Factsheet N° 2

November 2026

LOCATEE

ENERGY PERFORMANCE ASSESSMENT OF THE MULTI-FAMILY BUILDING STOCK

The potential of renovation for energy demand reduction, decarbonisation and energy poverty mitigation

ANALYSIS FOR THE CITY OF TORRES VEDRAS



Co-funded by the European Union under n°101167621. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them. This work has also been funded by the Green Fund (GRFU).

Energy performance assessment of the multi-family building stock

Why this analysis?

LOCATEE Deliverable 3.3 quantifies the impacts of selected renovation and renewable energy measures the energy performance of representative multi-family dwellings in Rumia, Torres Vedras and Piraeus. The analysis links technical performance with investment cost and potential household energy bill reductions, informing municipalities to prioritise interventions to local building conditions and energy poverty vulnerability.



- Representative typologies are grounded in local dwelling stock data, including construction period, EPC class and heating systems.
- The DREEM model simulates baseline energy needs under thermal comfort conditions and tests renovation scenarios.
- Results are compared through potential energy consumption reduction, cost-effectiveness and potential energy bill reductions.

Overview

City of Torres Vedras | Portugal

10 dwelling typologies

Before 1981 / 1981-2000 / 2001-2010

How the DREEM assessment works

1 DWELLING CHARACTERISATION

Construction period, EPC class, dwelling area (m^2), envelope and heating/cooling systems

2 BASELINE SIMULATION

Climate, household composition, appliances and thermal comfort setpoints

3 RENOVATION SCENARIOS APPLICATION

Thermal insulation and windows upgrade, heating system upgrade, heat pump installation and 3 kW_p solar PV installation

4 TECHNICAL/ECONOMIC/ ENVIRONMENTAL IMPACTS COMPARISON

Energy consumption reduction, environmental impact (i.e., carbon emissions reduction), technoeconomic assessment and potential energy bill reduction

DREEM model components



Climate & water

Typical Meteorological Year data provide high-resolution irradiance and temperature conditions for each pilot.



Building envelope

Geometry, construction materials, U-values, thermal resistances/capacities and solar potential are utilised to model the thermal behaviour of each typology.



Energy demand

Bottom-up modelling captures heating, cooling, appliances and occupancy/activity profiles.



Thermal comfort

Predicted Mean Vote (PMV) / Predicted Percentage of Dissatisfaction (PPD)-based comfort benchmarks define indoor temperature requirements.

Renovation scenarios

Scenario	What changes	Applicability
Dwelling envelope improvement	External walls insulation with windows upgrade	**All typologies** for testing the effectiveness of envelope interventions in each pilot
Heat pump installation	Electrification of dwelling heating with a high-efficiency heat pump	**All typologies** for testing high-efficiency heating systems
Oil to gas boiler upgrade	Transition from an existing oil boiler to a higher-efficiency condensing gas boiler	**PT_4, PT_8, PT_10** where the existing heating system is an older lower-efficiency non-condensing gas boiler
Natural gas boiler upgrade	Transition from a lower-efficiency non-condensing gas boiler to a higher-efficiency condensing gas boiler	**PT_3, PT_6, PT_7** where the effectiveness of a higher-efficiency biomass heat recovery system needs to be assessed
Renewable energy production	Installation of a 3 kWp residential solar PV system	**All typologies for testing the effectiveness of renewable technologies in each pilot**

INTERPRETATION NOTE

EPC classes are not harmonised across Europe. A class with the same letter may reflect different national thresholds. Cross-pilot typology comparisons should therefore focus on modelled energy outcomes and local context rather than EPC classes alone.

City of Torres Vedras

Through the prism of the existing building stock

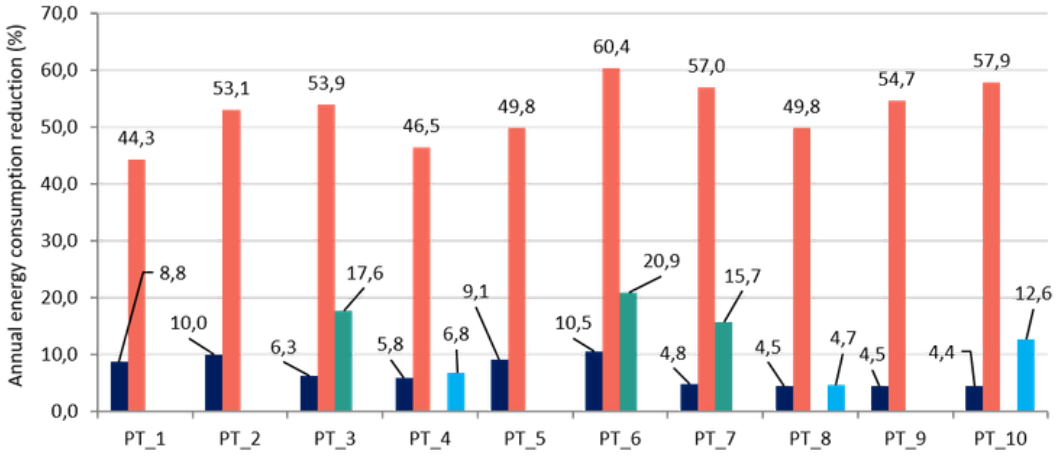
Ten dwelling typologies represent three construction periods and a heterogeneous mix of electricity, gas and biomass heating. This diversity is important for energy poverty policy because low-cost biomass, heating through electric heaters and cooling needs could create different technical and affordability pathways.

