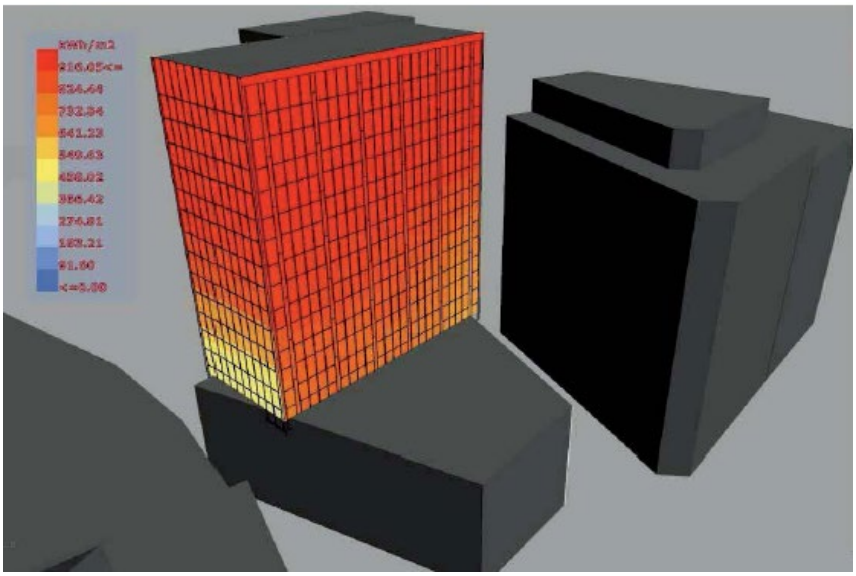
GrowSmarter
Transforming cities for a smart, sustainable Europe

FACTSHEET

Efficient and smart climate shell and equipment refurbishment of tertiary buildings

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



LOW ENERGY DISTRICT

- Energy management systems can reduce the energy consumption of the buildings by around 10%
- Efficient and smart climate shell and equipment refurbishment of tertiary buildings can reduce energy consumption by 60%
- Efficient and smart climate shell and equipment refurbishment of tertiary buildings increase public awareness of energy saving actions. and verification of

Barcelona

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no 646456. The sole responsibility for the content of this document lies with the author and in no way reflects the views of the European Union.

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What is the solution?

This solution includes passive and active energy refurbishment of almost 12.500 m2 of tertiary building types including a hotel, a sports centre and an education centre. It is estimated that this solution will reduce combined energy consumption of the refurbished buildings by almost 2GWh/year.

Due to differences in the occupancy and use profiles between each building, each of these three typologies of building will need an individual solution for refurbishment. Although these measures have been proposed following specific energy audits, they have a high potentiality of replication in similar buildings needing refurbishment.

Hotel	Sport centre	Education centre
• Need for high standard of thermal comfort in the rooms (heating and cooling) • Requirement for individual temperature settings for each room. • Continuous consumption (lighting and air conditioning) for common areas	• Strict requirements for indoor air quality • strict requirements for quality and temperature of water in swimming pool • High internal gains due to occupancy • High consumption of water • High energy consumption for lighting	• Strict requirements for indoor air quality in classrooms • High internal gains in classrooms due to occupancy and computers • Need to quickly satisfy the heating/cooling demand during peaks of occupancy • High energy consumption for lighting • Different needs for each classroom depending on occupancy and exposure to external environment
Passive measures		
• Façade and roof insulation • Change of windows	In swimming pool area: • Pool insulation • Roof insulation • Insulation between dressing rooms and swimming pool (thermal zoning)	• Façade and roof insulation • Change of windows
Active measures		
• Replacement of existing boiler • Replacement of existing chiller high efficiency with heat recovery) and optimisation of chiller operation • Optimisation of water distribution loop usingtwo-way valves and frequency inverters) • BEMS (Building Energy Management System) installation (optimisation of the working calendar and improvement of the air-conditioning control system)	• New dehumidifier with heat recovery • Optimisation of the water distribution loop by applying two-way valves, frequency inverters and variable speed pumps) • Change of chiller, with a high efficient heat pump with heat recovery for heating and cooling. • Replacement of existing lighting with LEDs • Implementation of BEMS (Building Energy Management System)	• Installation of a high efficiency ventilation system, with heat recovery and free cooling • Installation of LED lighting in areas which do not yet have LEDs. • Building Energy Management System
Renewable energy contribution		
• Aerothermal heat pumps for the cooling process with performance higher than 2.5 (European Directive 2014/11/UE)	• Aerothermal heat pumps for the cooling process with performance higher than 2.5 (European Directive 2014/11/UE)	• Photovoltaic panels integrated into the façade

How does it work?

Implemented passive measures in tertiary buildings:

Façade insulation, roof insulation (Hotel, sports centre, education centre)

External Thermal Insulation Composite Systems (ETICS) reduce heating demand and improve internal comfort in winter.

In summer, external insulation reduces the heating of the façade due to solar irradiation while preventing heat dispersion from inside to the exterior. In summer it is important to use natural ventilation and to avoid direct sunlight using solar protection systems.

External insulation reduces cold bridges in comparison to internal insulation.

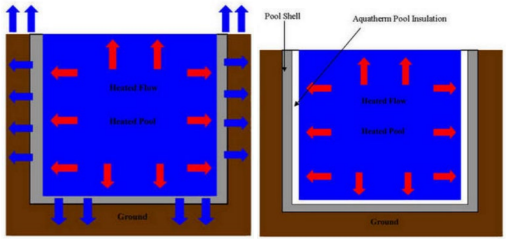
Change of windows (Hotel, education centre)

Changing the windows achieves multiple objectives:

- Improves thermal insulation (lower U than the existing windows) and reduces solar transmission to the inside, otherwise defined as the 'lower solar factor' – g, the percentage of heat that passes through the glass.
- Overcomes the cold bridge of the window itself by installing a window with a thermal break
- Reduces infiltration, thanks to a high quality installation and higher air permeability class (UNE EN 12207)
- Improves acoustic comfort

Insulation of pool (Sports centre)

The thermal insulation of the walls and ground surrounding the swimming pool helps to reduce the heating demand for the pool water because it reduces thermal losses through the structure.



