RHC Solutions for Buildings and Industry - 3rd Edition

Wednesday, September 7th, 2022 | 8:30h - 11:45h | Workshop | Hybrid

SUSTAINABLE PLACES 2022

TRI-HP PROJECT · ASTEP · hycool · PLURAL · SHIP2FAIR · SolBio Rev · SunHorizon · GEOFIT · RINNO · FRIEND SHIP · ministor · SWS heating · ENVISION · Hybrid BioVGE

#SUSTAINABLEPLACES2022

RHC for Buildings and Industry

"Renewable Heating and Cooling Solutions for Buildings and Industry – 3rd Edition"

SEP. 6TH – SEP 9TH, 2022 NICE, FRANCE

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AGENDA

08.30 – 09.15: **RHC solutions in industries**

09.15 – 10.00: **High TRL RHC technologies for buildings**

10.00 – 10.15: **Coffee break**

10.15 – 11.15: **Low TRL RHC technologies and storage solutions for buildings**

11.15 – 11.45: **RHC technologies for NZEBs**

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RHC solutions in industries

hycool
Solar Cooling Systems

FRIEND SHIP

SHIP2FAIR

ASTEP

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Prof. Dr. Uli Jakob
Dr. Jakob energy research GmbH & Co. KG
uli.jakob@drjakobenergyresearch.de

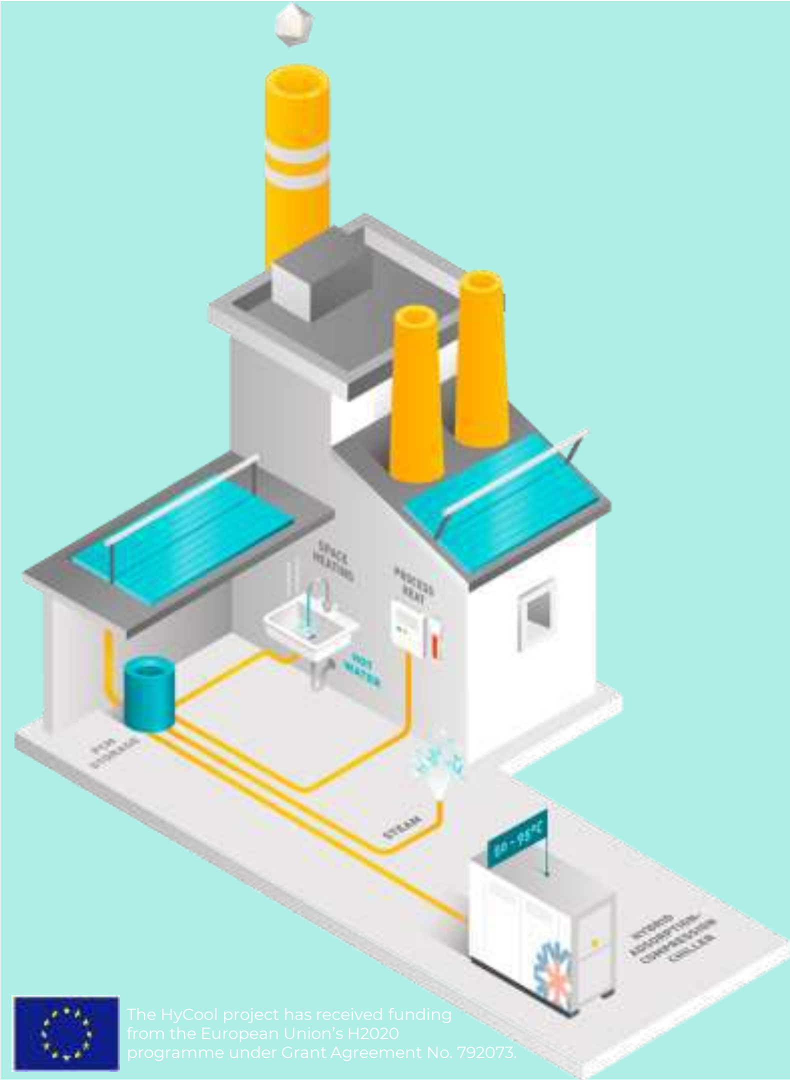
Industrial Cooling through Hybrid system based on solar heat

HyCool project mission is increasing the current use of Solar Heat in Industry Processes, and to do so the project proposes the coupling of a **Fresnel CSP Solar thermal collectors** (FCSP) system with specially build **Hybrid Heat Pumps** (HHP) for a wider output temperature range to increase the potential implementation in industry.

Duration: 1 May 2018 to 31 October 2022

Partners: 15 from 10 EU countries

Goal: Demonstration of a reliable energy source for greener, de-carbonized, more energy-efficient industrial processes



The HyCool project has received funding from the European Union's H2020 programme under Grant Agreement No. 792073.

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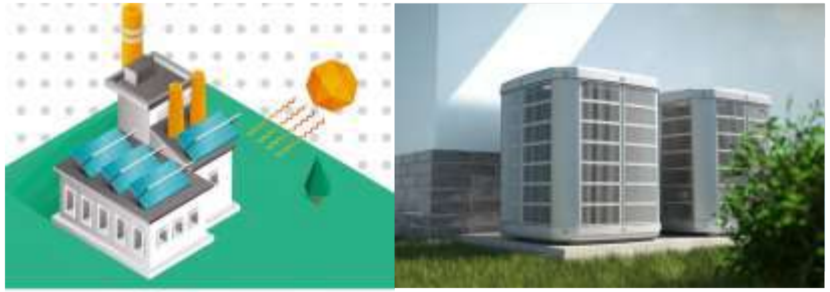
hycool©
Solar Cooling Systems

Demonstration and monitoring of HyCool systems at pilot sites in Spain

Pilot site	Bo de Debò factory	Givaudan factory
Type of client	Producer of precooked fresh dishes based on meat, fish and vegetables	Producer of flavours and fragrances
Linear Fresnel collector field (Ecotherm)	36 modules of 10 m^2 each, total of 360 m^2	80 modules of 10 m^2 each, total of 800 m^2
Hybrid heat pump (Fahrenheit)	HHP in cascade layout, model with 12 kW cooling capacity at -10 °C and 18.5 kW at 5 °C	HHP system consisting of 2 adsorption heat pumps and 4 vapour compression chillers with nominal cooling capacities of 30 to 50 kW respectively (total of 260 kW)
Compact solar thermal storage (AIT)	Phase-change material storage tank with 120 °C max and a capacity of around 200 kWh	Phase-change material storage tank with a melting temperature of around 204 °C at 16 bar

hycool
Solar Cooling Systems

CEN Workshop Agreement (CWA) and eLearning Tool



CEN WORKSHOP AGREEMENT (CWA)
Characterization of a hybrid heat pump module

Kick-off Meeting
2022/04/29

CWA is a **tool to increase the visibility, replicability and usability of the findings of the EU innovation project HyCool**.

Topic: **Experimental characterization of the hybrid heat pump module**

Publication: **Expected in November 2022** (free access to the document)

eLearning Tool provides introductory material of Hybrid Heat Pumps etc.

YouTube Channel:
https://youtube.com/playlist?list=PL_F0NPzv2Arx2Sm_e4FYWLIwpNf2a7Erf

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SHIP2FAIR project

Solar Heat for Industrial Process towards Food and Agro Industries commitment in Renewables

Presenter:

Dimitris Papageorgiou

TVP SOLAR

Thermal Vacuum Power

SHIP2FAIR project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 792276

SHIP2FAIR

H2020 Project GA 792276

BUDGET: 10 M€
DURATION: 2018-06/2023

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Context

Decarbonization pathway for industry

Operational integration of Solar Heat for Industrial Processes (SHIP)

SHIP

Goals

Unveiling the untapped potential of solar heat for agrofood industries

Share of solar heat 10%-40% in demo-sites

2.9 MWth installed

Approach

Solar heat integration in the agro-food sector:

- Demonstrate 3 solar thermal technologies
- Develop and demonstrate the:

(a) Replication Tool (feasibility of solar heat);

(b) Control Tool (operational optimisation)

Team

15 partners

Coordinator:

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Innovative Cases of SHIP

Larnaudie demonstration site

Towards 100% carbon-free industrial heat

Location: France, South – West

Technology: High Vacuum Flat Panels (HVFPs)

Solar field size: 1600m^2 - 1MW$_{th}$- 1’219MWh/y

Application: Two solar loops for (a) boiler feed water pre-heating @140C, and (b) process hot water

Solution beyond SHIP2FAIR scope: Integration with thermal storage & industrial heat pump

Martini&Rossi demonstration site

Maximise useful solar heat all year round

Location: Italy, North

Technology: HVFPs

Solar field size: 596m2 - 327kW$_{th}$- 349MWh/y

Application: Dual mode (a) Oct-Mar: Hot water @ 90C for space heating, and (b) Apr-Sep: Process steam @3.7bar with solar heat @170C; indirect steam generation

Barriers
Challenges
Opportunities

SHIP2FAIR

Barrier 1. Unequal playing field

Poor access to financing

High CAPEX & industry's expectation for fast return to cheap fossil fuels status

Green-wishing & green-washing

Challenge 1. User acceptance

Low awareness

Low data availability on processes

Risk-sensitive decision making

Loose decarbonisation commitments

Opportunity 1. Favourable economic conditions

Enduring high NG & electricity prices

Available financing & incentives for RES

TVP SOLAR

Ba.2. Regulatory requirements

Regulatory fragmentation

Poor adaptation to SHIP

Authorities lack familiarization with SHIP

Ch.2. Integration into thermal processes

Need for tailored solutions

Limited availability of space

Matching heat demand profiles & production dependencies

Thermal storage & heat pump option

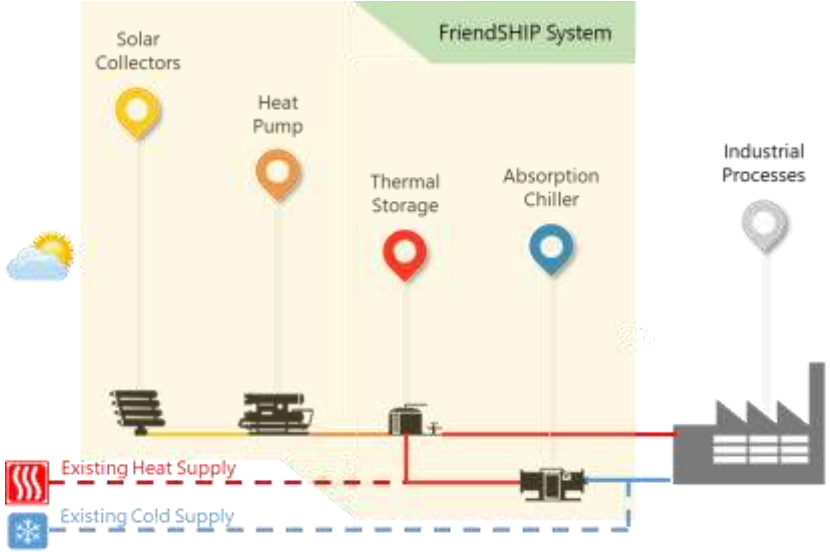
Op.2. Vast market potential for SHIP

Unexploited SHIP market potential

No many options available to decarbonise industrial heat

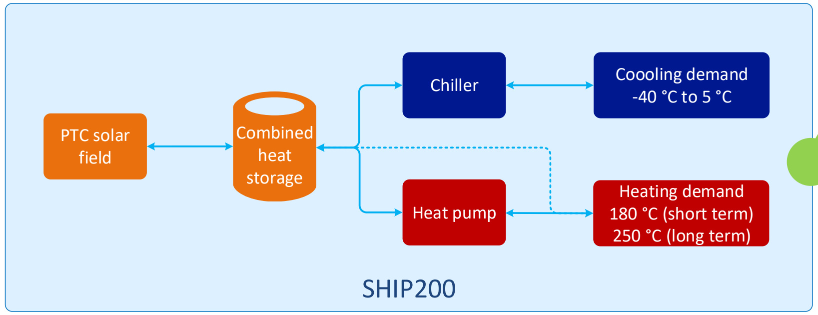
Process industries gradually shift their eyes on solar thermal

