ANALYSIS

zero co2 plana

ENERGY AND ACCESSIBILITY REFURBISHMENT OF THE PUBLIC RENTAL HOUSING POOL

alokabide

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ALOKABIDE | Public company dependent on the Basque Government for the development of the social function of housing through the rental policy

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1. INTRODUCTION

Global interest in the energy efficiency of buildings has been increasing in recent years, prompted by the effects of climate change. Buildings account for 40% of Europe's energy consumption and 36% of its CO2 emissions. Numerous regulations have therefore been put in place to **improve buildings' energy efficiency, and so reduce its negative impact on our planet.**

The 2018/844/EU Energy Performance of Buildings Directive (EPBD) requires Member States to establish a long-term strategy for supporting the refurbishment of all residential buildings, transforming them into **decarbonised housing pools with high energy efficiency by 2050.**

In the case of new-builds, these requirements are guaranteed by rules of mandatory observance, such as the Technical Building Code. In the case of existing buildings, however, there is widespread confusion and considerable complexity involved in ensuring its compliance; especially so when considering that Directive 2018/844/EU requires the annual refurbishment of 3% of the existing housing stock.

Faced with this situation, the Basque Government's Undersecretary for Housing at the Department of the Environment, Territorial Planning and Housing *[Viceconsejería de Vivienda del Departamento de Medio Ambiente, Planificación Territorial y Vivienda del Gobierno Vasco]*, through the Directorate for Housing and Architecture, has launched the ***Plan ZERO Plana,*** a pioneering scheme that analyses the future of existing housing and the new model for managing public rental accommodation to deal with the challenge of climate change. This scheme is being headed by ALOKABIDE, a public company that manages the rental pool and has a privileged understanding of its circumstances.

This is the sternest environmental challenge Basque public housing has ever faced, while at the same time constituting an opportunity to guarantee the long-term sustainability of the public rental housing pool and, in turn, improve tenant's quality of life.

In response to the current scenario, which is witnessing exponential growth in rentals, the definition of a holistic model for energy management in public housing is going to lie at the heart of this plan. This renders it crucial **to analyse the specific criteria of efficiency and sustainability inherent to rental management,** as opposed to other areas.

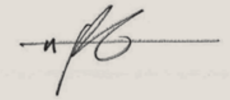
In this case, the importance of the operating stage within a housing block's life-cycle is decisive when rolling out solutions in energy improvements, especially considering the very different profile of use to the rest of the housing stock: overrepresentation of low-income households, priorities other than environmental ones, frequent issues with neighbours, etc.

The Plan ZERO Plana is part of a strategic scheme within the Basque Government's 2020 Science, Technology and Innovation Plan *[Plan de Ciencia y Tecnología e Innovación - PCTI*. Conscious of the fact that zero-consumption new-builds are now a reality, we are turning our attention to refurbishment. We are referring to this as a "smart" process, not only because it is associated with new technologies, but also because it integrates other variables besides energy, such as Universal Accessibility. We are driven by the belief that an energy-efficient housing pool must also be fully accessible, otherwise it is not sustainable, and less so in a society such as our own that is increasingly ageing.

Furthermore, this R&D&i scheme includes the maintenance variable, linking it to the over-riding goal of recording zero energy consumption. To do so, we are resorting to **a methodology called BIM** (Building Information Modelling) backed by advanced digital and electronic systems, with the ultimate aim being to guarantee the proper maintenance of the public rental pool. It is not simply a matter of reducing energy consumption, but also of deploying the advanced management of housing through the alignment of innovation, refurbishment, and maintenance.

The Plan ZERO Plana will be used to identify, prioritise and arrange investment over the coming five-year periods for the dual purpose of providing a pool of public rental accommodation that is advanced, efficient and well-maintained **for giving the public at large a better service.** This is a qualitative step forward when addressing the issue of zero energy consumption in buildings and the reduction of CO2 emissions by adopting an approach that is no longer fragmentary, one building at a time, but instead within an overall perspective of the pool in its entirety. Furthermore, it is addressed by creating synergies among different innovation projects that contain specific aspects involving the reduction of consumptions and emissions. Zero energy consumption, and zero emissions, **the Plan ZERO Plana places R&D&i at the service of the environment, but also, and above all, of the people that live in public housing.**

We are already seeing the results, yet that is not all that matters. The road taken is also interesting in itself, now working with a different approach in which the actual buildings are not the main focal point, but instead the public service provided through them to the people living in them. Addressing a project of the magnitude of the Plan ZERO Plana, with so many variables and stakeholders of such a diverse nature, is in itself a challenge in terms of organisation and teamwork. This is the sternest environmental and social challenge that public housing has ever faced in Euskadi-The Basque Country, and we are truly looking forward to it.



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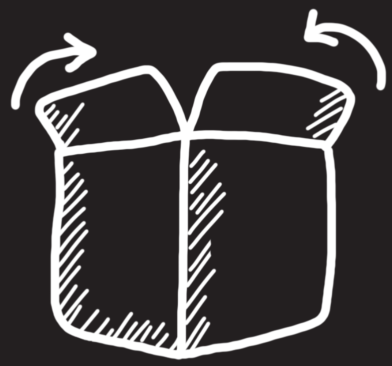
2. STRUCTURE

What is the public rental pool like in the Basque Autonomous Community (CAPV), and what steps need to be taken to make it more efficient and fulfil the requirements of a holistic service?

For the past three years, Plan ZERO Plana has been analysing the Basque Government's own public rental pool of 234 buildings and 7700 housing units distributed throughout Euskadi-The Basque Country. They constitute a unique ecosystem that has involved further exploring sundry focal points, in terms of both the pool's eco-refurbishment and the critical points and technical solutions related to its energy enhancement and the management of properties.

The work has involved studying the impact of demographic changes, the growing use of social housing, the impact of climate change, and the technological revolution, as the "main trends that will set the course for Basque social housing over the coming decades" towards "more sustainable, healthier and more manageable" accommodation. The overall mission is **to find original formulas for the public rental service.**

Schematically, Plan ZERO Plana has been organised into three STAGES:

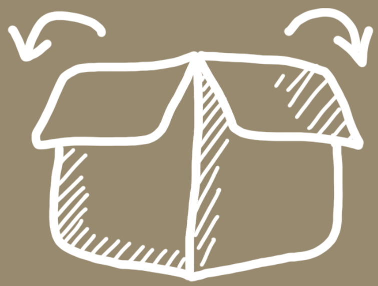


STAGE 1. ANALYSIS of the public rental housing pool

The first step has involved forming a general view of the stock of public housing in the Basque Country and analysing the energy status of rental accommodation, with the aim being to **identify the impact on management** arising from the use of energy and establish the potentially most important focal points.

An analysis has been conducted of types and models of buildings, a new inventory has been launched for the overall pool, and the database has been updated with the generation of indicators as the basis for BIG DATA (general information, existence of problem areas, building and architectural data, assessment of accessibility, installation systems, energy consumptions etc.).

In addition, an energy assessment has been made of the pool of public rental housing, which has been based on an energy audit involving 11 different buildings that reflect the pool's complexity, being classified as follows: three levels of energy efficiency (high A-B, medium C-D, and low E-F-G), two types of heating and hot water installations (communal or individual) and two climate zones (temperate C1 or cold D1E1).



STAGE 2. Plan ZERO Plana for energy and accessibility refurbishment

The second aim has been to furnish ourselves with a **medium-to-long-term strategy** for the implementation of refurbishment processes that transform our pool of social housing, improving its specifications to provide tenants with a service that is better, more eco-friendly and a driver of economic activity.

As one of the solutions considered, the Plan ZERO Plana has studied the technical and operational feasibility and the financial viability of the energy and accessibility refurbishment of buildings towards a scenario of almost zero energy consumption. The aim is to set an example in the management of buildings with a high energy performance insofar as this is consistent with their affordability, financial viability and sustainability in a broader sense, without forgetting the tenants.

A number of core principles related to rentals have been established for the design of the processes, with the definition of a management paragon for energy in social housing. Control variables, indicators and metrics, and disclosure processes have all been identified, together with techniques for improvement and the roadmaps for achieving them.

STAGE 3. Operational deployment and implementation

Thirdly, the operational deployment has begun of those processes with the greatest economic, environmental or social repercussions, prioritising technical improvement solutions and the corresponding roadmaps. All this has been encapsulated in the refurbishment master plan referred to as **Plan Director de Rehabilitación 2020-2050.**

At the same time, schemes have been launched for disclosing the strategy to sectors involved in energy efficiency and construction. Renewable energies and energy efficiency lie at the heart of the commitment to a clean energy transition that will satisfy the requirements of our users, the economic development of Euskadi-The Basque Country, and the environment.

Introducing an energy system that is smart, socially fair and sustainable calls for robust policies, competitive businesses and technological innovation. This means that marshalling the digital transformation of energy and buildings will be crucial for the success of the transition of our housing pool.

All this involves equipping our buildings and ALOKABIDE with the tools that cater for current and future needs regarding the modelling and maintenance of the housing pool under its management, and which accounts for a highly significant part of its operations. This has led to the drafting of the public rental housing pool's own BIM protocol with the choice of level of detail (LOD), level of maturity, type of information generated, type of coordination, and model adapted to the public management of a housing pool.

3. ANALYSIS OF THE PUBLIC RENTAL HOUSING POOL

3.1. Scope

The initial step has involved establishing a general view of the stock of public rental housing and setting the starting point for the forthcoming **revolution in the energy sector** and the transition to a green economy, where social awareness, political decision-making and economic signals have all aligned for the first time.

This has involved considering not only environmental issues, but also those arising from the operation, maintenance and availability of buildings, together with their energy costs. This has provided us with an accurate analysis, focusing on end users, as well as furnishing us with an overall view of their relationship with energy.

The Basque Government's public rental housing pool consists of 136 buildings with more than 50% ownership, besides a stake in another 100 in which it has a minority holding. All together this means **over 7,700 public housing units** in the Basque Country's three provinces. This is a large number of buildings/properties with a wide range of installations, which generate different situations among users: very different heating quotas between buildings, the greater or lesser efficiency of housing, the installation of renewables to reduce energy costs or their absence, etc.

13,600
Overall housing units

5,900
Private homes under management (Bizigune)

7,700
Public housing units under management

234
Buildings managed

The private housing units in Bizigune's pool require a double service; on the one hand, for the tenant, to guarantee a habitable home with an affordable rent, and on the other, for the owner, to guarantee the payment of a fair market rent on a regular basis and the return of the accommodation in perfect conditions, all within the framework of the Urban Rental Law.

In the case of public housing, however, the service focuses both on the accommodation's **habitability** and on the **control and supervision of the buildings' maintenance and upkeep**, pursuant to both the Urban Rental Law and Horizontal Property Law.

Out of the 234 buildings managed by ALOKABIDE:

Full public ownership (housing)

100 % → **97 Buildings**

>50 % → **39 Buildings**

→ **136**

Minority public ownership (housing)

<50 % → **98 Buildings**

The Plan ZERO Plana therefore focuses on the 136 buildings in which the initiative and responsibility in matters of maintenance and upkeep correspond to ALOKABIDE/ Basque Government, either as sole owner or as majority owner. In turn, the legal status of the housing association will inform each one of the processes provided for in the Plan ZERO Plana, an aspect that will be addressed in the corresponding section.

3.2. Description of the existing housing pool

3.2.1. Breakdown of types

The macro analysis of the public housing stock has involved identifying **key variables** for classifying the basic inventory of 136 buildings considered in the Plan ZERO Plana. This first definition of TYPES has been based on ALOKABIDE's initial documents, with this list growing and being extended during the development of the Plan ZERO Plana in response the needs of the research streams being generated.

Pursuant to the strategic aims of the ALOKABIDE public company in the choice of parameters, and based on technical data, the following series of operational criteria have been considered:

- The need to identify uniform groups in terms of size.
- The creation of a manageable number of groups.
- The need to use criteria that are currently being applied in the inventory of buildings.
- The need to arrange these criteria in order of importance.

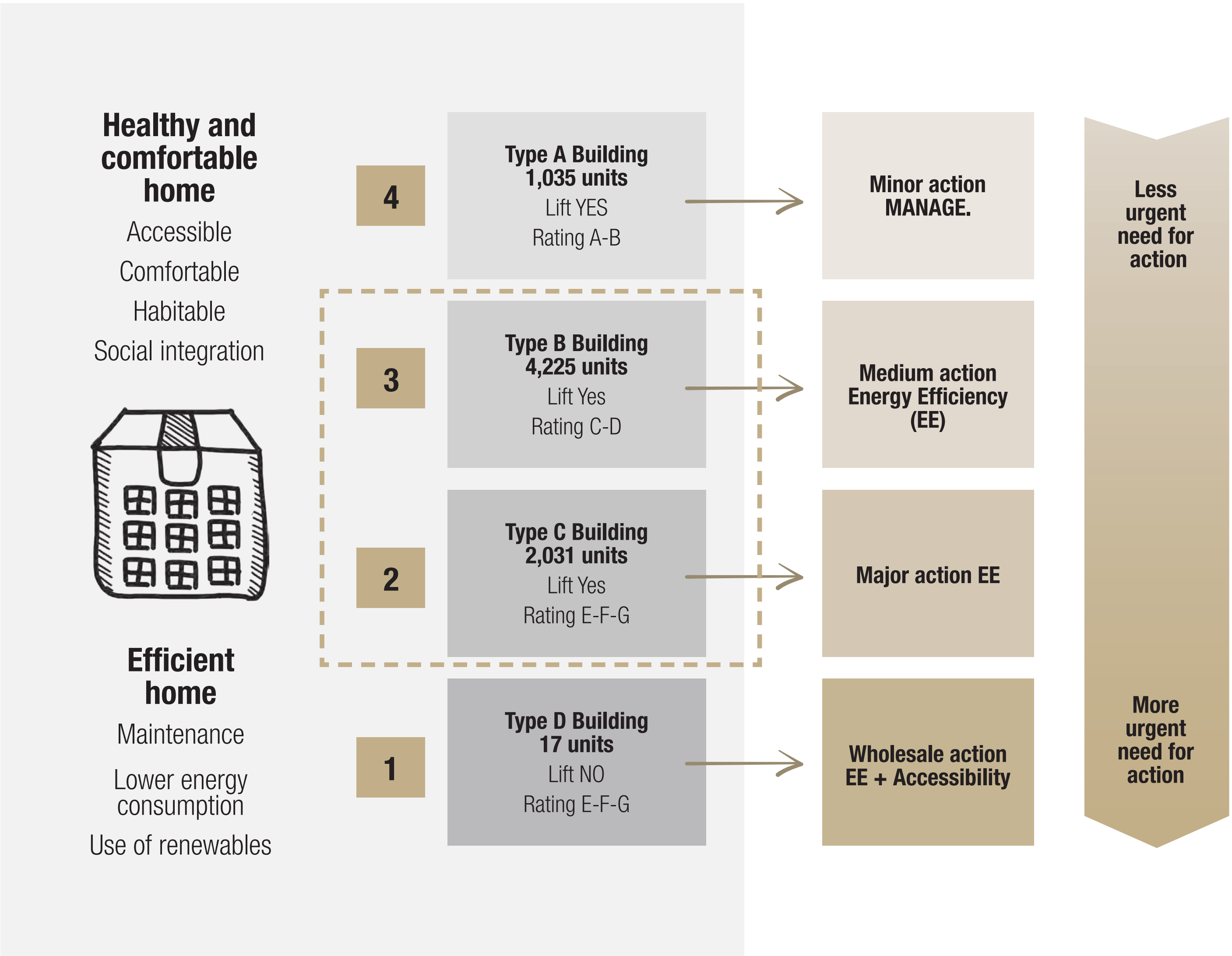
This means that four key parameters have been used for classifying the existing pool of buildings into their various types:

- **Percentage of ownership,** identifying two groups:
  - 100 % ownership.
  - 51-99 % ownership.
- **Availability of a lift** in the building, identifying two groups:
  - Building with lift (yes).
  - Building without lift (no).
- **Energy Performance Certificate (EPC),** identifying three groups:
  - Rating A-B.
  - Rating C-D.
  - Rating E-F-G.
- **Type of heating**, identifying two groups:
  - Individual heating system.
  - Communal heating system.


OWNERSHIP
100 %
LIFT
YES
LIFT
NO
A
B
C
D
E
F
G
COMM. HEAT.
IND. HEAT.
NO HEAT.
OWNERSHIP
>51 %
LIFT
YES
LIFT
NO
A
B
C
D
E
F
G
COMM. HEAT.
IND. HEAT.
NO HEAT.

The result has been a tree with 12 branches or subgroups, which have been arranged into four types of buildings, according to the parameters used here, providing for a pre-analysis of the different DEGREES of action required. *There are no type D buildings (with public ownership > 50%).*

To complement the previous work from the perspective of energy research, the need became apparent to include the parameter of climate zone to make the overall analysis more accurate.



