



FACTSHEET

Efficient and smart climate shell refurbishment of residential buildings

PART OF SMART SOLUTION 1: EFFICIENT AND SMART
CLIMATE SHELL REFURBISHMENT



Fig. 1: Image: www.idae.es

LOW
ENERGY
DISTRICT



- Passive energy refurbishment is essential for improving comfort and reducing energy consumption in dwellings in the Mediterranean climate
 - District heating can be applied to residential buildings to reduce gas consumption reduce greenhouse gas emissions, and improve air quality
- Efficient and smart climate shell and equipment refurbishment of residential buildings can reduce energy consumption up to 50%
- New business models of public-private partnership can incentivise energy refurbishment in the residential sector

Barcelona

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What is the solution?

This solution includes passive and active energy refurbishment of almost 10.500 m² of residential buildings in Barcelona. The most representative constructive typologies of the city have been chosen, in order to promote replicability at scale.

Passive measures aim to solve typical problems of the Mediterranean climate such as thermal discomfort due to cold bridges and lack of insulation.

Active measures aim to reduce consumption and emissions, by using more efficient systems and/or renewable energy. It has been estimated that, thanks to this solution, energy consumption of the refurbished buildings will be reduced by almost 400 MWh/year.

Passive measures:

- Façade insulation, roof insulation
- Change of windows and removal of cold bridge between window and façade
- Blinds installation

Active measures:

- Change of boilers
- Connection to district heating
- Efficient water taps
- HEMS (Home Energy Management System) installation

How does it work?

Passive measures in residential buildings:

Façade insulation, roof insulation

External Thermal Insulation Composite Systems (ETICS) are incorporated into the façades, as part of the building's structural

rehabilitation. For roof insulation, the use of external or internal solution depends on the construction solution chosen.

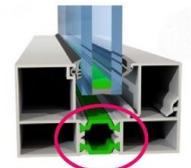
External thermal insulation helps reduce heating demand and to improve the internal comfort in winter. In summer, external insulation reduces heating of the façade caused by solar irradiation and prevents heat dispersion from inside to the exterior. In summer it is important to use natural ventilation and avoid direct sunlight, using solar protection systems. Furthermore, external insulation reduces cold bridges more easily than internal insulation.

Window replacement

(Image: Qualumsign)

In the buildings where windows have been replaced, the principal requirements were:

- Double glazing, transmittance $U < 2W/m^2K$, solar factor $g < 0,6$, to improve thermal insulation and reduce solar transmission
- Thermal break, to solve the cold bridge
- Air permeability class 3 (UNE EN 12207), to reduce infiltration



Special requirements for wind resistance and water resistance have been included for windows in high buildings.

Cold bridge between window and façade

The cold bridge generated by the installation of the ETICS insulation system in the façade and the windows has been studied. The image on the right shows that it is possible to reduce thermal dispersions by insulating the window jamb, in comparison to the left figure, where there is no insulation.

Installation of blinds

Blinds have been installed to:

- Control direct solar transmission inside the dwelling, reducing cooling demand.

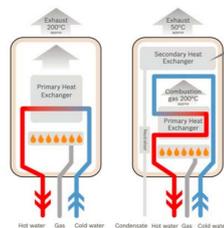
- Reduce thermal discomfort at night during the winter, providing additional protection to the window glass.

Adjustable roller blinds provide further benefits: changing the orientation of the slats can better control the transmitted solar radiation, ensuring that natural ventilation cools the dwelling effectively.

Active measures in residential buildings:

Change of boilers

(Image: Bosch):
Conventional system (left)
versus Condensing system (right)



Replacing existing boilers with condensing boilers reduces gas consumption and CO₂ emissions due to the more efficient system. A condensing boiler achieves an average performance score of '1' (nominal performance 1.09) compared to an average 0.85 performance score for a conventional boiler.