Start: 01/05/2020
Duration: 48 months
Coord: CEA
Consortium: 10
Budget: 4,999,423.74 €
Type of action: RIA
Topic: LC-SC3-RES-7-2019 Solar Energy in Industrial Processes



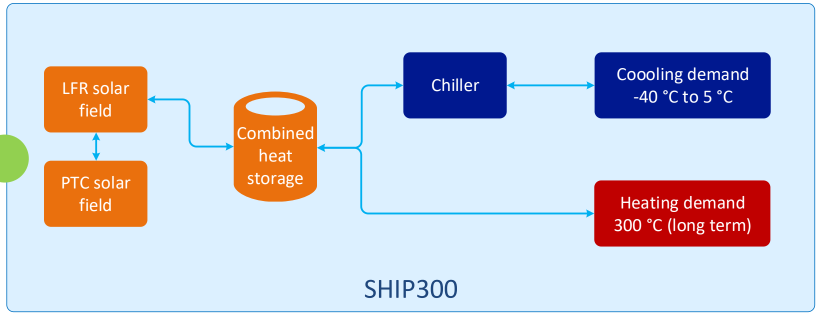
Overall Concept

Main options



Validation of SHIP200 in relevant conditions
Demo site Grenoble (FR), Annual DNI 1,400 kWh/m²

Numerical validation of SHIP300 in relevant conditions *End-users sites (DE, PT, SP)*



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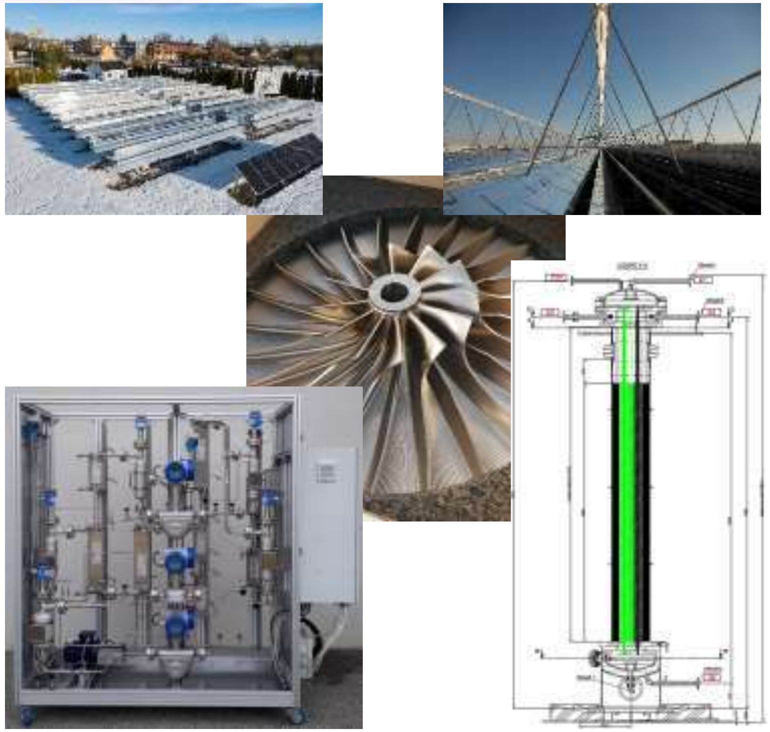
FRIENDSHIP

ABSOLICON SOLAR COLLECTOR AB · INDUSTRIAL SOLAR renewables onsite · RINA · SINTEF · ines · AMIRES · cea · SONAE · CLARIANT

Main innovations

FRIENDSHIP aim at superior performance by **incorporating several new improvements and functions to the standards SHIP solution**:

- **Low-cost solar collectors** combined with **selective coatings** (improve absorbance) and **nanoparticles** (improve heat transfer)
- An advanced **very high temperature heat pump** that enables continuous and stable heat supply at target temperatures **between 180 and 250°C**
- A **high-density combined thermal storage** that allows the storage of heat from the solar heat loop as well as from the process loop
- A cooler that enables **cold production** for industry from the residual high-temperature heat, either by using an **absorption** or **ejector** chiller
- An **advanced control management** will allow the enhancement of the quality and availability of heat, to match the process demands and rationalise the use of the existing energy sources



- Interface = Storage Capacity
- Provide Heating & Cooling
- Scalable vs both: Customers' needs & Site Free Area/Spaces

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ASTEP: Summary

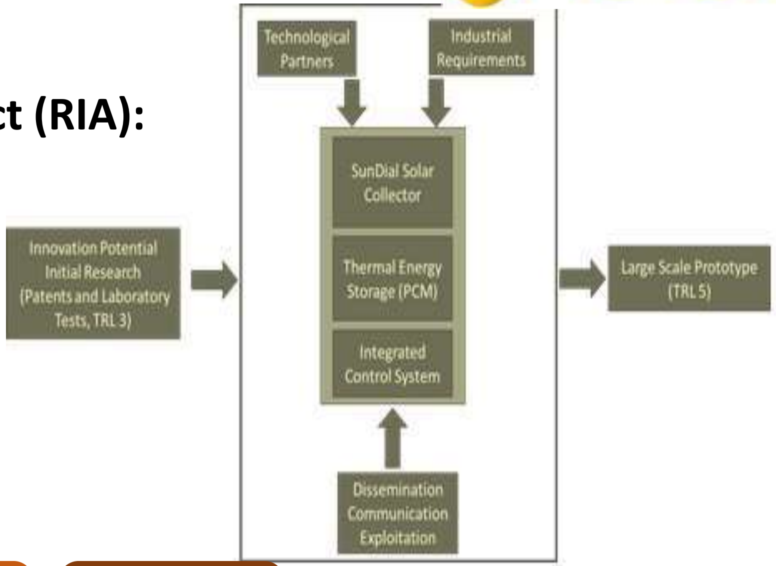
Application of Solar Thermal Energy to Processes (ASTEP), 4 years H2020 project (RIA):

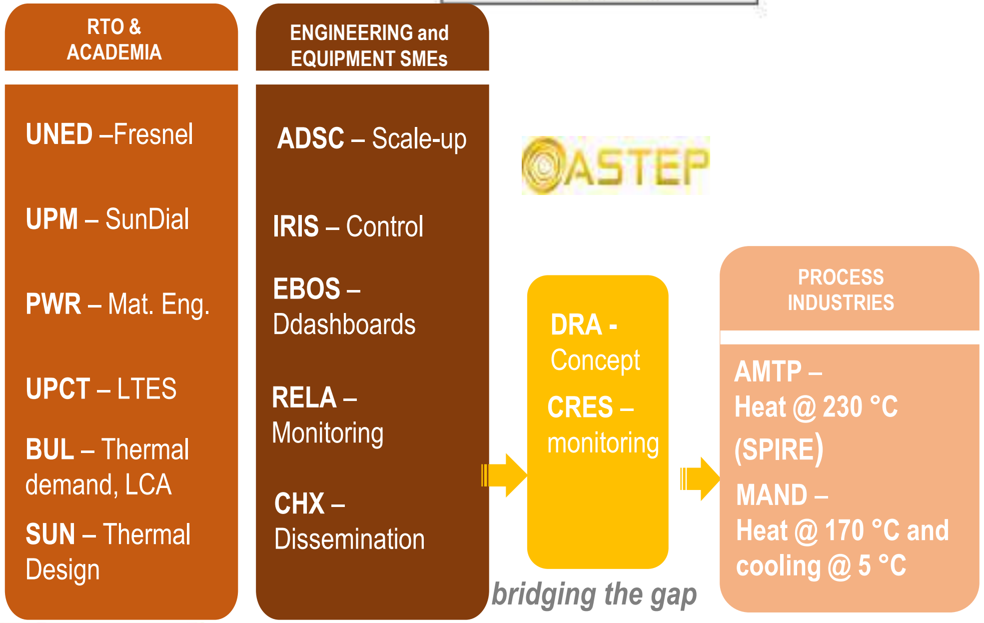
ASTEP will install a single module of 17 kW_{th} (peak) in each industry to produce:

- 50 kWh per winter day.
- 135 kWh per summer day.

Solar contribution of 25 MWh yearly. Avoiding 11.4 t of CO_2 to the Atmosphere.

Two Case Studies: Dairy and Steel Industries. Located in Corinth (Greece) and Iasi (Romania).





ASTEP: Key Technical Aspects

ASTEP will create a new innovative Solar Heat Industrial Process (SHIP), based on two innovative designs:

- Solar collector (SunDial) by ADSC, UPM and UNED.

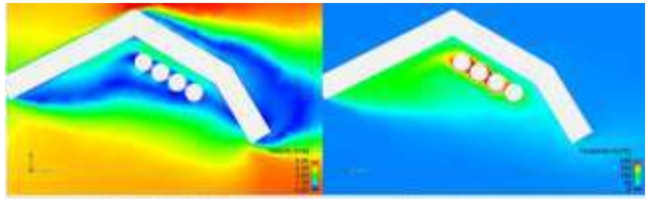


Fig. 2. Air velocity and temperature maps around the receiver

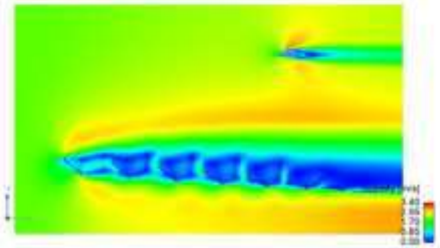
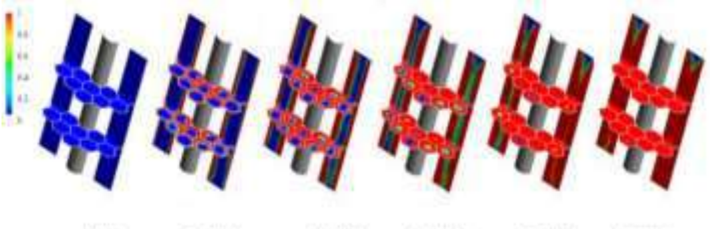


Fig. 3. Air velocity around the whole collector

- Phase Change Material (PCM) Thermal Energy Storage (TES) by PWR, UPCT, and ADSC.



Integrated via a control system developed by IRIS for flexible continuous operation.

ASTEP: Key Technical and Economical Challenges

Key Technical Challenges

Challenge 01.

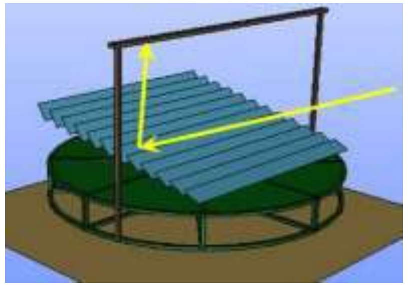
Use Case 1: Mandrekas Corinth (Greece), lat. is 37.93 N.

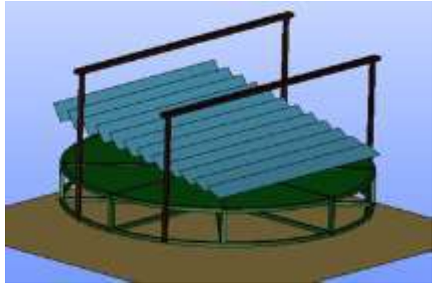
- Daytime 8 bars steam generation (175 ºC), to pasteurize milk, and 24/7 cooling for storing at temperatures around 5 ºC.
- Simpler SunDial forces the storage system to become especially relevant to meet heat demand requirements.
- Most efforts to develop the salt-salt mixture storage.

