

EDEA RENOV project
ENERGY EFFICIENCY IN ARCHITECTURE
ENERGY REHABILITATION AND INNOVATION



LAYMAN REPORT



edeaRenov
EXPERIMENTAL ARCHITECTURE

SUMMARY AND OBJECTIVES

The main aim of EDEA-Renov project is the development of new solutions to design, evaluate and rehabilitate existing dwellings, enhancing energy savings, sustainability and employment, using renewable energies.

This Project began with the support of **LIFE + 09 Program**, looking for solutions in the field of construction, it was demanding new solutions and tools in order to develop energy building rehabilitations.

The Project highlighted as basic objectives the supporting of good practices in energy efficiency in order to improve the awareness of any agent involved in the construction process (builders, users, technicians, etc...)

The main Project purpose is, through energy rehabilitation, **to reduce the energy losses and CO₂ emissions in buildings during their running**, contributing to mitigate a part of the climate change of our planet.



Extremadura, Spanish region where EDEA-Renov Project has been developed.

EDEA-Renov Project has been developed mainly in Extremadura (in the middle-west of Spain), however the results obtained in the project can be applied in other climates or in buildings located in other regions with a similar climate.

EDEA-Renov has completed several results focused on the improvement of the guidelines, knowledge and supports the dwellings energy rehabilitations.

The best way to sum up EDEA-Renov project is highlighting the huge number of achievements completed:

- More than **500 simulations in 9 models of representative buildings in 2 different neighbourhoods of social dwellings** have been made. This process has found the most suitable energy rehabilitation measures in each case.
- **6 social houses energy rehabilitations have been made**, studying the costs and real improvements in the buildings, also comparing with the non-rehabilitated houses around it.
- **10 tests about energy improvements and installations have been made in EDEA demonstrators in Caceres.**
- **EDEAsim: on-line energy simulator has been made.** It is able to study the energy efficiency of any building without technical knowledge, making it easy and accurate in order to make rehabilitation studies, providing economic, environment and social results as well.
- **8 dwellings have been monitored** in order to check the real improvements achieved after the energy rehabilitations and user's energy consumption behaviours.





BIENVENIDO A LA HERRAMIENTA DE EVALUACIÓN ENERGÉTICA EDEASim



La herramienta EDEASim le permite evaluar energéticamente su edificio o vivienda para conocer los ahorros energéticos y económicos que puede llegar a alcanzar.



Web EDEASim (<http://edeasim.gobex.es>)

· **EFICIEX has been developed: a low cost and open source monitoring system.** It is able to measure the dwelling comfort and energy consumption, providing notifications through a mobile app.

· **16 technical courses have been realized in order to train builders, technicians and users.** These courses were theoretical and practical.

· **6 main publications have been published** in order to improve the knowledge and tools of users and technicians in the energy efficiency field.

· **ClimEX: Extremadura climate database** has been developed; it provides climate files of 66 towns of the region.

- More than **1000 people have visited the EDEA demonstrators** during the project EDEA-Renov.

- There were more than **1300 assistants in courses and talks** of energy rehabilitation and construction legislation.

PROJECT'S PARTNERS

The **General Direction of Architecture and Housing** of the Ministry of Public Works, Housing, Urban Planning and Tourism of the Regional Government of Extremadura has been the Coordinator of the EDEA-Renov project.

The partners were institutions of architecture, engineering, research and energy: **Fairbanks architects & Eduardo Montero**, "**Valladares Ingeniería S.L.**", **INTROMAC** ("Instituto Tecnológico de rocas ornamentales y materiales de construcción"), **ACCIONA S.A.** and **AGENEX** ("Agencia Extremeña de la Energía").

Also it is important to mention the collaborations undertaken by: **Neighbourhood association of Santa Engracia (Badajoz)**, **Weber S.A.**, **Extremadura University** and **ABIO Group of Polytechnic University of Madrid**.

Partners of EDEA Renov.



