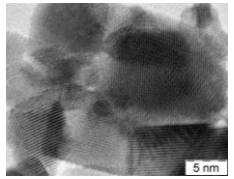
Consiglio Nazionale delle Ricerche

Italian National Research Council

SORPTION-RELATED RESEARCH ACTIVITIES

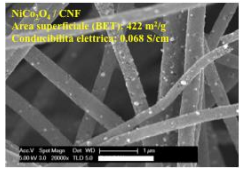
CNR - INSTITUTE FOR ADVANCED ENERGY TECHNOLOGIES

RESEARCH AREAS



Technologies for Hydrogen - green energy vectors production and storage - CO_2 recycling

Innovative technologies for thermal energy storage and transformation



Sustainable technologies for electric energy production and storage

Application of technologies and integrated systems for Energy Efficiency - Smart Energy Technologies

Social and Environmental Impact of Energy Technologies

SORPTION RESEARCH GROUP @ CNR ITAE

RESEARCH TOPICS AND FUNDED PROJECTS

	Materials	Components	Detailed modelling	System modelling	Prototyping / testing
Thermal energy storage	Piano Nazionale di Ripresa e Resilienza #NEXTGENERATIONITALIA; COOL; PRIN 2017; SWS heating; HYBUILD Hybrid Energy Storage for Buildings			HYSTORE Hybrid Services from Advanced Thermal Energy Storage Systems; ThumbsUp	StoRIES
Renewable H&C in buildings / industries			SoBjo Rev	SunHorizon; GEOFIT SMART GEOTHERMAL	hycool Solar Cooling Systems; ZEOSOL
Cooling & Desalination on-board of vessels	zhenit	FI-ShipS; ENGINMMONIA			
DHN-integrated sorption technologies		HYPERGRYD		MISSION INNOVATION accelerating the clean energy revolution	
Direct air capture		SOLDAC FULL SPECTRUM SOLAR DIRECT AIR CAPTURE & CONVERSION			

SORPTION RESEARCH GROUP @ CNR ITAE

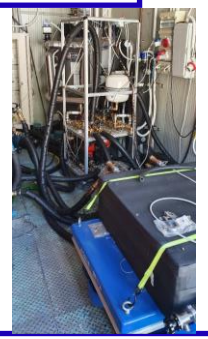
CURRENT STAFF

Antonino Bonanno	**Researcher** *(Materials Engineer)*
Vincenza Brancato	**Researcher** *(Materials Engineer)*
Andrea Frazzica	**Researcher** *(Materials Engineer)*
Valeria Palomba	**Researcher** *(Materials Engineer)*
Alessio Sapienza	**Researcher** *(Materials Engineer)*
Salvatore Vasta	**Researcher** *(Mechanical Engineer)*
Girolama Airò Farulla	**Post-doc** *(Energy Engineer)*
Omais Abdur Rehman	**PhD Student** *(Energy Engineer)*
Yannan Zhang	**Post-doc** *(Energy/Mechanical Engineer)*
Elmira Pirshayan	**Post-doc** *(Nuclear Engineer)*
Roberto Capparelli Marcal	**Post-doc** *(Mechanical Engineer)*
Mohsen Pourfallah	**Post-doc** *(Mechanical Engineer)*
Fabio Costa	**Lab Technician**
Davide La Rosa	**Lab Technician**
Luigi Calabrese	**Associated Professor** *(Materials Engineer)*
Elpida Piperopoulos	**Associated Professor** *(Materials Engineer)*

