SUN COUPLED INNOVATIVE HEAT PUMP

Federica Fuligni

federica.fuligni@rina.org

SunHorizon Project Coordinator

Technical Project Manager & Business Developer

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

PROJECT SCOPE AND VISION

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

Introduction

Context

help reducing technical and market barriers by providing robust data to evaluate performance in market segment

Approach

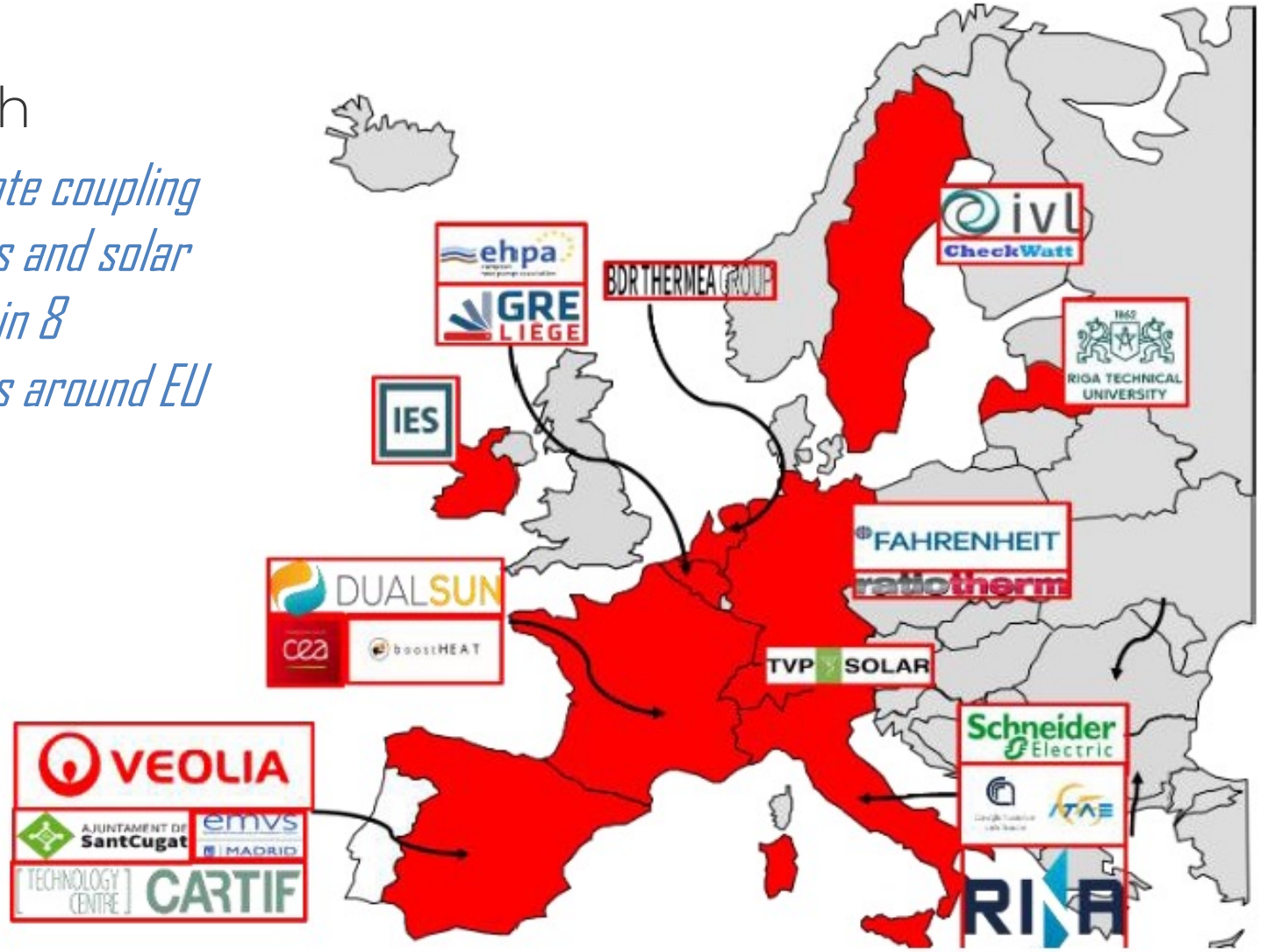
To demonstrate coupling of heat pumps and solar technologies in 8 different sites around EU

