DecarbCities2022

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Our vision and objective

The SunHorizon Technology Packages (TPs) aim to cover 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** (cut local energy bills up to 60% for provided H&C services; local CO2 cut up to 80%)
- **Promote cloud based functional monitoring for H&C purposes**
- **Reduce SunHorizon H&C technologies CAPEX and OPEX** (reduction of CAPEX up to 15%, reduction of internal losses up to 25%)
- **Demonstration of SunHorizon Innovations indifferent EU countries and type of buildings**
- **Promote the replication of SunHorizon Concept** (Realization of 4 replicability studies towards -60% CO2 savings and -40% energy bill)
- **Dissemination and Capacity Building**

This Project has received funding from the European Union’s Horizon 2020 Research and Innovation Programme under Grant Agreement N818329.
DEMO Sites - Presentations

• **Riga, Latvia**: small residential (2 single houses)

• **Madrid, Spain**: social housing apartment block (9 apartments)

• **Sant Cugat del Vallès, Spain**: tertiary civic center
Type of building: **small residential** (two single-family houses, 2012/2013)

<table>
<thead>
<tr>
<th></th>
<th>Imanta</th>
<th>Sunisi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heated space</td>
<td>235 m²</td>
<td>96 m²</td>
</tr>
<tr>
<td>Electricity consumption</td>
<td>~4.4 MWh/year</td>
<td>~7.2 MWh/year</td>
</tr>
<tr>
<td>Gas consumption</td>
<td>~39.6 MWh/year, 168.5 kWh/m²</td>
<td>~21 MWh/year, 218.8 kWh/m²</td>
</tr>
<tr>
<td>Pre-SunHorizon</td>
<td>individual <strong>gas boiler</strong> for DHW and space heating through radiators (Imanta, Sunisi) and under-floor heating (only Sunisi)</td>
<td></td>
</tr>
</tbody>
</table>

**Demonstration action**

TP2: mixed solar-assisted integration of gas-driven thermal compression **heat pump** with boiler (Boostheat) for space heating + DHW; **hybrid solar PV-T panels** (DualSun) to assist BH evaporator and for preheating + electricity production for building appliances coupled with **glycol storage** and **stratified thermal storage** tank (Ratiotherm) + Smart Energy electrical heater for residual PV-T electricity.

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**DEMO Site – Riga, Latvia**

- **Installation** of TPZ components in Riga, Imanta

- **Oskar tank**
- **BH indoor unit**
- **BH outdoor unit**
- **PVT panels on ground**

- **Control, monitoring and ICT devices**
- **BH display**

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DEMO Site – Riga, Latvia

• **Installation** of TP2 components in Riga, Sunisi

- PVT panels on roof
- BH outdoor unit

- electricity meters

- PV inverter, smart el. heater, monitoring

- BH indoor unit

- Boiler room, piping for integration of TP2 components

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**DEMO Sites – Riga, Latvia**

**Technical and social risks & difficulties**

Initial assessment: very **limited risk** in coupling both innovations (i.e. HP boiler and solar hybrid PV-T)

However, a number of challenges observed during deployment phase:

⇒ The **technologies are unknown** to the Latvian market and the installers have limited experience

⇒ Successful **integration of controls** requires active involvement of all technology providers

⇒ Unfamiliarity and **precaution of potential end-users** to decide swapping their existing “old, reliable” gas boiler with a completely new technology package consisting of a number of components

⇒ The new technology package needs much **more space** compared to the old gas boiler, so the existing boiler rooms were not suited for that and other premises were used

⇒ Approval of new gas piping installation **time-consuming**, long waiting lines of the gas DSO as a result of Covid-related restrictions and a lot of construction work ongoing

⇒ The procedure for approval of solar panels was **significantly relaxed** in Latvia during our deployment phase (now approval of municipality is generally not required)
PV production from solar panels (1 Jan – 4 May 2022)

Imanta: 2.90 MWh produced (10.24 kWp installed)

Sunisi: 2.68 MWh produced (9.6 kWp installed)
DEMO Site – Madrid, Spain

Type of building: **Large residential Social housing** apartment block, envelope under retrofit, 10 flats with a ground floor + 4 floors (1072 m²) near the town center of Madrid. Solar energy potential: 62 m².