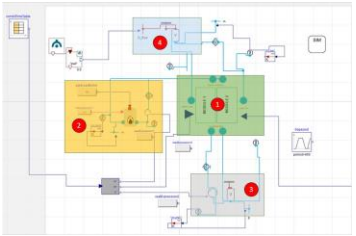
FACILITIES

Sorbent materials characterization


Components testing rigs

Large-scale (90 kW-HT) and low-scale (35 kW-HT) prototypes testing rigs



TRNSYS 18

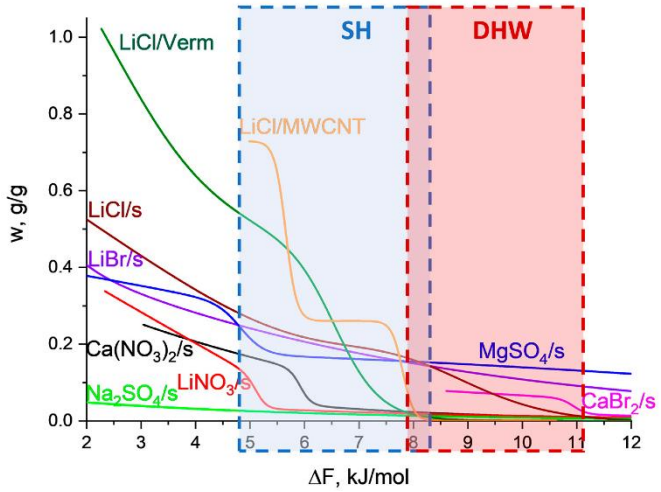
COMSOL MULTIPHYSICS®

CFD, components and system modelling

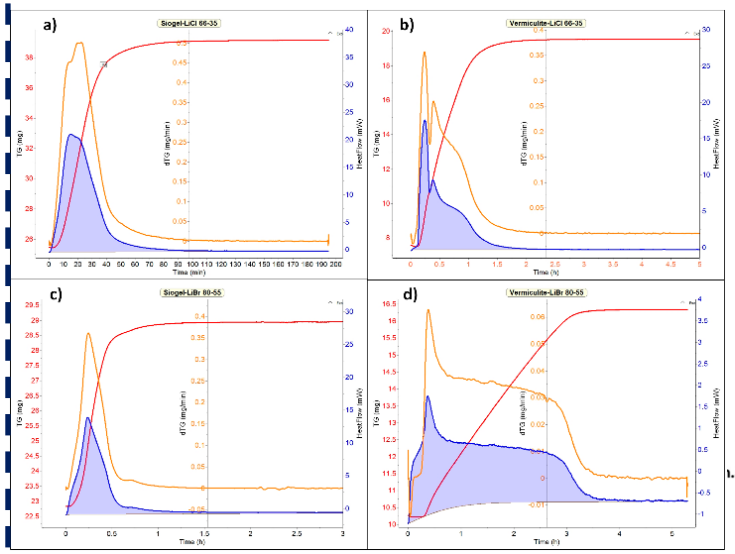
RECENT ACTIVITIES AT MATERIALS LEVEL

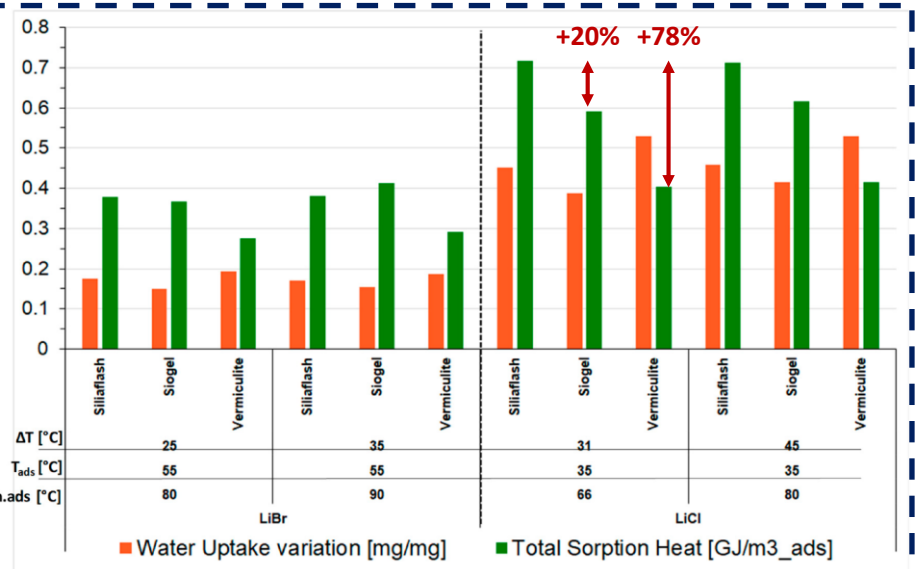
COMPOSITE SORBENTS FOR SEASONAL TES

Materials and boundaries definition



Composites characterization and TES density estimation





- **Long term stability demonstrated for SG/LiCl(30 wt.%)**
- **Prototype testing under lab conditions and field test**