Goals

Reducing system costs and improving performance

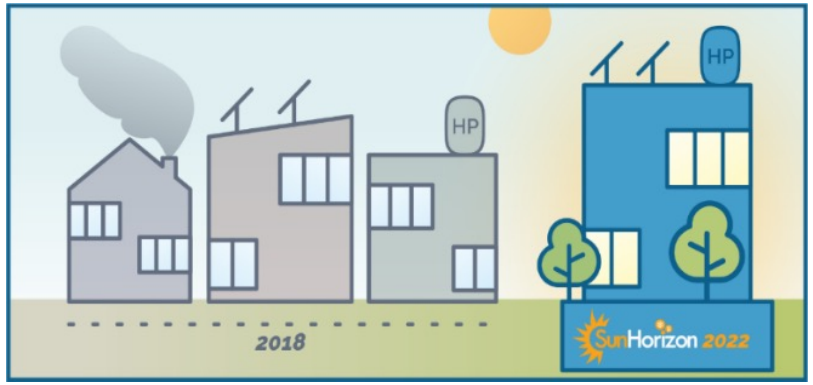
Team

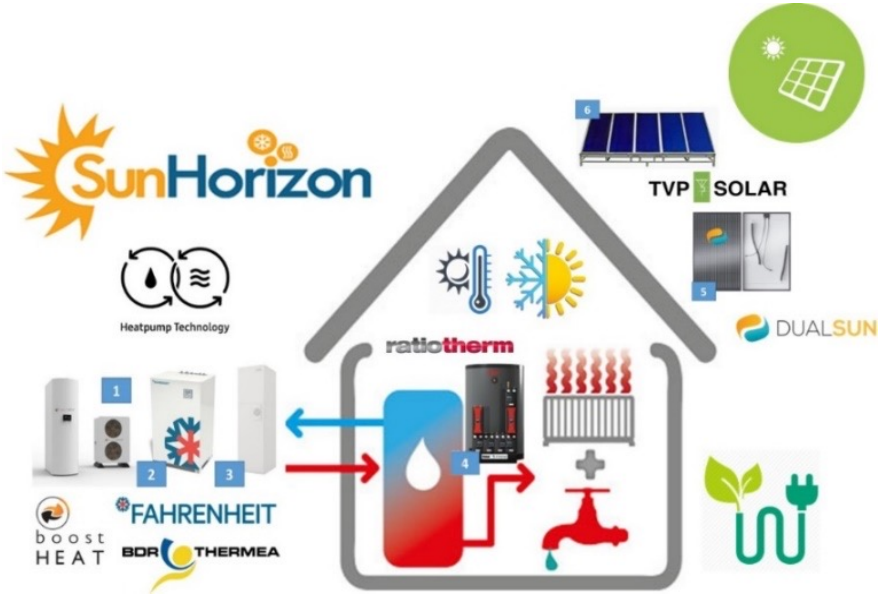
21 partners



This Project has received funding fr

SunHorizon goal





TRL 7 – Sun and HP as baseload of EU H&C systems
6 Technologies to be integrated – 5 Technology Packages – 8 Demos
3 Research Pillars based on Functional Monitoring Data exploitation