<table>
<thead>
<tr>
<th>Heated space</th>
<th>1.072 m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yearly thermal demand estimation</td>
<td>~ 13 MWh DHW, 18 MWh electricity, 60 MWh space heating, 4 MWh cooling.</td>
</tr>
<tr>
<td>Pre-SunHorizon</td>
<td>Existing individual appliances per flat: gas boiler supply DHW and space heating through radiator circuit and air/air split for cooling.</td>
</tr>
</tbody>
</table>
Demonstration action: TP4, Parallel integration:

- reversible HP (BDR) for space heating + cooling + DHW;
- Thermal output from solar hybrid PV-T (DUALSUN) to cover heat demand and to assist BDR evaporator;
- PV-T (DUALSUN) electricity production to cover building appliances electricity consumption.

<table>
<thead>
<tr>
<th>Component</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>DS Panels</td>
<td>50 m²</td>
</tr>
<tr>
<td>BDR HPs</td>
<td>9 kW (Brine-Water) for DHW and SH, 27 kW (Air-Water) as back-up and space cooling</td>
</tr>
<tr>
<td>RT Tanks</td>
<td>1300 l for DHW, 1000 l for SH/SC</td>
</tr>
<tr>
<td>DS glycol tank</td>
<td>200 l</td>
</tr>
</tbody>
</table>
DEMOSite - Madrid, Spain - Passive Renovation

- **ENVELOPE:** External Insulation 8 - 10 cm. U value = 0,262 W/m2K
- **ROOF:** Integration of insulation layer: 80 mm de Extrude Polystyrene, total thickness: 52 cm; Uvalue = 0, 26 W/m2K
- **WINDOWS:** Substitution of windows: Aluminum TBB Double Glazed with Low Emission layer + Solar Control 4+4-16-6; Uvalue = 1,00 W/m2K
- **LIFT:** Change location of the lift to improve the accessibility

Façade before

Façade after

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Overview of the process of renovation:
SUNHORIZON Building refurbishment and construction works consists of 2 phases:

• 1st PHASE:
Dwelling refurbishment, improvement of insulation, etc. + Pre-installation SH: Interior installation and exterior distribution system (interior heat exchangers, fan coils, interior and exterior distribution pipes and conducts, ventilation, etc.).

Roof before renovation

Roof after renovation
DEMO Site - Madrid, Spain - SUNHORIZON Renovation

PHASE 1:

- Fan Coil and Plenum
- Distribution pipes
- Heat Exchanger for DHW
- Heat Recovery unit for Ventilation
- Old Lift hole converted to Installation shaft
PHASE 2: SunHorizon equipment connection to the pre-installation (Hydraulics, Electrics and Controls) and commissioning.

First Shipment containing the 1000L and 1300L arrived Second Half July
DEMO Site - Madrid, Spain - SUNHORIZON Renovation

50 m² (approx 10 kWe) DS panels (PVT)  

Solar Field

Roof Technical room

A/W Heat Pump

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Technical and social risks & difficulties

⇒ Generalized material supply delays

Main Contractor Issues:

⇒ Lack of experience and knowledge in executing high complexity systems, specially associated to hydraulics and communication and controls

Impact:

⇒ Installation works timing
⇒ Legalization of the electric system and therefore the process of contracting an increase of power required for the commissioning
DEMO Site - Madrid, Spain - Energy Efficiency Impact

GHG savings of 71%
Non Renewable Primary energy savings of 87%
DEMO Site – Sant Cugat del Vallès, Spain

Type of building: Tertiary civic center (Surface: 2,440.25 m² in 1 floor)

<table>
<thead>
<tr>
<th>Heated space</th>
<th>1,200 m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity consumption</td>
<td>~200 MWh/year</td>
</tr>
</tbody>
</table>

Pre-SunHorizon

- Reversible air to water heat pump: 93.6 kW (cooling capacity) – 96.3 (heating capacity).
- Air handling unit (AHU): 110 kW (cooling capacity) – 67.78 (heating capacity).
- 2 x split air conditioner: 2.1 kW (cooling capacity) – 3 (heating capacity).

