Factsheet N° 2

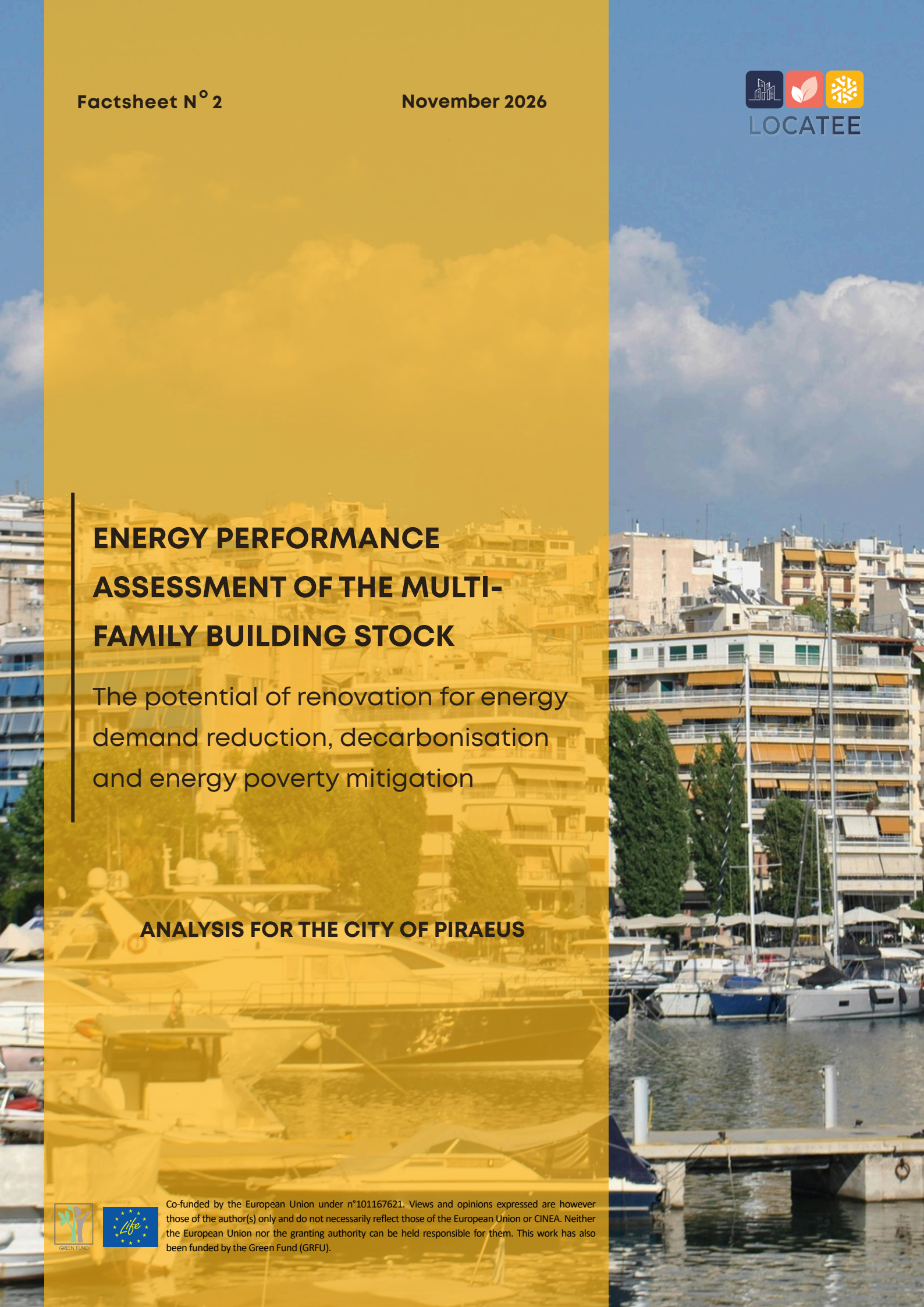
November 2026

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 PIRAEUS



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

Municipality of Piraeus | Greece

8 dwelling typologies

Before 1981 / 1981-2010

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	GR_1-4, GR_6, GR_7 where the existing heating system is an oil boiler or a low-efficiency non-condensing natural gas boiler
Natural gas boiler upgrade	Transition from a lower-efficiency non-condensing gas boiler to a higher-efficiency condensing gas boiler	GR_5 where the existing heating system is an older lower-efficiency non-condensing gas boiler
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 Piraeus