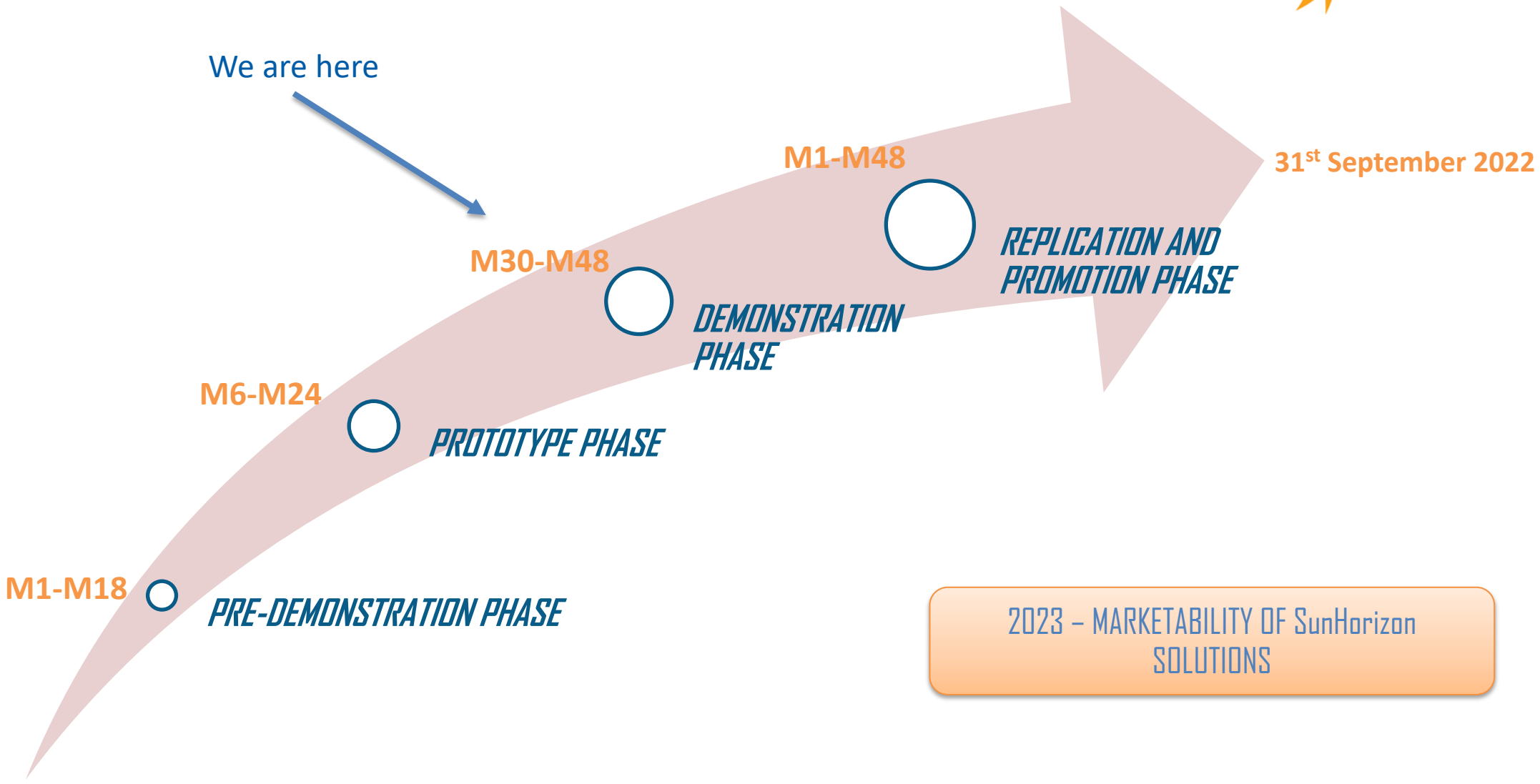
DESIGN – MANUFACTURE - CONTROL

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

PROJECT TIMELINE AND RESULTS TO DATE

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

SunHorizon Timeline



2023 – MARKETABILITY OF SunHorizon SOLUTIONS

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

Relevant Results

January 2020 (M15)

Technology specification

The technology packages have been simulated, with ranges from 30% until 76% energy saving, and up to 84% cost saving. Self consumption ratio until 95%.

September 2021 (M36)

Technologies delivered

All the technologies have been shipped to the demo sites between June and September 2021.
3 demosites have completed the installation.

April 2022 (M43)

Installation completed

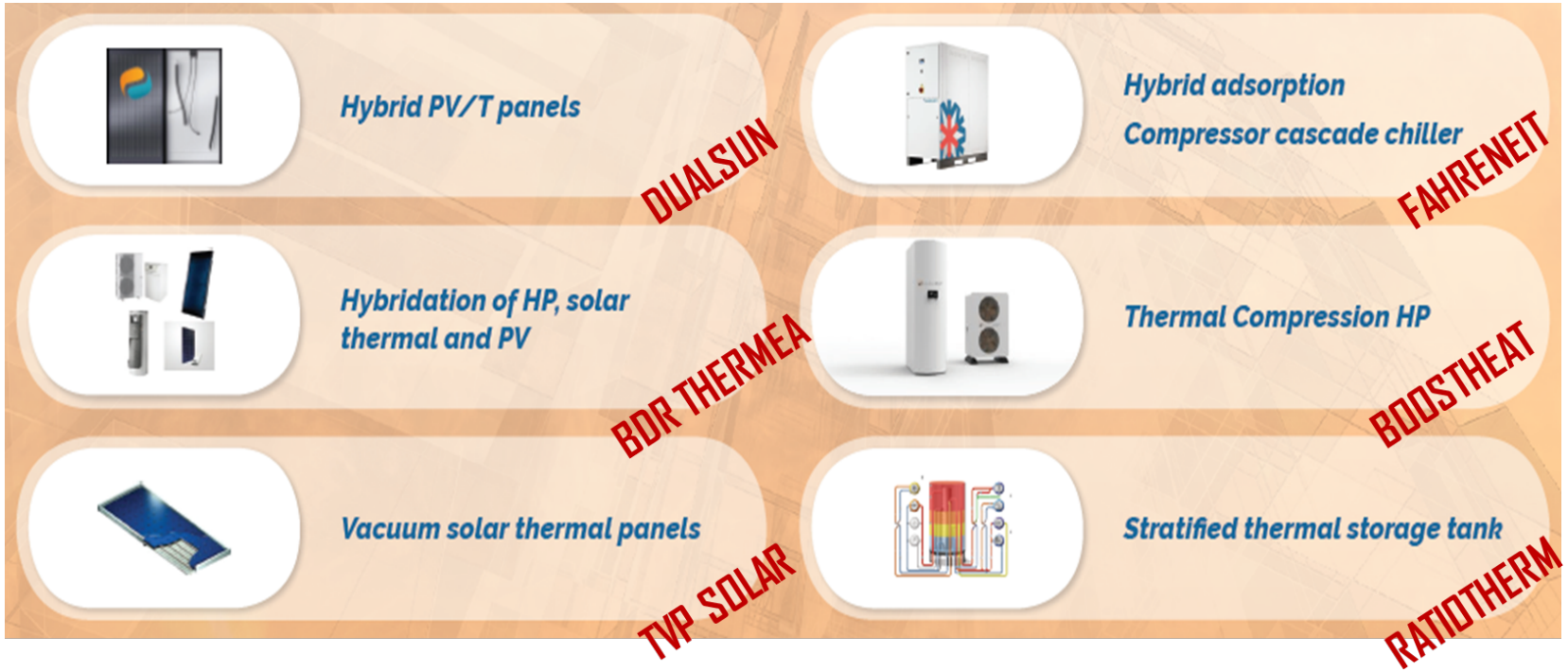
All demosites will have completed the installation.
One year extension is on the planning.