Connection to district heating

Centralisation of the building's heating system combined with a connection to the district heating Districlima significantly reduces gas consumption by using (in this case) waste heat recovery from the incineration process.

This solution is one of the innovative concepts of smart cities of the future.

Efficient water taps

The use of shower flow regulators and aerators in bathroom and kitchen taps reduces gas consumption and energy emissions through reduced water consumption. It is estimated that this

solution saves up to 50% of water compared to standard consumption.

HEMS (Home Energy Management System) installation

The installation of a HEMS helps to monitor and control energy (gas and electric) consumption. The possibility for each client to receive personalised advice and optimised services using monitors and mobile Apps helps to raise awareness about reducing consumption.

The components for gas and electric monitoring and control are:

- Smart home automation centre
- Smart thermostat
- Smart Plug (control of consumption and on/off).
- Energy monitor
- Sensors and actuators for monitoring gas consumption through low-range RF technologies.

The buildings chosen for this solution will be monitored before and after the refurbishment, until the end of the project.

The objective is to evaluate the energy savings caused by the refurbishment and to help the owners to know how their behaviour affects consumption.

Business Model Used

As there is low energy demand for heating and cooling in Barcelona's residential sector because of the local climate, energy refurbishment itself is not feasible. Furthermore, buildings often have no heating system, so that energy refurbishment can only be justified from the point of view of thermal comfort and not by energy savings.

The strategy to retrofit residential buildings that will undergo structural works aims to

reduce the investment cost of passive energy refurbishment, by sharing the expenses for the works that are required in both cases (for example the use of scaffolding). In Spain, the obligation to periodically submit buildings to preventive maintenance, after carrying out the Technical Inspection of Buildings (ITE), shows that existing buildings have a need for structural rehabilitation. In these cases there is the opportunity to combine them with energy actions.

The cost of energy refurbishment nonetheless remains high for the owners. The solutions carried out by Gas Natural in residential buildings is a business model of public-private collaboration, where the investment is paid part by grants from the council and European funds, and part by Gas Natural, acting as an energy services company (ESCO).

In the ESCO model the end customer will have a single interlocutor, which manages and coordinates all the agents needed to execute the energy rehabilitation. The ESCO guarantees the energy savings and assumes the maintenance costs and the owners of the building pay the investment in monthly instalments during the ESCO contract.

Expected Impact

Improving quality of life:

- Improved comfort of building typologies with a high level of occupancy: hotels, education and wellness centres.
- Better awareness and possibility by the tenants themselves to control consumptions

Reducing environmental impact

- Reduction of energy consumption by 30–70% depending on the building typology

- Reduction of CO2 emissions thanks to the reduction of consumptions and to the use of renewable energy and waste heat recovery
- Better quality of external air

Promoting sustainable economic development:

- Increase of the market value of buildings thus increased market visibility and customer attraction
- Creation of buildings controlling costs and emissions thanks to the energy management system.

Potential for replication

Pre-conditions for replication in other European cities:

- Existence of a building stock in need of refurbishment with high thermal and electric consumption.
- Existence of regulations requiring energy efficiency improvements in case of refurbishment.

Organisational resources and knowledge required within the public administration:

- Public administration should be aware of the high potential of consumption and emission reduction of these different solutions. Administrations should propose ways of promoting the amortization of rehabilitations through grants or tax incentives. In particular, it should update grants and incentives to the newest technologies and latest distribution processes and energy management.
- Public administration need to be aware of the conditions needed for a public-private collaboration within an ESCO business model

Stakeholders to involve:

- Owners and hotel industry brands, sports facilities, public and private educational sector
- ESCO companies
- Public administration
- Architects, Engineers
- Manufacturers and distributors of products for the generation, distribution, management and control of thermal and electric energy
- Tenants of the building

Potential barriers:

- Convincing owners to invest in actions with higher payback than the ones they use to accept for investing.
- Convincing owners of the importance of integral passive and active refurbishment