3.2.2. Replicability

Now that the types of building have been identified, and with a view to providing significant data for analysing the pool, we have chosen **11 representative buildings**, with the project's work and research being perfectly contextualized by the following buildings:

Description	Address	Number of rental properties	% ownership of units under management	Lift	EPC	Heating	Climate zone
228 IBAIONDO	Rio Bayas 32-34-36-38-40, Donostia 78-80-82, Landaverde 41-43-45-47-49	228	100 %	YES	E	INDIVIDUAL	D, E
SALBURUA 171	Paseo Iliada 6-8-10	171	100 %	YES	A	COMMUNAL	D, E
ZABALGANA 126	Av. Derechos Humanos 33-35-37 y Villabuena Álava 1-3-5	126	100 %	YES	D	COMMUNAL	D, E
OLABEAGA 11	San Nicolas de Olabeaga 62	11	100 %	YES	E	INDIVIDUAL	C
MIRIBILLA 60	Claudio Gallastegui 21-23-25-27	60	100 %	YES	D	INDIVIDUAL	C
MUSKIZ 40	Las acacias 8-10-12-14	40	100 %	YES	E	COMMUNAL	C
GERNIKA 30	Bizkaia 14	30	100 %	YES	C	COMMUNAL	C
MARRUTXIPI 55	Fernando Sasiain 22-24-26-28-30-32 Sibilia 46	55	100 %	YES	D	INDIVIDUAL	D, E
MUTRIKU 75	Hirigibel 2-4 y Lehendakari Agirre 21	75	100 %	YES	E	COMMUNAL	D, E
LUTXANA-MUNOA 39	Konturri nº 2,4	39	100 %	YES	A	COMMUNAL	C
HERNANI 20	Laiztiaga 6	20	100 %	YES	B	INDIVIDUAL	D, E

Other buildings that will be a source of information and provide data for analysing the plan are the three already framed within the Eco Compact City Network (ECCN) strategy that was introduced prior to the launch of the Plan ZERO Plana in 2017:

Description	Address	Number of rental properties	% ownership of units under management	Lift	EPC	Heating	Climate zone
AMURRIO 21	Bañuetaibar 1-3-5	21	100 %	NO	E	INDIVIDUAL	D, E
ITURRITXO 9	Calzada vieja de Ategorrieta 163	8	67 %	NO	G	INDIVIDUAL	D, E
ORTUELLA 8	La Estación 86	7	88 %	NO	G	INDIVIDUAL	C

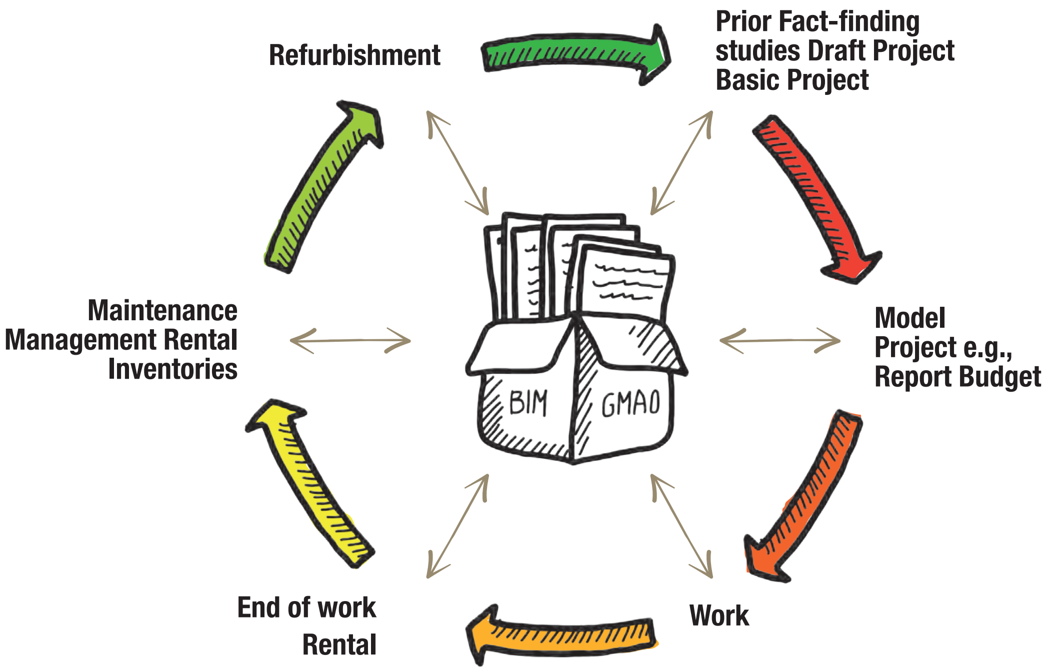
3.2.3. Specifications of the public pool

Specifications of the existing public pool with a view to extracting data on the type, purpose, construction and accessibility, considering the buildings' energy refurbishment and their maintenance and rental.

There is a diversity and very broad range of documentation currently available on the public rental pool due to the staggered times that the public buildings have come under ALOKABIDE's management, although in some cases it is also scarce. It should be remembered that the Basque Government issued its mandate to the public company ALOKABIDE in 2005, when a varying cluster of buildings and housing units for rental came under public management.

There are therefore **numerous and diverse documentary sources** of a different nature, origin and degree of development containing an extensive range of data with no common structure. This means that the management and use of these data is inefficient and that the search for detailed and accurate information is complicated.

In view of this, the range of documentary sources related to building, architecture and construction, and even energy aspects, has been structured so that the information collated on the basis of certain common criteria provides greater quality in terms of content, transparency and accessibility, making it easier to read and more appealing to the eye.



The development of the Plan ZERO Plana within the ambit of public management and digitisation sets a range of goals in terms of the use of innovative property management systems (CMMS, BIM, CRM…), which means that identifying the specifications of the existing pool is especially important for ensuring these systems are fully integrated.

The following tasks have been involved in drawing up the overall pool's specifications:

Task 1: Classifying the information available on the buildings

- A diverse range of files and documents have been provided on each building, including the following; prior studies, basic projects, building projects, reports, completion reports, plans (PDF or CAD), energy performance certificates (EPCs), energy performance labels, refurbishment or maintenance reports…
- A selection has been made accordingly of a series of files that are common to all the projects (building project, completion report, plans, EPC and energy performance label), which have been used to gather data and provide a source of information.

Task 2: Selection of indicators required for compiling the specifications

- The short-listed files have been used to provide indicators corresponding to the different strategic ambits of ALOKABIDE's management.

Task 3: Drafting of a template for recording the indicators as a tool for listing the specifications

- Based on the data selected and those verified in the fieldwork, a common template has been drawn up for all the buildings, linked to the file of the initial inventory developed by ALOKABIDE. It is an open tool that is easy to use and visual, catering for the modification and updating of indicators, and even the inclusion of new ones, and all the information can then be exported to the CMMS.

Task 4: GIS integration

- The public pool is included in GIS tools for making it easier to establish work criteria and priorities.

Task 5: Identification of sources of integration with management systems (CMMS, BIM, CRM)

- The aim is to conduct a thorough process of data analysis for their inclusion in the various management tools.

The data compiled from the aforementioned documentary sources have furthermore been structured according to the plan's strategic pillars: health (housing unit), environment (building) and advanced management (pool), thereby paving the way for decision-making in future actions.

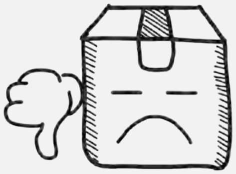
3.3. Maintenance and state of repair

The public rental pool is mostly in good condition, as a result of being maintained by the public company ALOKABIDE. It is true, however, that the supervision of corrective and preventive maintenance has identified a number of issues (in management) whose sphere of action is complemented by the scope of the Plan ZERO Plana. This explains the interest in crossing the existing data in terms of the most significant problem areas with the different results from the analysis of the buildings' accessibility and energy efficiency.

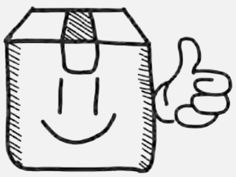
Accordingly, the analysis of the pool, in terms of maintenance and state of repair, is based on a detailed review of the different issues recorded and managed by ALOKABIDE in each building, in order to gain a clear view in each case of the need for action in this matter.

ALOKABIDE building in Marrutxipi (San Sebastian-Donostia)

ALOKABIDE building in Mina del Morro (Bilbao)



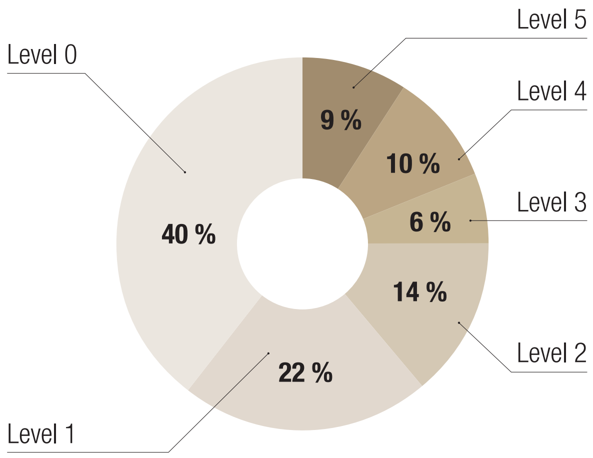
There are 5 **levels of deficiencies** identified in the state of repair of the 136 buildings considered in the Plan ZERO Plana:



5	Deficiencies in the cladding or envelope due to wear and tear that may lead to the detachment of materials and/or objects falling into the street or to areas inside the building (damaged ledges, worn cladding on frontages (brickwork, mortars…), etc.).
4	Deficiencies that affect living conditions: damp courses from leaks on the frontage, roof and ground…
3	Deficiencies that affect the rental service and are annoying: damp in garages and/or storerooms. Communal areas affected by some or other issue: no off-street parking, estates…
2	Serious aesthetic deficiencies: poor image suggesting neglect and lack of maintenance.
1	Minor aesthetic deficiencies.
0	No deficiencies.

As noted on the previous page, the impact that ALOKABIDE's management has on the buildings depends largely on ownership, with cases in which the publicly owned housing units are in a minority in the building, with public management having less of an impact. Nevertheless, the Plan's analysis focuses on the 136 buildings with more than 50% public ownership.

This means the public rental pool records the following state of repair:



Of the 136 buildings considered in the Plan ZERO Plana, 18% (25 buildings, the oldest ones) have issues related to the cladding or envelopes, where the work falls within the Plan's remit. Four of them are already undergoing energy refurbishment, with a different degree of progress in each case.

Those buildings recording scores of 4 or 5 have, to a greater or lesser extent, deficiencies due to deterioration in the case of the oldest ones or due to leaks.

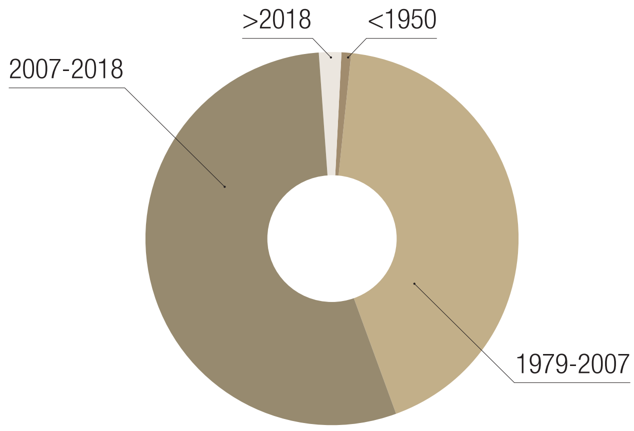
Nonetheless, they all involve **the oldest buildings** under management.

The remaining 82% are generally in an excellent state of repair and any deficiencies they do have are not related to energy or accessibility issues.

Regarding the age of the public rental pool:

The sole, building that is over 40 years old, Iturritxo 9, is undergoing a full refurbishment within the scope of this Plan ZERO Plana. With the exception of this case, all the public buildings have been built at least according to the standards of Spain's technical building codes: NBE-CT-79 (43%) or CTE (57%).

The average age of the buildings in the rental pool is **15 years**. When we consider solely those buildings with an ownership of more than 50%, the average for the 136 buildings is 12.5 years. The average building is estimated to be around 10 years old.



Building specifications of facades

The most common **building system** among the 136 buildings is the double-skin arrangement (2H), generally ceramic, with an air chamber (CA) and insulation (A = thickness). The thickness of this insulation, nonetheless, varies according to age and regulatory requirements. Those built in the period 1979-2007 have thicknesses of 4 cm, while those from the 2007-2018 period may reach 10 cm. In terms of the outside cladding, although bare brick is the most common or a mortar finish, this varies for aesthetic reasons or depending on the project, alternating finishes even on the same vertical frontage.

The **outside carpentry** used (lacquered aluminium with a thermal temperature break, ML+R) is standard on almost all the buildings, although some do have oak carpentry (Mab). The windows normally involve double-glazing, although the outer and inner panes vary in thickness, with an interior gap of ≤ 12 mm (C4).

As regards the **roofing**, there are flat ones, inverted flat ones, accessible ones, sloping ones, and even garden roofs; thermally insulated in all cases.

Maintenance and repair of the public rental pool

ALOKABIDE's management of the maintenance of the public rental pool requires liaising with housing associations when they have already signed contracts for the maintenance of the premises and their main features. Within the scope of the Urban Rental Law, ALOKABIDE is responsible for the sum of repairs and actions arising from ordinary maintenance, according to its share as corresponds to its percentage of ownership.

ALOKABIDE has also drawn up a **Maintenance and Repair Plan for the buildings it manages** that involves regular inspections (some mandatory, others voluntary) to ensure their preservation and sustainability. The analysis described here is therefore based on the outcomes of this management.

3.4. Energy audit

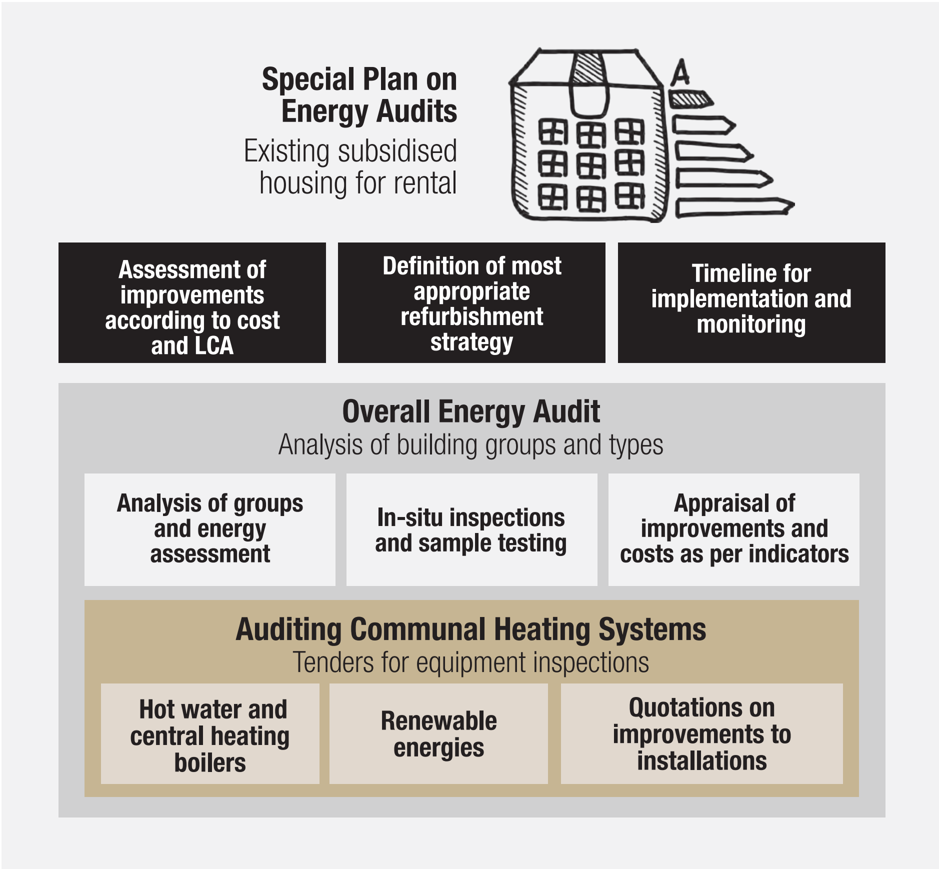
In terms of the analysis of the energy efficiency of the public rental pool, the Plan ZERO Plana has designed a detailed study on the types of households, with a view to gathering pertinent data on the energy performance of the buildings under management.

At the same time, this work has been used to comply with the Basque Government's Decree on Sustainability regarding the rental pool (article 18), whereby *"existing subsidised housing units, being held for rent, developed by the public sector in the Autonomous Community, shall be governed by a special plan to determine the need to conduct an audit and the timeline for doing so, drafted by the department with powers in the matter of housing and approved by the cabinet, upon the recommendation of the Committee for Energy Sustainability".*

3.4.1. Special Plan on Energy Audits

The Special Plan on Energy Audits for the public rental pool has been drawn up in cooperation with various key stakeholders in the Science, Technology and Innovation Plan.

The following image shows the three levels of action this plan involves:



Lower level – Audits of Communal Heating Installations:

As part of the Plan ZERO Plana, a tender has been called for conducting energy audits on communal hot water and heating systems, including renewable energy installations. This has meant checking the performance of the main installation in the existing pool through in situ measurements and the review of maintenance contracts.

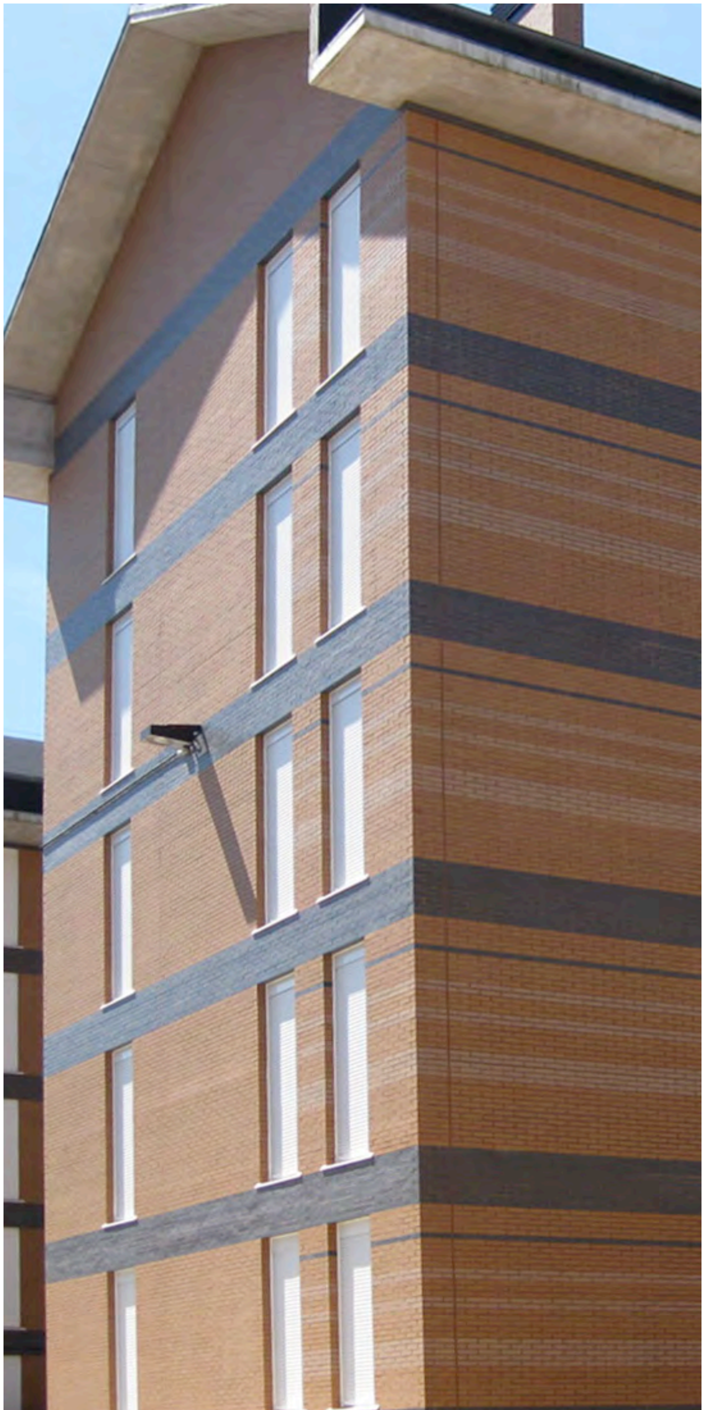
Intermediate level – Overall Energy Audit:

As the Special Plan's core mandate, an Overall Energy Audit has been conducted of the public rental pool. This has involved the building types identified during the development of the Plan ZERO Plana, undertaking a more detailed analysis including inspections, testing and verification through representative sampling, verifying the different levels of energy performance among the complex pool of rental housing units.