SANTA ENGRACIA AND SAN LÁZARO NEIGHBOURHOOD

The main tasks of EDEA-Renov Project have been developed in the social neighbourhood of Santa Engracia (Badajoz) and San Lázaro (Mérida). Energy improvements in dwellings, studies and workshops have been accomplished during the project.

EDEA-Renov is a **demonstration project** which has completed several tasks related to energy efficiency. The majority of the tasks are related to the dwellings located in **Santa Engracia (Badajoz) and San Lázaro (Mérida) social neighbourhoods**.

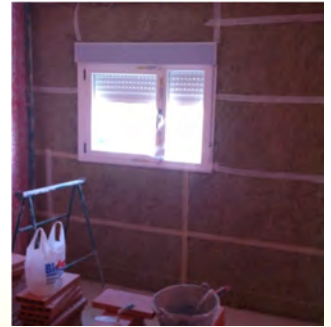
The below tasks have been developed in the neighbourhoods:

- **Climate analysis** of the neighbourhoods.
- Development of more than **130 dwellings floor and elevation plans** and more than **50 dwellings energy studies**.
- **Monitoring of 8 dwellings** and testing 3 different monitoring systems.
- **Energy improvements of 6 dwellings**: insulation improvements, windows and doors replacement and new HVAC systems.
- **Project of 63 dwellings energy rehabilitation** in San Lázaro (Mérida).
- **Energy rehabilitation workshops** for social dwelling users . 40 participants.
- **Assesment for social dwelling users** in the neighbourhoods technical offices: activities coordination, grants request, installation guidelines etc...
- **Thermography and "Blower Door" tests** in order to evaluate energy improvements implemented.

These works have allowed to **define the optimal rehabilitation works** in each type of house, **to monitor energy consumption behaviour in social housing** and to improve **the energy efficiency users' awareness**.



Santa Engracia (Badajoz) and San Lázaro (Mérida) neighbourhoods.



Energy rehabilitations of dwellings in Santa Engracia and San Lázaro



Monitoring system and high efficiency installations of social dwellings.



Construction workshops for unemployed builders in Santa Engracia (Badajoz)



EDEA DEMONSTRATORS

EDEA demonstrators is a research center to study the energy efficiency in construction formed by two twins houses, they are located in Cáceres, and they were developed during "LIFE+ 07 EDEA project" (finished in 2013).

During EDEA-Renov project the following improvements have been developed:

- **A roof pond facility** has been installed in the terrace of the demonstration house.
- **A solar chimney** has been installed in the south façade of the demonstration house.
- **Solar blinds** have been installed in all the south windows.
- Center accessibility has been enhanced with a **new outdoors pavement**.
- **Visitors reception building has been rehabilitated** creating a new multiuse room for presentations, talks and products exhibitions.
- **An evaporative cooling system** has been installed in the reception building.
- All the new improvements have been **implemented in the control system**.

All these improvements have 2 objectives:

- 1- **To improve the quality of the visiting** for the professionals, students and users.
- 2- **To add new installations and bioclimatic systems** in order to realise new tests during EDEA-Renov Project.

The main results of the test realized in EDEA demonstrators during EDEA-Renov project are:

- **Roof pond did not improve** significantly the energy efficiency of the demonstrator.
- **Solar chimney has improved the average indoor temperature about 2-6 °C in winter and 2-3 °C during summer nights.**
- During sunny days of winter, **solar panel heating system reduced the energy consumption of the house by 66%.**



Solar chimney in EDEA demonstrators.



EDEA demonstrators (twin houses): outdoor view (left), installation room (center) and indoor view (right).



ENERGY SIMULATION STAGE.

EDEA-Renov Project simulations have been used to specify the energy improvements in the houses rehabilitated, to compare different simulation programmes and to calibrate EDEAsim online software.

One of the main tasks of the project is the development and study of the energy simulations of the energy improvements in Santa Engracia and San Lázaro neighbourhoods.