Swimming pool with and without insulation

Thermal zoning between spaces with different design temperatures *(Sports centre)*

It is possible to further reduce energy consumption for heating and cooling by isolating the common walls between spaces with different design temperatures. In this way, each thermal zone will be managed individually and better control of consumption will be possible.

Implemented active measures in tertiary buildings:

Replacement of existing boiler *(Hotel)*

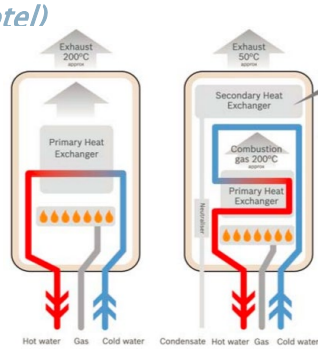


Image: Bosch – Conventional system (left) versus Condensing system (right)

The replacement of existing boilers with condensing boilers reduces gas consumption and CO2 emissions thanks to a more efficient system.

A medium performance of 1 is considered for the use of condensing boiler (nominal

performance 1.09), in comparison to a medium performance of 0.85 for the use of conventional boiler.

Replacement of existing chiller with high efficiency heating pump *(Hotel, sports centre)*

In the case of chillers with heat recovery, an evaluation of the recovered heat in comparison to the heating demand is required during months with simultaneous cooling and heating demand. This is important because heat recovery reduces the performance of cooling generation, and most of the recovered heat needs to be used to compensate for this loss.

It is also important to evaluate the performance of partial loads and to analyse the difference in performances when installing one or more chillers.

The chillers proposed within this solution have a seasonal energy efficiency ratio of 3.8-4.3.

Optimisation of the chiller operation by monitoring its performance allows further reduction of electricity consumption by improving the management of the on/off profile and adapting the load profile.

Optimisation of water distribution loop *(Sports centre)*

The installation of two way valves in a circuit with a lot of distribution points reduces energy losses caused by circulation of water in zones where there is no energy demand.

This leads to reduced electricity consumption by the pumps, helping to avoid thermal losses.The installation of frequency inverters will allow the group of pumps to work at variable flowrates.

Installation of dehumidifier with heat recovery in the swimming pool *(Sports centre)*

This solution allows the recovery of latent energy from the dehumidification process. It is a very efficient solution, because in a heated pool, water vapour is constantly created by the water evaporating into the air from the pool surface. The electricity consumption of this solution is optimised thanks to the use of variable speed fans to vary the recirculation airflow

Replacement of existing lighting with LEDs *(Sports centre, education centre)*

LED technology improves the efficiency of lighting systems as less power is required to meet the same lighting requirements compared to other existing technologies.

This solution is also an improvement in terms of its life cycle costs, as it has a longer life expectancy than other comparable technologies leading to lower maintenance costs. Replacements are rarer, leading to lower production-related energy consumption.

BEMS (Building Energy Management System) installation *(Sports centre, education centre, hotel)*

The Building Energy Management System (BEMS) is based on price and origin of the energy. It has been estimated that it reduces energy consumption by approximately 10%.

Functions:

- Monitoring of energy consumptions (electricity, gas, water..) and possibility to export monitoring reports to Excel
- Clear display of consumption for each system and zone
- Help controlling consumption and to take decisions for the optimisation of

the working calendar of different systems, in order to improve both the control system and thermal comfort.

Implemented renewable energy solutions:

Aerothermal heat pumps (cooling) *(Hotel, sports centre)*

This measure corresponds to the active measure "Replacement of existing chiller with heating pump of high efficiency with heat recovery".

European Directive 2014/11/UE certifies aerothermal energy from heat pumps as renewable energy if their performance is higher than 2.5.

Photovoltaics integrated into building façade *(Education centre)*

This solution has been proposed after analysing a building's orientation and shadows. It provides added value to the project as the roof of many buildings serves other purposes (HVAC equipment, services for building users, etc) and is therefore not able to host photovoltaic panels. This change will serve to test a new solution with higher replication potential.

Business Model Used

The business model used is an ESCO model, where Gas Natural Fenosa acts as an energy services company. In this model the end customer will have a single interlocutor, which manages and coordinates all the agents needed to execute the energy rehabilitation.

The savings guaranteed by the energy refurbishment will pay the investment of the energy services for the works during a contractual relationship accorded with the energy services company.

The ESCO guarantees the energy savings and assumes the operation and maintenance costs during the contractual period. At the end of the contract, the energy savings will be a direct benefit for the customer.

Integration with other smart solutions

In some cases, this solution is integrated with the smart solution "Smart Energy and Self-sufficient block", where the following services are offered to tertiary buildings and to residential blocks:

- Replacement of existing lighting with LED technology
- Installation of a photovoltaic system with energy storage
- Installation of Building Energy Management System

Expected Impact

A positive impact is expected in terms of the following key GrowSmarter objectives:

Improving quality of life:

- Improved comfort of building typologies with a high level of occupancy, for holidays (hotel), learning (education centre) and wellness (sporting centre).
- Better awareness and possibility by the tenants themselves to control consumptions

Reducing environmental impact

- Reduction of energy consumption by 30-70% depending on 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 in market value of buildings and consequently 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 be involved:

- 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