Upper level – Special Plan on Energy Audits:

Based on the results recorded by the overall audit, the upper level identifies the **most appropriate refurbishment strategy,** considering the costs of the improvements and the potential options according to the indicators. The Special Plan thus helps to define the overall guidelines for the work to be undertaken by the Plan ZERO Plana, the timeline for its implementation and monitoring for self-assessment and the application of future corrections.

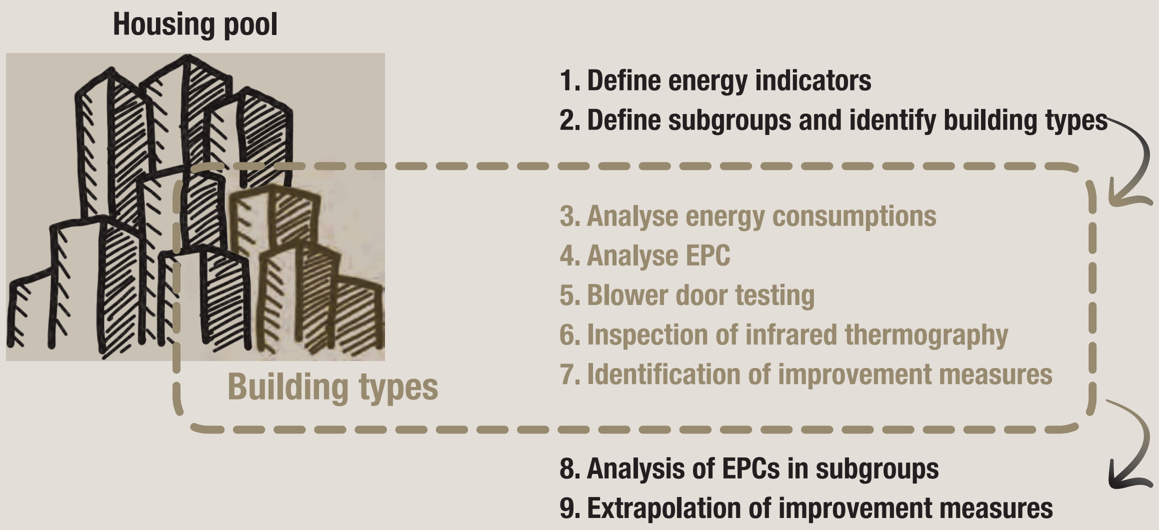
This special plan on audits includes an analysis of information, data gathering, testing, visits to buildings, and the analysis of reports and their findings, as well as any conclusions with a direct bearing on the Plan ZERO Plana.



3.4.2. Overall Energy Audit

An individual energy audit on each one of these buildings as provided for in the Plan ZERO Plana (136) is ruled out for reasons of both time and form. Instead, an overall audit has been held involving the representative buildings for each one of the types identified, which means analysing a representative sample of the pool and gathering detailed in information on the energy performance of those buildings.

The results are subsequently extrapolated to the pool of rental accommodation, providing two layers of analysis: one at the level of housing pool and the other involving individual audits



The Overall Energy Audit's main lines of action involving the public rental pool are as follows:

- Define the energy and sustainability indicators that are most suited to the existing pool of rental accommodation.
- Detail the classification of subgroups with similar energy specifications based on the building types described in the PCTI.
- Identify the standard or representative buildings in each subgroup.
- Analyse the energy performance of each subgroup through each representative building's EPC.
- Conduct in situ inspections on health conditions and building quality, using blower door testing and infrared thermography.
- Analyse the real consumptions recorded, at least over the past year, in the representative buildings.
- Assess possible improvements and identify the most effective ones for each subgroup.

The aim pursued with this methodology is to answer the following strategic questions:

What is the true energy efficiency of the public pool of rental accommodation? What are the most appropriate improvement measures for decarbonising the pool of housing for social rental? What contribution can the energy audit of these buildings make to all the other facets of the Plan ZERO Plana?

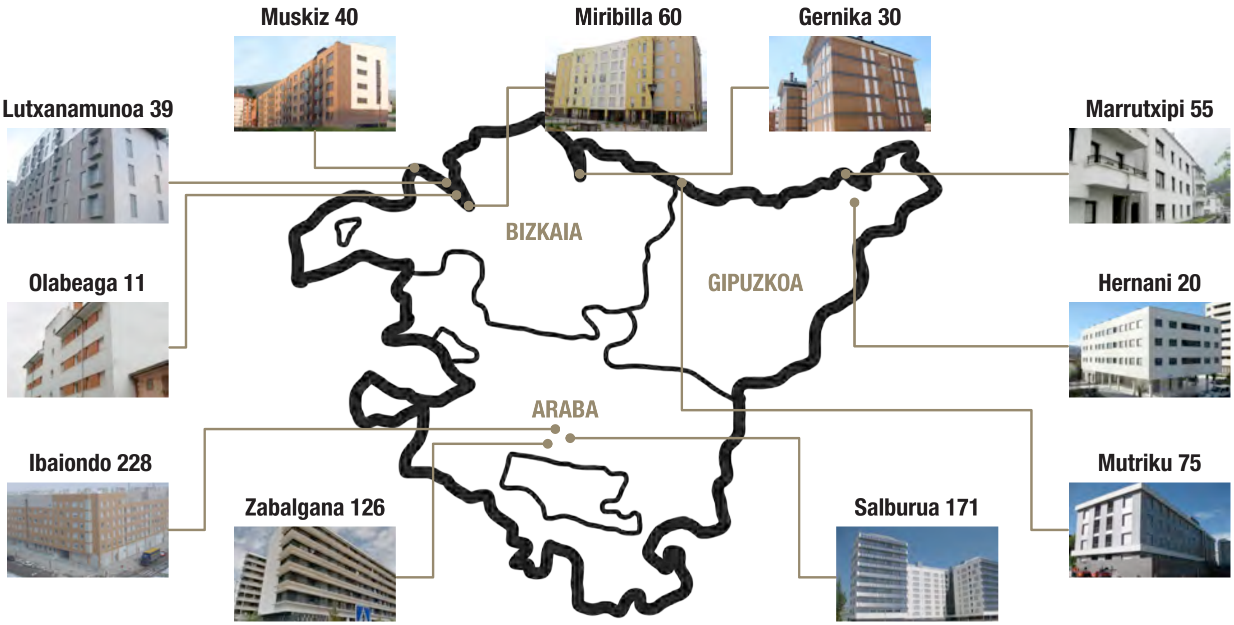
The pool's energy analysis has involved tweaking the groups of building types described earlier in order to record more accurate results from an energy perspective. The definition has therefore been based on the following parameters:

- **Energy rating,** identifying three groups:
  - Rating A-B.
  - Rating C-D.
  - Rating E-F-G.
- **Type of heating,** identifying two groups:
  - Individual heating.
  - Communal heating system.
- **Climate zone,** identifying two groups:
  - Climate zone: Province of Bizkaia, C.
  - Climate zone: Provinces of Araba and Gipuzkoa, DE.

According to the inventory of buildings considered in the Plan ZERO Plana, the above classification of types provides the following distribution:

TYPE (ENERGY RATING)	No. BUILDINGS	REPRESENTATIVE BUILDING
1c-C	9	LUTXANA-MUNOA 39
1c-DE	8	SALBURUA 171
1i-C	-	-
1i-DE	2	HERNANI 20
2c-C	12	GERNIKA 30
2c-DE	32	ZABALGANA 126
2i-C	4	MIRIBILLA 60
2i-DE	19	MARRUTXIPI 55
3c-C	3	MUSKIZ 40
3c-DE	7	MUTRIKU 75
3i-C	18	OLABEAGA 11
3i-DE	22	228 IBAIONDO
	136	

These buildings are geographically distributed as follows:



Location of the 11 representative buildings selected for the energy audit.

The selected buildings were built between 2004 and 2015, with the oldest being Ibaiondo 228, Olabeaga 11, and Miribilla 60, while the most recent is the development at Hernani 20, built in 2015. This means that the 11 buildings chosen are a representative sample of the pool because they coincide with the periods of highest building activity.

The building development with the most housing units is Salburua 171, and the one with the fewest is Olabeaga 11. Energy audits have been conducted on 855 housing units out of a total of 7700 in 136 public rental buildings managed by ALOKABIDE. The buildings' distribution and the number of floors varies considerably, with some developments consisting of one or two blocks; there are also developments with units on the ground floor and others without, and the same applies with attic units.

Finally, regarding the energy installation, six buildings have a communal system for producing hot water and central heating, whereas the other five have individual boilers. Most of the developments use either communal or individual boilers for central heating and hot water boilers, with the exception being Lutxana-Munoa 39, which has a geothermal water-to-water heat pump.

The most widely used renewable energy is solar thermal for supporting the production of hot water, although a photovoltaic façade has been fitted at Salburua 171. The buildings at Marrutxipi 55, Olabeaga 11 and Ibaiondo 228 do not have renewable energy installations.

Following the definition of the representative buildings, the next step has involved an **individual energy audit**, which basically involves analysing their energy consumptions, checking their EPCs and verifying their health and building quality using blower door testing and infrared thermography.

Once the detailed energy audits have been completed, the results for improvement measures are extrapolated to all the other buildings in each subgroup by comparing the EPCs and the energy indicators.

3.4.2.1. Analysis of energy consumptions

This section provides the main results obtained from the analysis of the energy consumptions of the buildings chosen for the energy audit. This analysis has used the utility bills for each building's main energy consumptions. Depending on the type of installation in each building, a specific type and billing period have been established. Furthermore, the data may come from different sources, depending on each development's energy management model.

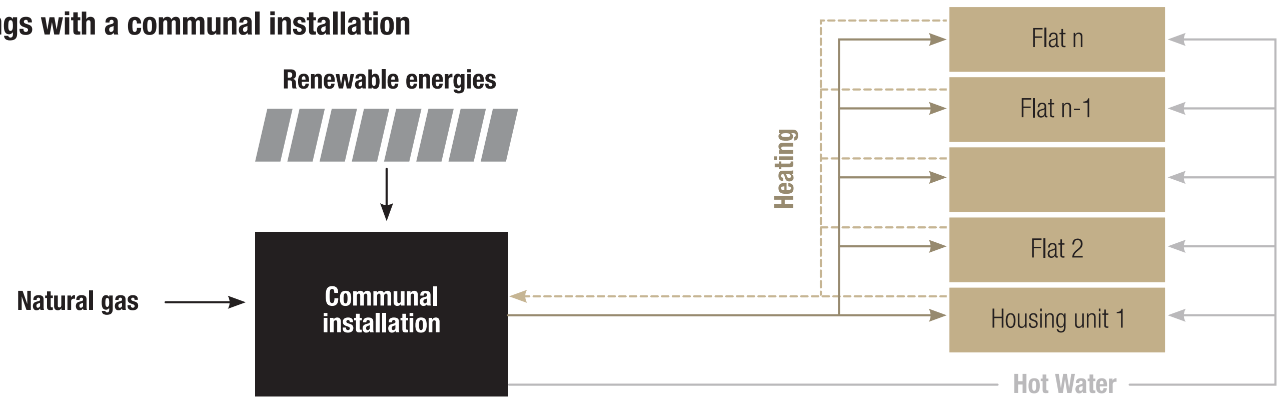
The compilation of the energy consumptions differs depending on whether the installation is communal or individual.

Buildings with a communal installation

Those buildings with communal central heating and hot water record the data for energy consumptions specified in the figure below. Generally speaking, the following are the consumptions for most of the developments with communal installations:

- Consumption of natural gas by the communal installation: this involves consumption of the main fuel by the heating and hot water installation. These figures have mostly been obtained from the invoices of natural gas retailers.
- Consumption of hot water and heating per housing unit: the figures reflect the consumption of heating and hot water for each one of the housing units in each development. The consumption of heating is generally stated as energy consumption [kWh], while the figures for hot water usually correspond to the volume of hot water used [m3]. These data have mostly been obtained from the bills issued by the energy provider.
- Production of renewable energies: when the building has a renewable energies installation (solar thermal, photovoltaic, etc.) the figures for energy used have been based on the data provided by the energy manager or the project's design data .

Buildings with a communal installation



Energy flows in developments with a communal installation.

These are the energy consumptions that have generally been considered for the study of communal installations.

In the case of developments such as LUTXANA-MUNOA 39, the communal installation works with heat pumps, which means the system uses mainly electricity to run this equipment. In turn, the SALBURUA 171 development has a photovoltaic facade.

The following table shows **the energy consumptions analysed in each communal installation**, indicating the data period and their source. Most of the cases have sought to analyse data over more than two years, although this has not been possible in certain developments, either because the information was not available or because of the large amount of data.

HOUSING DEVELOPMENT	MAIN CONSUMPTION OF THE COMMUNAL INSTALLATION	CONSUMPTION OF HOT WATER AND HEATING
LUTXANA-MUNOA 39	**Electricity** Monthly invoices from 11/12/2016 to 13/12/2018 *Source: Electricity company*	Bimonthly readings from 15/11/2017 to 17/01/2019 *Source: Estate manager*
SALBURUA 171	**Natural Gas** Monthly invoices from 26/08/2017 to 25/03/2019 *Source: Natural Gas company*	Hourly readings from 2016 to the present *Source: AUGE system*
GERNIKA 30	**Natural Gas** Monthly invoices from 27/12/2016 to 27/03/2019 *Source: Natural Gas company*	Bimonthly readings from 07/11/2017 to 09/01/2019 *Source: Estate manager*
ZABALGANA 126 from	**Natural Gas** Monthly invoices from 22/12/2016 to 20/12/2019 *Source: Natural Gas company*	Bimonthly readings from 20/12/2017 through to November 2018, hourly consumption November to December 2018. *Source: Estate manager and AUGE System*
MUSKIZ 40	**Natural Gas** Monthly invoices from 24/11/2016 to 20/12/2018 *Source: Natural Gas company*	Bimonthly readings from 28/12/2017 to 28/12/2018 *Source: Estate manager*
MUTRIKU 75	**Natural Gas** Monthly invoices from 24/06/2018 to 29/05/2019 *Source: Natural Gas company*	Bimonthly readings from 05/12/2017 to 05/12/2018 *Source: Estate manager*

Table: Source of the data used in the energy audit.

Housing units with an individual installation

In the case of buildings containing housing units that each have their own boilers for central heating and hot water, the only figures available are for the annual consumption of natural gas in each home, as shown in the following diagram:

Housing units with an individual installation

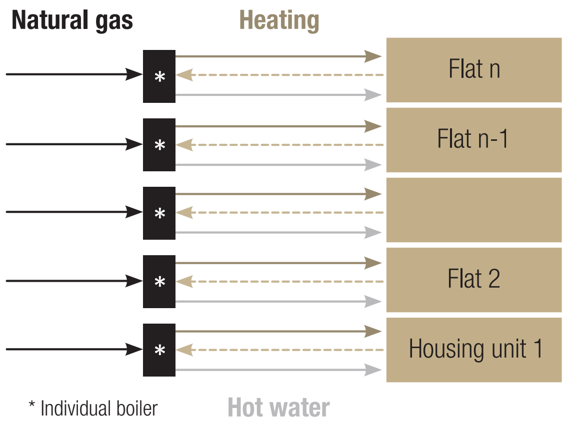


Figure: Energy flows considered in the developments with an individual installation.

Work is currently underway on the seasonal adjustment of these consumptions through the manual reading of the meters on a quarterly basis. The aim is to distinguish between the use of heating and hot water in the overall consumption of natural gas. On a provisional basis, to advance the energy audit's results, a profile has been created for the consumption of heating and hot water of people living in the type of developments under study here.

This has involved all the detailed data on the consumption of heating and hot water in those developments with a communal installation, as separate figures are available for the consumption of heating and hot water. This study reveals that out of the overall amount of energy entering a housing unit of this nature, 53.8% is used for heating and 46.2% for hot water.

The following figure presents the profile for the monthly consumption of heating and hot water for social rental accommodation with a communal installation, which has been extrapolated to analyse the energy consumption of housing units with an individual installation.

Consumption of hot water over the total use of energy in the housing unit

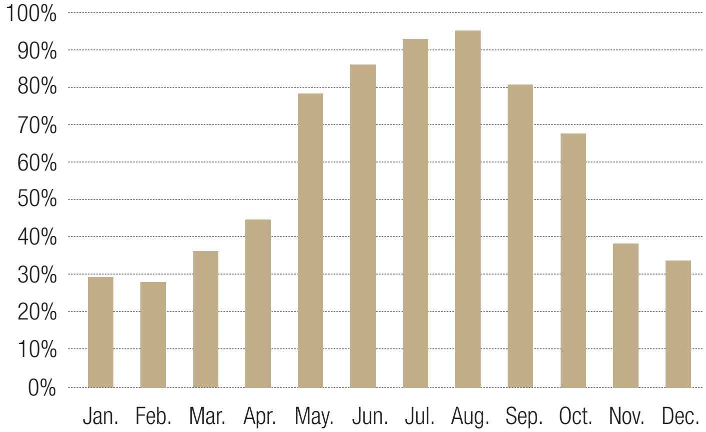


Figure: profile of the consumption of heating – hot water according to the data for the consumption of developments with a communal installation.

In the case of developments with individual installation in each housing unit, the energy data have been obtained from the distributor Nortegas, which has provided the total annual fuel consumption for all the housing units for 2017 and 2018.

Besides the energy consumptions involving the production of heating and hot water, the analysis has also included each housing unit's use of electricity. The data available in this case correspond to each unit's monthly consumption of electricity in 2017 and 2018. These data have been provided by the electricity company Iberdrola.

3.4.2.2. Energy balance

Following the compilation of all the energy bills specified in the previous section, and after their thorough screening to remove any possible mistakes and bring all the measuring periods in line, an analysis has been conducted of the data according to energy balances. This has involved calculating the main energy indicators for the buildings' analysis.

These energy indicators are related to those selected for the Plan ZERO Plana, as described in section 3.1.

The following table presents the study's main energy indicators, with subsequent disclosure of certain significant results that correspond to other relevant aspects of this study, such as the distribution of consumptions and energy poverty. The Mutriku 75 development has been divided into two buildings, as this is how the EPCs have been issued.