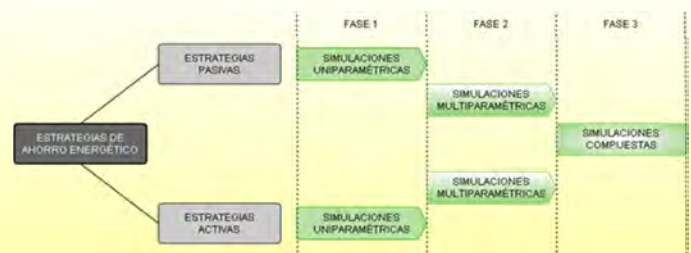
During this phase **9 models were selected to characterize all the houses** in those 2 neighbourhoods (more than 1300 dwellings in them). These models are **1 complete block of flats and 8 individual dwellings**.

46 construction improvements and 46 types of installations have been selected for the simulations in the models.

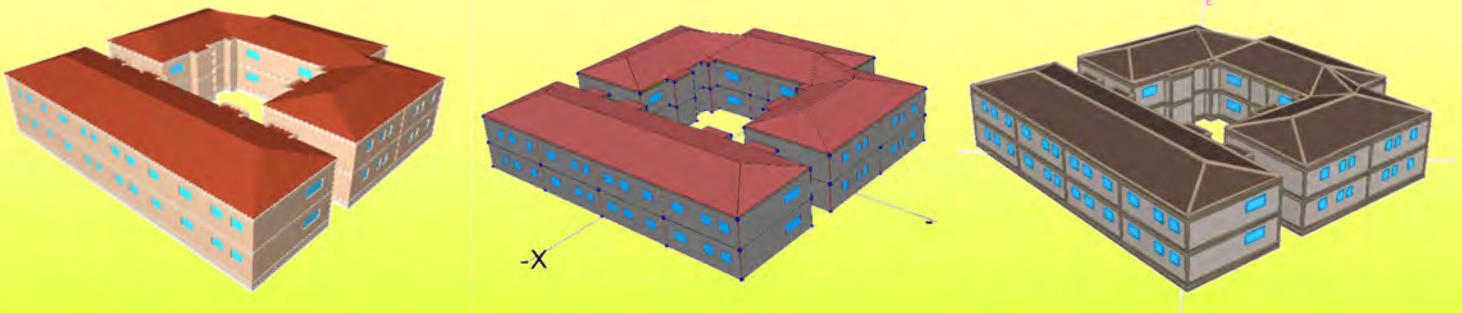
Simulation phase has been developed using **3 simulation programs** (CE3, Calener and Design Builder). The objective was to compare the accuracy and the results in order to determinate which one is more appropriated in each case.

The following stages were developed for every model and simulation program:

- Stage 1: **Uni-parametric simulations**. Applying only 1 energy improvement per simulation.
- Stage 2: **Multi-parametric simulations**. Using a combination of the best constructive (passives) or installation (actives) improvements independently, using the results of the previous stage to choose them properly.
- Stage 3: **Combined simulation**. Using the best construction and installation improvements combinations in order to reach the most effective energy savings.



Energy simulation phases in EDEA-Renov.



Tridimensional models of the block of flats in 3 simulation programs: Design Builder (left), CE3 (center) and Calener (right).



The most important results achieved during the simulation process were:

1- **Every single dwelling requires more energy consumption during winter** than during summer.

2- **The external thermal insulation improvements** (M1, M2, M5 and M6 in the bottom graph), **were about 5% more efficient than the internal thermal insulation solutions** (M3, M4, M7 and M8).

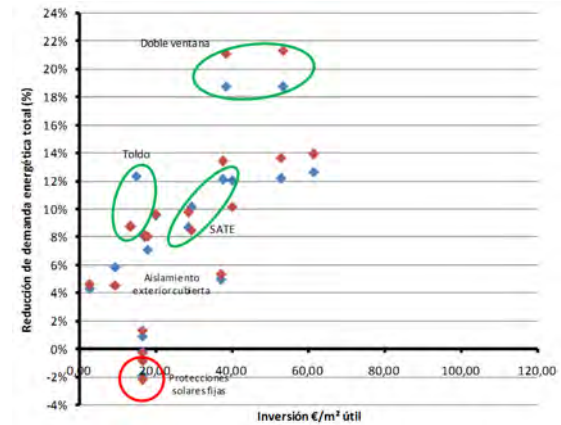
3- **Double window improvements** (M11, M12 and M13 in the bottom graph) **have been more efficient than windows substitutions** (M9 and M10).