Challenge 02.

Use Case 2: AMTP Iasi (Romania), lat. 47.1 N.

- Color coating tubes of finished products to be pre-heated to a temperature of 220 ºC.
- Storage system requirements are less demanding with the two-axis SunDial.
- Industrial process temperatures are higher.
- More complex storage system, where corrosion or dilution phenomena must be regarded.





Economical Challenges

Raw Material

Logistics

For more information:

https://astepproject.eu

https://www.linkedin.com/company/astep-h2020

https://twitter.com/astepproject

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ASTEP: Key Patents, Communication & Dissemination Activities

Patents (4 National/2 International)

- 4 Spanish patents ES2578804B2, ES1138715U, ES2537607B2 and ES2713799A1, which belong to UPM and UNED. 2 International patents WO/2016/166388A1 and WO/2016/166390A1, which belong to UPM and UNED.

Conferences (3)

- Enerstock 2021: J. Enriquez, R. Herrero, A. Rovira et al **"ASTEP, Application of Solar Thermal Energy to Processes**".
- Sustainableplaces 2021:
- Sdewes 2021:

Conference proceedings (6)

- Thermal losses characterization for the receiver of the SunDial, the rotary Fresnel collector **Autores:** Barbero, Rubén; Montes, María José; Abbas, Rubén; Enriquez, Juan; Domingo, Jerónimo; Iranzo, Alfredo; Gómez, Mateo; Arnanz, David; Rovira, Antonio; **Publicado en:** SolarPACES2021, 2021; **Editor:** SolarPACES; **DOI:** 10.5281/zenodo.5772950.
- Dynamic analysis of the SunDial, the rotatory Fresnel collector **Autores:** Barnetche, Magdalena; González-Portillo, Luis Francisco; Ibarra, Mercedes; Barbero, Rubén; Rovira, Antonio; Abbas, Rubén ;**Publicado en:** SolarPACES2021, 2021; **Editor:** SolarPACES; **DOI:** 10.5281/zenodo.5772923.
- Design and integration of a solar heat system based on the SunDial for industrial processes **Autores:** Ibarra, Mercedes; Barbero, Rubén; Barnetche, Magdalena; Gonzalez-Portillo, Luis Francisco; Abbas, Rubén; Rovira, Antonio; **Publicado en:** SolarPACES2021, 2021; **Editor:** SolarPACES; **DOI:** 10.5281/zenodo.5772878.
- Integration and Simulation of Solar Thermal Energy to Dairy Processes **Autores:** Tannous, Hadi; Masera, Kemal; Tassou, Savvas; Stojceska, Valentina; **Publicado en:** SolarPACES2021, 2021: **Editor:** SolarPACES; **DOI:** 10.5281/zenodo.5772925.
- Application of Solar Thermal Energy to Dairy Industry **Autores:** Masera, Kemal; Tannous, Hadi; Tassou, Savvas; Stojceska, Valentina; **Publicado en:** UKHTC2021, 2021; **Editor:** UKHTC2021; **DOI:** 10.5281/zenodo.5772959.
- Enhancement of SunDial Optical Performance Handling Cosine and End Losses **Autores:** Abbas, Rubén; Montes, María José; Cano, Javier; González-Portillo, Luis Francisco; Sebastián, Andrés; Muñoz-Antón, Javier; Rovira, Antonio; Martínez-Val, José María; **Publicado en:** SolarPACES2020, 2020; **Editor:** SolarPACES; **DOI:** 10.5281/zenodo.5772861.

Peer reviewed articles (1)

- A new design of multi-tube receiver for Fresnel technology to increase the thermal performance **Autores:** Montes, María José; Abbas, Rubén; Barbero, Rubén; Rovira, Antonio. **Publicado en:** Applied Thermal Engineering, 204, 2022, Page(s) 117970, ISSN 1359-4311; **Editor:** Pergamon Press Ltd.; **DOI:** 10.1016/j.applthermaleng.2021.117970.

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High TRL RHC technologies for buildings

GEOFIT
SMART GEOTHERMAL

SunHorizon

Hybrid BioVGE

SUSTAINABLE PLACES

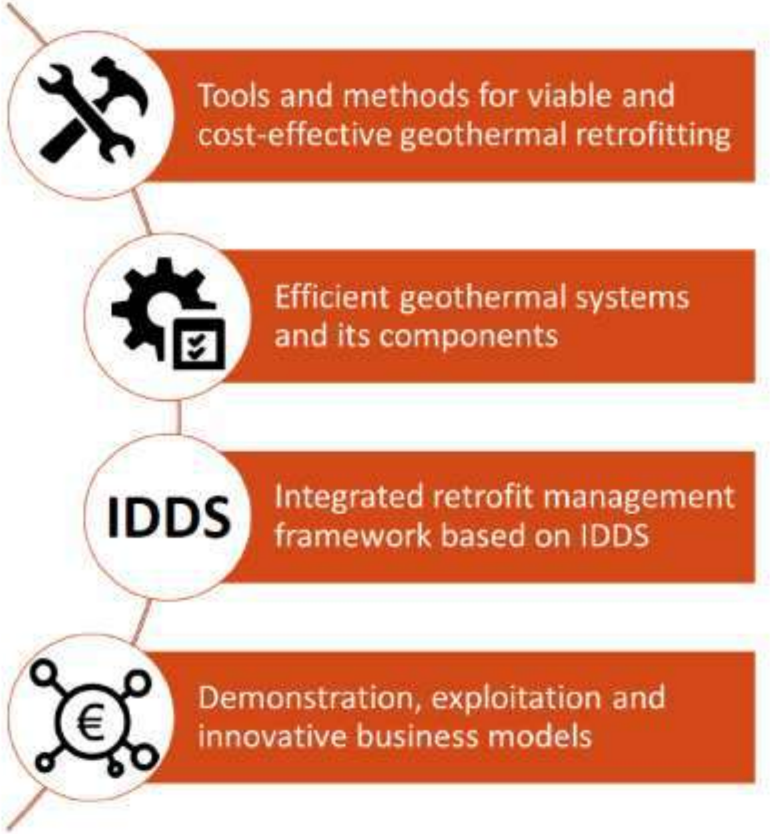
OUR RESPONSE

GEOFIT SMART GEOTHERMAL

GEOFIT: *Economical enhanced geothermal systems for energy efficient building retrofitting*

- **4 year** H2020 project (May 2018-April 2022)
- **24 Partners**
- Innovation Action supporting the H2020 Societal Challenge of Secure, Clean and Efficiency Er
- Part of INEA's Energy Portfolio (Low Carbon Economy (LCE), Renewable Energy Technologies
- **€ 9.7 million cost / € 7.9 million funding**

INEA currently oversees 17 Geothermal projects with a total funding of €125 million (May 18)



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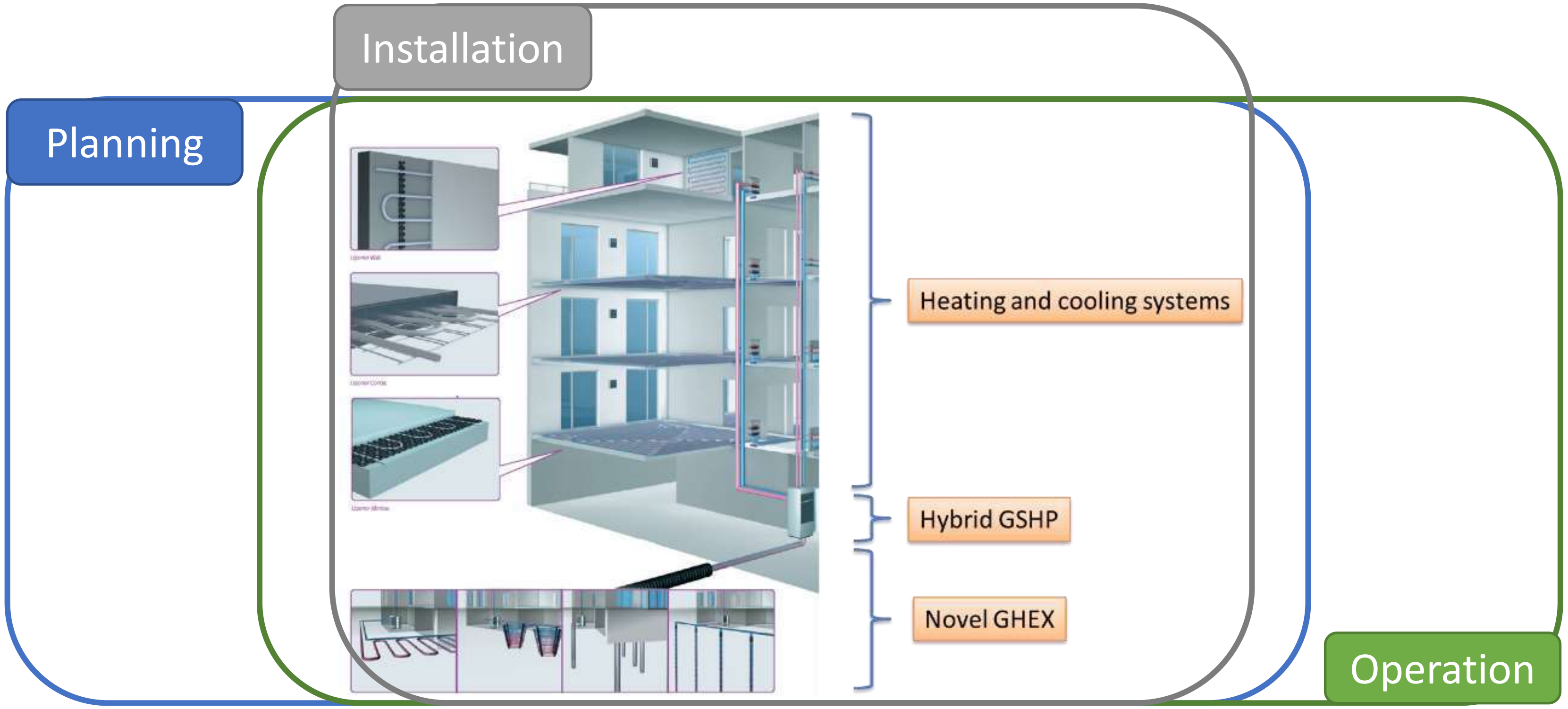
PROCESSES: PLANNING, INSTALLATION, OPERATION

Technology toolsets to support the building processes around the technology couplings



BIM / Survey / Baseline   Drilling, Monitoring & Integration   Geothermal as a smart asset

Concept image courtesy of partner Uponor

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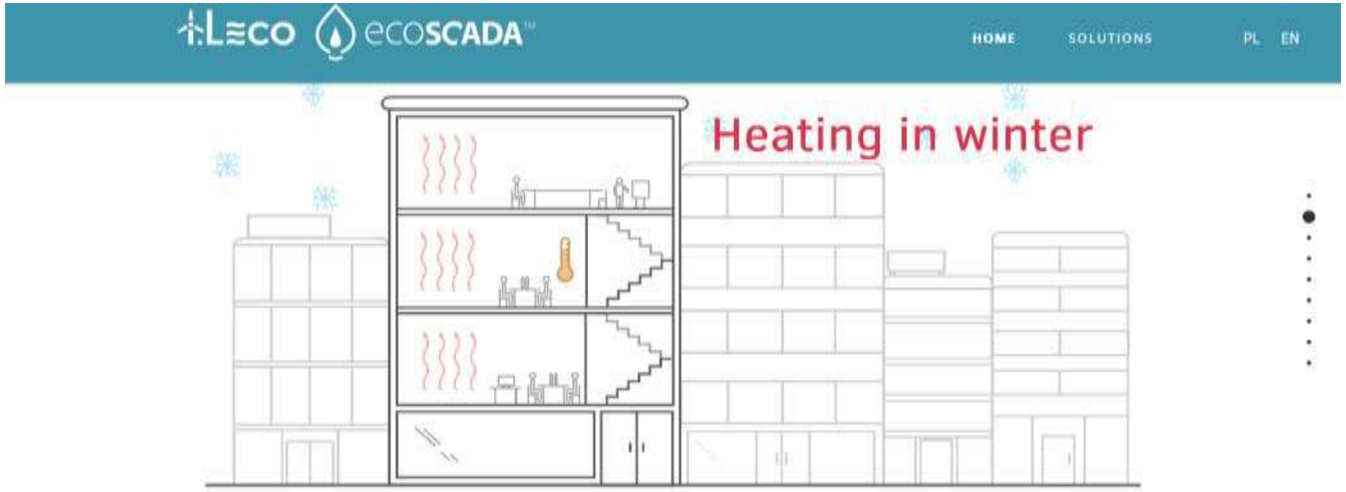

