Solar field & BESS

- Provides the necessary heat input and electricity

Prepared by: Athanasios Nesiadis, Nikolaos Nikolopoulos

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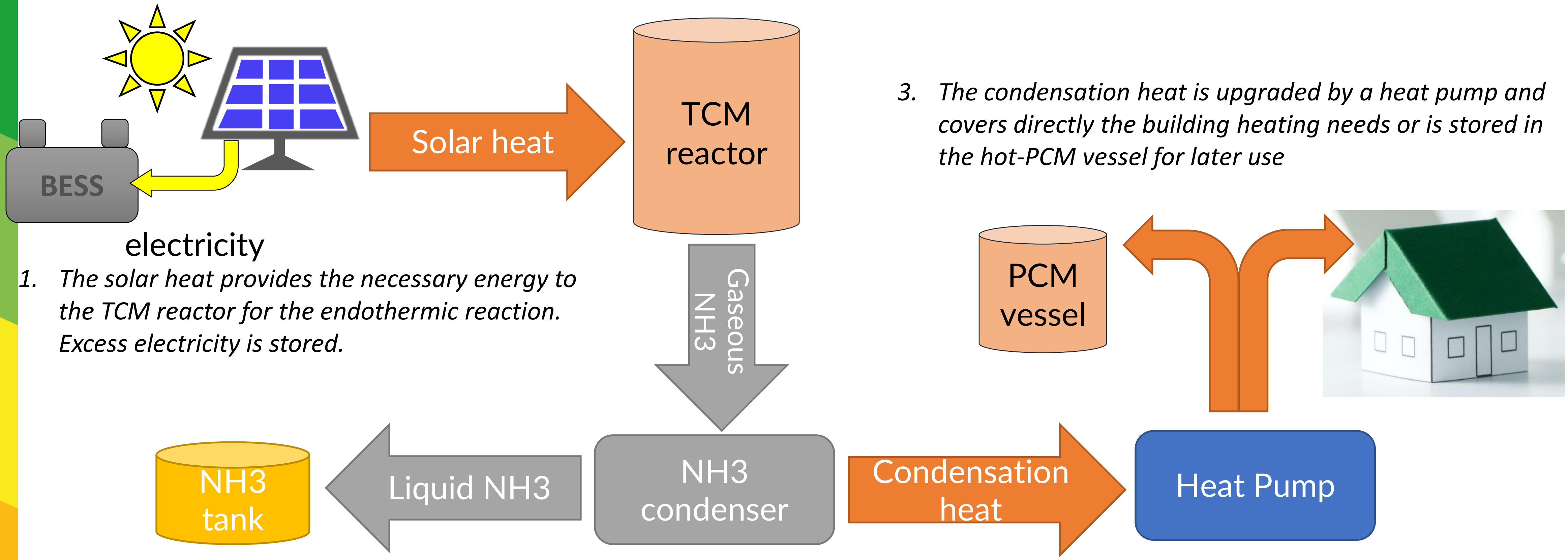
Basic operating principle

Charging Phase (winter & shoulder season days)



1. *The solar heat provides the necessary energy to the TCM reactor for the endothermic reaction. Excess electricity is stored.*
2. *The produced gaseous ammonia is condensed and stored in a tank*
3. *The condensation heat is upgraded by a heat pump and covers directly the building heating needs or is stored in the hot-PCM vessel for later use*