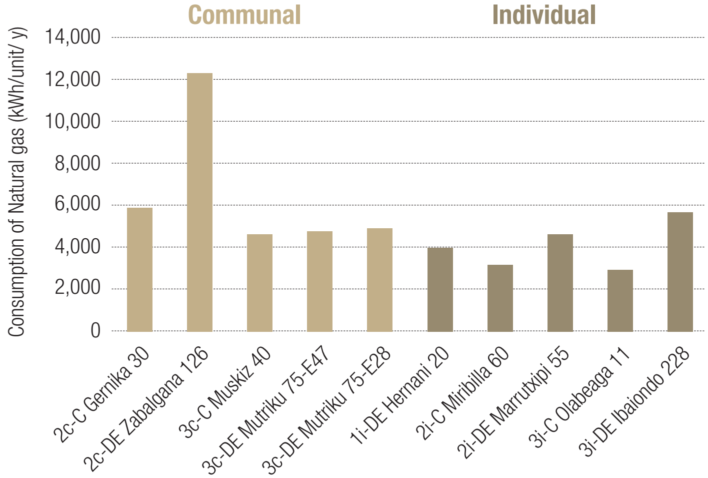
BUILDING	NATURAL GAS CONSUMPTION			ELECTRICITY CONSUMPTION		USEFUL ENERGY	
	Annual total (kWh/y)	Average per housing unit (kWh/unit·y)	Average surface (kWh/m^2·y)	Average anual total (kWh/y)	Average per housing unit (kWh/unit·y)	Heating by surface area (kWh/m^2·y)	Hot water per user (m3/user·year)
1i-DE Hernani 20	81,195	4,059.8	41.9	42,706	2,135.3	20.0	17.2
2c-C Gernika 30	178,028	5,934.3	82.8	43,823	1,460.8	23.6	15.5
2c-DE Zabalgana 126	1,552,928	12,324.8	129.1	219,877	1,745.1	25.5	13.9
2i-C Miribilla 60	195,335	3,255.6	43.2	112,069	1,867.8	20.7	9.8
2i-DE Marrutxipi 55	248,653	4.521	35.8	84,527	1,536.9	17.1	19.8
3c-C Muskiz 40	183,288	4,582.2	48.7	60,016	1,750.4	15.7	14.5
3c-DE Mutriku 75-E47	225,228	4,792.1	55.1	67,746	1,441.4	23.2	18.22
3c-DE Mutriku 75-E28	138,264	4,938.0	54.9	38,100	1,360.7	21.4	14.2
3i-C Olabeaga 11	32,470	2,954.8	39.7	11,531	1,048.3	19.0	16.5
3i-DE Ibaiondo 228	1,284,317	5,633.0	82.6	377,001	1,653.5	39.5	17.9

Table: main results of the energy analysis of the reference buildings

The above table shows that the building with the highest annual consumption of natural gas is the Zabalgana 126 development, followed closely by Ibaiondo 228. The development with the lowest consumption of natural gas is Olabeaga 11.

The figure below shows the figures for the annual consumption of natural gas per housing unit in each building, providing an overall analysis of all the consumptions recorded in all the housing units studied, both in developments with communal installations and those individual ones in each housing unit.

Graph of the consumption of natural gas per housing unit



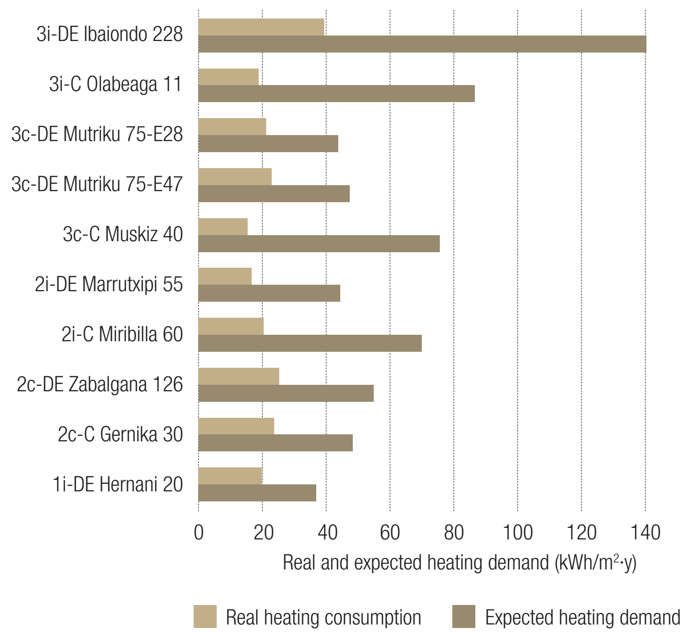
An analysis of the above graph shows that the highest consumption of fuel per housing unit continues to correspond to Zabalgana 126, with figures up to six times higher than Olabeaga 11, which is the development with the lowest consumption per housing unit

There is no clear relationship either between this consumption and the type of energy installation (communal and individual), although the average consumption of individual installations (4,084.2 kWh/unit/y) is slightly lower than the average consumption of communal ones (6,514.3 kWh/unit/y).

The following figures shows **the heating consumption per surface unit in each development, compared to the heating demand specified in the EPC in each case. This graph shows that none of the developments analysed consumes enough energy to attain suitable levels of comfort.** The development that comes closest to the expected demand for heating is Hernani 20, with a difference of 17.6 kWh/m2/y, while the biggest difference is recorded at Ibaiondo 228, with a 100 kWh/m2/y divergence between consumption and the expected heating demand.

It should be noted that the heating consumption for individual installations has been explained using the hot water profile, which means the results may vary to some extent when the meter readings are completed.

Real and expected heating demand in representative buildings

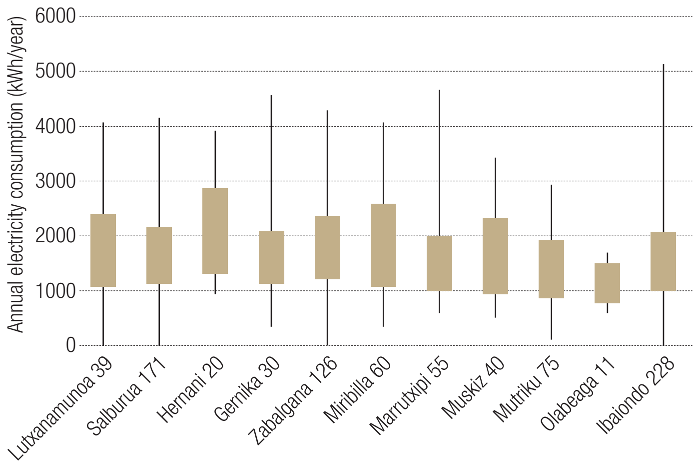


A brief analysis has also been made of each development's electricity in 2017.

The next figure shows the distribution of the annual electricity consumption of the representative developments, considering the 25 and 75 percentiles. There is a considerable difference across all the representative buildings.

According to the SPAHOUSEC study conducted by IDEA in 2011, the average nationwide consumption of electricity per housing unit is 3,487 kWh/year, which means that 75% of the housing units consume less than this figure.

Annual electricity consumption of representative buildings in 2017



3.4.2.3. Analysis of EPCs

This stage of the energy audit involves, on the one hand, checking that each building's Energy Performance Certificate (EPC) has been completed properly, suitably covering all the building's features and the energy production installation's operating parameters; in addition, **the EPC's results are compared with those of the analysis of true consumptions.**

The following table presents the comparison between the EPC's parameters and the analysis of the developments' real consumptions:

Comparison of results between the energy analysis and the EPC

CONSUMPTION	ZABALGANA 126		IBAIONDO 228	
	Real	EPC	Real	EPC
Primary non-renewable energy (NRPEC) [kWh/m²·y]	153.7	99.8	98.3	260.9
Calefacción (CEU) [kWh/m²·a]	25.5	55.1[1]	39.5	140.3[1]
ACS (CEU) [m³/usuario·a]	13.9	9.77	17.9	10.22

[1] This figure corresponds for the expected demand for heating in the EPC

Non-renewable primary energy consumption (NRPEC)

In the case of Zabalgana 126, the true NRPEC is higher than specified in the EPC, whereas the real consumption at Ibaiondo 228 is less than expected in the EPC. This difference is due to the **low efficiency of the energy installation at Zabalgana 126,** as explained in section 3.3.2, whereas the energy installation at Ibaiondo 228 involves individual boilers, whose theoretical performance is 89%.

Consumption of heating

The true consumption of heating is given by readings on the individual meters in each housing unit, while the EPC indicates the expected demand for heating. At both Zabalgana 126 and Ibaiondo, **the consumption of heating in the housing units is significantly lower than expected.** This is a preliminary sign that tenants are consuming significantly less energy than required for their personal comfort.

Consumption of hot water

By contrast, more hot water is actually consumed than expected in the EPC, specifically 4.13 m3 more at Zabalgana 126, and 7.68 m3 more at Ibaiondo 228. It should be noted that the consumption of hot water at Ibaiondo has been calculated according to the central heating profile.

3.4.2.4. Blower door testing

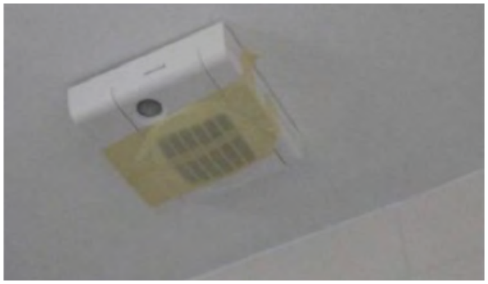
A blower door test is used to measure **a building's airtightness, as well as to locate the main cracks or points where air is leaking through**, both in the envelope and within the premises.

This test is regulated by the UNE EN 13829 standard and involves creating a pressure drop between the inside and outside of the building by placing a blower, or fan, within the framework of the front-door to each housing unit. This allows measuring the flow of air through the envelope and establishing its level of permeability.

The B testing method has been used (measuring the building envelope), which means that any opening built into the building's envelope needs to be closed or sealed (windows, doors, firewalls, etc.), and all adjustable openings need to be closed. This involves sealing all the ventilation conduits in bathrooms and kitchens and the aerators on windows.

The following pictures illustrate the assembly of the blower door on one of the housing units being tested. They also show the sealing of a ventilation conduit in the kitchen and the sealing of the roller blind box on a window.


Assembly of the blower door


Sealing of the ventilation conduit in the kitchen


Sealing of an aerator on a window in the living-room

The tests involved, on the one hand, the building joints on the envelope and carpentry assemblies (windows, doors, etc.), and on the other, the different features that pass through the building's envelope (ventilation and air conditioning conduits, drains, cabling, etc.). This test is therefore of considerable use for the energy audit, as besides recording the building's seepage rate, it also detects building faults whose solution may mean major energy saving and greater comfort for tenants.

The decision on the number of homes to be tested follows the indications of the Basic Guide on the Thermal Control of Buildings [*Control Control Térmico en Edificación*] [4], drafted by the Basque Government's Building Quality Control Laboratory (LCCE), which has ample experience in this type of testing, as determined by the number of homes in the building according to the following table:

Number of blower door tests according to the number of homes

No. homes in the building	No. homes to be tested
n ≤ 10	1
10 < n ≤ 30	2
30 < n ≤ 50	3
50 < n ≤ 100	4
n ≥ 100	6

Moreover, certain criteria need to be followed when choosing the homes to be tested in each building, thereby ensuring the sample selected is as representative as possible.

Blower door testing selection policy

Priority	Selection criterion
1	Standard type
2	Higher ventilation flow
3	Lower ventilation flow
4	Ground floor
5	Top floor
6	Others

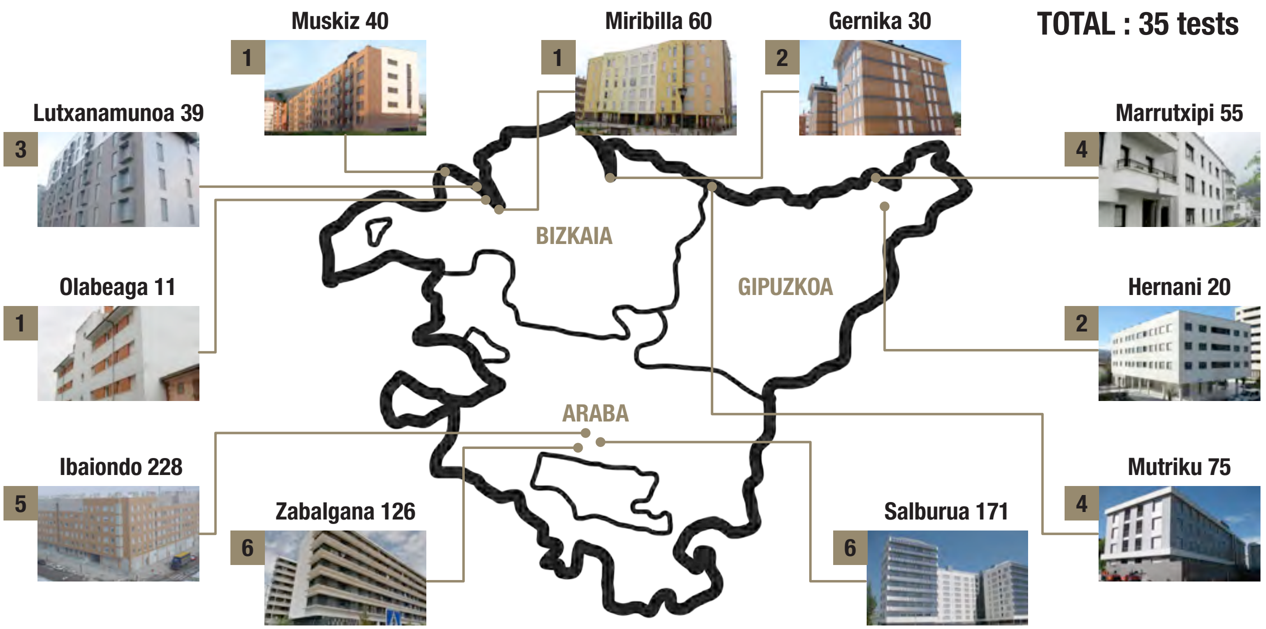
This study has sought to apply these criteria in the selection of the homes to be tested. Nevertheless, the fact that these homes are occupied has made the test more complicated to hold. Accordingly, the screening process has first considered those homes that are unoccupied at the time of the test, and secondly, a further filter has been applied to these housing units, with the aim being to ensure that most of them fulfil the above selection criteria.

The next table shows the buildings subject to the energy audit and the number of blower door tests to be performed.

Homes in the representative buildings to be tested for the energy audit

Development	No. homes to be tested
1c-C Lutxanamunoa 39	3
1c-DE Salburua 171	6
1i-DE Hernani 20	2
2c-C Gernika 30	2
2c-DE Zabalgana 126	6
2i-C Miribilla 60	4
2i-DE Marrutxipi 55	4
3c-C Muskiz 40a	3
3c-DE Mutriku 75-E47	4
3i-C Olabeaga 11	2
3i-DE Ibaiondo 228	6
TOTAL	**42**

The overall energy audit will involve a total of 42 blower door tests. By the time of this analysis, 32 of them have been completed.



The table on the next page shows the figures for the air changes per hour for each one of the tests conducted thus far, while the figure on this page shows the air changes per hour according to the volume of the housing unit tested.

Data are also provided for the characteristics of the units that have already been tested, specifying the floor they are located on (ground, intermediate or top), the number of bedrooms and the distribution (fully exterior, end, intermediate, etc.).

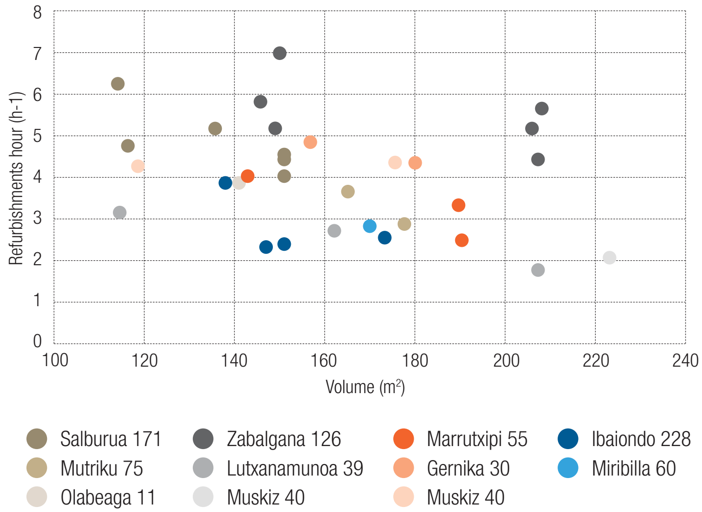
Development	Street	Housing unit	Floor	Bedrooms	Orientation	Volume [m3]	Envelope [m2]	Floor area [m2]	n50 Depr [1/h]
1c-C LUTXANAMUNOA 39	Konturri	Portal 2 - 5C	5	2	Fully exterior	162	238	66	2.79
1c-C LUTXANAMUNOA 39	Konturri	Portal 4 - 4B	4	2	Single aspect	115	178	47	3.05
1c-C LUTXANAMUNOA 39	Konturri	Portal 4 - 4A	4	3	Fully exterior	207	281	85	1.67
1c-DE SALBURUA 171	Paseo de la Iliada	Portal 10 A - 1E	1	1	Single aspect	114	171	45	5.91
1c-DE SALBURUA 171	Paseo de la Iliada	Portal 10 A - 4E	4	1	Single aspect	117	173	46	4.62
1c-DE SALBURUA 171	Paseo de la Iliada	Portal 10 A - 6A	6	2	Fully exterior	151	214	59	4.11
1c-DE SALBURUA 171	Paseo de la Iliada	Portal 6B - 3B	3	2	Double aspect	151	200	58	4.47
1c-DE SALBURUA 171	Paseo de la Iliada	Portal 6B - 8E	8	2	Fully exterior	151	214	59	3.92
1c-DE SALBURUA 171	Paseo de la Iliada	Portal 8 - 7B	7	2	Single aspect	136	184	53	4.97
1i-DE HERNANI 20	Laiztiaga Auzoa	Portal 6 - 3F	3	3	End	157	235	73	4.99
1i-DE HERNANI 20	Laiztiaga Auzoa	Portal 6 - 3E	3	3	End	180	236	73	4.2
2c-C GERNIKA 30	Bizkaia Kalea	Portal 14 - 3E	3	1	Double aspect	176	224	68	4.06
2c-C GERNIKA 30	Bizkaia Kalea	Portal 14 - 2C	2	1	Single aspect	119	161	46	4.16
2c-DE ZABALGANA 126	Villabuena de Álava	Portal 5 - 4A	4	3	End	207	263	82	4.45
2c-DE ZABALGANA 126	Villabuena de Álava	Portal 5 - 4B	4	2	Single aspect	149	203	58	5.01
2c-DE ZABALGANA 126	Derechos Humanos	Portal 37 - 1A	1	3	Fully exterior	208	263	81	5.57
2c-DE ZABALGANA 126	Derechos Humanos	Portal 37 - 1C	1	2	End	150	212	59	6.91
2c-DE ZABALGANA 126	Derechos Humanos	Portal 33 - 1A	1	3	End	206	263	82	5.09
2c-DE ZABALGANA 126	Derechos Humanos	Portal 37 - 4B	4	2	Single aspect	146	33	57	5.4
2i-C MIRIBILLA 60	Don Claudio Gallastegui	Portal 27 - 1C	1	2	End	170	225	64	2.84
2i-DE MARRUTXIPI 55	Fernando Sasiain	Portal 32 - 1B	1	3	End	190	244	75	2.61
2i-DE MARRUTXIPI 55	Fernando Sasiain	Portal 32 - 3A	3	2	End	143	203	59	4.17
2i-DE MARRUTXIPI 55	Fernando Sasiain	Portal 24 - 2B	2	3	Fully exterior	190	245	75	3.33
2i-DE MARRUTXIPI 55	Fernando Sasiain	Portal 26 - 3B	3	2	End	122	181	54	4.41
3c-C MUSKIZ 40	Las Acacias	Portal 10 - Bajo	B	1	2 Fully exterior	223	184	88	2.06
3c-DE MUTRIKU 75	Lehendakari Aguirre	Portal 21 - Bajo	D	0	2 Single aspect	165	224	64	3.5
3c-DE MUTRIKU 75	Lehendakari Aguirre	Portal 21 - 2H	2	2	Single aspect	178	232	70	2.69
3c-DE MUTRIKU 75	Lehendakari Aguirre	Portal 21 - M2A	-2	3	End	214	276	83	4.39
3c-DE MUTRIKU 75	Lehendakari Aguirre	Portal 21 - 1G	1	2	Single aspect	182	242	71	3.32
3i-C OLABEAGA 11	San Nicolás de Olabeaga	Portal 62 - 3B	3	2	Single aspect	141	201	56	3.75
3i-DE IBAIONDO 228	Landaverde	Portal 45 - 3B	3	2	Single aspect	151	206	60	2.46
3i-DE IBAIONDO 228	Río Bayas	Portal 40 - 3A	3	2	Double aspect	147	201	58	2.29
3i-DE IBAIONDO 228	Landaverde	Portal 45 - 3C	3	3	Fully exterior	173	229	70	2.58
3i-DE IBAIONDO 228	Río Bayas	Portal 34 - 2B	2	2	Single aspect	138	114	54	3.69
3i-DE IBAIONDO 228	Río Bayas	Portal 36 - 2A	2	3	Fully exterior	178	146	70	2.71

Results of the blower door tests.