4- **Fixed solar protection improvements** (M14-M19 in the bottom graph) **have been inefficient** because of the lack of solar incomes during winter.

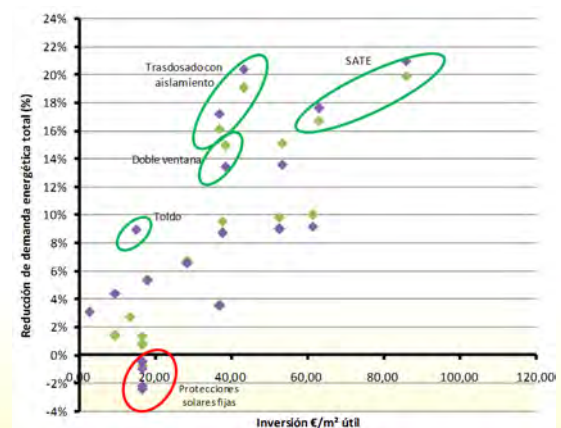
5- During the simulation phases, 3 installations have highlighted:

- **Gas condensing boiler.**
(less primary energy consumption).
- **Aero thermal heat pump.**
(less final energy consumption).
- **Biomass boiler.**
(less CO₂ emissions).

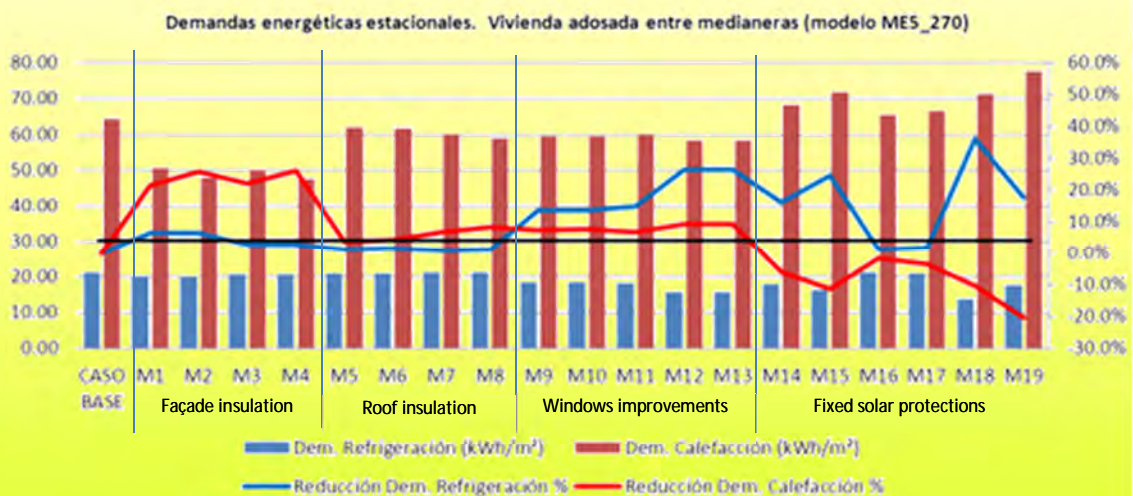
Also the energy simulations developed during the EDEA-Renov project have determined the economic profitability of the improvements of each model.



Construction energy improvements graph of an individual house between party walls in San Lázaro (Mérida).



Construction energy improvements graph of an individual house in corner in San Lázaro (Mérida).



Construction energy improvements graph of an individual house between party walls in San Lázaro (Mérida).



EDEAsim: ENERGY SIMULATION FOR EVERYONE

EDEAsim is an online tool which allows every dwelling user to realise an energy simulation to evaluate rehabilitation costs and some sustainability aspects.

EDEAsim is a simplified simulation on-line tool which takes advantage of all the works developed during the simulation phases of the project and provides a service for any building user interested in realising an energy study of his/her own house, making all the process as easy as possible.