PROJECT FUNDED BY EU COMMISSION UNDER H2020 PROGRAMME N. 764025

ONGOING ACTIVITIES AT MATERIALS LEVEL

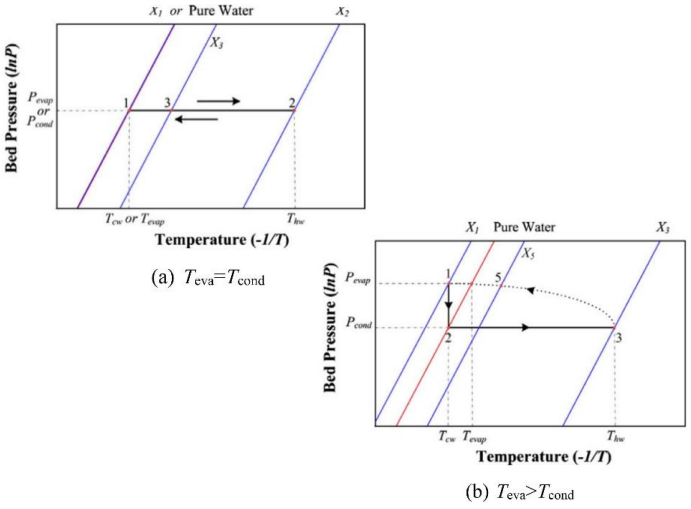
MATERIALS FOR SORPTION DESALINATION

Materials and boundaries definition

Micro-porous Silica gel

Composite SG / 30 wt.% LiCl

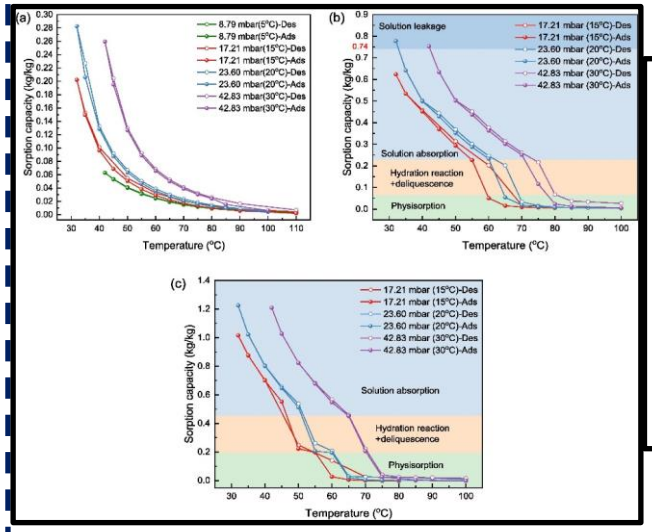
Composite Verm / 45 wt.% LiCl

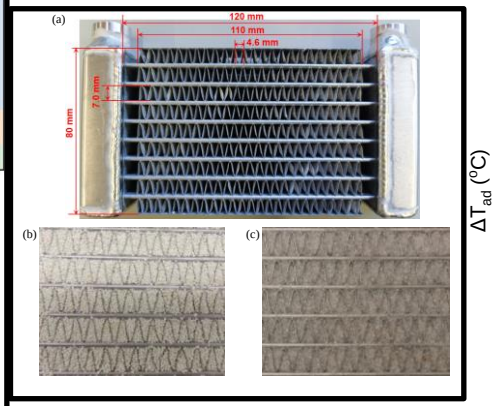


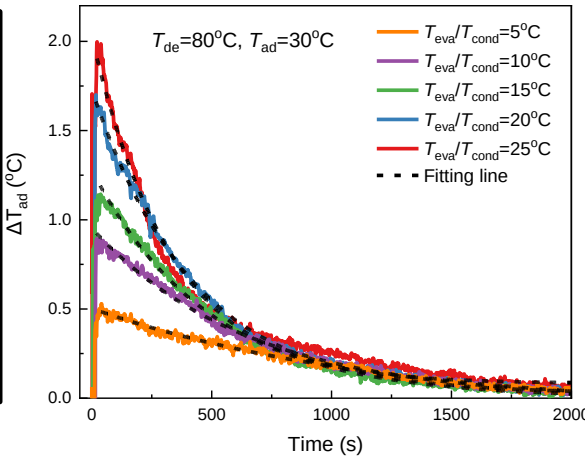
(a) T_{eva}=T_{cond}

(b) T_{eva}>T_{cond}

Composites equilibrium and kinetic characterization