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

TECHNOLOGIES AND DEMOSITES

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

SunHorizon Technologies



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

SunHorizon technologies

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

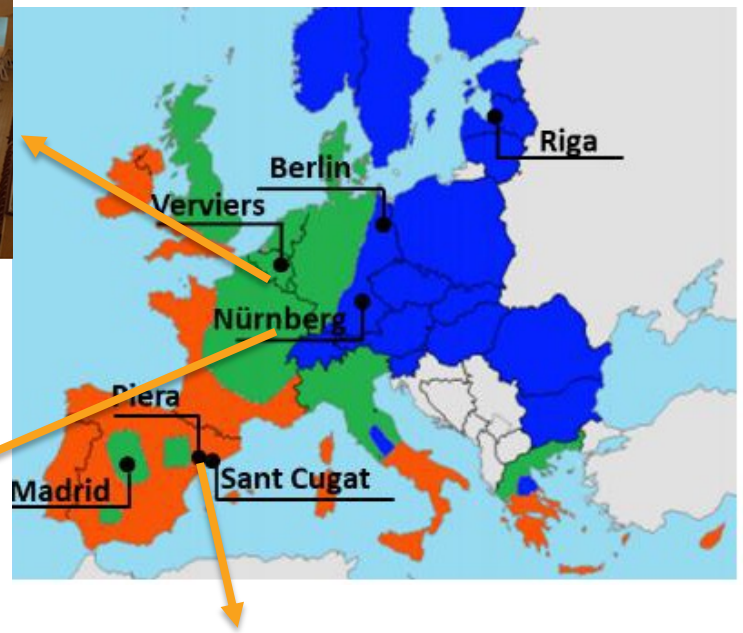
Pool heating

DHW

5 technology packages

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

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	Piera (Spain)	Warm	Small residential	**TP4**: BDR + PV
6	Verviers (Belgium)	Average	Tertiary (Sport Centre)	**TP1**: TVP+BH
7	Verviers (Belgium)	Average	Tertiary (Swim. pool)	**TP2:** DS+BH
8	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 N. 818329

SunHorizon Technology Packages (TP)

TP1

TP2

SunHorizon TP		Solar-HP integration concept	Description
TP1	TVP+BH	Parallel integration	TVP for space heating and DHW; BH to cover non-solar periods
TP2	DS+BH	Mixed solar-assisted/ parallel integration	BH for space heating and DHW support; DS PV-T thermal output to assist BH evaporator and cover preheating of demand; + electricity for appliances
TP3	TVP+FAHR	Solar-driven HP for cooling	TVP for space heating + DHW in winter + activation of the thermal compressor of the adsorption chiller (FAHR) for space cooling
TP4	DS+BDR	Parallel integration	DS PVT thermal output to cover part of space heating + DHW demand + electricity production to cover reversible heat pump electricity consumption
TP5	TVP+BH+ FAHR	Mixed solar-driven/ parallel integration	TVP for space heating + DHW; BH to cover non solar periods; FAHR adsorption chiller activated only by BH or also by TVP