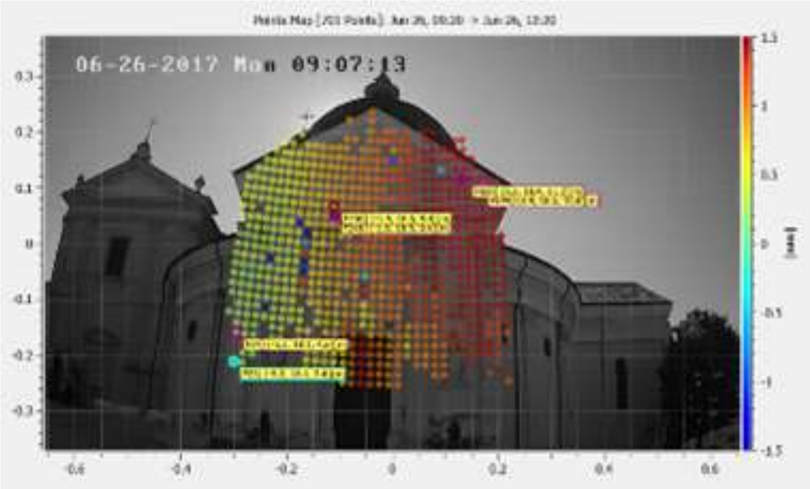

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MAIN FINDINGS

Quantitative results

- Reduction of 50-60% of primary energy consumption compared with values before renovation (electric Heat Pumps)
- Reduction of 25-30% of primary energy consumption compared with values before renovation (hybrid HP)
- Increase by 15-20% of HP COP thanks to Low Temperature Heating (electric HP)
- Reduced running costs by 30 % (depends on local energy prices)
- Drilling cost in Spain: 60-70 k€ for 11 boreholes and 40 kWth HP
- Excavation cost in Italy: 20-25 k€ for a 24x7x2 m field and 12 kWth HP.

MAIN FINDINGS

Qualitative results

- Authorisation process depends on specific country (Italy: Closed loops do not need authorization, open loops do).
- Many skills required around the table -> Integrated D&D Solutions recommended.
- Low GWP does not automatically mean lower energy efficiency
- If the HP needs to be integrated in existing radiator-based systems:
    - Use high temperature HP
    - Insulate the building
    - Optimize flow rates (hydraulic, energy valves that control the DT across radiators).
- To avoid ground freezing in the long run, consider:
    - Increasing size of GHEX
    - Using ground for passive or active cooling in summer.
    - Using additional heat source for the HP (dry heater in Galway).
- Underground utilities can be detected with a GPR survey.

Serena Scotton, Project coordinator, RINA Consulting spa

This Project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement N. 818329

Our vision and objectives

The SunHorizon Technology Packages (TP) aim at covering at least 80% of the Heating & Cooling needs of refurbished and new single/multi- family/tertiary buildings.

Demonstrate up to **TRL 7** innovative and reliable HP solutions that acting properly coupled and managed with advanced solar panels can **provide heating and cooling to residential and tertiary building with lower emissions, energy bills and fossil fuel dependency**.

- Increase SunHorizon H&C technologies performances
- Promote cloud based functional monitoring for H&C purposes
- Reduce SunHorizon H&C technologies CAPEX and OPEX
- Demonstration of SunHorizon Innovations indifferent EU countries and type of buildings
- Promote the replication of SunHorizon Concept
- Dissemination and Capacity Building

This Project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement N818329

Consortium

An Industry driven Consortium:

- 5 top level Academic Polytechnic Institutions
- 12 industrial partners:
- 5 Large Enterprise (LE)
- 7 Small and Medium Enterprises (SMEs)
- 4 association and stakeholders acting as demosite

This Project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement N818329

SunHorizon

The demosite needs, are supplied with 5 different technology combinations, that combines the following technologies:

Heat pumps

FAHRENHEIT
Cooling Innovation

BDR THERMEA GROUP

BOOSTHEAT
ENERGY UNITES PEOPLE

Solar technologies

BDR THERMEA GROUP

DUALSUN

Storage

ratiotherm

BDR THERMEA GROUP

Needs

Space cooling

Space heating

5 technology packages

This Project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement N818329

SunHorizon: Demosites

Nº	Location	Climate	Building type	SunHorizon TP
1	Berlin (Germany)	Cold	Small residential	**TP1**: TVP+BH
2	Nürnberg (Germany)	Cold	Large residential	**TP2**: DS+BH
3	Saint Cugat (Spain)	Warm	Tertiary (Civic centre)	**TP3**: TVP+FAHR
4	Madrid (Spain)	Average	Large residential	**TP4**: DS+BDR
5	Cluj-Napoca	Cold	Dormitory	TP1: BH+TVP+DS
6/7	Riga (Latvia)	Cold	Small residential	**TP2:** DS+BH

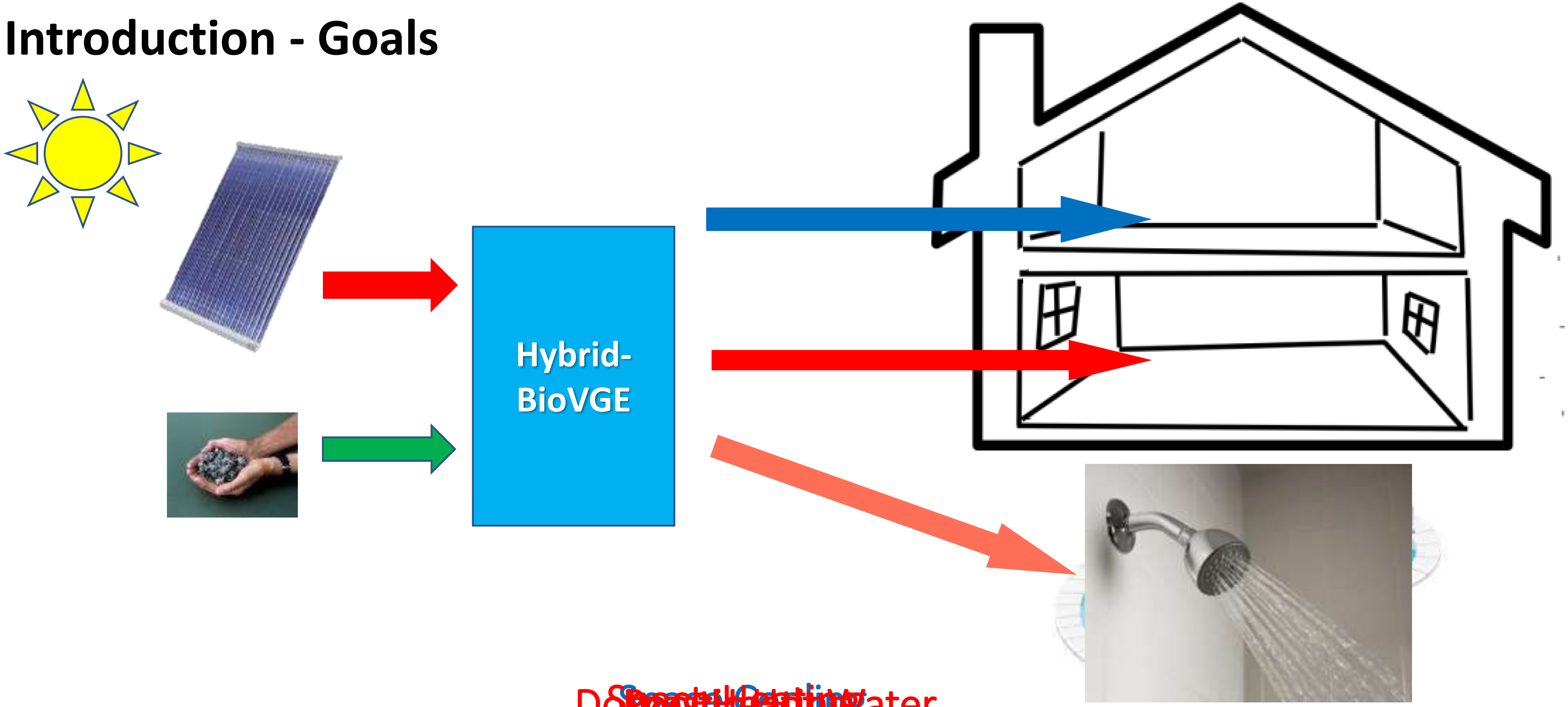
This Project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement N818329

Hybrid Variable Geometry Ejector Cooling and Heating System for Buildings Driven by Solar and Biomass Heat

Sustainable Places 2022 – 7th September 2022

Szabolcs Varga

1. Introduction - Goals



1. Introduction - Team

Academic partners:

TU Graz

ALMA MATER STUDIORUM UNIVERSITÀ DI BOLOGNA

HSR HOCHSCHULE FÜR TECHNIK RAPPERSWIL — SPF INSTITUT FÜR SOLARTECHNIK

Industrial partners:

HARGASSNER HEIZTECHNIK DER ZUKUNFT

SOLARFOCUS

~~comPLex~~

Duration:

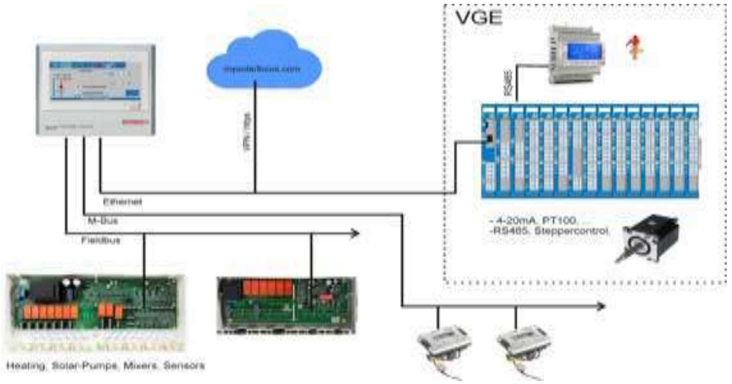
Start date: 01/06/2019 → 42 months → End date: 30/11/2022

1. Introduction - Approach

- Development of design and simulations tools
- Development of improved performance components
- Development of integration methods
- Development of control system
- Prototype construction and testing