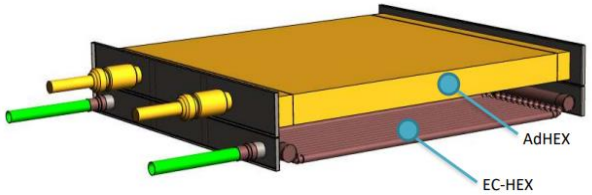
- **First promising results on composite sorbents (20 to 40% higher than silica gel)**
- **Kinetic testing of silica gel coatings ongoing**

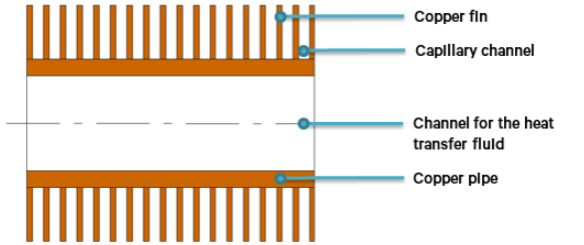
PROJECT FUNDED BY EU COMMISSION UNDER HEU PROGRAMME N. 101056801

RECENT ACTIVITIES AT COMPONENTS LEVEL

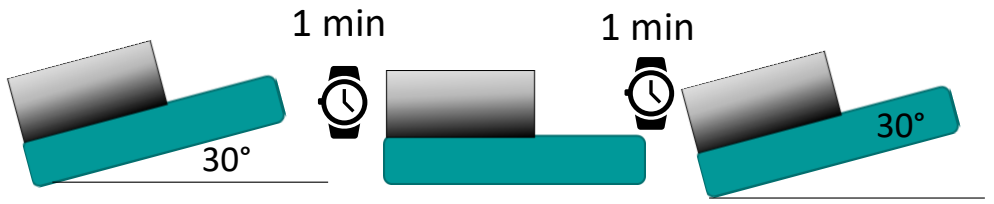
ADSORBER/EVAPORATOR MODULE UNDER OSCILLATING CONDITIONS

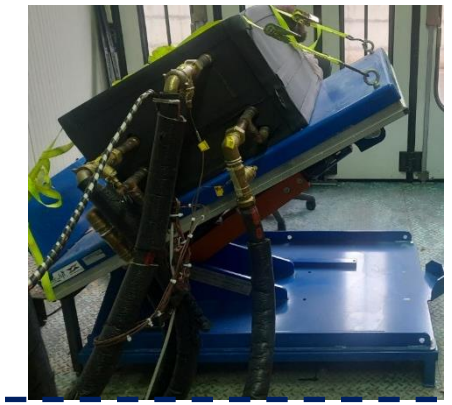
Module arrangement for the investigated design