The value of the air changes per hour ranges between a minimum of 1.79 h-1 in a three-bedroom housing unit in LUTXANA-MUNOA 39, and a maximum of 7.03 h-1 in a two-bedroom unit in ZABALGANA 126.

The homes analysed at IBAIONDO 228 are the ones recording the best air changes per hour, even though this is one of the oldest developments in the selection of representative buildings.

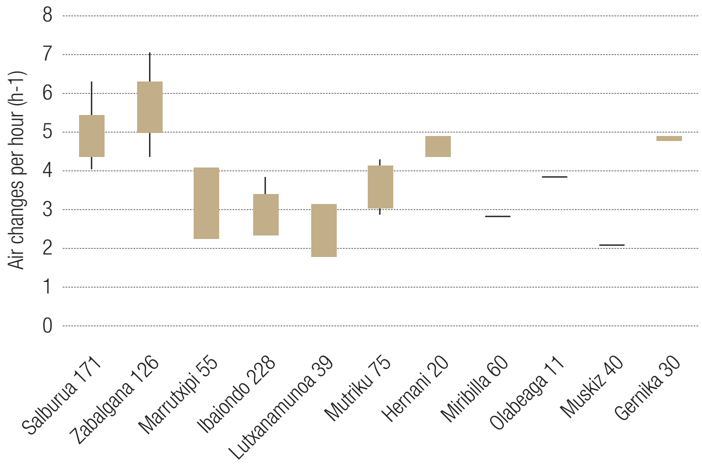
Air changes per hour in terms of the volume of the housing unit tested



By contrast, the worst results for the blower door testing have been recorded for the buildings at SALBURUA 171 and ZABALGANA 126, which are two of the more recent developments.

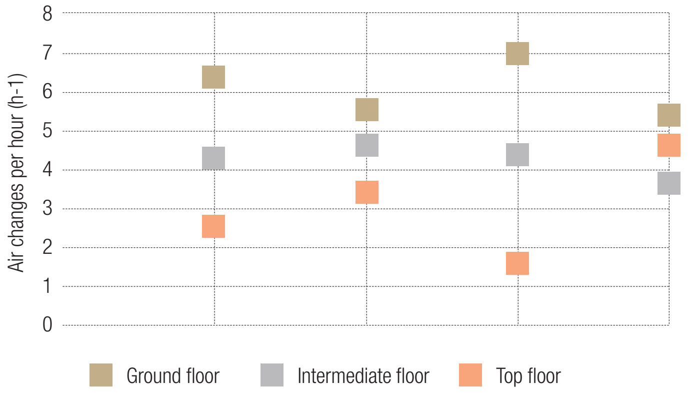
This is more readily apparent in the next figure, which shows that these two developments record a variability of 2.18 h-1 in SALBURUA 171, and 2.58 h-1 in ZABALGANA 126.

Dispersion of the air changes per hour according to the development



A unit's position in the building shows that those situated on the lower floors have so far recorded the worst results, as shown by the following graph:

Air changes by hour according to floor number



Rate of seepages according to the housing unit's location.

3.4.3. Monitoring housing (for dynamic simulations and optimum-cost design)

As part of the energy analysis of the existing housing pool, **a method has been applied for the optimum-cost design of one of the representative buildings, which may be extrapolated to all the other buildings of the same type.** This has involved the virtual modelling of a building with Design Builder software, based on the project data provided by ALOKABIDE; with subsequent calibration of real energy consumptions and weather data. The work on this virtual model permits analysing the technical feasibility and financial viability of undertaking the different refurbishment measures considered during the Plan ZERO Plana.

Nevertheless, the modelling of the IBAIONDO 228 buildings has required monitoring a series of housing units under very specific conditions in order to analyse comfort (temperature, humidity, CO2) and the energy consumption of real buildings.

This way of gathering data is different to energy surveillance, and will be explained in due course in the section on the profile of energy use. There is no need to collect data on all the housing units, but **a great deal more data are required than simply temperature and humidity.** This requires a 4G router with a M2M for pooling data and connectivity, a temperature/humidity/CO2 sensor, contact probes (distinguish between hot water and heat) and transmitter of natural gas and electricity meter readings.

The following sensors have been installed:

- Thermal comfort, a sensor that measures temperature, humidity and CO2. The level of CO2 is interesting because it reflects air changes, etc.
- Consumption of hot water and heating. Gas meters and thermocouples have been installed on the hot water outlet to know how the heat generated by the boiler is distributed at any given moment.
- Electricity consumption. A device has been installed that instantly records electricity consumptions on a very frequent basis (even several times a second, using the Mirubee app or similar).
- Weather station. A weather station has been set up to record data on the climate conditions outside the building.

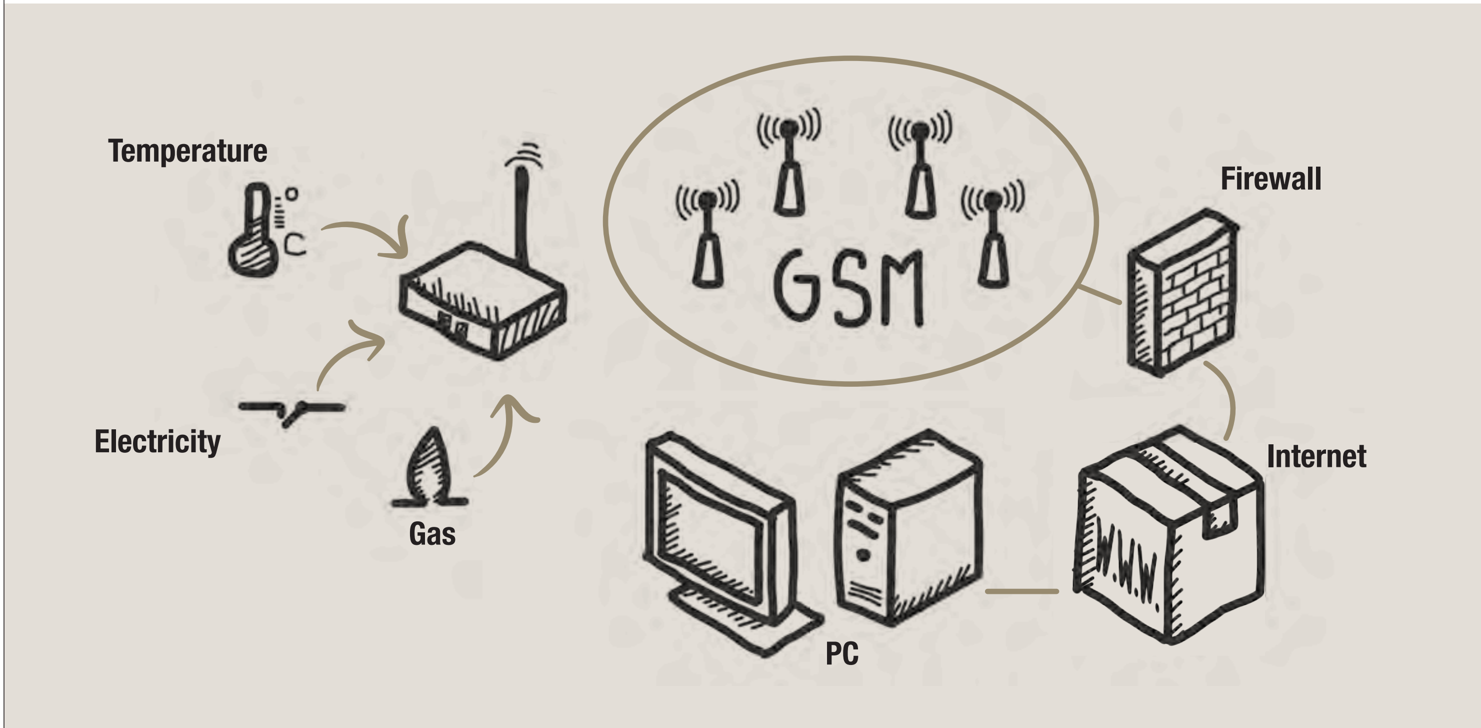
The representative building selected has provided seven housing units (from two separate entrances because it is a large development), choosing a ground-floor flat, an intermediate one, and another on the top floor, with the aim being that the consumptions in 2018 are as close as possible to the average. As the building has individual heating in each housing unit, the data have finally been transmitted through a data concentrator connected by radio to the platform where all this information is stored.

The calibration of the IBAIONDO 228 building has called for a specific weather file for the period when the readings are being taken, extracting the information from the Euskalmet weather office's database for the same period as the data recorded in the building.

The virtual energy model includes geometric data, the building specifications for the features on the envelope, and information on the building's array of installations. The model is designed to reproduce the building's true state with the utmost detail.

The model has been fed with the heating conditions and times identified during the data-gathering process, verifying that the thermal fluctuations within the housing units, between the virtual model and the real building, are similar. The timetable for the consumption of heating has been essential for ensuring the quality and validity of the project's conclusions.

Once the model has been calibrated, it is assumed that any action or alteration made to it would behave in a similar way as if applied to the real building itself. The conclusions of this analysis and the description of the most cost-effective solutions for each type of building are presented in the section "technical solutions by building type" in the operational deployment of the Plan ZERO Plana.



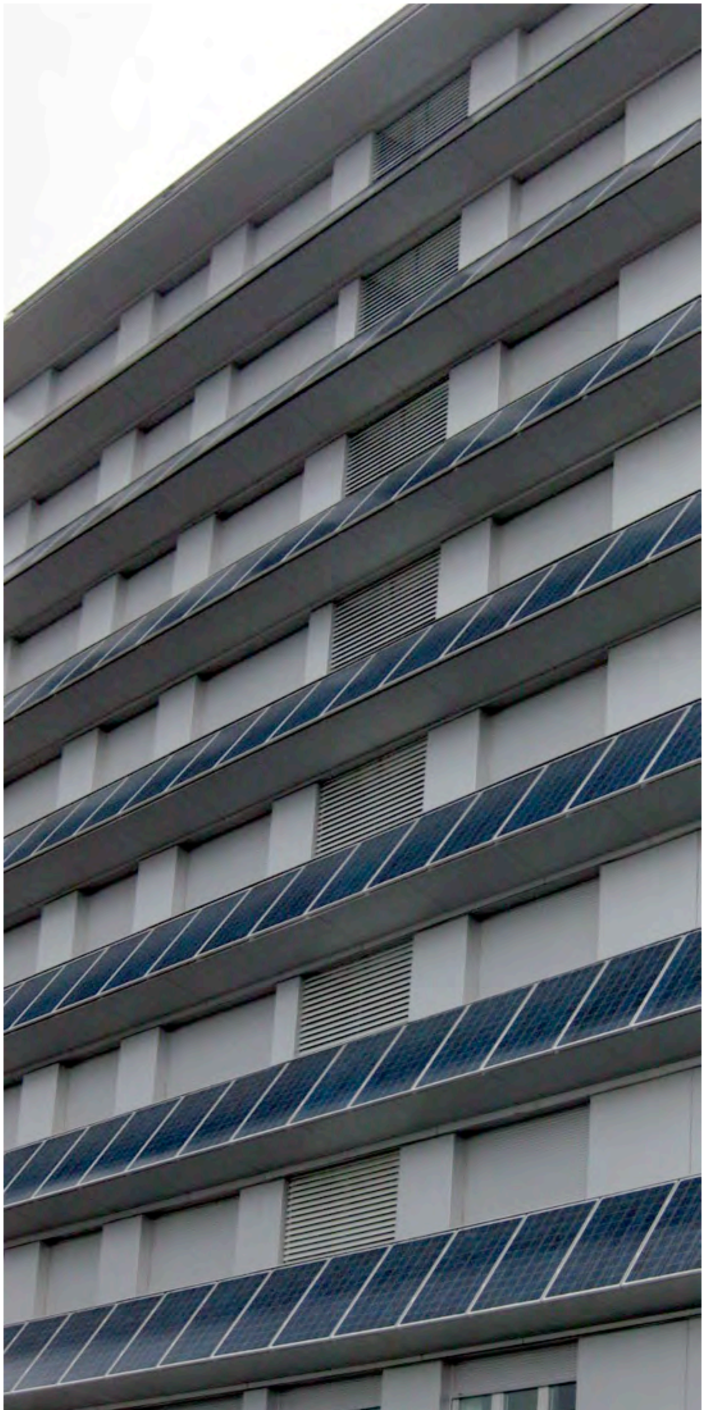
3.5. Renewable energies

The analysis of the public rental pool has also involved a study by ALOKABIDE of the renewable energies that have now been mounted on the buildings. The analysis has been based on two key parameters: on the one hand, information on the current state of the renewable energy installations, their performance and their contribution to the hot water and heating systems, and on the other, a feasibility study on enlarging the current installations or introducing new renewable energies.

Current state of renewable installations

For a number of years now, ALOKABIDE has been adopting a preventive approach through its Maintenance and Repair Plan for the housing it manages to ensure, on the one hand, the scheduling of the regular mandatory inspections of each building, and on the other, the arrangement of voluntary preventive inspections.

As far as renewable installations are concerned, a detailed inventory is provided of the number of developments with renewable energy currently managed by ALOKABIDE, specifying their type, province and status (2018 Report):



PROVINCE	MICRO				SOLAR THERMAL				SOLAR PHOTOVOLTAIC			
	2015	2016	2017	**2018**	2015	2016	2017	**2018**	2015	2016	2017	**2018**
ARABA	2	1	1	**1**	21	21	22	**22**	-	-	0	0
	1	2	1	**0**	-	2	1	**0**	-	-	0	0
	-	-	1	**2**	4	2	2	**3**	-	1	0	0
BIZKAIA	-	-	0	**1**	15	16	16	**18**	-	-	0	0
	-	-	1	**0**	1	4	2	**1**	-	-	0	0
	-	-	0	**0**	1	1	2	**1**	-	-	0	0
GIPUZKOA	1	2	3	**2**	11	11	11	**15**	1	1	1	1
	1	-	0	**0**	2	5	5	**3**	-	-	0	0
	-	-	0	**1**	1	2	3	**2**	-	-	0	0
TOTAL	5	5	7	**7**	56	64	64	**65**	1	2	1	1

2018	IN SERVICE	60
	PENDING SERVICING	4
	OUT OF SERVICE	9

The total figure for renewable energy generated in 2017 amounted to 1,319,947.62 kWh, with a saving of €105,595.81.

The figure for 2018 reveals a total production of total renewable energy amounting to 1,411,217.81 kWh, which means a saving of €112,897.42. The following is a clearer presentation, comparing these two years:

2017		2018	
ENERGY (kWh)	€ (0.08 €/kWh)	ENERGY (kWh)	€ (0.08 €/kWh)
1,319,947.62	105,595.81	1,411,217.81	112,897.42

The electricity generated by the proposed installation covered the average annual energy demand of 434 households. (Average energy consumption. This figure is based on the average annual consumption of an average household in Spain -2.71 people- and is equal to an annual electricity consumption of 3,250 kWh).

What's more, the energy generated stopped the annual atmospheric emission of 917 t of CO_2, 3,212 kg of SO_2, and 1,327 kg of NOx. CO_2 is the main cause of the increase in the greenhouse gas effect, with SO_2 being responsible for acid rain.

In addition, a purifying photosynthesis effect was prompted equal to 3,377 trees.

The following are the GROSS/ANNUAL savings for tenants in each housing unit in each one of the three Basque provinces:

PROVINCE	2017 3,665 homes € / UNIT.	2018 4,041 homes € / UNIT.
ARABA	€28.08	€29.52
BIZKAIA	€29.76	€32.85
GIPUZKOA	€19.03	€20.67
WEIGHTED AV/UNIT	**€26.13**	**€27.94**

Considering that the cost of ORDINARY PREVENTIVE MAINTENANCE of this type of installation for tenants is 12 €/year, their NET SAVING/YEAR is as follows:

PROVINCE	2017 3,665 homes € / UNIT.	2018 4,041 homes € / UNIT.
ARABA	€16,08	€17,52
BIZKAIA	€17,76	€20,28
GIPUZKOA	€7,03	€8,67
WEIGHTED AV/UNIT	**€14,13**	**€15,94**

The following conclusions have been reached:

- The figures for 2018 record a total production of renewable energy of 1,411,217.81 kWh, which means :
  - A total saving of €112,897.42.
  - A reduction in atmospheric emissions of 917 t of CO_2.
  - A reduction in atmospheric emissions of 3,212 kg of SO_2.
  - A reduction in atmospheric emissions of 1,327 kg of NOx.
  - The prompting of a purifying photosynthesis effect equal to 3,377 trees.
- This shows that for every € spent on maintenance, each tenant receives a return of DOUBLE that amount.
- Considering the sum of maintenance costs in 2018, including those paid by ALOKABIDE, it may be affirmed that each € spent on maintenance will generate a return of €1.3 per person.