2. Relevant results - 2021

- Development of intelligent control system



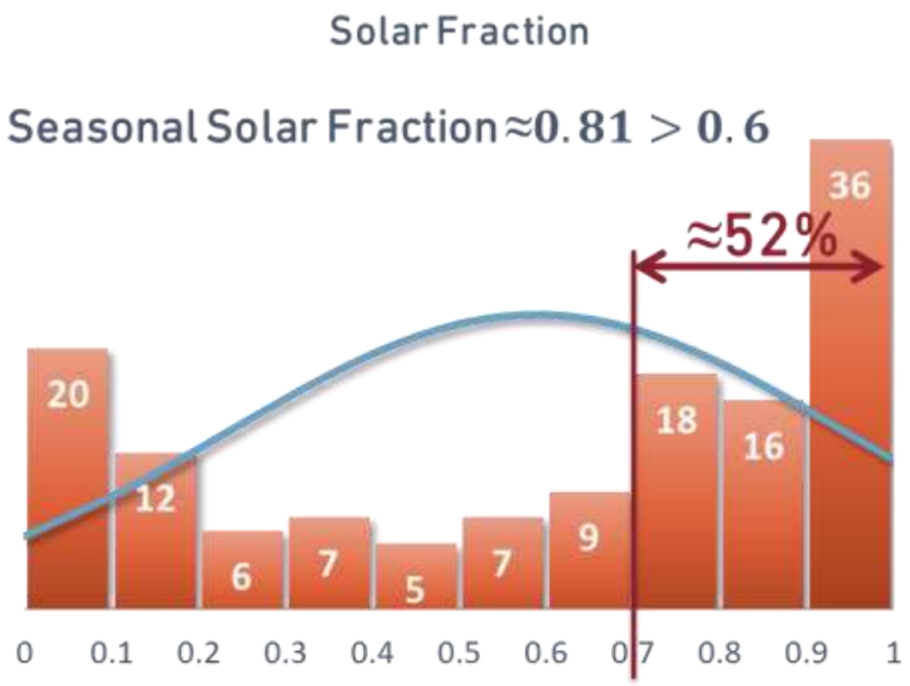
- Prototype construction

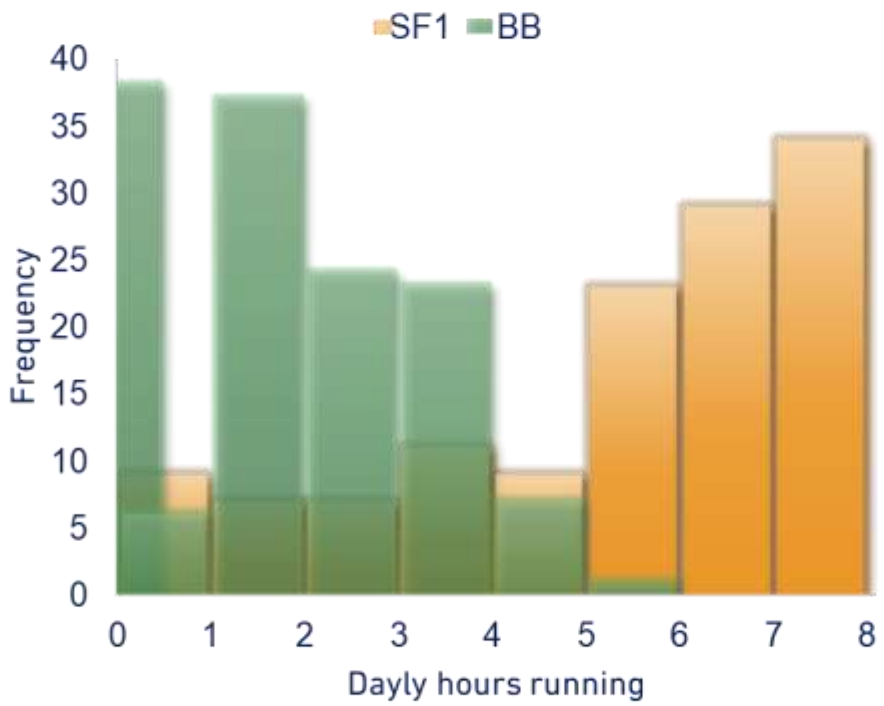
Steyr

Porto


2. Relevant results - 2022

- **Winter season testing**

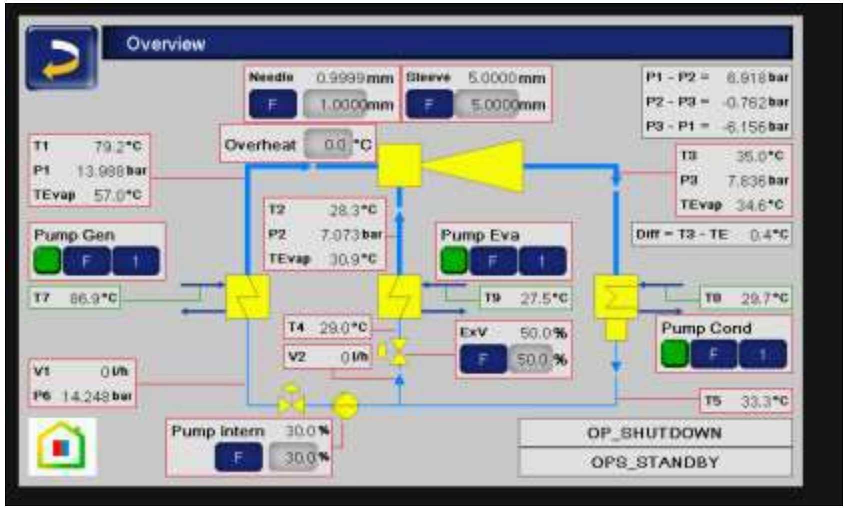




3. Lessons learnt (last year)

1 Make systems as simple as possible

2) Test first in-house before testing in real site



3) Oversize dissipation for heat driven cycles

Low TRL RHC technologies and storage solutions for buildings

SWS heating

SolBio Rev

RINNO

MINISTOR

TRI-HP PROJECT

SUSTAINABLE PLACES

RHC for Buildings and Industry

"Renewable Heating and Cooling Solutions for Buildings and Industry – 3rd Edition"

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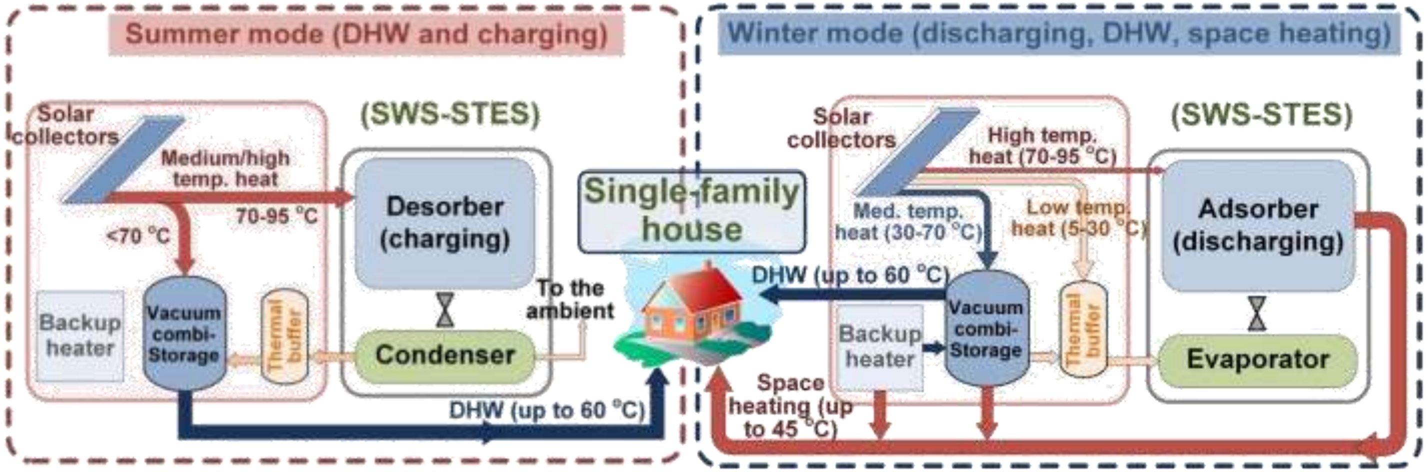
SWS heating

Development and Validation of an Innovative Solar Compact Selective-Water-Sorbent-Based Heating System

06/2018 – 11/2023

Objectives

- To develop a **new sorbent material** in the SWS family with optimised sorption properties,
- To develop a **compact multi-modular SWS-STES configuration** with high **corrosion resistance**, high **durability**, **ease of installation** & **maintenance**, and **low total cost**.



Consortium

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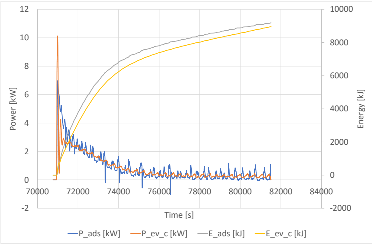
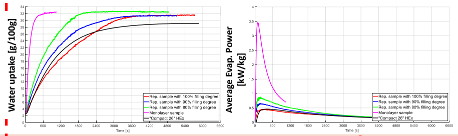
SWS heating



1° year

KPIs definition and first **modules modelling and design**



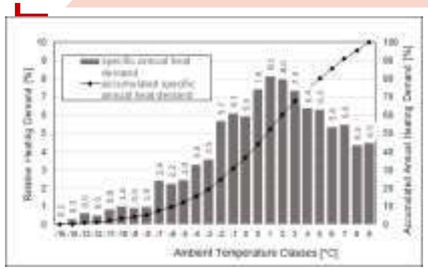
3° year

System **design** and **lab-scale testing**; System performance **simulation**

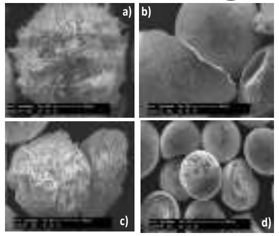
Technology validation under **two climatic conditions**

TRL 3 - 4

TRL 5



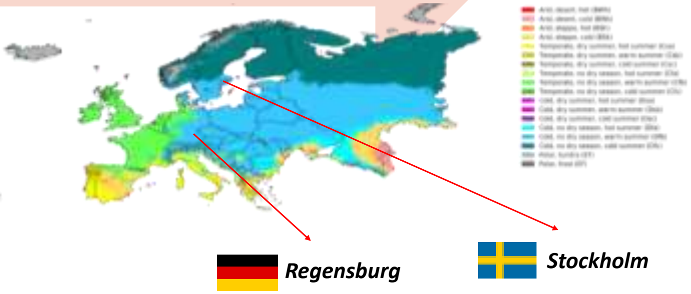
Composite sorbent definition and first **reactor design**



2° year

Demo site preparation, installation and commissioning

4° year



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SWS heating

Main achievements

- Composite sorbent with achievable energy density up to 1.0 GJ/m^3
- Design of compact reactors with improved heat transfer performance
- Optimized components for the overall system implementation (solar collectors, PCM tank, controller…)

Main challenges

- Mass transfer resistance inside the reactor
- Long-term operation of the system
- Scaling-up and replicability of the technology

SUSTAINABLE PLACES

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

What is MiniStor?