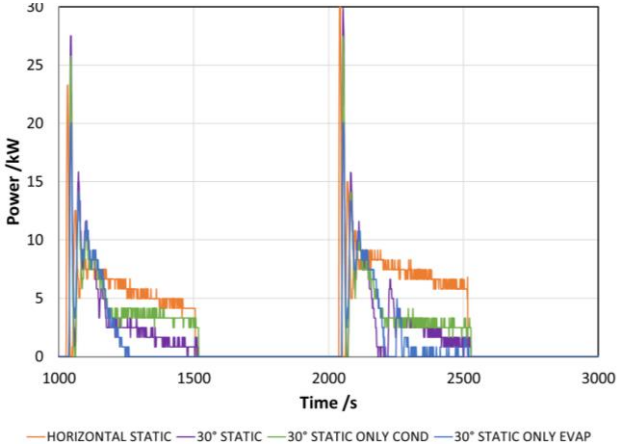


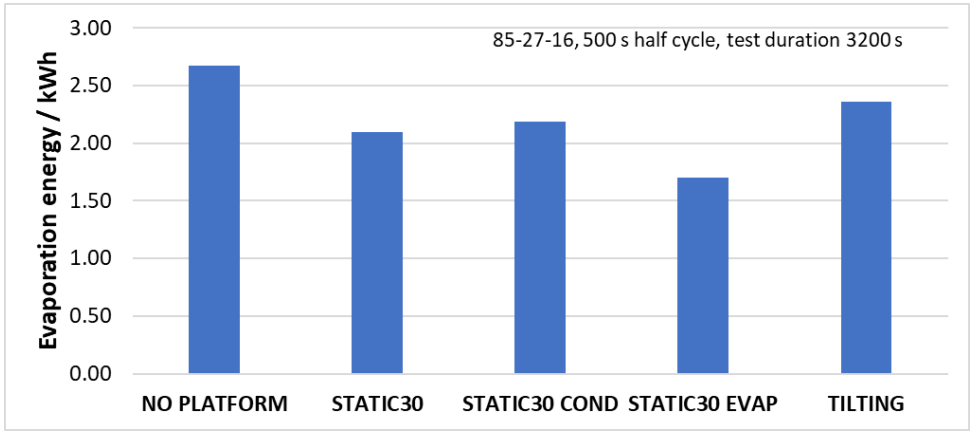


Operating conditions testing









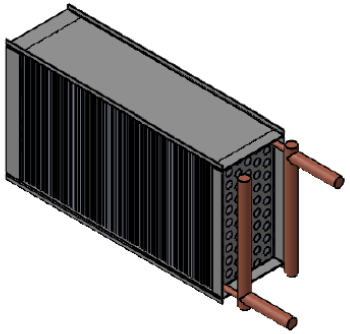
PROJECT FUNDED BY EU COMMISSION UNDER H2020 PROGRAMME N. 9555413