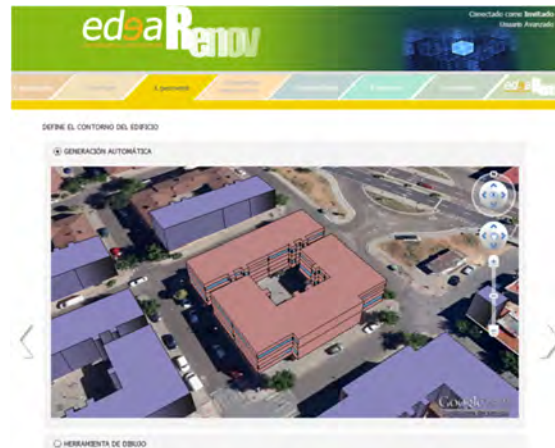
Some EDEAsim features are:

- Google Earth® building searching.
- Cadastre database (free and compulsory administrative registry of buildings in Spain) integrated to make automated 3D geometry of the building searched.
- Manual drawing tool when Cadastre geometry is inappropriate.
- Energy Plus 8.1. simulation engine (the most internationally accredited).
- During simulations, it uses ClimEX project climate files and C.T.E. files (Regulatory framework which marks the quality and security features for buildings).
- EDEAsim has an enormous database with all the information developed during the project: construction solutions, installations, prizes, sustainability data, etc...
- PDF report exportation to save the simulation results.

EDEAsim can be used from:

<http://edeasim.gobex.es>

<http://edeasim.aidico.es>

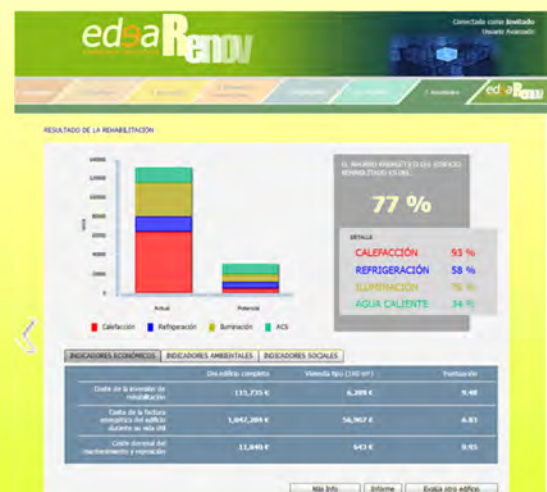


Simulation modelling through Cadastre + Google Earth in a block of flats (Mérida)

EDEAsim has 2 simulation phases:

- The first determines the nowadays energy consumption and the building energy savings potential.
- In the second one the user selects the improvements measures in order to study different options of energy rehabilitation.

Finally, EDEAsim users can save different reports and compare energy savings and investments among them.



Results screen of EDEAsim v1.0



TECHNICIANS TRAINING AND DISSEMINATION.

Professionals and companies should be the main agents involved in the advances of the energy rehabilitation improvements. EDEA-Renov has given courses and publications in order to support building sector in this task.

EDEA-Renov project has achieved results focused on the improvement of the knowledge of the new construction solutions, installations and monitoring system, also energy efficiency innovations of the construction field.

During the EDEA-Renov development there were important changes in national and European regulations to the development of energy certifications and minimum requirements in energy efficiency of building. **This fact has made more valuable the role of EDEA-Renov as a catalyst and a guide about the best solutions for the compulsory energy requirements nowadays.**

EDEA-Renov project has trained technicians in the following activities:

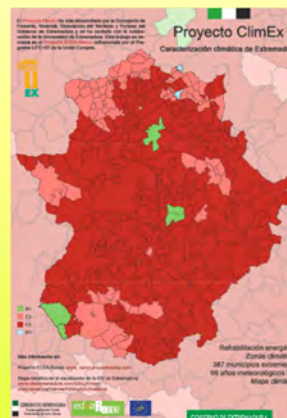
- **7 energy certification courses** with the Spanish official programs with more than 100 assistants.
- Around **1000 rehabilitation agents** trained **in the Extremadura region** to manage the Rehabilitation and Housing Plan 2013-2016.
- **21 events** of dissemination, congresses and presentations of results celebrated with more than 1000 assistants.
- **More than 1000 visits hosted in the EDEA demonstrator center** in Cáceres during EDEA-Renov project (between 2011 and 2014).