44.3 - 60.4 % Heat pump energy reduction	**40.1 - 70.4 %** Thermal insulation bill reduction
34.8 - 160 % Annual electricity demand coverage by solar PV production	**2.16** Solar PV electricity generated (kWh) per € of investment

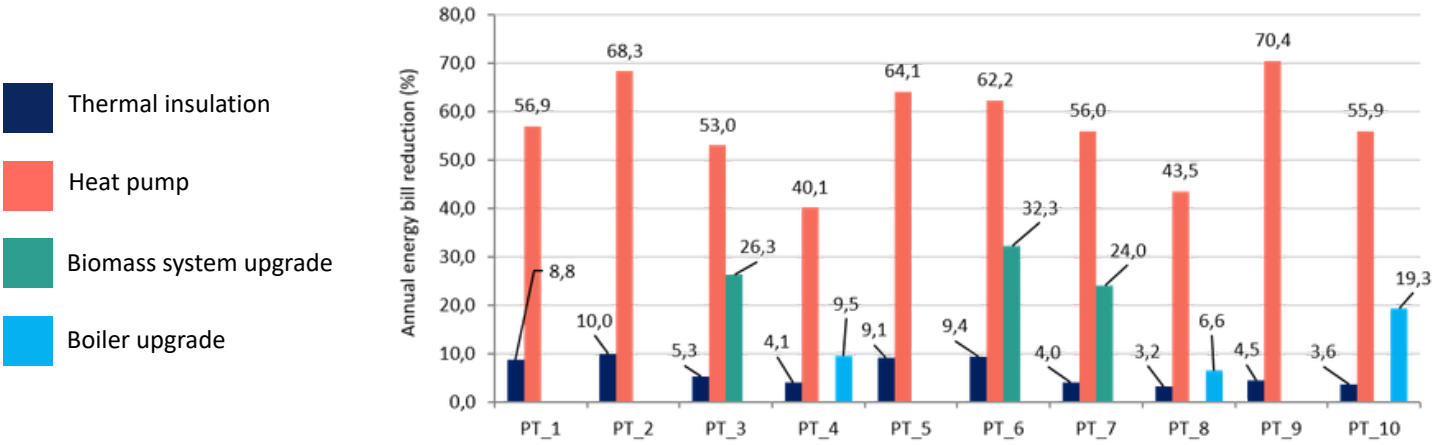
Representative dwelling typologies

Typology no.	Construction Period	EPC Class	Heating System
PT_1	Before 1981	C or D	Electric heaters
PT_2	Before 1981	E or F	Electric heaters
PT_3	1981-2000	C or D	Biomass heat recovery system
PT_4	1981-2000	C or D	Non-condensing gas boiler
PT_5	1981-2000	E or F	Electric heaters
PT_6	1981-2000	E or F	Biomass heat recovery system
PT_7	2001-2010	C or D	Biomass heat recovery system
PT_8	2001-2010	C or D	Non-condensing gas boiler
PT_9	2001-2010	E or F	Electric heaters
PT_10	2001-2010	E or F	Non-condensing gas boiler