ONGOING ACTIVITIES AT COMPONENTS LEVEL

HYPERGRYD LAB-SCALE TESTING OF SORPTION TES REACTOR FOR DHN INTEGRATION

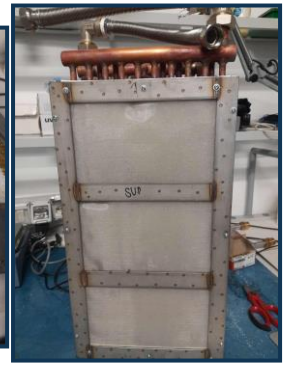
Sorption Technologies

Adsorber manufacturing

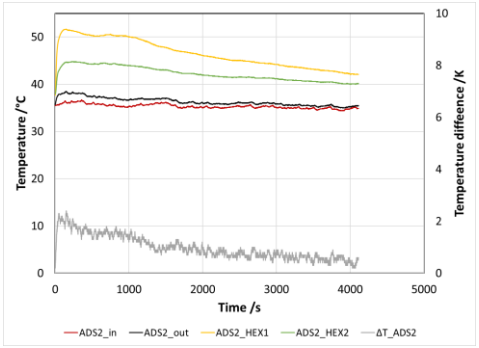


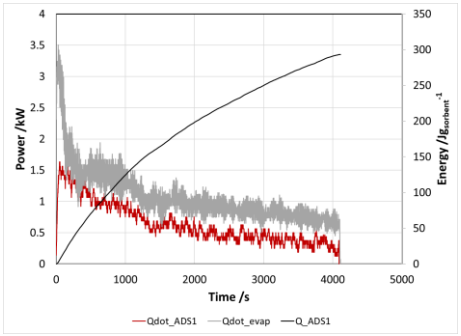
Composite SG + 25 wt.% $CaCl_2$

Pure composite and mixed with microporous SG

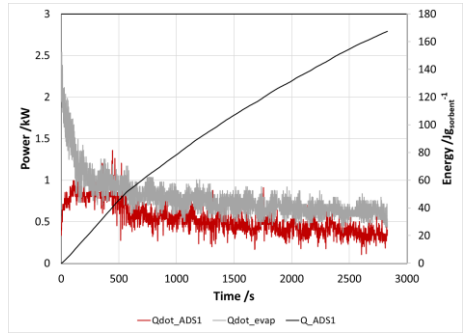


Testing results



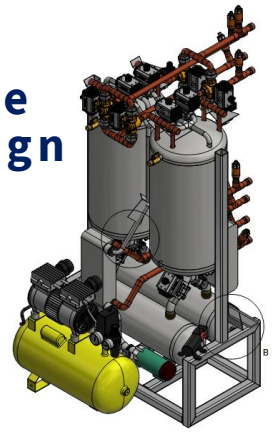


50/50 vol. ratio



40/60 vol. ratio

First lab-scale prototype design



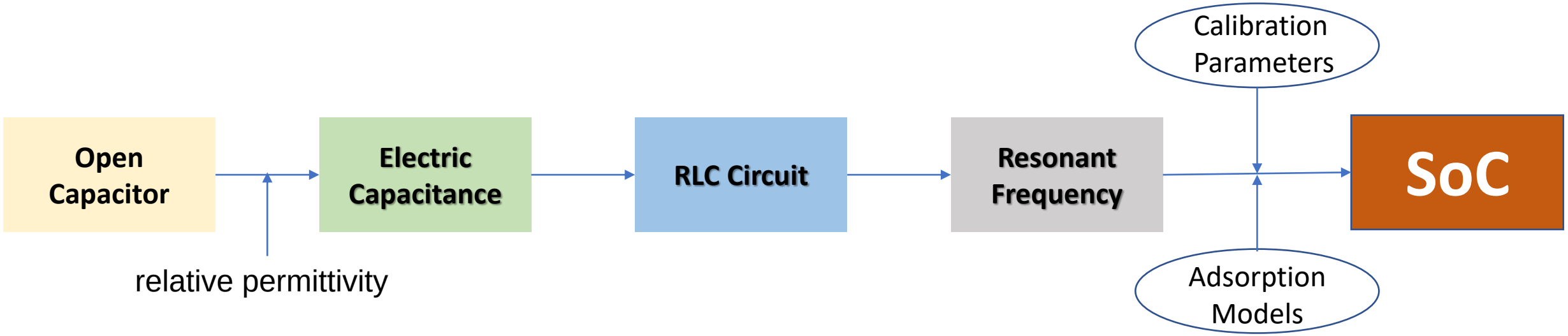
- **Manufacturing and testing of the lab-scale prototype**
- **Large-scale prototype to be tested in a DHN-connected living lab**

PROJECT FUNDED BY EU COMMISSION UNDER H2020 PROGRAMME N. 101036656

ONGOING ACTIVITIES AT COMPONENTS LEVEL

Development of a sensor for the direct extimation of the State Of Charge (SoC) of Adsorption Thermal Energy Storage (TES)

The SoC of the storage material is critical for ensuring the system's efficiency and reliability, as it determines how much heat can be stored and used



resonant frequency ~ moisture content of the material → relative permittivity ~ water content

In cooperation with:

DIEEI – University of Catania

Piano Nazionale di Ripresa e Resilienza
#NEXTGENERATIONITALIA

The activity is partially funded by PNRR-NEST Project

RECENT ACTIVITIES AT MODELLING/SYSTEM LEVEL

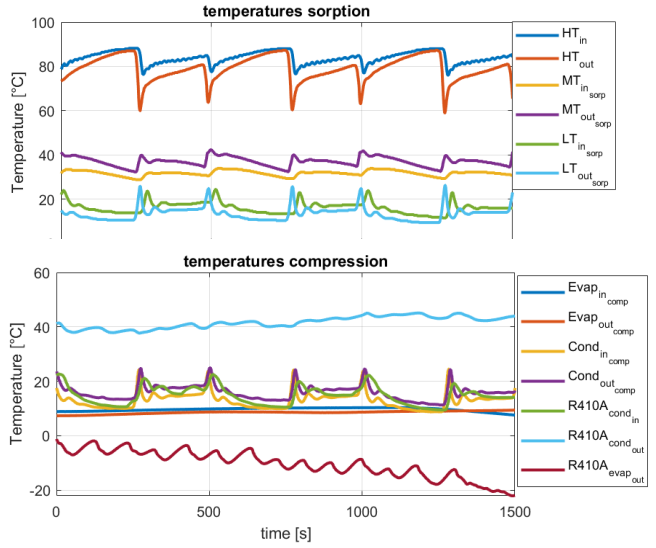
HYBUILD Hybrid Energy Storage for Buildings — MODELLING&TESTING OF CASCADING SORPTION/COMPRESSION CHILLER — FAHRENHEIT Cooling Innovation.