Analysing the viability of implementing renewable energies.

With a view to considering the steps to be taken in the Plan ZERO Plana within the field of renewable energies, an analysis has been made of the buildings included in the plan, based on the following parameters:

The result of this analysis provides a range of measures to be taken on the buildings depending on their current functioning and the options for introducing new installations; this review has thrown up the following:

PARAMETERS	RESULTS
No renewables system and no space on roof.	**4 %** of the buildings require a detailed analysis for upgrading their current systems to more sustainable ones.
No renewables system but space on roof.	**41 %** of the buildings do not have renewable energies but they do have space for their installation. They largely involve buildings prior to the TBC, with shared ownership.
There is a renewables system but out of service.	**9 %**
There is a renewables system in service but no additional space on roof.	**5 %**
There is a renewables system in service and there is additional space on roof.	**40 %** of the buildings already have renewables installations and they are fully operational. They largely involve buildings with 100% public ownership.

Viability of renewable energies to be implemented in the public housing stock

As regards the analysis of the renewable energies available for implementing in the public rental pool, ALOKABIDE, through its internal processes for defining design criteria based on its experience in the management of a large property market held for public rental, has developed an approach within the Plan ZERO Plana based on three basic indicators:

INSTALLATIONS		**Impact** on the inside of the housing units, and effect of their implementation on tenants' lives.	Cost of **maintenance** for users.	**Reduction in** CO_2 emissions and reduction in the use of **primary energy from non-renewable sources.**	COMMENTS
GEOTHERMAL		**5**	**3**	**4**	Geothermal technology is difficult to install on existing buildings, and is less interesting for installations that only require heat. It affects thermal emission systems inside housing units, which need to be low temperature, and this type of installation is not usually considered for existing buildings.
AEROTHERMAL	Aerothermal support system in communal installation for producing hot water.	**1**	**3**	**3**	Aerothermal technology is easy to install on communal systems as a support for hot water production. This is also the case with individual hot water and heating systems with low-temperature radiators and for replacing individual electric boilers or for the separate installation of hot water production systems. Nevertheless, it is difficult to install on existing buildings for central heating in which the thermal emission systems were designed for high temperatures, where besides changing production equipment there is also a need to replace pipes and radiators.
	Individual hot water and heating system, installations with high-temperature radiators to be changed to low temperature.	**5**	**3**	**4**	
	Individual hot water with aerothermal system, with no effect on central heating.	**3**	**4**	**3**	

BIOMASS		**1**	**5**	**5**	Biomass is another technology that is difficult to install in existing buildings, given its greater requirements in terms of space, both for the equipment itself and for the storage silos. Flues made of specific materials are required, the silos need to be fitted with loading mouths and ventilation for filling, etc.
SOLAR THERMAL	Installations with a communal natural gas boiler, which do not have solar panels, with the deployment of individual natural gas boilers with solar panels.	**1** **4**	**3** **4**	**3** **3**	Flat panel thermal solar energy is a technology that is easy to install on existing buildings, producing high-temperature energy that can be integrated into communal installations and individual systems. It records very good indicators for emissions and the consumption of primary energy, although these depend on the energy supplementing it.
EVACUATED TUBE SOLAR THERMAL	Installations with natural gas boiler. Installations with individual natural gas boiler with solar panels.	**1** **4**	**3** **4**	**3** **3**	Evacuated tube solar thermal energy is another technology that is easy to install on existing buildings, even more so than flat solar panels, producing high-temperature energy that can be integrated into communal installations and individual systems. It records very good indicators for emissions and the consumption of primary energy, although these depend on the energy supplementing it.
SOLAR PHOTOVOLTAIC		**1**	**2-4**	**5**	This is one of the energies with the smallest impact on housing and which requires the most maintenance. Nevertheless, the installation depends heavily on the type of roof and the space available, as it needs a large area for installing enough kWs to supply energy to all the building's communal services.
SOLAR THERMAL PHOTOVOLTAIC		**-**	**-**	**-**	This is not currently considered a feasible option for widespread installation because it is still an emerging technology.
MICROGENE-RATION		**-**	**-**	**-**	This is not considered a feasible option for housing.

Conclusions

Based on the above detailed analyses, we conclude that the installation of renewable energies on existing buildings involves the following:

1.- Finetuning EXISTING SOLAR installations, extending them in those cases in which it is physically possible to do so.

2.- The widespread replacement of the pool of individual boilers, opting for INDIVIDUAL AEROTHERMAL systems or EFFICIENT CONDENSING BOILERS.

3.- Conduct a strategic study on the installation of SOLAR PHOTOVOLTAIC systems for harnessing energy in communal and/or individual areas.

4.- GEOTHERMAL, BIOMASS AND WIND POWER systems are not feasible in existing buildings due to their material requirements and the added maintenance costs they incur for the housing associations involved.

5.- More specifically, depending on each building's location and the type of heating installation, we propose the following measures:

For buildings near the coast, with individual heating and hot water:

- Individual aerothermal for hot water and heating.
- If there has been a sharp drop in demand, one might also consider Joule-effect electric radiators, with aerothermal being used exclusively for hot water.

For buildings near the coast, with communal heating and hot water that do not have thermal solar panels, the following alternatives are proposed:

- Installation of solar panels, if the roof is flat and there is enough room in the boiler room.
- Aerothermal for supporting hot water (communal production) and replacement of gas boilers with condensing heating boilers. Reduction in the temperature at which central heating water is distributed , due to the drop in demand.
- Aerothermal for hot water and heating in a communal system, reducing the temperature at which central heating water is distributed.
- Individual aerothermal for hot water. Communal central heating with more efficient boilers or fewer CO_2 emissions (condensing), reducing the temperature at which central heating water is distributed due to the drop in demand, and closing the heating circuit in summer.

For buildings near the coast, with communal central heating and hot water, together with solar thermal panels:

- Replace the boilers with more efficient ones that emit less CO_2 (condensing, biomass…), lower the temperature of central heating water due to the drop in demand.
- Replace boilers with aerothermal for communal central heating. If the panels have a low output, also for supporting hot water.

For buildings inland, with individual central heating and hot water:

- Thermal solar energy for supporting hot water production, with individual storage. Replacement of boilers with condensing ones with individual storage.
- Individual aerothermal for hot water and heating.
- Individual aerothermal for hot water and heating with electric radiators.

For buildings inland, with communal central heating and hot water, and which do not have solar thermal panels.

- Installation of solar thermal panels for supporting hot water if the roof is flat. If this is not feasible, aerothermal for hot water.
- Replace the boilers for central heating and hot water with more efficient ones or that emit less CO2 (condensing). In all cases, lower the temperature of central heating water due to the drop in demand.
- Individual aerothermal for hot water while keeping communal central heating, although replacing the boilers. In all cases, lower the temperature of central heating water by reducing demand. This solution allows switching off the central heating in summer.

For buildings inland, with communal central heating and hot water that have solar thermal panels:

- Replace the boilers with more efficient ones or with fewer emissions (condensing). In all cases, lower the temperature of central heating water by reducing demand.

3.6. Accessibility

Mindful of the impact that the comprehensive refurbishment of the public rental pool has on the quality of life of tenants, in terms of both energy and universal accessibility, the development of the Plan ZERO Plana calls for an in-depth analysis of the pool's state with a view to the steps to be taken, not only regarding buildings and housing units, but also of management.

The choice of buildings analysed for an accurate diagnosis has gone beyond the representative buildings and has adopted the following criteria, in order of priority:

1. Developments identified as "representative buildings" within the projects.

2. Buildings constructed prior to Decree 68/2000. This has involved the use as reference of the date of each development's rating, provided by ALOKABIDE.

3. Buildings constructed in the first years after Decree 68/2000, assuming that the licence has been issued for a project dating from before the legislation was enacted. As in the preceding point, the reference used corresponds to each development's rating date.

4. In some cases, and for practical reasons, developments geographically close to the preceding ones or to each other.

The following methodology has been used for the analysis:

- Gathering of data from ALOKABIDE: inventory of buildings, list of buildings with no lift, preventive IPEs, plans of garages and list of adapted housing.
- Gathering of geographical data (Google Maps).
- Gathering of official statistical data (geoEuskadi).
- Gathering of data from fieldwork. The buildings have been chosen because they are representative of each type, prior to Decree 68/2000, or constructed in the first years after its enactment. The assessment has been made according to separate entrances.

A summary of buildings/developments and separate entrances that have been visited (analysis conducted for each separate entrance).

SUMMARY	BUILDINGS / DEVELOPMENTS			ENTRANCES		
	ARA	BIZ	GIP	ARA	BIZ	GIP
Existing pool	41	48	44	190	165	100
Representative buildings	4	5	3	31	16	11
Assessment	21	16	24	107	83	56

Ara: Alava; Biz: Bizkaia; Gip: Gipuzkoa

The aspects to be assessed have initially been based on ALOKABI DE's proposition, whose reference is Basque legislation applicable to technical building inspections - ITEs (Decree 241/2012).

- The building's operational conditions: accessibility from the outside, accessibility between floors, and accessibility on each floor.
- Availability of accessibility aids: accessible parking spaces and accessible mechanisms.
- Funding and nature of the information.

Notwithstanding the above, the aim is to modify both the datasheet and the scope of the analysis, increasing the detail in both areas: on the one hand, obtaining a more accurate snapshot, and on the other, doing so for each separate entrance.

The following are the parameters proposed for the assessment:

- **Compliant.**
- **Non-compliant - Minor.** The rating of “minor” does not refer to the degree of compliance, but instead to an estimation of the impact or consequences due to this non-compliance, regarding either the conditions of accessibility in its current state, or the budget for a hypothetical project for improving its accessibility. It should not therefore be understood as an assessment of a minor statutory non-compliance.
- **Non-compliant - Major.** Along the same lines as the preceding paragraph, a “major” rating refers to the impact or consequences of the specified non-compliance.
- **Not applicable.** For example, if the building does not have any adapted accommodation, the items referring to aspects related to them are rated as “Not applicable”.
- **Insufficient data.** This assessment is given to those aspects that have not been assessed, either because it has not been possible to physically access the area to be assessed, or because not enough data are available. This latter situation has occurred, for example, when the signage -or its absence- means that the adapted parking spaces cannot be identified, or when it is not possible to rate the level of lighting in an area -mainly because the inspections have taken place during the daytime.

In addition, to ensure the analysis is consistent with the various lines of research involved in the Plan ZERO Plana, a general study has been included for each building, establishing degrees of accessibility based on figures, within a scale ranging from 1 to 5 (1 = less serious, 5 = most serious), for an overall understanding of the housing pool analysed.

The accessibility chain depends on the condition of each one of its links.

The work has focused on this evidence, singling out the weakest links in each building.

A further assessment has then been made of the degree of accessibility by areas, also using a scale of 1 to 5 (1 = less serious, 5 = most serious). The analysis is completed with the following content:

- Estimation of the impacts on each one of the following aspects: (1) mobility, (2) use, (3) orientation, identification, and location, (4) safety against such risks as falls or entrapment, (5) ageing.
- Estimation of the level of impact, depending on the building’s year of rating (pre- or post-Decree 68/2000).

** The attached table shows the assessment criteria, adopted from current legislation on matters of accessibility.*

1. Physical and sensorial accessibility - Lift

			DEVELOPMENTS		
LIFT	Almost the entire pool has a lift (it should be remembered that the fieldwork involved visiting 50 % of the buildings, but 100 % of those without a lift). There is a high degree of both physical and sensorial accessibility to the accesses and lift cabins.	1	22	37 %	Minor non-compliances in call mechanisms, with little contrast, Lack of touch flooring or gaps in interior handrails.
		2	18	30 %	Lower width 110 cm, but higher one 105 cm. No mirror opposite door in cabins with facing doors.
		3	12	20 %	80 cm lift door.
		4	2	3 %	Free space for lower access of 150 cm. Lower cabin door of 105 x 140 cm.
		5	0	0 %	Lower cabin dimension of 90 x 120 cm.
			6	10 %	No lift.

2. Physical accessibility - communal areas

PHYSICAL ACCESSIBILITY	Although there is still ample room for improvement regarding the numerous statutory non-compliances, the pool has a high level of physical accessibility.	1	0	0 %	-
		2	25	42 %	The width of the main door is less than 90 cm, even though the door leaf is 90 cm or more.
		3	28	47 %	The door leaf on the main door is less than 90 cm. The main door into the entrance has a step, although the secondary access is on a level.
		4	5	8 %	There are one or two steps in the entrance to the building. The leaf on the main door is less than 80 cm. There are main passageways that are less than 150 cm wide.
		5	2	8 %	There are more than two steps at the entrance to the building.

3. Sensorial accessibility - communal areas

SENSORIAL ACCESSIBILITY	The degree of sensorial accessibility to the pool is generally low.	1	0	0 %	-
		2	0	0 %	-
		3	0	0 %	-
		4	54	90 %	No specific feature has been installed, except for reflector strips on doors.
		5	6	10 %	The choice of colours or materials makes it difficult to use the features provided.

A. Main conclusions on accessibility to communal areas in buildings.

The following are the main conclusions on the accessibility to communal areas in the buildings being analysed here:

- **Numerous statutory non-compliances have been identified.** It should be noted that even new-builds continue to record non-compliances. Although this may be due to numerous factors (ignorance of the legislation, shortcomings or lack of resources in supervision or monitoring, etc.), the rate at which certain non-compliances are identified suggests certain agreement (among builders, society…) on aspects or articles that appear in the regulations as “mandatory” compared to others that can be classified as “optional”.

- **Nonetheless, the degree of physical accessibility to the housing pool may generally be considered high.** Although the urban landscape in many towns and cities in the Basque Autonomous Community does not provide the best conditions of accessibility, Euskadi-The Basque Country is making a major effort to ensure accessible environments in both urban areas and buildings. The public rental pool is no exception, and although there is still plenty of room for improvement, the degree of physical accessibility of communal features – except in certain developments - provides people with restricted mobility with the necessary facilities to access the main amenities available in a building and its surrounding area.

- **The buildings with the greatest obstacles to accessibility are those constructed prior to the enactment of Decree 68/2000.** The fieldwork has found clear evidence of the positive influence of the enforcement of Decree 68/2000. A simple comparison between, for example, a building constructed in 1990 and another in 2005: the care paid to aspects related to accessibility changed a great deal over these years. One might well ask about the social aspects that have been incorporated into social housing projects over the ensuing 15 years up to 2020, and the nature of the true impact on the building pool.

- **The most restrictive obstacles are those involving physical accessibility, with vertical mobility being the outstanding one.** This makes a lift the most decisive feature that is almost taken for granted in new-builds, but which reveals its full potential as a regenerating device and as a resource for the creation of accessible environments when it is installed in existing buildings. Accordingly, besides the particular specifications of lift cabins, any steps taken should at least guarantee the conditions of accessibility to and from the accesses to the building –entrance and garage- and each housing unit.

- **The degree of sensorial accessibility to the housing pool may generally be considered low.** Although this should not be taken as any consolation, this appears to be a shortcoming that affects the urban and building environment in its entirety (from housing to urban features, from public areas to transport), affecting both public and private developments. This lack of attention paid to sensorial accessibility is compounded by our inability -both as technical professionals and public servants- to adopt measures regarding cognitive accessibility, and even other obstacles such language and cultural ones.

- **The accessibility chain depends on the condition of each one of its links.** The work has embraced this premise, finding the weakest links in each building inspected. Yet as regards the analysis the communal elements, it needs to be stressed that only a handful of these have been inspected in the entire chain. These are the ones that should uphold people's right to equal access to those amenities ranging from bathrooms and toilets through to the public square. This means there are two significant areas that should receive some kind of attention in the future: on the one hand, housing units that can be adapted to the varying capabilities of its occupants, and on the other, those decisions related to the location of building plots within the local terrain and the layout of their urban environment.

- **Ageing has not been a major consideration in this analysis.** The fact that the people living in this housing pool are significantly younger than Basque society as a whole is also accompanied by the consideration that, specifically referring to the use of communal features in buildings, older individuals do not reveal any different conditioning factors or habits -there could be certain nuances on the impact that garages have on older women-. Hence the reason that, despite including the ageing perspective in both the analysis and in the proposals, no specific content has been considered, except for the mention of cognitive accessibility.

B. Main conclusion on the building pool regarding other social aspects.

- **Our tenants, younger than the Basque population.**

The Basque Country is no exception to the steady ageing process that is affecting other developed societies. Today in Euskadi-The Basque Country (EUSTAT, 2019) the following percentages are recorded regarding ageing:

- Population aged 65 and over: 22.24%.
- Population aged 75 and over: 11.08%.

These figures are compared to those obtained for each development based on a survey conducted by geoEuskadi of each segment corresponding to the municipal census (EUSTAT, 2018). The datasheets for each block of housing units (retrievable from the digital archives or clicking on the points on the map) indeed reveal that the tenants of the public rental pool are younger than the Basque population as a whole, with numerous developments in which the percentages are under two digits, especially in Vitoria-Gasteiz.

There are, nonetheless, exceptions to this rule -and these figures may be studied in detail in ALOKABIDE's databases- such as AMURRIO 21 (26% and 11%), BASAURI 80 (23% and 11%) and MORLANS 70 (25% and 15%).

Social isolation. This is a phenomenon that has emerged forcefully, and risen to prominence on political agendas . It seemed an issue whose positive or negative impact could be studied and analysed through the specific designs of the communal features inspected. Yet the figure available (percentage of housing units with a single occupant, provided by the municipal census (EUSTAT, 2016)) is clearly insufficient, especially when considering that the sphere of analysis has focused on a specific type of accommodation whose very characteristics distort the value of that single figure. This explains why this study does not contain any observations or proposals related to loneliness

- **The entrance and the stairway: social areas, areas of conflict.**

The fieldwork has shown -with some exceptions- that a building's communal features are simply considered to be transit areas, with stairways being nothing more than exit routes in the case of an evacuation.

It is understandable that the size of stairways has been reduced in response to the need to provide larger housing units that never seem to have enough space. Yet it is also noted that this reduction in the size of communal features is also meant to avoid conflicts and antisocial behaviour or disturbances.