Through the prism of the existing building stock

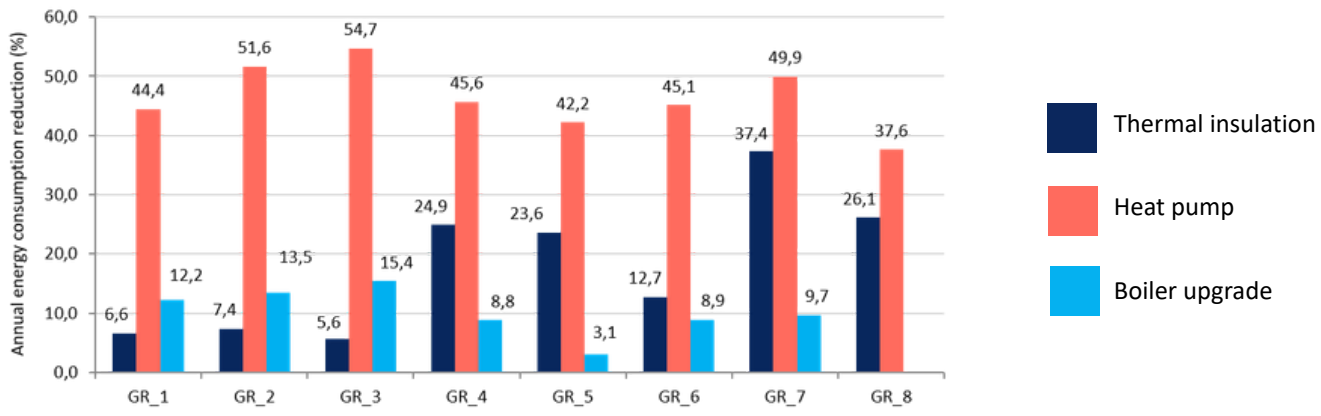
Eight representative dwelling typologies cover pre-1981 and 1981-2010 dwellings, with EPC classes from C to G. About 63.72% of the municipal dwelling stock was built before 1981. Many analysed typologies use oil heating, creating substantial scope for both technology efficiency improvement and fuel switching.

37.6 - 54.7 % Heat pump energy reduction	**30.9 - 63.6 %** Thermal insulation bill reduction
34.7 - 132.2 % Annual electricity demand coverage by solar PV production	**1.90 - 6.72** Solar PV electricity generated (kWh) per € of investment

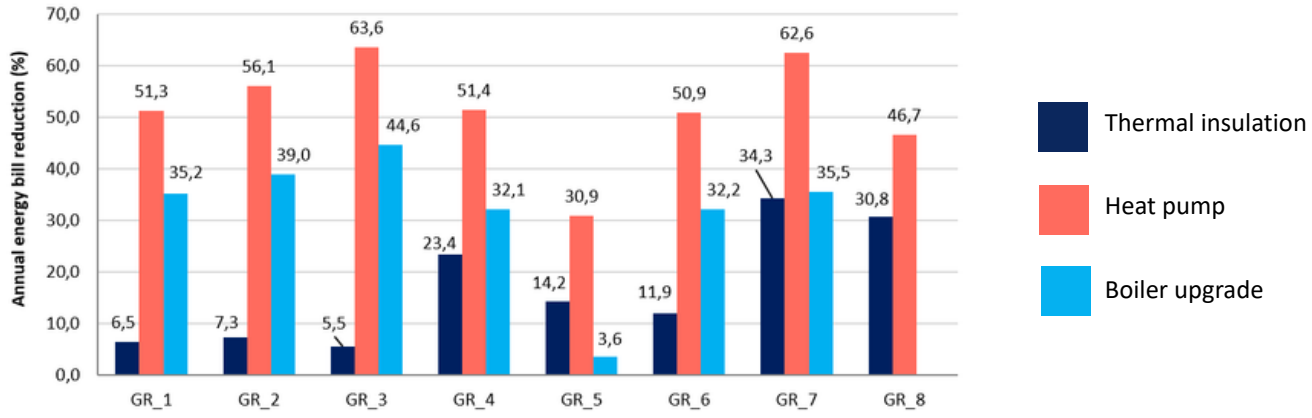
Representative dwelling typologies

Typology no.	Construction Period	EPC Class	Heating System
GR_1	Before 1981	D	Oil boiler
GR_2	Before 1981	F	Oil boiler
GR_3	Before 1981	G	Oil boiler
GR_4	1981-2010	C	Oil boiler
GR_5	1981-2010	C	Non-condensing gas boiler
GR_6	1981-2010	E	Oil boiler
GR_7	1981-2010	G	Oil boiler
GR_8	1981-2010	G	Electric heaters