TP3

TP4

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

SIMULATIONS AND TESTING

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

Results from simulations

SunHorizon TP		Solar-HP integration concept	Results from (TRNSYS dynamic) simulations:
TP1	TVP+BH	Parallel integration	In Berlin: 43% of primary energy savings, and 37% of costs savings for the user In Verviers: ~30% of primary energy and costs savings.
TP2	DS+BH	Mixed solar-assisted/ parallel integration	In Nurnberg: ~ 33% of primary energy and costs savings, 80% of el. Self consumption ratio (SCR). In Verviers: ~25% of primary energy and costs savings. 95.1% of SCR In Riga: : ~37% of primary energy and costs savings. 43% of SCR
TP3	TVP+FA HR	Solar-driven HP for cooling	In Sant Cugat ~35% of primary energy and costs savings**
TP4	BDR + DS	Mixed solar-assisted/ parallel integration	In Madrid ~76% of primary energy and 84% of costs savings, and 37% of SCR In Piera ~59% of primary energy and 53% of costs savings, and 47% of SCR
TP5	TVP+BH + FAHR	Mixed solar-driven/ parallel integration	TP only tested in simulation, in 3 locations and 2 types of buildings (tertiary and apartment building)

Test bench simulation just completed in May '21

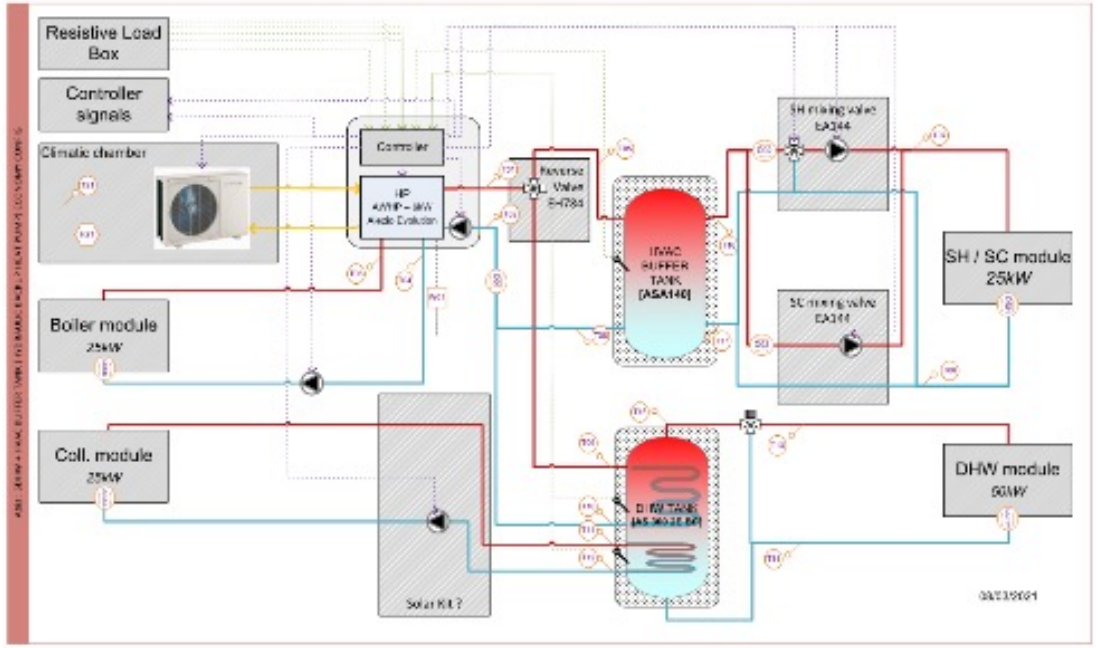
This Project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement N. 818329

TP4-BDR system test principles and real hardware running in semi-virtual lab

The semi-virtual lab test of TP4 from BDR for residential heating, cooling and DHW application was performed in March-April, in T3.3, following a custom **8-days test sequence** developed by CEA for Piera demo site in Spain.

BDR developed TP4 new concept for maximising the overall system emissions savings and the PV electricity self-consumption through BDR 6kW reversible air source heat pump and 440L water storage, 4m² thermal and 10m² PV flat solar panels (virtually emulated) with homogeneous tilted roof integration.