Minimal Size Thermal and Electrical Energy Storage System for In-Situ Residential Installation

- Compact system for heating, cooling and electricity storage
- High-performance thermochemical material (TCM) reaction
- Storage based on phase-change materials (PCM)
- Hybrid photovoltaic thermal (PVT) collectors
- Home Energy Management System (HEMS) + IoT

1:1 meetings during Sustainable Places – info@ministor.eu

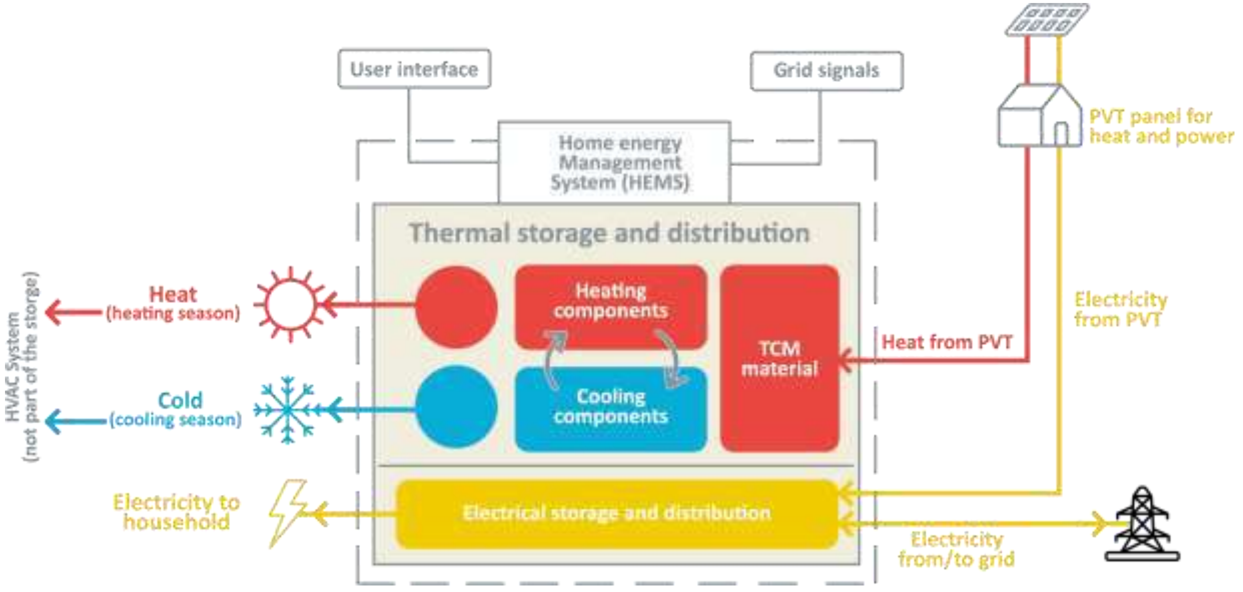
CERTH – Georgios Zisopoulos zisopoulos@certh.gr

CNRS – Driss Stitou driss.stitou@promes.cnrs.fr

ENDEF – Adriana Coca adriana.coca@endef.es

DUTH – Paraskevi Dimitriadou pdimitri@env.duth.gr

R2M – Marco Rochetti marco.rocchetti@r2msolution.com



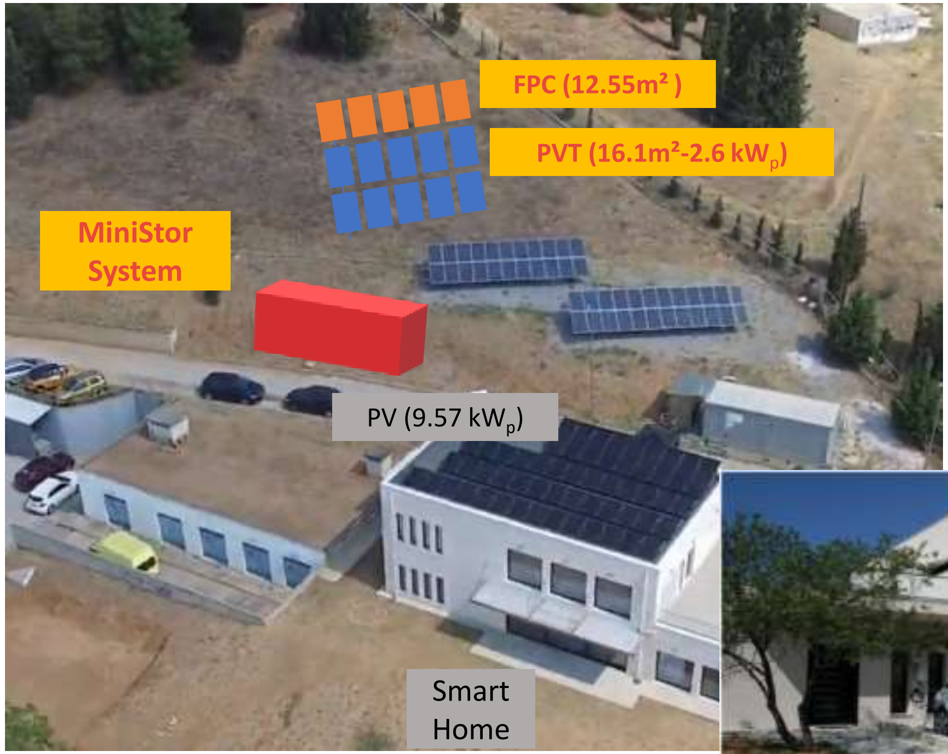
SUSTAINABLE PLACES

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

Thessaloniki (Greece) Pre-demo site

- Responsible partner : CERTH-ITI
- Housing type: Demonstration platform for novel technologies
- Construction year : 2017
- Testing area: Ground room (49m² - Western side)
- Connection to infrastructure: Installation of FCU at the test area (for heating and cooling)

CERTH
CENTRE FOR RESEARCH & TECHNOLOGY HELLAS



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Kimmeria (Greece) Demonstration site

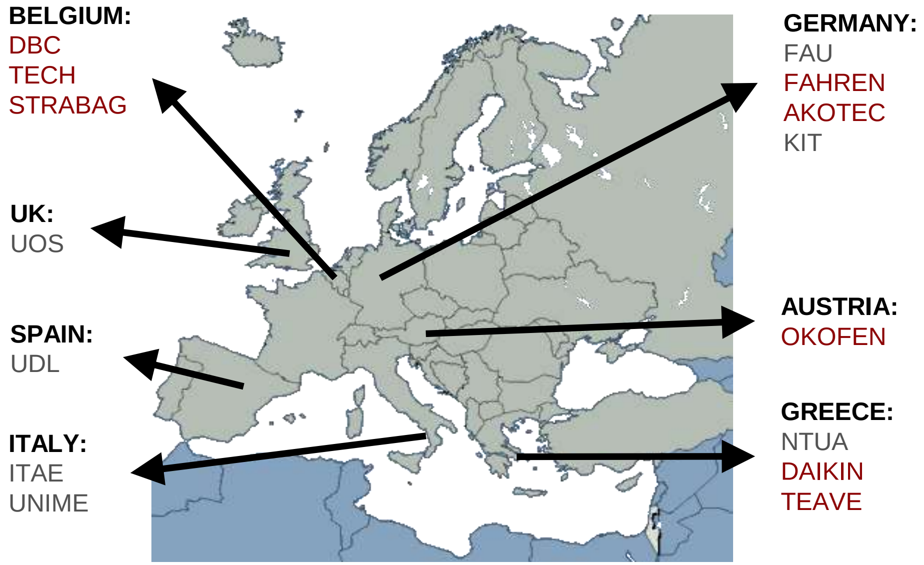
- Responsible partner : Democritus University of Thrace (DUTH)
- Housing type: Student residences
- Construction year : 1997
- Testing area: 5 student rooms at the ground and 1st floor (75.7 m² – Different orientations)
- Connection to infrastructure: Installation of FCU at the test area (for heating and cooling)

ΔΗΜΟΚΡΙΤΕΙΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΘΡΑΚΗΣ | DEMOCRITUS UNIVERSITY OF THRACE

SUSTAINABLE PLACES 2022
Sep. 6 - Sep. 9, 2022 | Nice, France

So[B]o Rev

Introduction



Context

Renewables exploitation (solar, biomass) for covering heating, cooling and electricity demand of buildings (residential, commercial) by integrating innovative technologies

Approach

- Lab development and testing of individual subsystems
- Control system realization
- Pilot testing in Greece and Germany
- System roadmap for future implementation

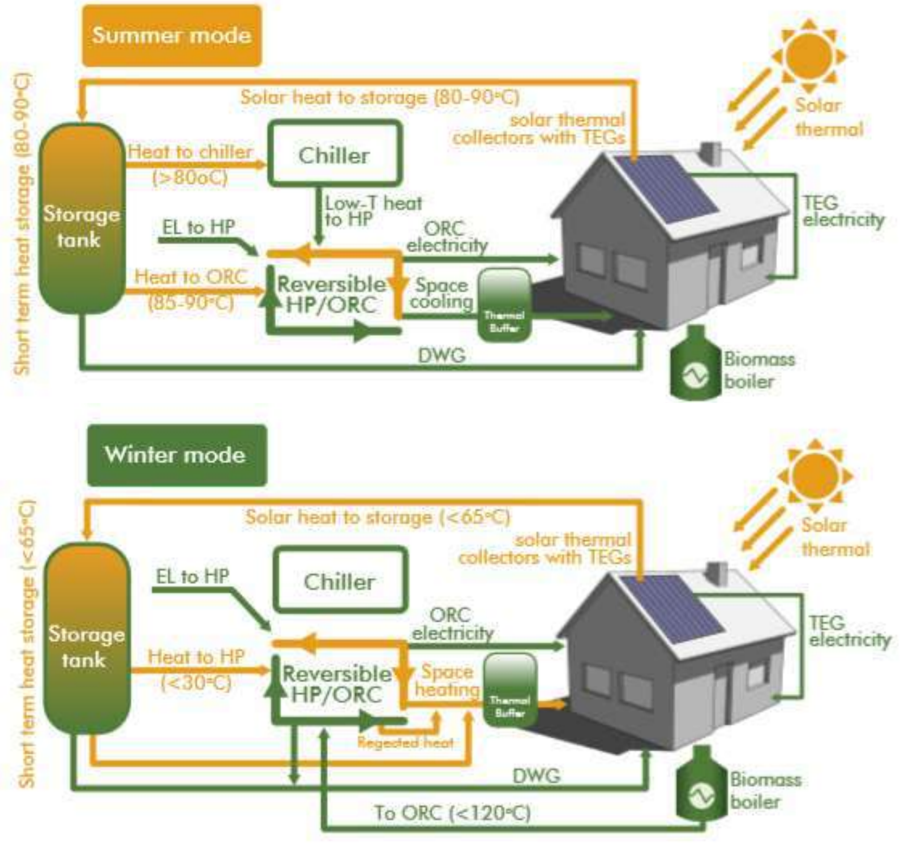
Goals

- Development of innovative technology systems
- Integration by means of advanced control
- System validation through pilot testing

