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ENSNARE Virtual Pilots: Testing Innovative Renovation Solutions Across Europe's Climatic Zones

The ENSNARE project conducted virtual demonstrations of three buildings in different European climates to evaluate the impact of renovation solutions, particularly the ENSNARE technologies: Photovoltaic panels (PV), solar thermal panels (ST), and insulation systems.

Key Methodology:

Each virtual pilot has a real, physical location but was also digitally simulated in five additional climate zones to analyze how ENSNARE technologies perform under diverse environmental conditions. This approach ensures that the results are applicable across Europe and not just limited to the pilot's actual climate.

The six climate zones used for all pilots were:

Climatic Zone	Representative City	Climate type
Cfb	Glasgow (UK) / Amsterdam (NL)	Temperate oceanic (mild temperatures, high humidity, frequent rain)
Dfc	Tampere (Finland)	Subarctic (hot, humid summers; mild winters)
Cfa	Milan (Italy)	Humid subtropical (hot, humid summers; mild winters)
Dfb	Ljubljana (Slovenia)	Warm-summer humid continental (cold winters, warm summers)
Bsk	Madrid (Spain)	Cold semi-arid (hot, dry summers; cold winters)
Csa	Barcelona (Spain)	Hot-summer mediterranean (hot, dry summers; mild, wet winters)

Glasgow Virtual Pilot (Helix building)

1. Activities Done

- Modeled a two-story office building in Glasgow using IES-VE software.
- Applied five renovation scenarios, including:
 - Shallow retrofit** – light envelope insulation.
 - Deep retrofit** – thicker envelope insulation, electric heat pump.
 - ENSNARE Tech A** – façade insulation + PV on three facades (south, east, west).
 - ENSNARE Tech B** – façade insulation + PV only on the south facade.
 - ENSNARE Tech C** – façade insulation + PV on east & west facades.

2. Characteristics of the Pilot

- Physical Location:** Glasgow, Scotland (Temperate oceanic - Cfb).
- Additionally Simulated in:** Tampere, Milan, Ljubljana, Madrid, and Barcelona.
- Year of construction:** 2002



Figure 1: Location and orientation of the Helix building, Glasgow (UK)



Figure 2: 3D model of the Helix building in Glasgow

3. Results

- Energy Performance:**
 - ENSNARE Tech A (PV on three facades) had the highest renewable energy generation in Barcelona – Csa).
 - ENSNARE Tech B (PV only on south facade) and ENSNARE Tech C (east & west PV) produced the highest renewable energy in Barcelona – Csa as well.
 - Deep retrofit reduced heating demand, but had an overall lower impact on total energy savings.
 - ENSNARE Tech A showed the highest total energy savings, particularly in Cfa, Bsk, and Csa climate zones.
- Environmental Impact:**
 - ENSNARE Tech A (PV on three facades) reduced the most primary energy use in Ljubljana (~9% per year).
 - ENSNARE Tech B (PV only on south facade) also exhibited the highest primary energy use reduction in Ljubljana (~5% per year).
 - ENSNARE Tech C (east & west PV) also performed the best in Ljubljana (~7% per year) in terms of primary energy savings.
 - Deep retrofit reduced significant heating demand in Temperate oceanic (Cfb), Subarctic (Dfc), and Warm-summer humid continental (Dfb) zones, but had a lower impact on primary energy savings.
 - Significant GHG emissions reductions were observed across all ENSNARE scenarios.