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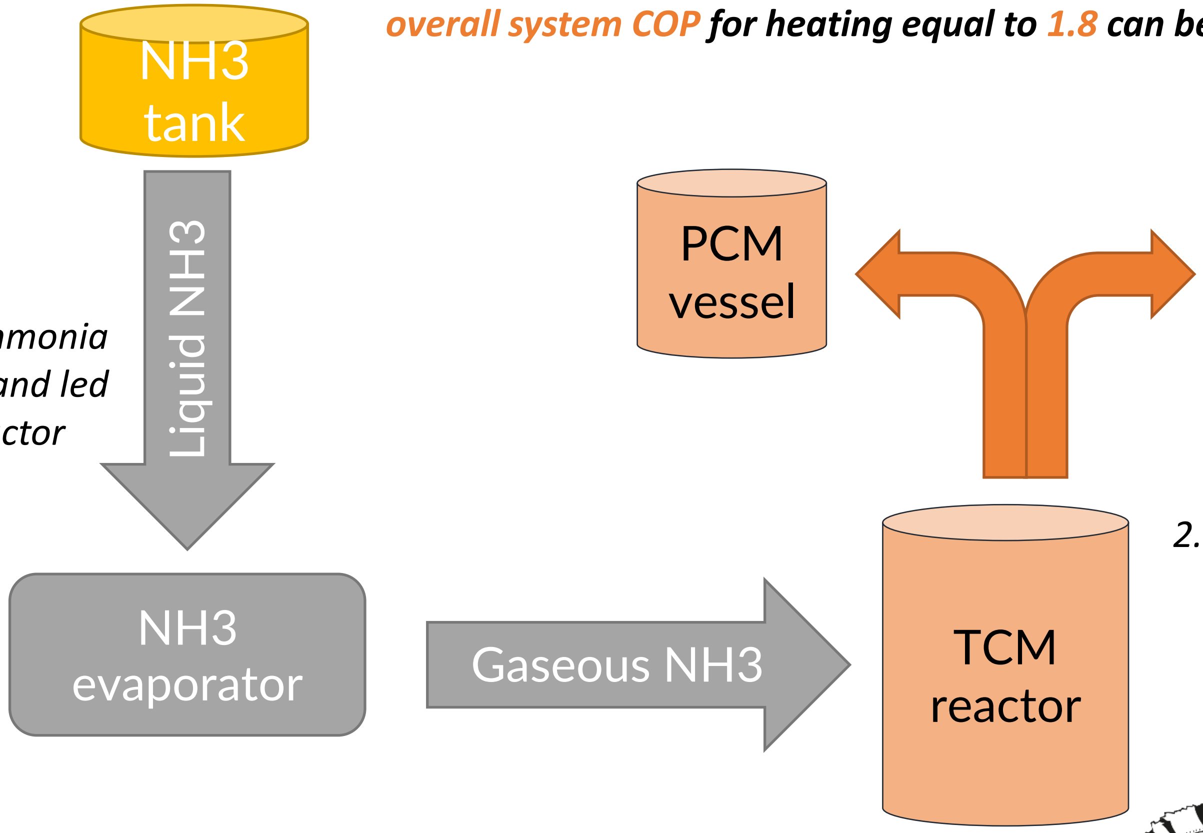
Basic operating principle

Discharging Phase (winter nights)

Considering the energy released during both the charging and discharging phases, an overall system COP for heating equal to 1.8 can be achieved.

1. *The liquid ammonia is evaporated and led to the TCM reactor*



2. *In the TCM reactor the exothermic reaction takes place. The released heat covers directly the building heating needs or is stored in the hot-PCM vessel for later use*

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Basic operating principle

Discharging Phase (warm summer nights)

NH3 tank → Liquid NH3 → NH3 evaporator → Gaseous NH3 → TCM reactor

NH3 evaporator → PCM vessel / building

1. *The liquid ammonia is evaporated and led to the TCM reactor*

2. *Cooling capacity produced from the ammonia evaporation is stored in the cold PCM vessel or used directly in the building*