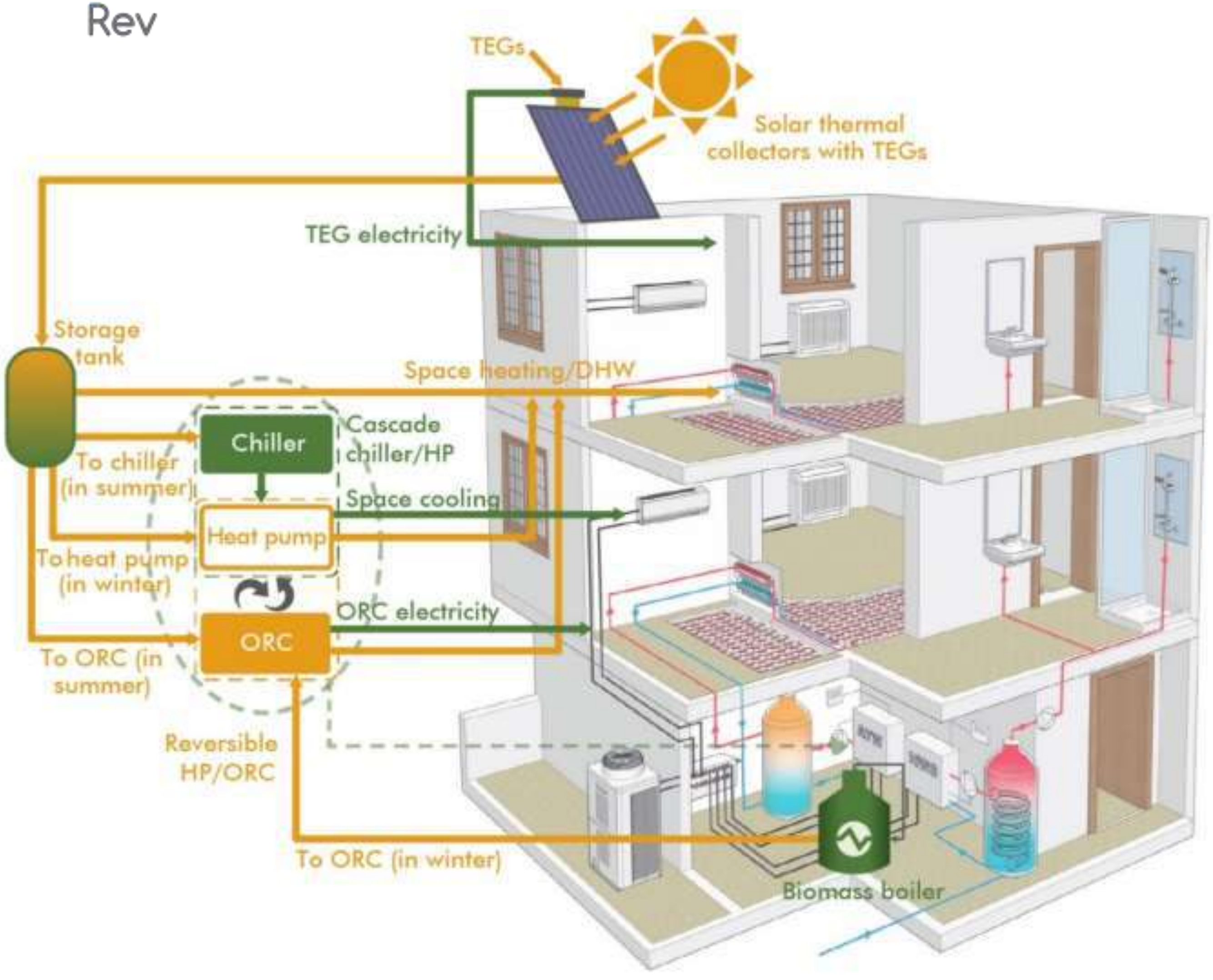
Team

Consortium of 15 partners (8 SMEs, 7 RTD) across Europe (Greece, Italy, Spain, Germany, Austria, Belgium, UK)

Introduction – Schematic Concept



SolBio-Rev system concept



SolBio-Rev system overview

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SolBioRev

Relevant Results

2019	2020-22	2022-...

2019 — System potential

- DHW 100% met by RES
- 70-90% RES share for space heating
- Up to 100% renewable cooling in Southern Europe
- Up to 60% RES share in Northern Europe

2020-22 — Systems development

- Notable emissions reduction and high-temperature biomass boiler operation (up to 110 °C)
- Efficient TEGs operation with solar collectors
- Stable and efficient R1234ze(E) heat pump operation
- Smart control development based on Deep Learning

2022-... — System testing

- Pilot buildings built (Athens-Greece, Nuremberg-Germany)
- Systems integration
- Annual testing

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SoBio Rev

Athens Pilot Building

- 60 m² surface floor area
- Multiple heating/cooling systems for system testing at various supply conditions (underfloor system, fan-coil units)
- Possibility for testing different envelope materials
- Artificial loads availability for system testing under different conditions (air-conditioning units, heaters...)

Seasonal testing to start in Spring 2023

Barriers Challeng

Barrier #1
Technologies

- Heat pump-based system operation under various conditions
- TEGs power output

Barrier #2
Economic

- High cost of subsystems and the integrated system

Challenge #1
Social acceptance

- Engagement of stakeholders and complexity compared to conventional systems

Challenge #2
Integration in buildings

- Installation, maintenance and retrofitting needs

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OST
Ostschweizer
Fachhochschule

TRI-HP PROJECT

Trigeneration systems based on heat pumps with natural refrigerants and multiple renewable sources

Dr. Daniel Carbonell

SPF Institute for Solar Technology
Eastern Switzerland University of Applied Sciences (OST)

SPF INSTITUT FÜR SOLARTECHNIK

TRI-HP PROJECT

Trigeneration systems based on heat pumps with natural refrigerants and multiple renewable sources

- Horizon H2020 research program
- Research and Innovation Action
- From TRL 3 to TRL 5
- Total EU contribution 5 M€
- Duration 2019 - 2023

TRI-generation systems

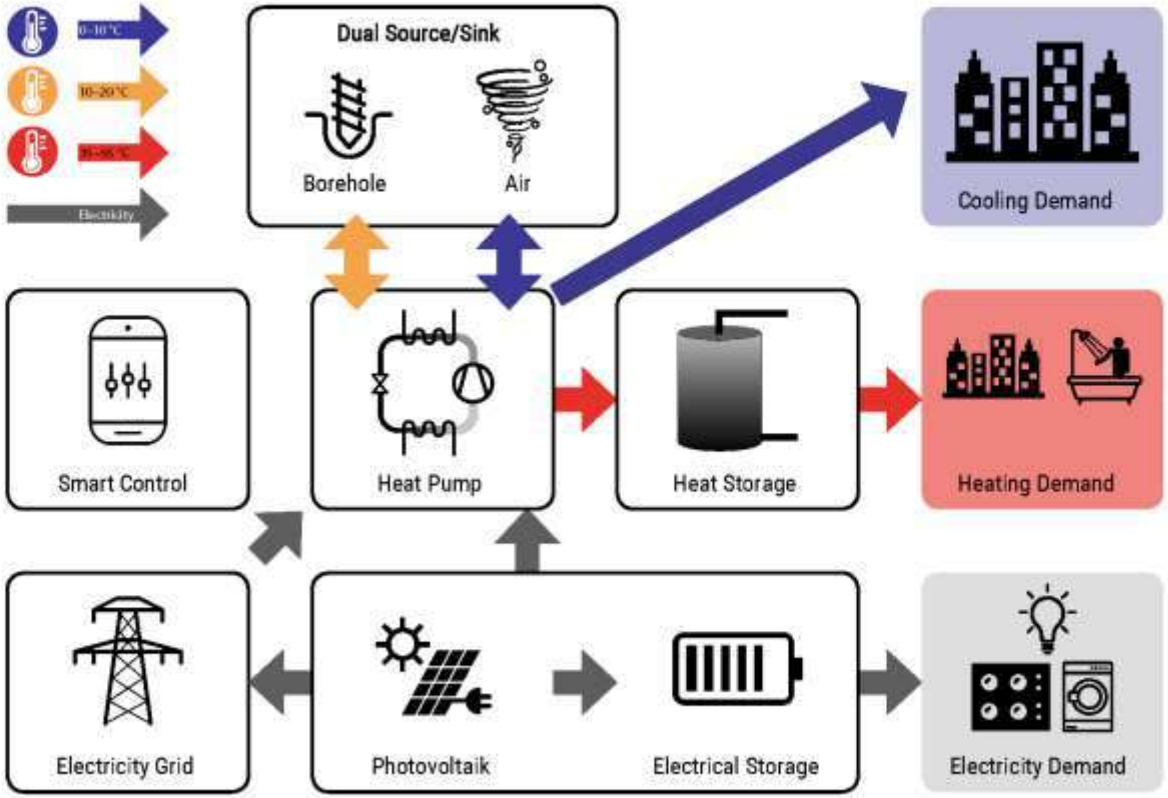
- Based on electrically driven **natural refrigerant heat pumps (HPs)** coupled with PV to provide **heating**, **cooling** and **electricity** to multi-family residential **buildings**

- Targets:
  - **80 % renewable on-site share** with net-zero energy concept (20 % exchanged with the grid)
  - **Cost reduction by 10 – 15 %** compared to current HP technologies with same energetic efficiency
  - **75 % GHG emissions reductions** respect to gas boiler and air chillers with grid purchased electricity.

www.tri-hp.eu

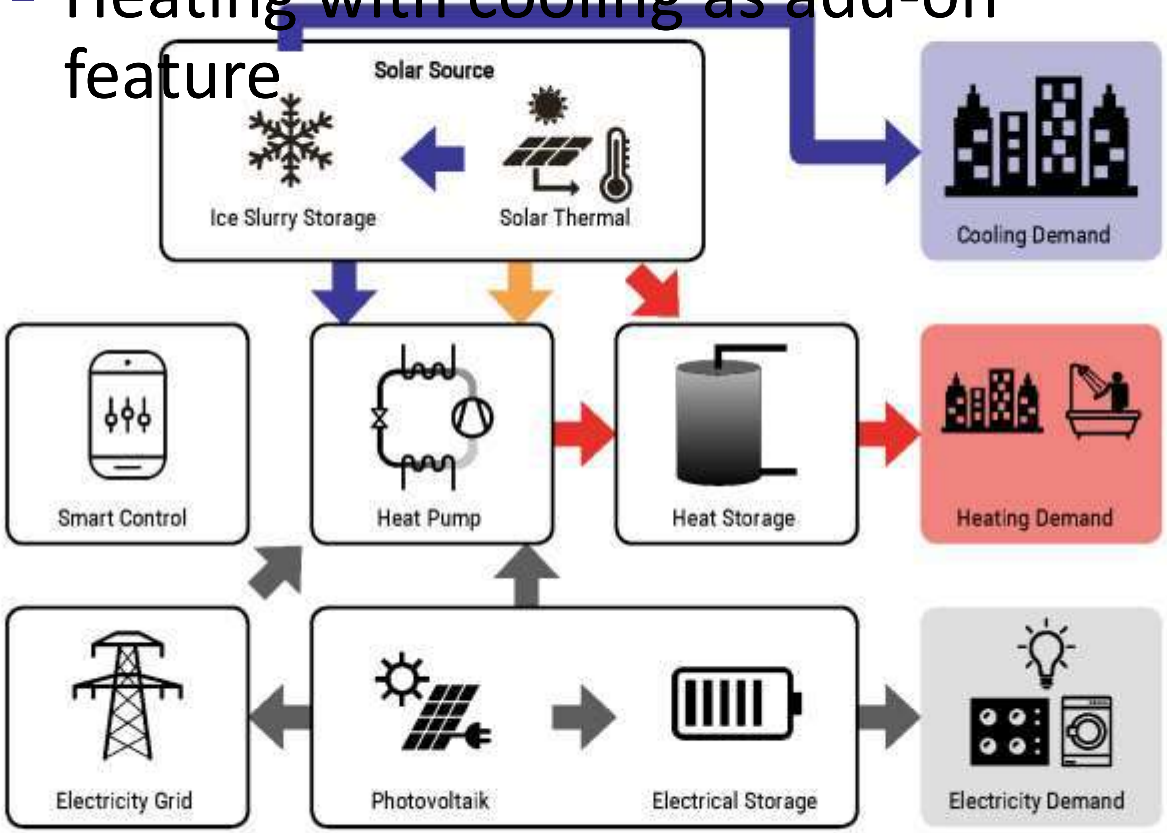
Dual source/sink system

- Source: ground and air
- Heating and cooling with



Solar-ice slurry system

- Source: solar with ice slurry as intermediate storage medium
- Heating with cooling as add-on feature



Technology Acceptance

- Understanding and improving stakeholder’s acceptance
- Analyse and identify the interest and needs of key stakehold

© SPF

- Methods
  - Qualitative **interviews** with stakeholders (DE, CH, ES, NO)
  - Regional **stakeholders workshops** (**DE**, CH, ES, NO)
- **Published Results** : Guidelines and recommendations of stakeholder’s acceptance

https:// doi:10.5281/zenodo.5500482;

Contact:

Dani.Carbonell@ost.ch

www.tri-hp.eu
https://zenodo.org/communities/tri-hp/

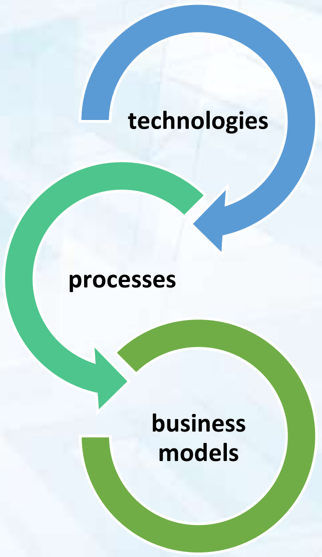
TRI-HP PROJECT | Trigeneration systems based on heat pumps with natural refrigerants and multiple renewable sources

June 2020
May 2024

RINNO - An augmented intelligence-enabled stimulating framework for deep energy renovation

RINNO aims to deliver a framework solution that will help drastically accelerating **deep renovation in energy inefficient buildings around Europe.** To deliver its ambition the project will offer innovative:

- **Technologies** (building envelope solutions, RES, hybrid and storage solutions);
- **Processes** (off-site/ on-site industrialization, optimization, facilitation);
- **Business models** (based on crowd-equity/ crowd-lending, collaborative financing, energy performance contracting).