In addition to these activities, it is important to mention the release of results and publications in order to improve the buildings energy efficiency comprehension and knowledge.

All the publications have been created with the same ideas: **easy-to-read and easy-to-use.**

The most relevant publications of the EDEA-Renov project are:

- **“Manual de eficiencia energética para construcción e instalaciones en viviendas de Extremadura”.**
- **66 climatic files in .epw extension** for the energy simulation in Extremadura municipalities (ClimEX).
- **“Catálogo de Elementos constructivos e instalaciones de Extremadura”** with 42 construction solutions and 80 types of installations studied.



ClimEX and Manual de Eficiencia Energética front pages



MONITORING RESULTS

The control of the real consumptions of a house and the users' awareness are the fields where there is more potential of improvement in the energy efficiency of the buildings.

Different monitoring systems developed by the project have been installed in order to know the real savings and comfort improvements of the rehabilitated dwellings.

The monitoring variables measured by the system are:

- **Comfort data:** Indoor temperature (°C), moisture (%) and air quality (p.p.m. of CO₂) also outdoor temperature and moisture.
- **Consumption data:** Power consumption (W y kWh), water consumption (L) and gas consumption (kWh).

The first wired system was installed in the 4 rehabilitated houses of Santa Engracia neighbourhood. This system is based on Arduino® with a Xively® database. The database can be viewed on:

<https://xively.com/feeds/3368415>



Santa Engracia dwellings webpage in Xively.

The second (wireless system) was installed in San Lázaro neighbourhood. This system was called EFICIEX and it was developed by EDEA RENOV project with an Arduino® and Raspberry Pi® hardware. An example of the database captured with EFICIEX is:

<http://eficiex.gobex.es/davidcarvajaljusto>

The data captured during EDEA-Renov project reveals that:

- An open source monitoring system developed by the project for a house has a cost between 150 and 300 €, depending on the installations and the size of the building.
- The energy consumption habits are, at least, as crucial as construction and installation improvements in order to reach an efficient home.

- The awareness and the correction of bad habits can save approximately 50%, comparing houses totally equal (same construction, orientation and installations).

- Social dwelling users are suspicious about the consumption of the high efficiency installations. In some cases, they prefer do not use them and they still use the out-dated installations.

- In 2 of 4 cases (Gévora 31 and Umbría 8 in Badajoz) the temperature and the power consumption have been optimized: indoor 20°C in winter and 26°C in summer investing a total amount of 60€ per month (including appliances consumptions).



EFICIEX: ENERGY ASSESOR

EFICIEX system is a low cost and open source sensors kit with a mobile application and a web database which allows to monitor and to send notifications to user's phones.

Because of the absence of an appropriated home monitoring and control system to develop the project aims (low cost and wireless), EDEA-Renov project has developed a system with a Raspberry Pi® and Arduino® technology focused on the energy efficiency improvement of the houses with a cost between 150 a 300 € per dwelling.

The system has **2 comfort sensor** (indoor and outdoor), **2 consumption sensors** (power and water/gas) and a **base station**. The sensors are wireless and powered by AA batteries.

The data of each dwelling are located in an own server (<http://eficiex.gobex.es>) and it is able to show the data online through a private user access.

Also 2 mobile applications have been developed for IOS and Android. These apps are able to show the data captured and they provide notifications programmed to improve the comfort and decrease the energy consumption at home.



EFICIEX Android mobile application screens



EFICIEX sensor system. From left to right: (1) Indoor comfort sensor, (2) Outdoor comfort sensor, (3) Base station (Raspberry Pi®), (4) water and gas consumption sensor and (5) power consumption sensor.





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