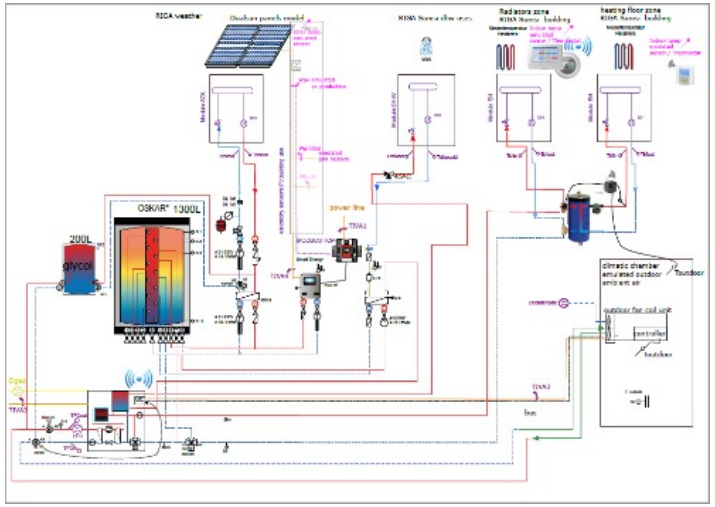
The analysis of the results is under work, it is already demonstrating nearly **60% annual primary energy savings** and **45% renewable energy ratio** of the real controller and hardware, very close to the estimated values by dynamic TRNSYS simulation.



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

TP2 system test principles and outlook of real hardware integration during

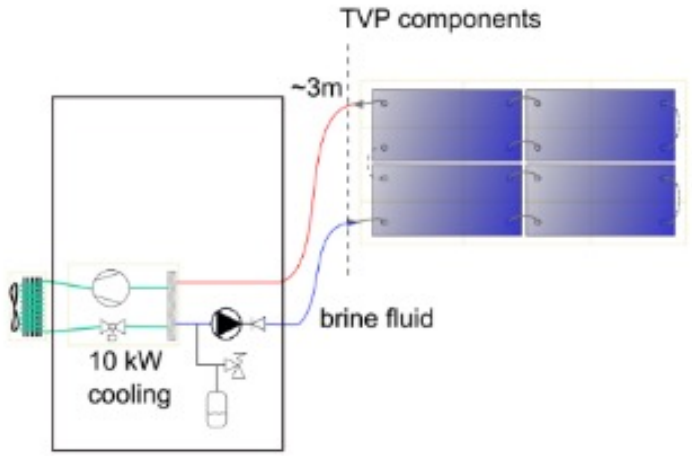
The test of TP2 involves **Ratiotherm** (solar heat distribution and 1.3 m3 stratified thermal storage, controller with electricity self-consumption strategy) and **Boostheat** (20kW thermal compression gas fired CO2 heat pump) as real hardware components while 50m² Dualsun solar **PVT panels are virtually emulated,** as well as the building and user heat and electricity demand.

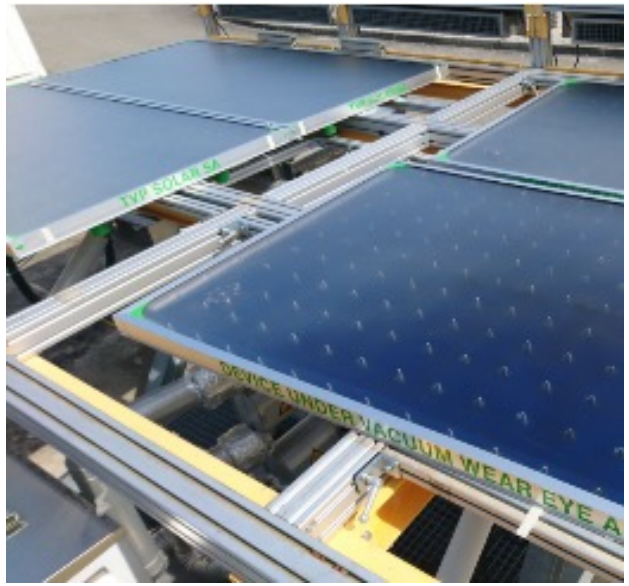


The TP2 installation in CEA INES semi-virtual lab is finished. A custom 9-days test sequence was developed by CEA to assess TP2 performance, mainly regarding gas and electricity consumptions in Riga Sunisi demo site in Latvia. **The test setup already allows gaining experience for fail proof connections and wiring recommendations of Ratiotherm and Boostheat** altogether, and validating the proper operation of controllers.

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

LT power high vacuum flat solar thermal panels testing





The Sunhorizon demo pilots of **TP3** in Sant Cugat, **TP1** in Verviers and Berlin are relying on **TVP solar LT power high vacuum flat solar thermal panels.**

Before being demonstrated also in INES PFE professional training platform in summer 2021, CEA is about installing 8m² LT power panels on its **sun tracking outdoor solar test bench** to get preliminary experimental performance assessment.

Tests will happen during a **few days in June** with appropriate weather conditions, in Chambéry, France. The resulting LTpower performance test datasets and numerical model are to be used in forthcoming TP1 semi-virtual test or further TVP solar sizing tools and performance simulations.