This will be delivered through an **operational interface with augmented intelligence** and an **occupant-centred** approach, taking into account the whole life cycle.

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Relevant Innovative RINNO Technology

Various types

wall-integrated | wall-mounted

Various charging systems

hydraulic | electric | hybrid (both)

Flexible hydraulic unit

- hydraulics
- control
- monitoring
- prefabricated
- adjustable
- ease of maintain

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RINNO

Innovative Elements

- Special heat exchanger design for low network-temperatures
- Optimized control via BUS-connected controller
- Flat shape for low space consumption
- Prefabricated hydraulic modules
- New insulation materials for tanks
- Special materials and components with low maintenance needs

Advantages for Retrofitting

- Flexible System integration
- Higher efficiency compared to centralized or conventional systems
- Low space consumption
- Short installation time
- Reduced maintenance cost

RHC technologies for NZEBs

PLURAL

ENVISION

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PLURAL: Plug-and-use Renovation with adaptable lightweight Systems

Speaker	Maria Founti, Coordinator
Organisation	National Technical University of Athens
Start date	01 October 2020, 48 months
Funding	H2020 - LC-EEB-04-2020:- Industrialisation of building envelope kits
Project website	https://www.plural-renovation.eu/

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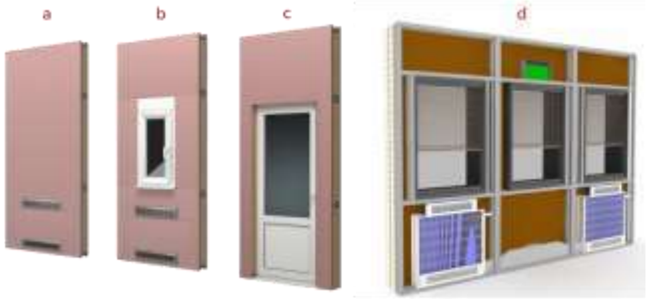
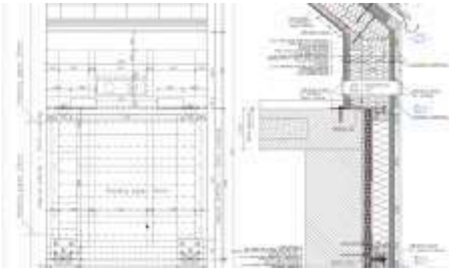
PLURAL Innovations-1

Three versatile hybrid Plug and Use - PnU - kits



The SmartWall PnU

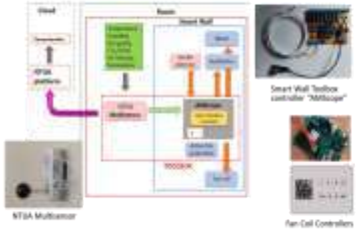
The HybridWall PnU



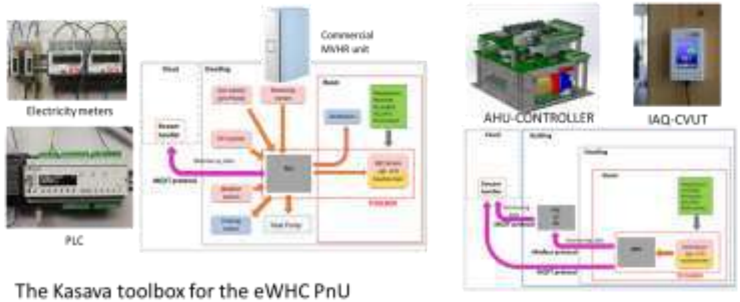
The eWHC PnU

PLURAL Innovations-2

The smart windows

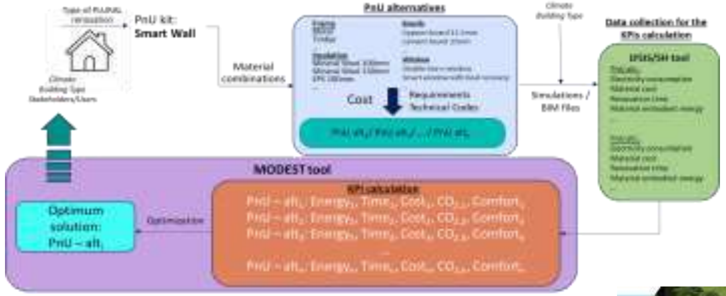


The SmartWall toolbox for Voula



The Kasava toolbox for the eWHC PnU

The toolboxes /supervisory control strategies

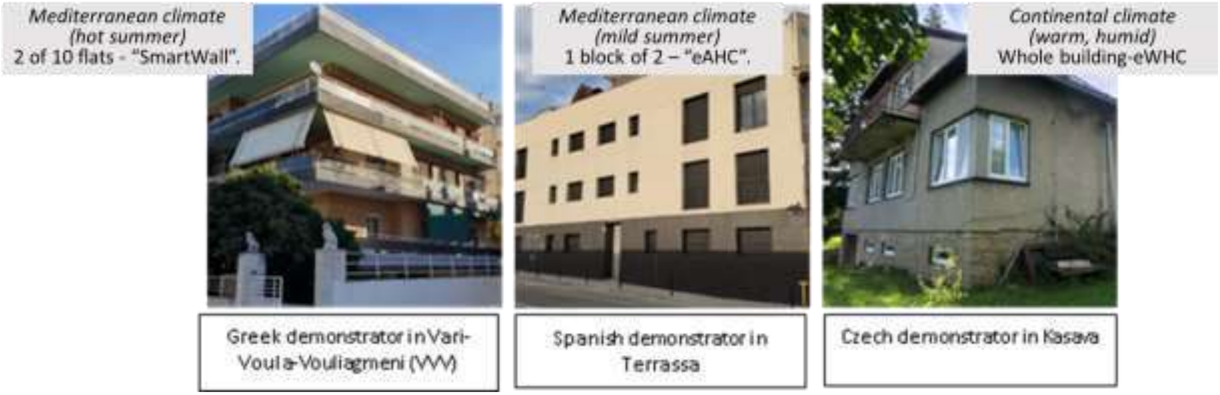


The IT and decision support tools: LYSIS and MODEST

PLURAL Innovations-3

Pilot validation and demonstration

- Three real demo cases/ Monitoring- **pre** and post retrofitting; modelling
- Three virtual demo cases; modelling
- Technical, **environmental**, and financial viability; Ensure NZEB status; Validate cost and renovation time



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PLURAL bottlenecks - criticisms

- Continuous increase of energy and diesel prices might affect production capacities and eventually production costs of PnU kits.

- Shortages on raw materials, high tech components, chemical compounds, etc., are already noticeable. At the moment, handled by PLURAL manufacturers

- Worldwide and/or European possible future lockdowns might affect businesses, infrastructures, organizations, commercial companies etc. and affect production of PnU kits.

Oct 2017- Sept 2022

Energy harVesting by Invisible Solar IntegratiON in building skins

ENVISION

Context

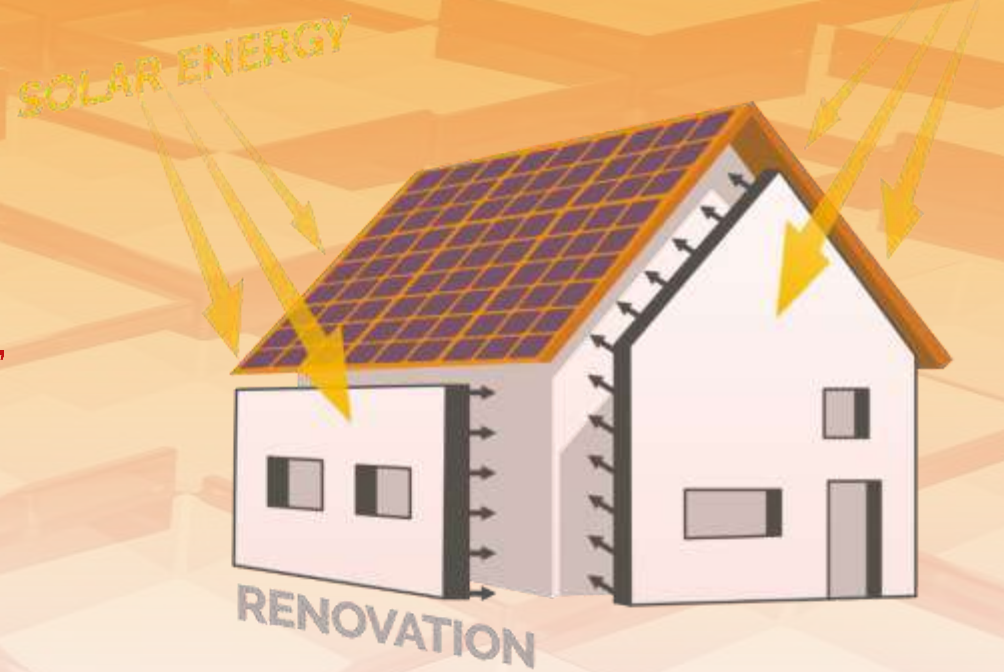
For reaching 2050 EU energy-neutrality goals, solar energy harvesting from all building surfaces should be maximized.

Approach

ENVISION technologies exploit the near-infrared (NIR) solar radiation, constituting roughly the 50% of the solar energy spectrum.

Goals

Active harvesting of the solar radiation from all the building surfaces, while retaining aesthetic aspects.



TNO innovation for life | EDF | Pilkington NSG Group | RINA | BGTec Sp. z o.o. Innovative facade solutions | AkzoNobel | NBA | EMERGO

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Relevant Innovative ENVISION Technologies

Goal TRL: from 4 to 7/8

Façade solar collectors with NIR absorbing colored coatings

Smart ventilated window

ENVISION

Smart ventilated window

Innovative facade solutions
BG Tec Sp. z o.o.
Innowacyjne rozwiązania fasadowe

Italian educational building (Southern EU Demo)

The Smart ventilated window will contribute to optimize heating and cooling loads, providing free heat gains in winter mode and removing it during summer season.

- It is a triple glazed window that harvests the solar radiation for space heating and DHW Purposes.
- Enables using also the glazed surface for energy production
- The building energy consumptions can decrease significantly for a dual perspective:

- Reduction of building energy demand (triple glazed unit)
- Production of thermal energy from renewable source

SUSTAINABLE PLACES

ENVISION

Façade solar collectors with NIR absorbing colored coatings

TNO innovation for life

AkzoNobel

EMERGO

Netherlands residential Demo (North EU Demo)
Italian educational building (Southern EU Demo)

The system consists of the use of solar thermal collector to be installed on the façade of the building.

- **The collectors are produced using a particular coating that makes possible the exploitation of the solar radiation also in the NIR area.**
- Link to district network and grid (Italy, University of Genoa Savona Campus)
- Real case study of Row Dwellings deep retrofit in Helmond & Eindhoven

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