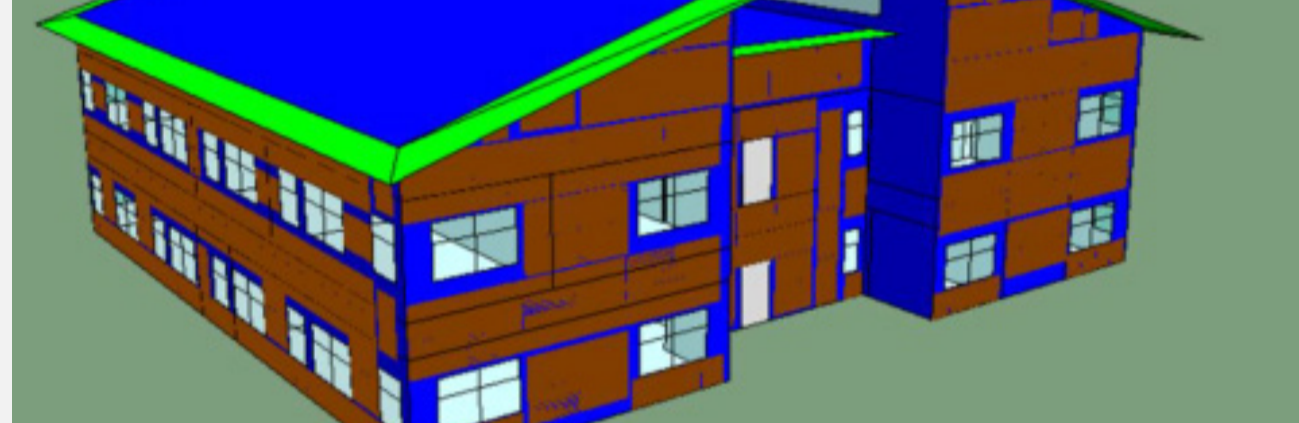


Figure 3: The representation of ENSNARE PV panels (brown panels) on south and east facades of the Glasgow pilot demonstration

Amsterdam Virtual Pilot

1. Activities Done

- Modeled a four-story mixed-use building in Amsterdam.
- Applied five renovation scenarios, including:
 - Shallow retrofit** – light envelope insulation.
 - Deep retrofit** – thicker envelope insulation, electric heat pump.
 - ENSNARE Tech A** – façade insulation + PV on three facades (south, east, west).
 - ENSNARE Tech B** – façade insulation + PV only on the south facade.
 - ENSNARE Tech C** – façade insulation + PV on east & west facades + ST on the south facade for domestic hot water.

2. Characteristics of the Pilot

- Physical Location:** Amsterdam, Netherlands (Temperate oceanic - Cfb).
- Additionally Simulated in:** Tampere, Milan, Ljubljana, Madrid, and Barcelona.
- Year of construction:** 1985

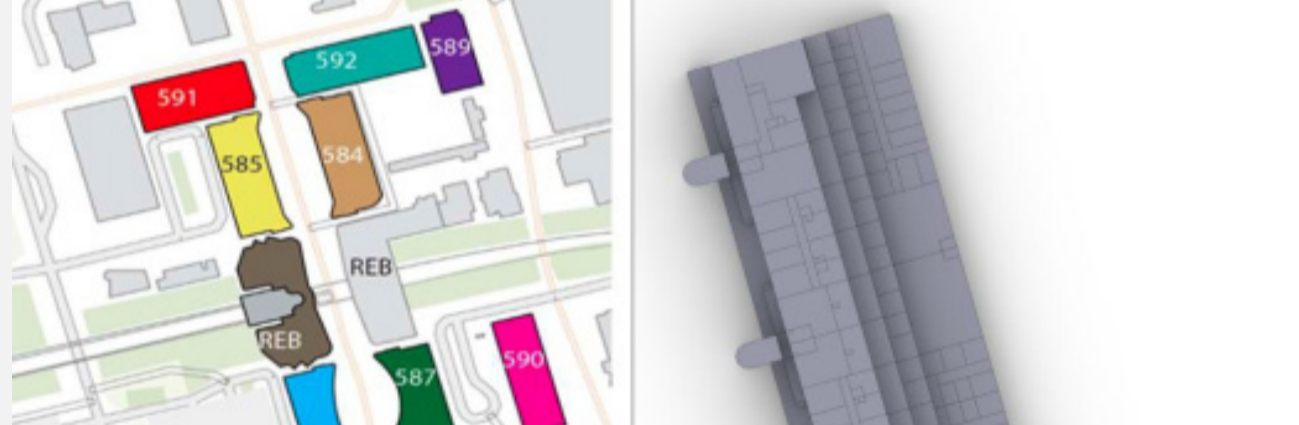


Figure 4: Location and orientation of the virtual building in Amsterdam and orientation