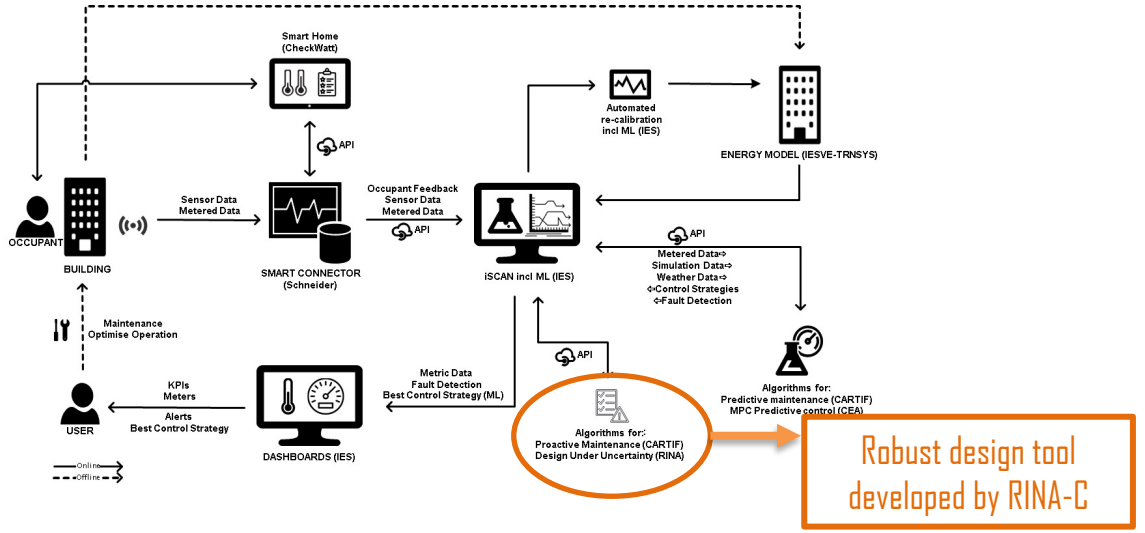
This Project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement N. 818329

WHAT'S NEXT

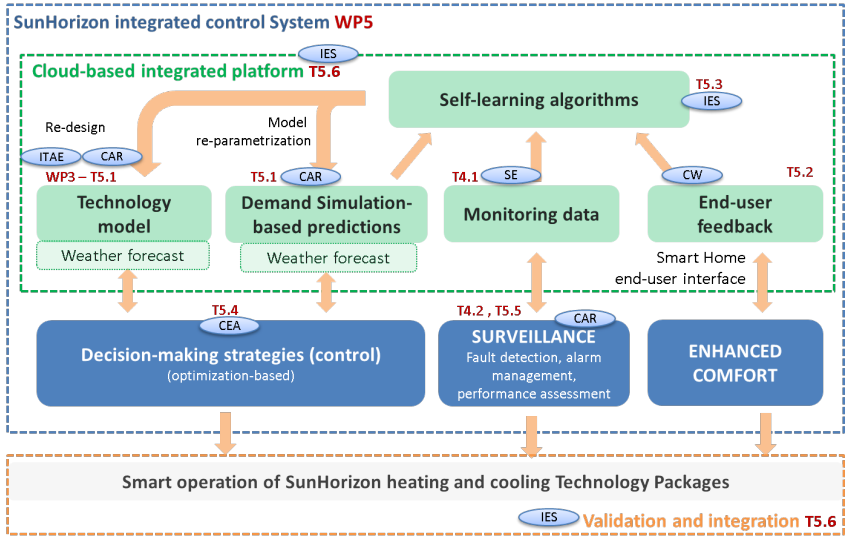
This Project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement N. 818329

SunHorizon: monitoring and control

- **Optimised sensoring/monitoring platform for:**
  - Control purposes
  - Design under uncertainty tool to reduce CAPEX (RINA-C)
  - Predictive maintenance strategy (reduce OPEX)



- **Developing an integrated smart control and surveillance system that combine**
  - Monitoring
  - Decision-making strategies
  - Prediction technique
  - Self-learning
  - End-users interaction