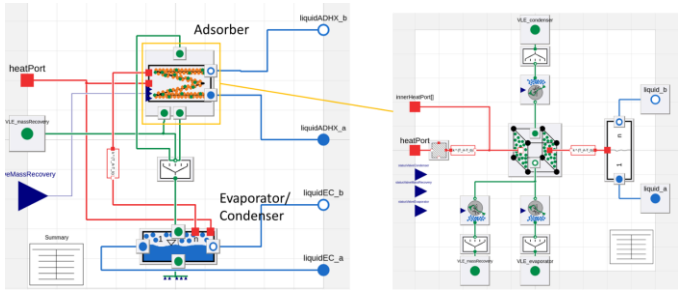
Lab installation

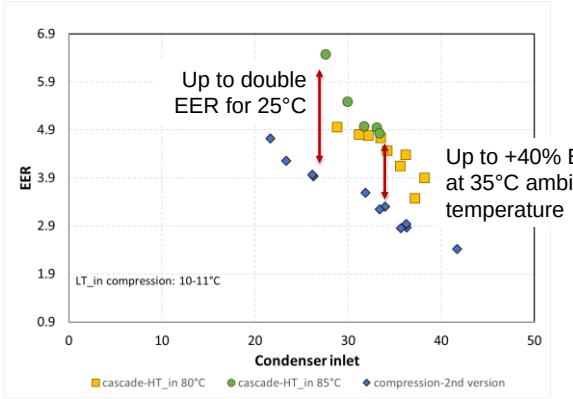
Adsorption module + compression HP and latent TES

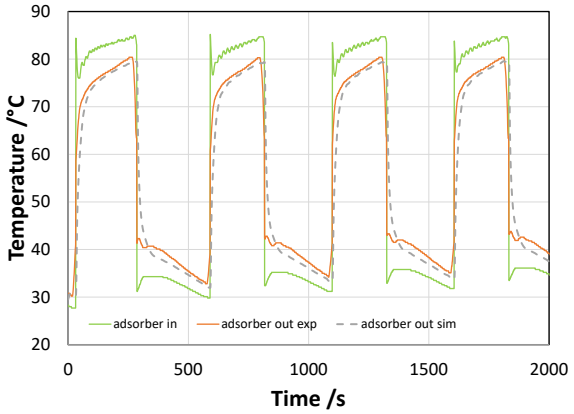
DC driver + electric batteries

Testing results & model validation









PROJECT FUNDED BY EU COMMISSION UNDER H2020 PROGRAMME N. 768824

Consiglio Nazionale delle Ricerche

RECENT ACTIVITIES AT MODELLING/SYSTEM LEVEL

TESTING OF HYBRID SORPTION HEAT PUMPS AND CHILLERS

FAHRENHEIT
Cooling Innovation.

Lab installations

hycool® Solar Cooling Systems

Cascade industrial sorption/propylene compression (up to 30 kW cool)

GEOFIT SMART GEOTHERMAL

Geothermal Gas-driven heat pump (up to 10 kW heat)

SunHorizon

Palallel commercial sorption/propan compression (up to 40 kW cool)