Figure 5: 3D visualisation in Amsterdam

3. Results

- Energy Performance:**
 - ENSNARE Tech A (PV on all facades) had the **highest renewable energy generation** (~545 m² of PV coverage).
 - ENSNARE Tech C (PV + ST for domestic hot water) considerably **reduced gas consumption**.
 - Deep retrofit improved insulation **but increased cooling demand** in warmer (Cfa, Bsk, and Csa) climates for the simulated conditions.
- Environmental Impact:**
 - ENSNARE Tech C provided the **significant GHG emissions reduction**, particularly in **Cfa, Bsk, and Csa** climates for ENSNARE solutions where solar thermal had a more significant impact on the replacement of gas heating.
 - ENSNARE solutions showed **comparative primary energy savings to deep retrofit** despite low coverage of façade area.

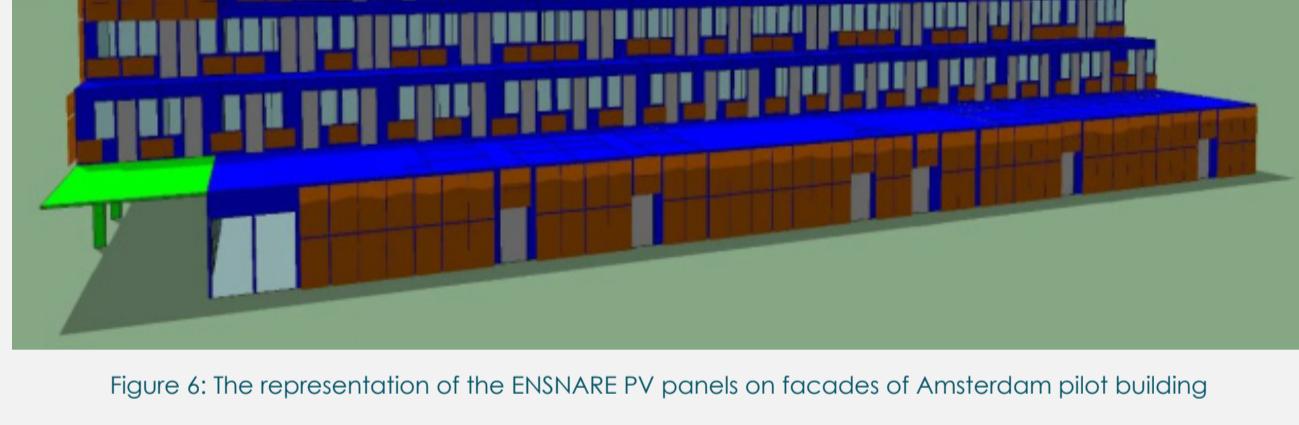


Figure 6: The representation of the ENSNARE PV panels on facades of Amsterdam pilot building

Milan Virtual Pilot

1. Activities Done

- Modeled a 12-story residential building in Milan.
- Applied different renovation strategies, including:
 - Shallow retrofit** – light envelope insulation + double-glazed windows.
 - Deep retrofit** – thicker envelope insulation + double-glazed windows + electric heat pump.
 - ENSNARE Tech A** – façade insulation + PV on three facades (east, west, south).
 - ENSNARE Tech B** – façade insulation + PV on the east and west facade.
 - ENSNARE Tech C** – façade insulation + PV on east & west + ST on the south facade for domestic hot water.

2. Characteristics of the Pilot

- Physical Location:** Milan, Italy (Humid subtropical - Cfa).
- Additionally Simulated in:** Amsterdam, Tampere, Ljubljana, Madrid, and Barcelona.
- Year of construction:** 1970