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

Beyond SunHorizon – Key Exploitable Results

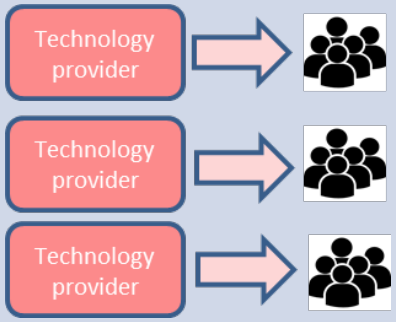
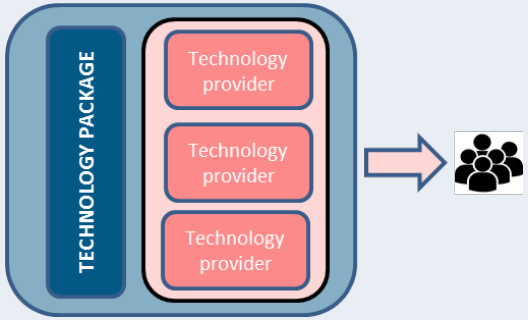
#	Results	Main partners
1	Vacuum Solar Thermal Panels	TVP SOLAR
2	Hybrid PV/T panels	DS - DUALSUN
3	Hybrid adsorption/Compressor cascade chiller	FAHR, ITAE
4	Thermal compression HP	BH - BOOSTHEAT
5	Hybridation of HP, solar thermal and PV	BDR THERMEA
6	Stratified thermal storage tank	RATIOTHERM
A	Self-Learning and In advance controller	CARTIF, CEA, **RINA-C**, RATIO, SE, CW, IES
B	Smart End User Interface	SE, CW
C	SunHorizon Tool Suite and Cloud Database	SE, CEA, CARTIF, IES, **RINA-C**, EXE, H&C manuf.

Solar Panel | Heat Pump | Storage

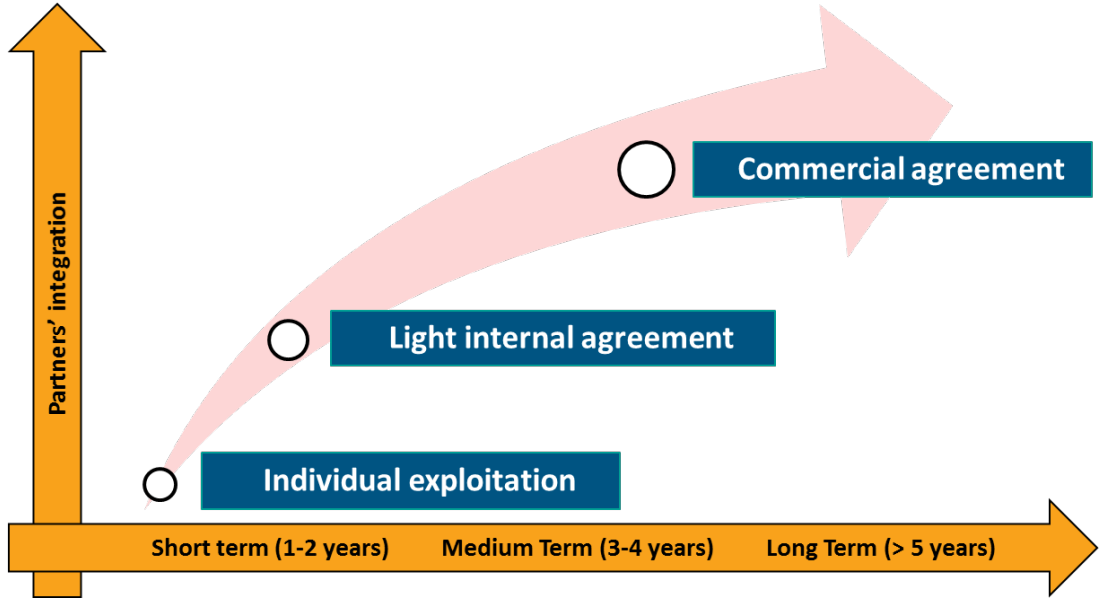
This Project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement N. 818329

Beyond SunHorizon – Exploitation strategies

Screening of potential BM patterns after the end of the project

Exploitation strategies at partner level		✓ Exploitation Model
Exploitation strategies at project level (technology package driven logic)		✓ Internal Agreement among technology providers ✓ Roles of partners towards clients' engagement ✓ Pricing and revenue models

Roadmap towards the commercialization of the SUNHORIZON technologies



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

BARRIERS AND CHALLENGES

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

Barriers and Challanges to date

Barrier 01.

Technologies do not always fit the (residential) owners requirements.

Barrier 02.

COVID-19 consequences on the construction industry, prices and times for execution.

Challenge 01.

Lack of an “integrator” partner, both for design and for post-project.

Challenge 02.

Budget for installation defined in proposal phase.

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

…QUESTIONS?

Federica Fuligni – SunHorizon Project Coordinator

Energy Systems & Sustainability Business Development

Federica.fuligni@rina.org

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