Nevertheless, more generous communal features (and not only in terms of surface area) would have a series of benefits: the most obvious one would be the positive impact of larger spaces on accessibility, while the cause-effect relationship on other social aspects are more debatable.

This balance, and many others involving the relationship between urban development and social segregation, appears in the highly recommended miniseries "Show me a hero" (HBO, 2015), based on true events.

- **Gender perspective: the communal landing as an extension of the home, as a workspace**

Advocates of women's rights propose considering the home as a workspace, where its occupants -especially women- undertake numerous tasks that include cleaning and upkeep (the home itself, laundry) and transformation (cooking); processes that also include the management of storage and the parking of "other vehicles".

The fieldwork has detected signs of the need to review the functions that have to be considered in housing projects.

- **Gender perspective: safety against threats and attacks, perceived safety.**

There are numerous factors with an impact on the perception of (un)safety, which could be encapsulated in the maxim "See and be seen".

3.7. Profile of energy usea

One of the lines of investigation with the greatest impact on the strategic reflections and analyses of the Plan ZERO Plana has been the **study of the use of energy in the public rental pool,** which has already been addressed with an empirical approach in the Energy Audit in section 3.3.

This work has meant another step forward in the consideration of parameters of greater import to users, such as awareness, surveillance and adjustment to a more responsible use of electricity and energy or hot water and heating. The aim is, in short, to provide the utmost comfort at the most affordable cost for users.

3.7.1. Energy surveillance

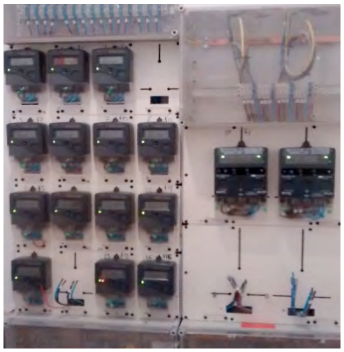
To ensure the accuracy of the research in a way that enables us to discover the profiles of energy use in the public rental pool, a highly specific monitoring strategy has been designed in one of the buildings owned by ALOKABIDE, namely, ZABALGANA 155.

Initial analysis

The first step has involved a personal and individual data-gathering process regarding each home's amenities, the way they are used, the costs applied, and the tenants' attitude toward energy. This door-to-door survey has been conducted on each one of the housing units in the building under study.

ZABALGANA 155

Each home has its own meter for energy and m3 of hot water installed on the landing on each floor

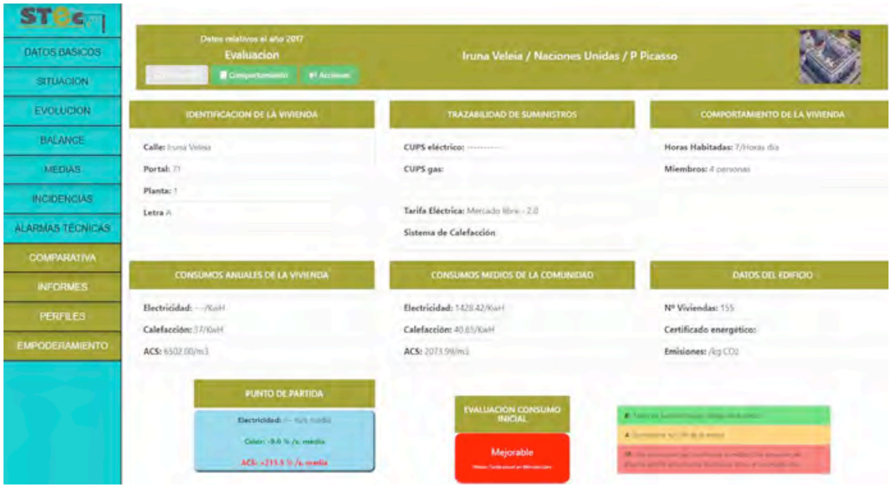


The mains electricity supply is separate for each home, with a digital meter for each unit deployed in several central locations.

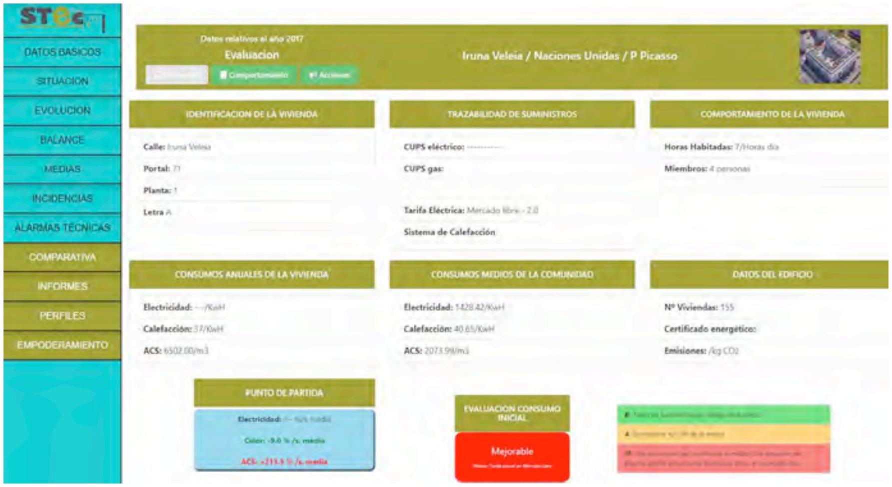
The following parameters have been evaluated during the inspection visits:

- Number of people in the household.
- Ages.
- Average household income.
- Times that the occupants are normally at home.
- Electric and thermal amenities.
- Type of bathroom fittings.
- Type of windows.
- Presence of damp.
- Type of lighting.
- Draughts.
- Details of the home's electricity contract and the name of the power company.
- Details of the price of energy.
- Details of the type of contract.
- Details of any energy benefits.
- Approximate monthly consumption of electricity and gas.
- Whether the occupants are conscious of when they use their household appliances.
- Details of the impact of using their appliances.
- Whether the occupants are mindful of their use.
- Details of the use of the thermostat.
- Perceived temperature in the home.
- Subjective comfort.
- Evaluation of different options: real temperature data, knowledge of neighbour's consumption, lowest possible price…

The figures obtained have been used to complete a factsheet for each home:

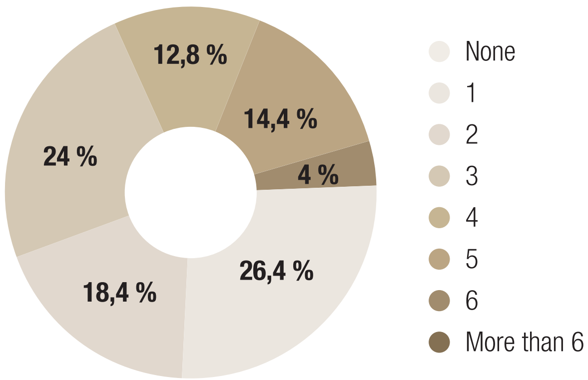


As far as possible, the readings for the consumption of heating, hot water and electricity have been included in the variables, and the results were made available to the tenants via a mobile platform, which displayed the home's use of energy compared to the average for the whole block.



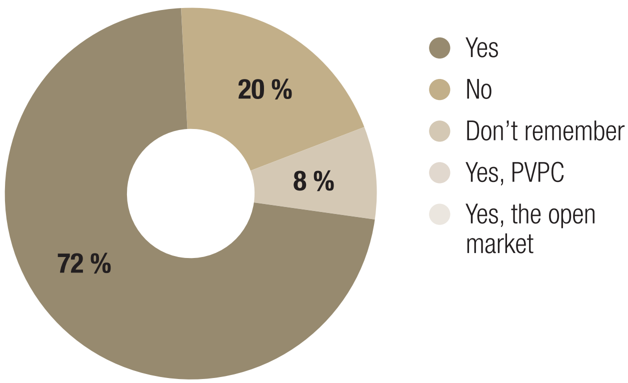
This prior analysis provided an initial snapshot of these homes' user profiles, with the following highlights:

31 % of the homes (48 units) have more than four occupants.

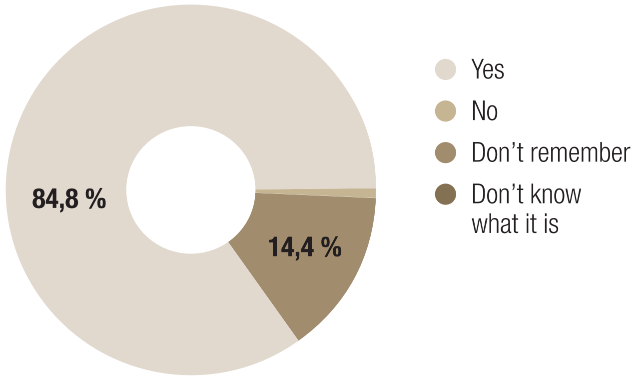


20 % of the homes (31 units) have damp due to condensation.

30 % do not know the price of energy; and either do not know or do not remember the rate contracted.



84,8 % of users do not receive subsidised electricity.

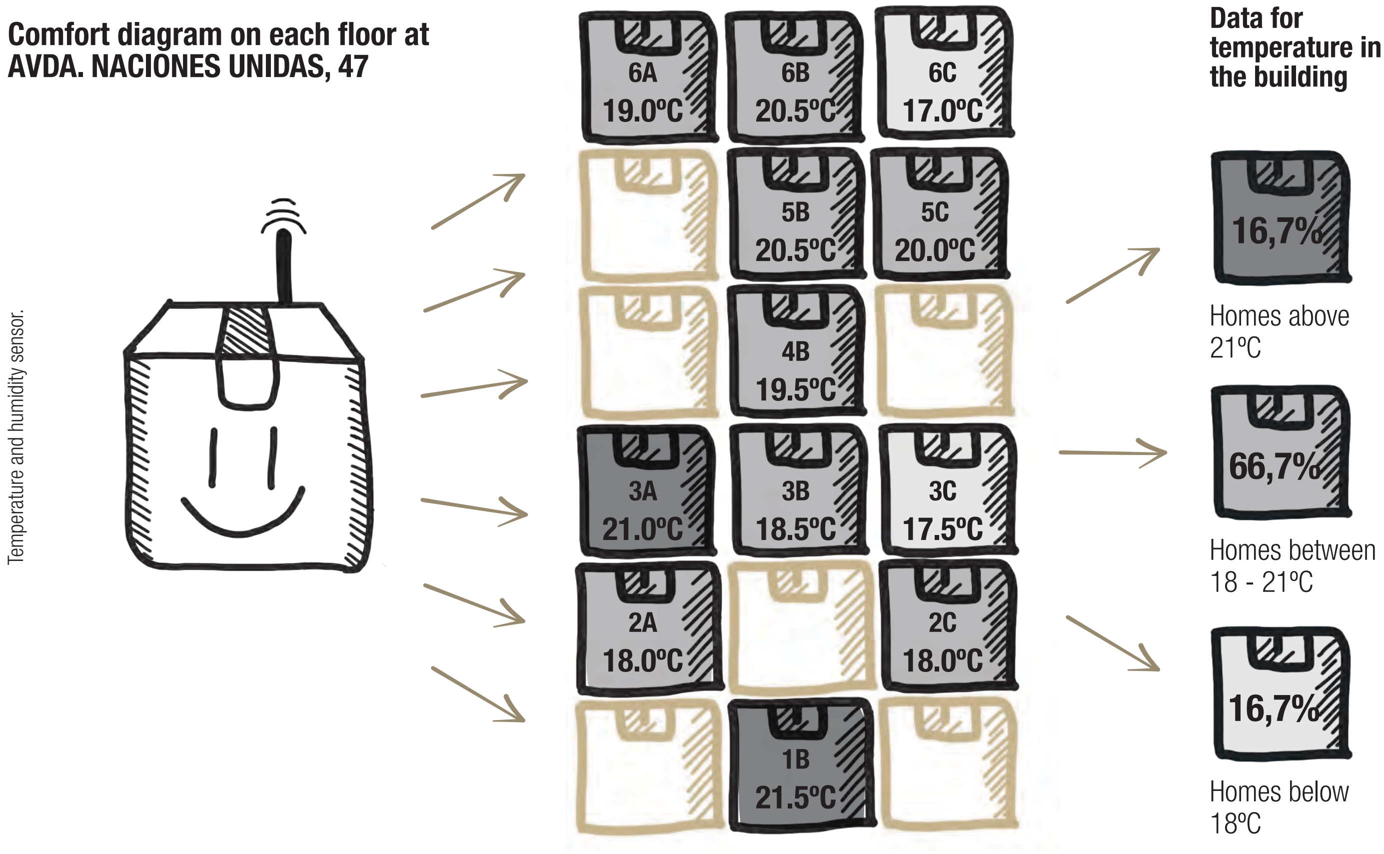


3.7.2. Monitoring comfort and consumptions

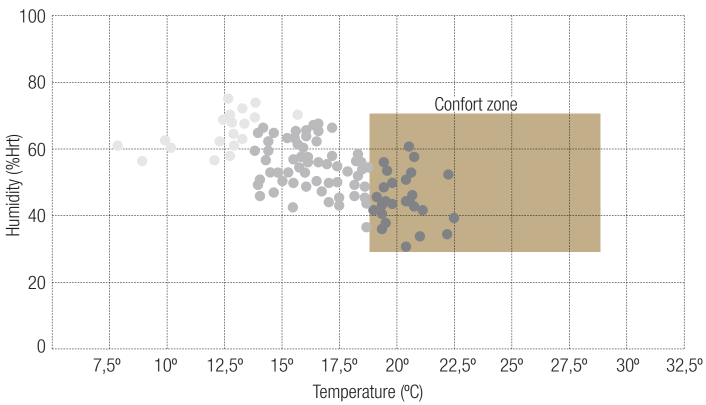
Following the initial analysis involving the door-to-door survey, a further step was taken to understand each home's energy situation. This involved monitoring 114 housing units with **temperature and humidity sensors** remotely connected to a platform via Sigfox technology.

The data gathered by the sensors have provided real-time information on the state of comfort in each home in the building, detecting situations of vulnerability in a very agile and graphic manner.

Comfort diagram on each floor at AVDA. NACIONES UNIDAS, 47



The figures show that ***67 % of the homes are below 18ºC, which means they are below the threshold of thermal comfort:***



These low consumptions not only reflect a reduction in each home's individual reading, as they also have a direct impact on the installation's fixed costs. The fixed part increases because there are few consumers to pay for the thermal distribution losses, which means the cost of having the services available are proportionally higher for tenants with a low consumption profile. **The occupants therefore have a negative perception of the installations because they continue having to pay despite not consuming.**

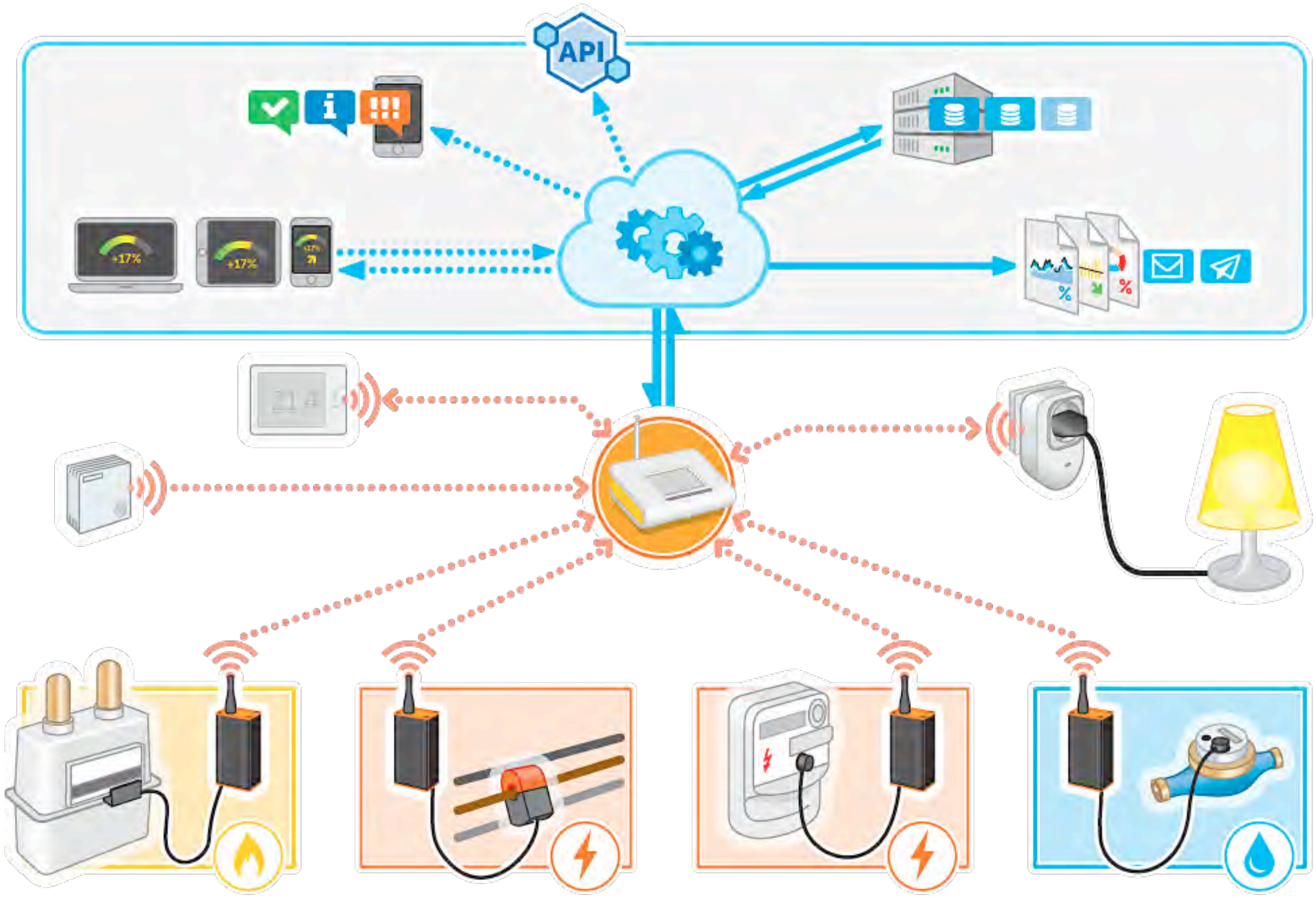
Besides monitoring comfort levels in the homes, and in order to discover the true conditions within them, a **data-gathering** infrastructure has been implemented for **consumptions of heating, hot water and electricity,** enabling both tenants and the owners to supervise the performance of their installations, and thereby optimise both comfort and costs.

This has involved the installation of a WiFi network for the transmission of data from the homes. This infrastructure includes the consumption and costs of heating, m3 of hot water, and consumption of electricity, creating a database of log records arranged by days, months, households, entrances and buildings.