Demonstration action

TP3. Solar-driven HP: Solar thermal (TVP) drives the thermal compressor of FAHR chiller with increased efficiency to provide 40kW(+60 kW) cooling capacity with existing 93 kW chiller on the existing cooling distribution.

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**DEMO Site – Sant Cugat del Vallès, Spain**

**Installation** of TP3 components in Sant Cugat del Vallès. Main components:

- **SOLAR FIELD (TVP):** 98 panels, 192 m², 125 kW.
- **Heat pumps (FAH):** Sorption unit 40 kW, compression unit 60 kW. Temp: 80-95°C (IN), 70-85°C (OUT)
DEMO Site – Sant Cugat del Vallès, Spain

- **Installation** of TP3 components in Sant Cugat del Vallès

  - TVP high vacuum panels system (125 kWth)
  - TVP system
  - Pump and expansion vessels of the FAHR system
  - FAHRENHEIT re-cooler system
  - RATIOHERM hot water storage system (10,000 l)
  - FAHRENHEIT hot water storage
Technical and social risks & difficulties

Initial assessment: very limited risk in coupling both innovations (i.e. HP boiler and solar hybrid PV-T)

However, several challenges observed during deployment phase:

- Minor budget deviations due to the rental of cranes and common material
- The installation of an exchanger in the heat stage has been foreseen to reduce the inlet temperature of the existing hot water heat pump. Temperatures of 70 to 95°C were not admissible at the inlet of the heat pump
- The solar panels total surface and distribution had to be adjusted according to the real roof surface.
- Difficulties to integrate the different monitoring system from different equipment
- The system had to manage some civil works to adapt the big volume of the thermal tank and some reinforcement had to be perform to support the solar field and the tanks
- The technical room needs minor adaptations like to increase the passage width for the entrance of the equipment (basically the chillers) and opening wall passages for the interconnection between the thermal tank and the chillers
SunHorizon App

The App allows users to view real-time information about their building’s indoor climate and energy consumption (temperature, humidity and CO2 concentration) through the installation of sensors in 10 rooms of the building.
DEMO Site – Sant Cugat del Vallès, Spain

Centre Cultural Mirasol (Sant Cugat pilot):
Opening hours: from Monday to Sunday 8am to 2.30pm and 4pm to 10pm
Following influx of users:
- 405 users in the mornings from Monday to Friday
- 330 users in the afternoons from Monday to Friday
- 170 users on weekends
- 905 users per week
- 3620 users per month

Total number of courses and activities offered per week:
- 55 courses and workshops on culture (music, painting, cooking, dance, yoga, etc)
- 3 daily professional training courses and ICT tools.
- 1 public school training classroom
- 1 theater and dance hall
- Daily workshops of permanent based cultural entities
- Daily space for the elderly day center and services (hairdressing, physiotherapy, etc)
Results:
The results we get from using these TVP solar systems and HP are:

- **Reduction of fossil energy consumption** as it provides renewable energy from the sun throughout the year either to generate cold or heat
- **Noise reduction** in the operation of the installation
- **Reduction of greenhouse gas emissions** in line with the objectives of reducing by 55% GHG emissions from the Covenant of Mayors (Covenant of Mayors) and our Climate Emergency Plan
### DEMO Sites – Replicability potential

<table>
<thead>
<tr>
<th>Riga, Latvia</th>
<th>Madrid, Spain</th>
<th>Sant Cugat del Vallès, Spain</th>
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</thead>
<tbody>
<tr>
<td>- Small residential (single houses 30% in Latvia) with natural gas connection (48% of dwellings in Latvia)</td>
<td>- Residential and tertiary</td>
<td>- Medium scale tertiary buildings and residential</td>
</tr>
<tr>
<td>- New and renovated buildings</td>
<td>- New and renovated buildings</td>
<td>- New and renovated buildings</td>
</tr>
<tr>
<td>All climates</td>
<td>- Sunny climates</td>
<td>- Sunny climates</td>
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Thank you!

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