Figure 7: Milano virtual buildings

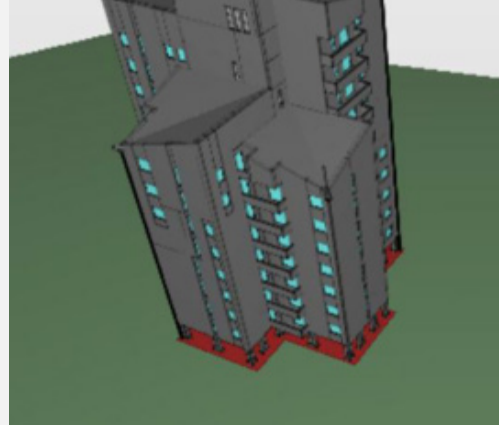


Figure 8: 3D model of the virtual demo building in Milan

3. Results

- Energy Performance:**
 - ENSNARE Tech A had the **highest renewable energy production** (~2044 m² PV coverage).
 - ENSNARE Tech C (PV + ST) was **highly effective for reducing gas heating demand**.
 - Deep retrofit improved insulation **but had lower overall energy savings** than ENSNARE solutions.
- Environmental Impact:**
 - ENSNARE Tech A provided the **highest primary energy savings** (~47% MWh/year in Tampere – Dfc).
 - ENSNARE Tech C drastically **reduced gas consumption** for heating, showing **significant GHG emissions reduction**.

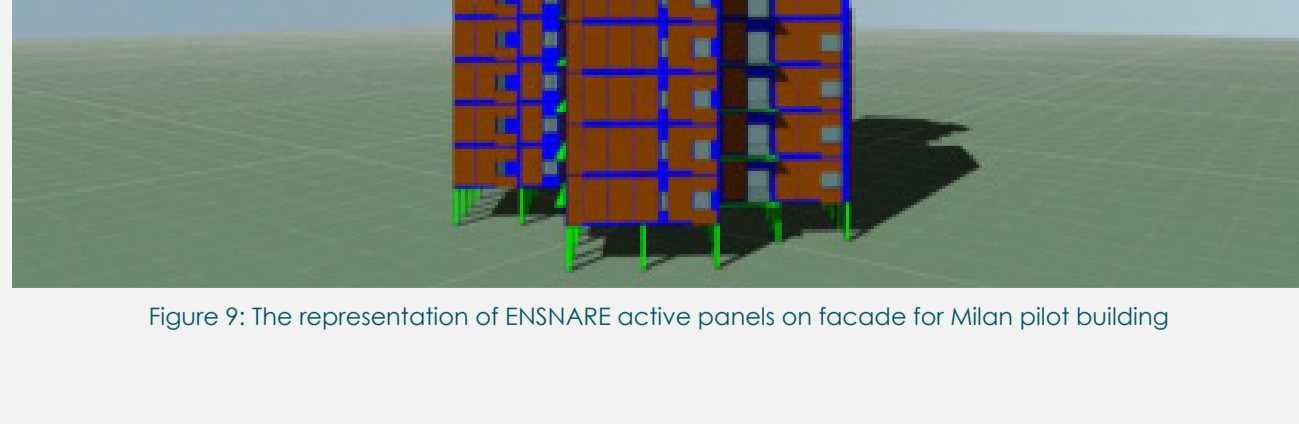


Figure 9: The representation of ENSNARE active panels on facade for Milan pilot building

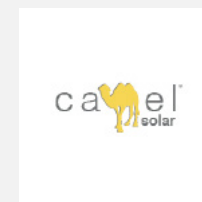
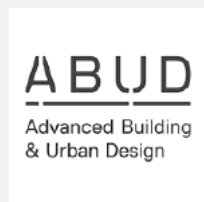
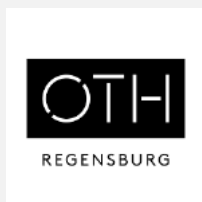
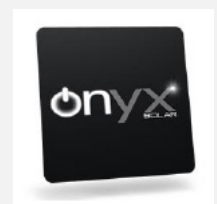
Final Key Takeaways

- Each virtual pilot had a real, physical location but was simulated in five additional climate zones to evaluate ENSNARE technologies in different environments across EU.
- ENSNARE solutions consistently outperformed traditional retrofits in energy savings and environmental impact.
- Energy savings varied across climates but ENSNARE Tech A (PV) and Tech C (PV + ST) delivered the best overall results.

Who are we?

The consortium

ENSNARE is an Horizon 2020 EU funded project carried out by 19 partners from 12 European countries: 11 SMEs, 5 research institutes, 2 corporations and 1 public body.



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