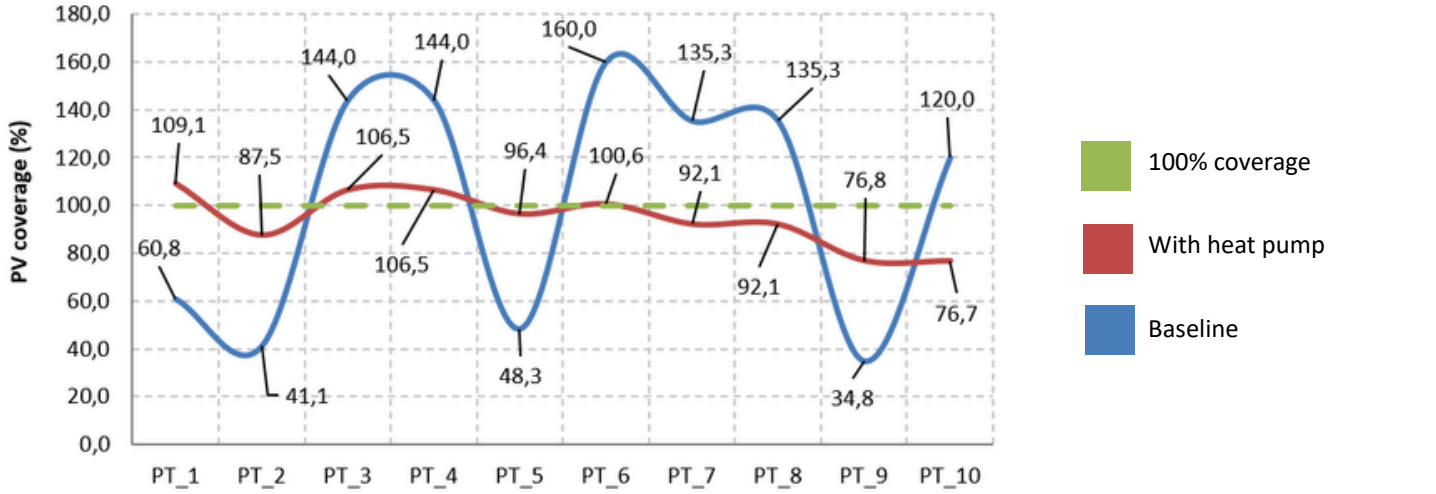
Annual energy consumption reduction (%)



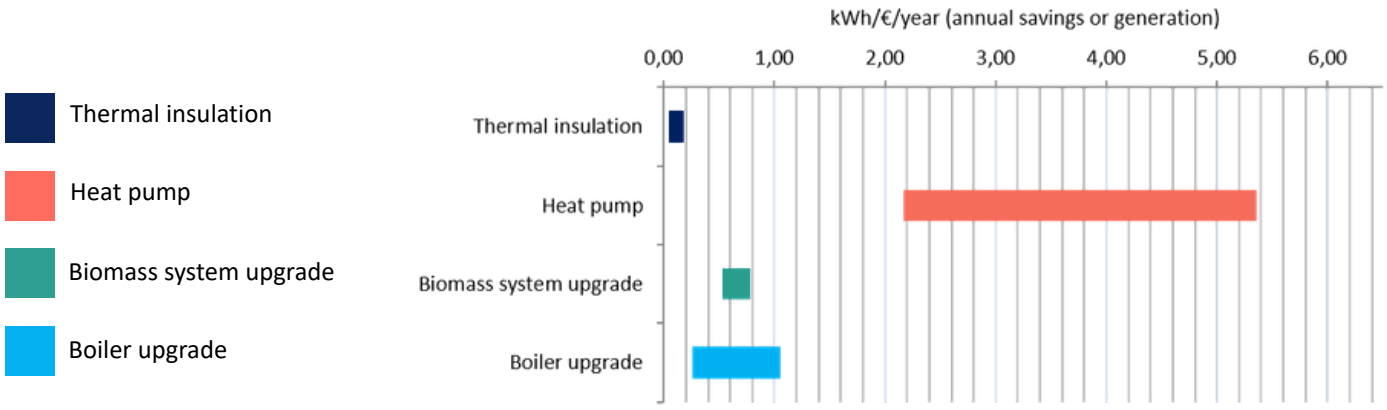
Annual energy bill reduction (%)



PV coverage (%)



Technoeconomic assessment



HIGHLIGHTS

- Heat pumps provide the highest energy savings and emissions reduction across all construction periods, reducing annual energy use by 44.3 - 60.4 % and CO_2 emissions by 44.3 - 83.2 %.
- Potential bill reductions from heat pumps are particularly high (40.1 - 70.4 %), reflecting the technology efficiency improvement and the relatively high cost of electricity used by electric heaters.
- Thermal insulation yields more moderate savings (4.4 - 10.5 %) and has comparatively low cost-effectiveness because of higher investment costs.
- Biomass system upgrades provide an intermediate option where heat pumps are unsuitable: 15.7 - 20.9 % energy savings and 24.0 - 32.3 % bill reductions in applicable typologies.
- Gas boiler upgrades have a lesser impact, with 4.7 - 12.6 % energy savings in the typologies where they apply.

SOLAR PV CONTRIBUTION

A 3 kW_p PV system produces around 6,072 kWh/year. The share of household demand electricity that can be covered by solar PV ranges from 34.8% to 160% across the examined typologies and scenarios. Heat pump installation paired with solar PV has lower coverage because of the electrification of the heating system. PV remains an important complementary measure for increasing household electricity self-sufficiency. Solar PV generation cost-effectiveness: 2.16 kWh/€/year.

INDICATIVE TARGETING LOGIC:

- Prioritise heat pumps in typologies where heating needs are covered with electricity (i.e., electric heaters) that have significant energy demand in the baseline scenario.
- Use efficient biomass as a transitional option where local low-cost fuel access is critical.
- Combine solar PV with heat pumps to further reduce exposure to electricity prices

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