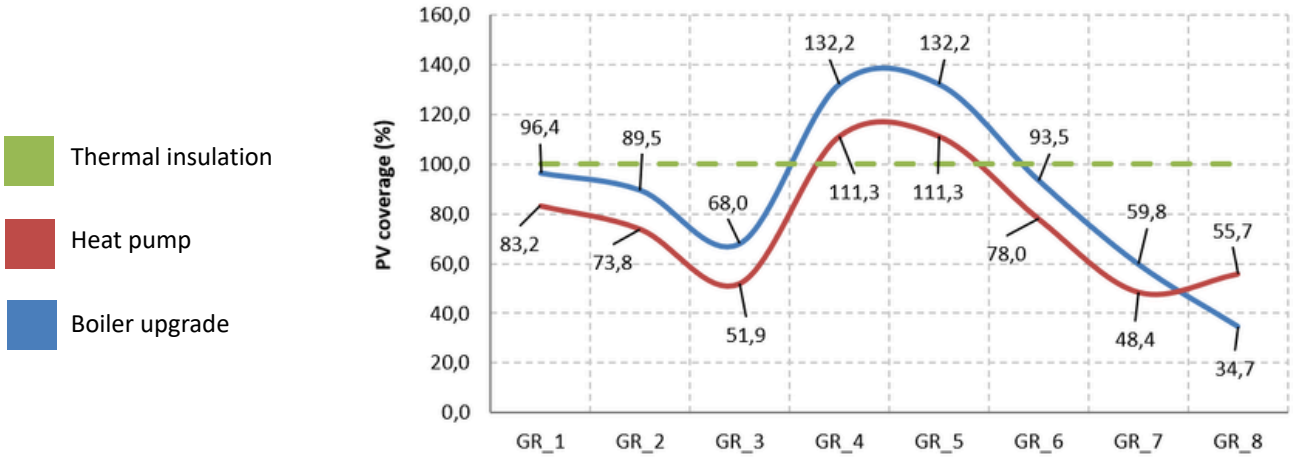
Annual energy consumption reduction (%)



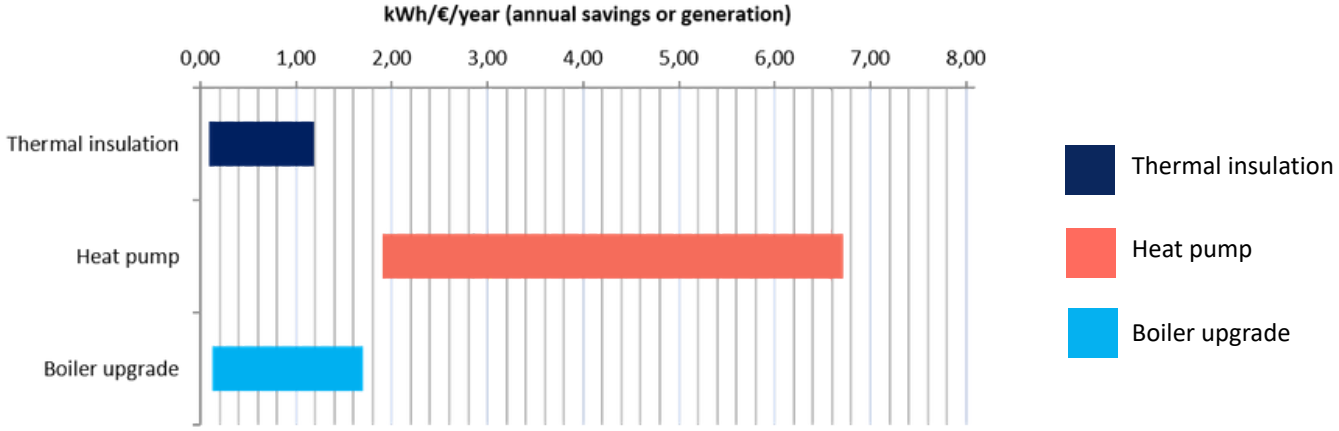
Annual energy bill reduction (%)



PV coverage (%)



Technoeconomic assessment



HIGHLIGHTS

- Heat pumps consistently deliver the largest savings: **37.6 - 54.7 %** lower annual energy use, **29.0 - 97.8 %** lower CO_2 emissions and 30.9 - 63.6 % potential bill reductions.
- Envelope upgrades are highly typology-dependent (**5.6 - 37.4 %** energy reduction) and become especially effective where windows and walls are not properly insulated.
- Boiler upgrades save **3.1 - 15.4%** of energy. In older oil-heated dwellings, they can generate sizeable bill and emissions reductions because the baseline boilers are inefficient and oil is relatively costly.
- Heat pump cost-effectiveness reaches **6.72 kWh saved per euro** in typology GR_3, the highest value found among the reported pilot typologies.
- The results support prioritising low-EPC, oil-heated dwellings where high energy demand and social vulnerability coincide.

SOLAR PV CONTRIBUTION

A 3 kW_p PV system produces about 5,886 kWh/year. The share of household demand electricity that can be covered by solar PV ranges from 34.7% to 132.2% 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: 2.10 kWh/€/year.

INDICATIVE TARGETING LOGIC:

- Prioritise heat pumps where oil heating and high energy consumption coincide.
- Use envelope upgrades for poor-performing windows/walls.
- Treat gas boilers mainly as a transitional option where immediate electrification is not feasible.

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