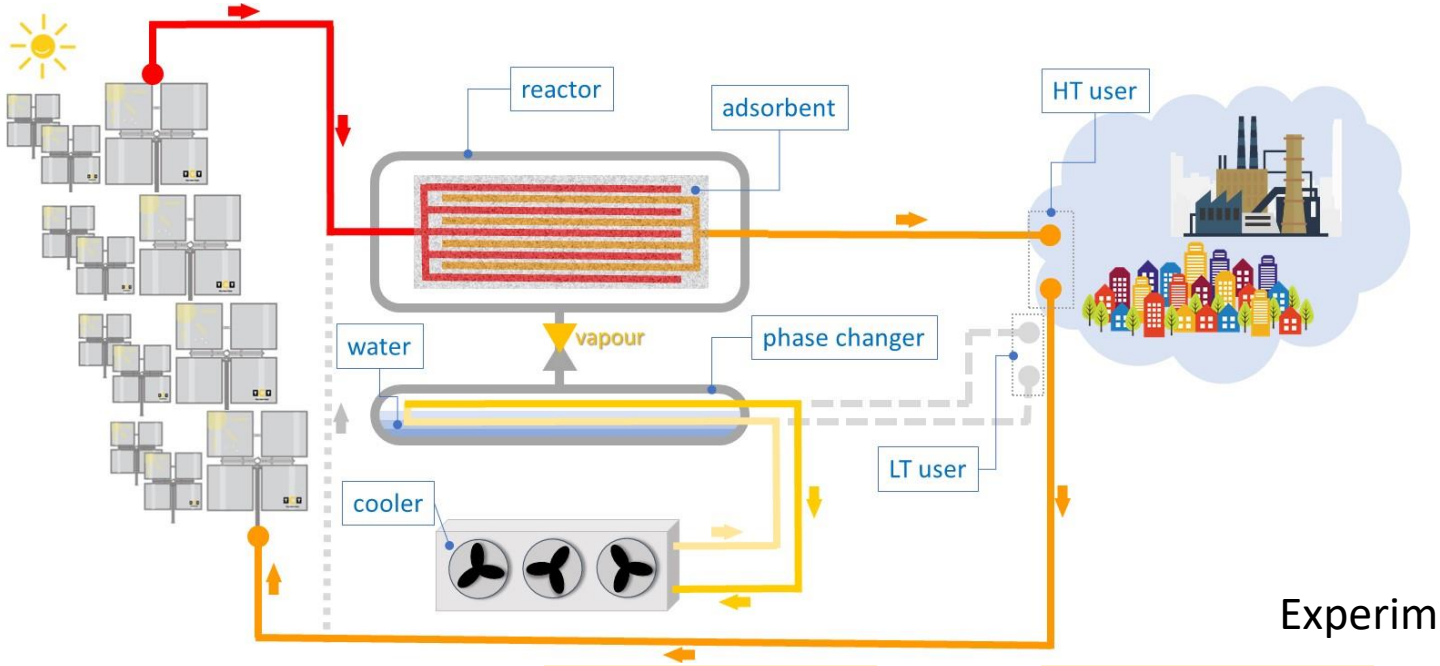
- **Improved SEER in cascading mode up to 25% down to -10 °C cooling provision**
- **Thermal COP of gas-driven HP up to 1.2 for geothermal integration**
- **Increased flexibility in operation thanks to the parallel integration**

PROJECTS FUNDED BY EU COMMISSION UNDER H2020 PROGRAMME N. 792073, N. 792210, N. 818329

Consiglio Nazionale delle Ricerche

ONGOING ACTIVITIES AT MODELLING/SYSTEM LEVEL

Investigation on the potentialities of CLOSED CYCLE sorption TES systems coupled with solar energy for HT applications



Dynamic Model

Thermodynamic Model

KPIs Definition

Experimental campaign

Results

WHY?

To demonstrate (once for all) the feasibility of such technology in operating conditions typical of the district heating and the industrial field.

Experimental tests are currently ongoing at POLITECNICO MILANO 1863

The activity has been partially funded by EERA JP Energy Strorage through the PhD Mobility Scheme

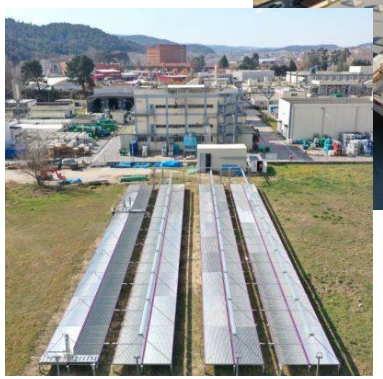
RECENT ACTIVITIES AT MODELLING/SYSTEM LEVEL

HYBUILD
Hybrid Energy Storage for Buildings

Installation and commissioning of a hybrid thermal/electric storage system in Spain

hycool
Solar Cooling Systems

Industrial hybrid chiller installation of a solar driven plant in 2 facilities in Spain



GEOFIT
SMART GEOTHERMAL

Geothermal gas-driven adsorption HP installation in a demo in Italy

SunHorizon

Hybrid heat pump integration in a civic centre in Spain driven by solar thermal collectors

PROJECTS FUNDED BY EU COMMISSION UNDER H2020 PROGRAMME N. 792073, N. 792210, N. 818329, 768824

Italian National Research Council

Thank you for your kind attention!
Grazie per l'attenzione!