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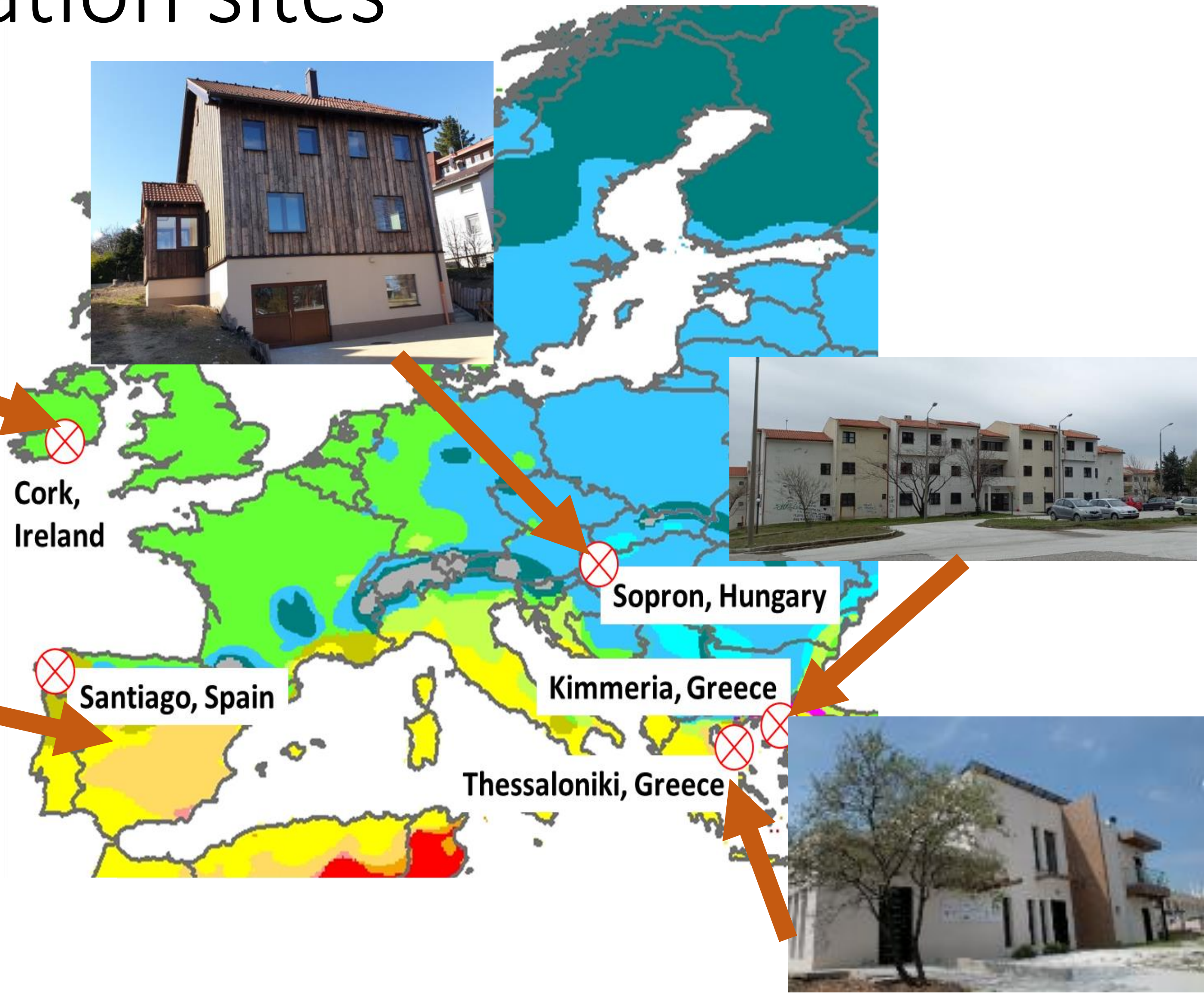
MiniStor demonstration sites

MiniStor will be demonstrated in a variety of demonstration sites located in:

- Greece (2 sites)
- Hungary (1 site)
- Ireland (1 site)
- Spain (1 site)



Implementing thermal storage in residential settings in Europe

Why we don't have high energy thermal storage in our houses?

- **Technology**
- **Price**
- **Regulation**
- **Consumer acceptance**

Implementing thermal storage in residential settings in Europe

Why we don't have high energy thermal storage in our houses?

Technology
Exploit potential of material properties with safe and reliable implementation

Price
Must compete with well-established technologies

Regulation
Regulations need to take into account new technological developments

Consumer acceptance
Confidence by the consumer, otherwise will never be accepted

Thank you!
Any questions?

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