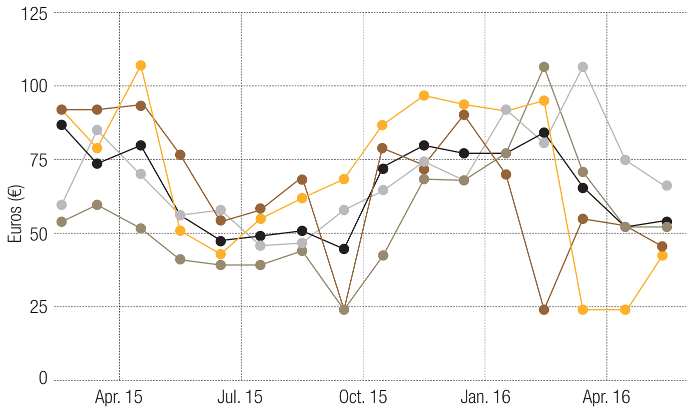
The real-time data and the aggregate consumptions and costs incurred at current rates are accessible on a website that combines the individualised indicators obtained in the previous step.

The monitoring and surveillance campaign has lasted a year, and users may track its development via a mobile app that is free and unrestricted.

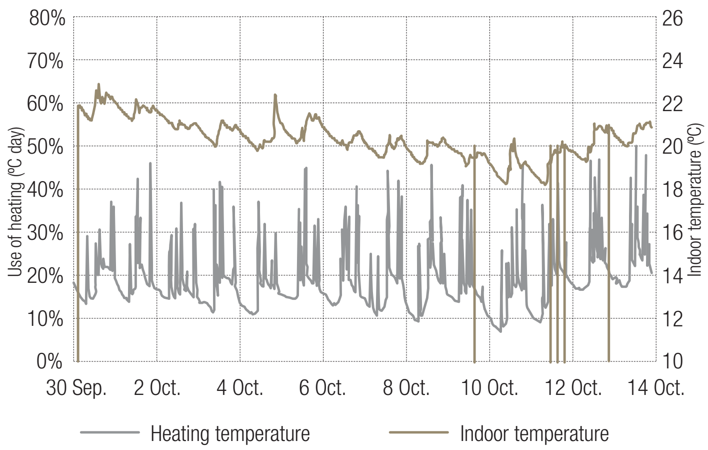
The following figure shows the basic structure of the systems, components and networks for real-time data-gathering:



Past record of costs



Comfortable housing – high heating use



The system uses the data obtained **by the meters for heating and m3 of hot water** from the platform in the building. This has involved installing a system for collecting and relaying data via Ethernet, which every 24 hours sends a convertible file to the data platform.

Data are read **on the electricity meters** located in the cupboards in each entrance using an individual optical reader with a signal concentrator and 3G router for the real-time transmission of the information from each meter and the application of the current rate, with display of the energy used compared to other households in the block.

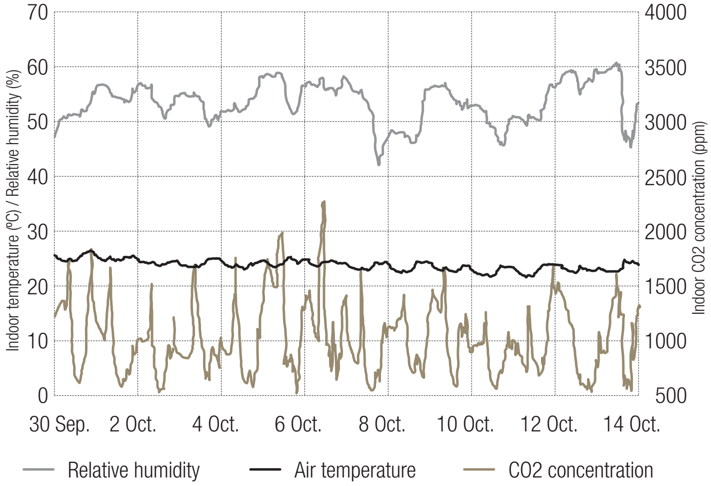
All the data generated in the building, both from the comfort sensors and regarding consumptions, have been loaded into a single web platform for their analysis by the research team in the Plan ZERO Plana. This platform provides real-time access to the performance of all the housing units in the building, generating different graphic monitoring scenarios, such as:

- Electricity consumptions
- Hot water consumptions.
- Thermal energy consumptions.
- Comfort temperatures.

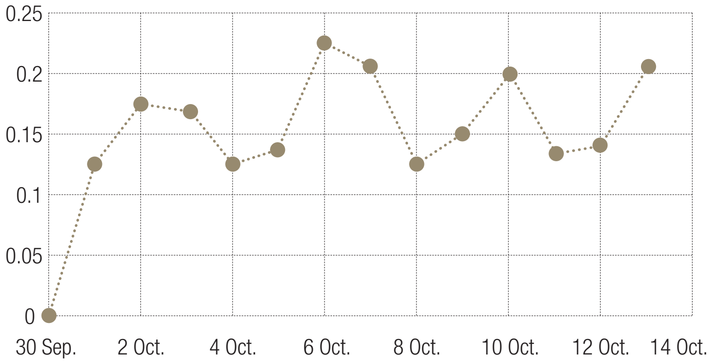
These detailed monitoring processes and tools provide extremely interesting results. Firstly, they have allowed quantifying the home's user habits, including the times when the occupants are most often at home. This has led to the identification of different heating and ventilation habits for establishing timetables and predictable usages. Secondly, it has allowed a more detailed quantification of the problems of indoor heating, health and, therefore, of the risks of energy poverty.

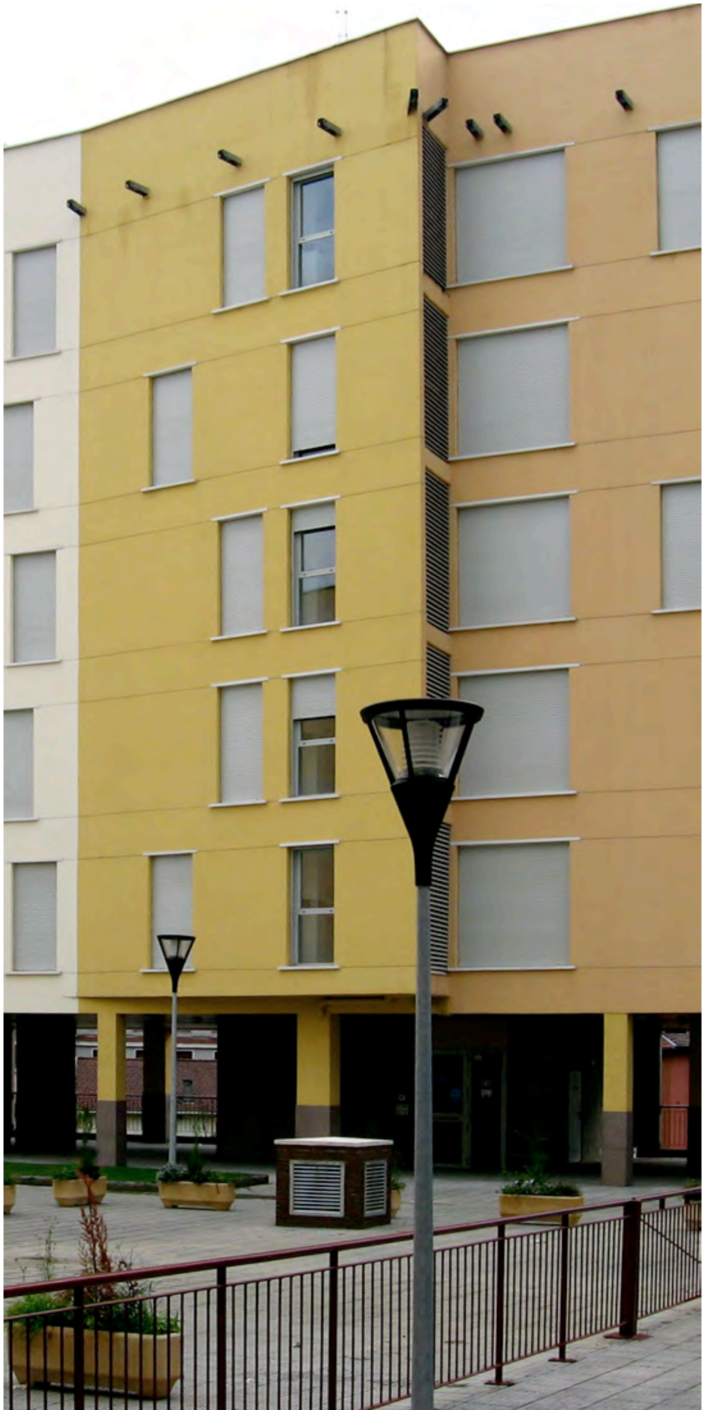
Besides the data already analysed, the analysis will be extended in time to plan **future actions for supporting users and instructing them** on how to make better use of their heating installations and apply healthier habits involving natural ventilation.

Details of the conditions of use of homes



Daily heating consumption (kWh)





3.7.3. Usage profile

The project involving the surveillance and monitoring of comfort and consumptions leads to the identification of the profiles for energy use in the public rental pool, which has enabled us to establish a consumption and cost profile in relation to the occupants of each housing unit and their level of comfort.

The data revealed in this investigation allow us to conclude that the use made of energy in the public housing stock significantly differs from the premises laid down for the design of housing; or to put it another way, **the design of public housing does not match the use made of it.**

The data gathered in the preceding research **reveal that the tenants in the public rental pool make much less use of energy than is to be expected** according to the calculation parameters and design criteria for this type of accommodation; these results, furthermore, were also foreseen in the public pool's energy audit in section 3.3.

GAS

As regards the annual average gas consumption per home, and compared to the data disclosed by the Basque Energy Agency (BEA) in 2013, we find the following differences broken down by provinces:

ALOKABIDE		BEA (Euskadi-The Basque Country)	
Araba	5,930 kWh	Araba	8,020 kWh
Bizkaia	4,346 kWh	Bizkaia	5,130 kWh
Gipuzkoa	5,793 kWh	Gipuzkoa	6,100 kWh
AVERAGE	**5,252 kWh**	**AVERAGE**	**5,930 kWh**

Real data for 31 buildings operated by ALOKABIDE (as Estate manager)

In the least favourable case, the true gas consumption per housing unit in the public rental pool has fallen by 26% in the province of Álava/Araba.

HOT WATER

In turn, hot water consumption has involved the study of nine developments belonging to ALOKABIDE, and they are compared to their theoretical consumption (calculated as per the TBC, producing 28 litres (person/day) at 60ºC.

$$Demand_{\text{Hot water}} = \frac{4187}{3600} \times \text{No. occupants} \times \frac{0.028\ m^3}{\text{Occupant}} \times (60 - \text{Water}\cdot t)$$

ALOKABIDE		CTE	
Araba	2,150 kWh	Araba	2,240 kWh
Bizkaia	2,050 kWh	Bizkaia	1,610 kWh
Gipuzkoa	2,050 kWh	Gipuzkoa	1,660 kWh
AVERAGE	**2,090 kWh**	**AVERAGE**	**1,840 kWh**

Real data for 9 buildings operated by ALOKABIDE (as Estate manager)

This table shows that when compared to the calculation parameters normally used, hot water consumption is slightly higher.

HEATING

It has already been stated in the energy audit (section 3.3.) that the consumption of heating is markedly lower. Nevertheless, a comparison with the TBC's theoretical consumptions reveals some significant differences:

$$Demand_{\text{Heating}} = \frac{Kg}{\text{performance of}_{\text{installations}}} \times \text{degrees–day} \times \frac{24}{1{,}000}$$

ALOKABIDE		CTE	
Araba	3,130 kWh	Araba	5,090 kWh
Bizkaia	3,515 kWh	Bizkaia	3,120 kWh
Gipuzkoa	1,930 kWh	Gipuzkoa	1,750 kWh

Real data for 9 buildings operated by ALOKABIDE (as Estate manager)

In contrast to the figures for hot water, the consumption of heating is higher than expected in Bizkaia and Gipuzkoa. Nevertheless, a verification using the combined sum of hot water and heating reveals that the consumption is still lower in any case.

Conclusions:

- **Almost half of the Housing Units (HUs) studied by ALOKABIDE consume less than 50% of their theoretical consumption.**

  - The effect of variables such as “the presence of those under the age of 18 in the home”, “the presence of over 65-year-olds” or “the lead tenant is a woman” only appears to matter in the first case, when there are minors. In this case, the figure for HUs that do reach 50% of their theoretical consumption exceeds 60%.

  - There are several homes that use alternative heating systems (butane gas cylinders or others), although the percentage is not very high. It is therefore to be expected that many of these HUs will not be able to provide a minimum level of comfort.

- **The HUs that consume more than 50% of the theoretical figure record an annual weighted income of more than €15 000; and only account for 25% of the total. This is evidence of the influence that income has on energy consumption.**

- The non-payments of rents or quotas do not seem to affect the manner in which heating is consumed.

- Electricity consumption in the public rental pool is lower than the results of all the comparative figures reached by other agencies.

- The consumption of hot water in the public rental pool is slightly higher than the theoretical figures calculated according to the TBC. There may even be some cases in which it is much higher, as reflected in the audit.

- In all cases, the consumptions of heating in the public rental pool are lower than those recorded in other housing pools.

3.7.4. Energy poverty

A growing concern for both ALOKABIDE and the Basque Government's Department of Housing is the difficulty some of the tenants in the public rental pool have for heating their homes. Hence the reason the Plan ZERO Plana seeks to analyse and contextualise situations of energy poverty in order to put forward measures designed to attend to it, support tenants, and resolve the issue; it is also true to say that since 2018 ALOKABIDE has already been developing a pilot scheme addressing these circumstances, and it is now at the assessment and adjustment stage.

*We understand **energy poverty** to mean a household's inability to **afford a minimal amount of energy services** to cover its **basic needs.***

According to the above, ALOKABIDE needs to properly identify those tenants that are in a state of energy poverty, with a view to helping them and mitigating serious cases of discomfort. At the time of writing this report, ALOKABIDE has launched a series of pilot schemes based on the information provided by the Energy Self-Management systems in place in some of its buildings.

There now follows a theoretical analysis for identifying cases of energy poverty, together with ALOKABIDE's own approaches based on its experience of managing its buildings.

According to the general definition proposed, there are two basic parameters for the analysis:

1.- HOUSEHOLD INCOME

The lower the household income, the more difficult it is to afford to heat the home.

2.- HIGH ENERGY BILLS FOR ACHIEVING A MINIMAL LEVEL OF THERMAL COMFORT

The following is the most widely accepted formula:

$$\text{Indicator of energy poverty} = \frac{\text{Energy bill}}{\text{Income}} > 10\ \%$$

- In other words: if energy bills account for more than 10% of household income, then that HU is considered to be in a state of energy poverty.

Data from over 1,000 HUs pertaining to ALOKABIDE reveal that **9.3% of them are in a state of energy poverty.** This is more or less the percentage calculated for the Basque Autonomous Community by other studies, so it does not seem to be an issue that is any more prevalent among tenants of ALOKABIDE than among other groups.

Nevertheless, **the problem arises when the occupants of an HU do not turn on the heating because they cannot afford to do so (except for those that do not want to pay and those that decide not to do so). Their bills are "zero", and so the above index does not detect these situations as the result is less than 10%.**

This calls for an adjustment of the above logic; calculating the theoretical energy bills for ensuring minimal thermal comfort and assessing their impact on the study.

The above data on HUs show that **16.9% consume less than 50% of the theoretical figure,** and some even consume nothing at all in hot water and heating.

The indicators considered here are diverse and very heterogenous:

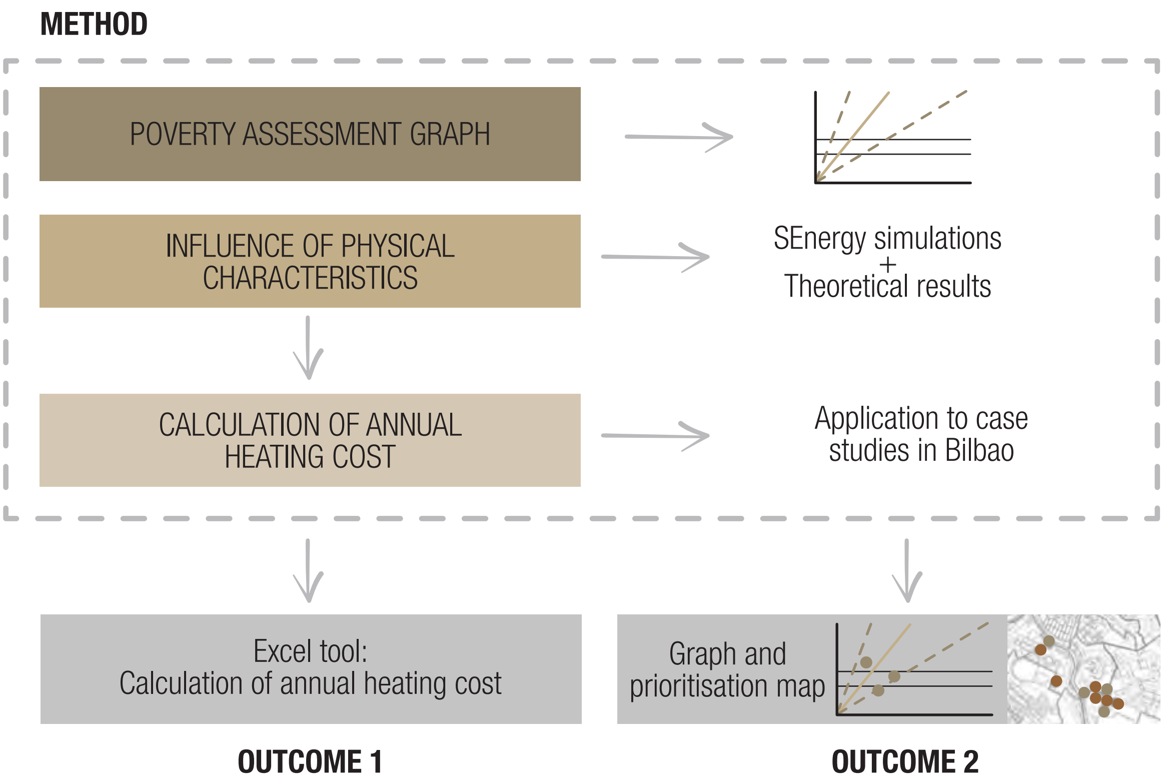
BUILDING	TENANT
HEATING COSTS	
Heating quota.	Low consumption in winter. False positive may be caused by the use of other fuels or because the house is not actually lived in.
Energy rating.	Few reloads in the AuGE self-management system and for small amounts.
Demand specified on the certificate.	Use of other fuels for heating: butane or kerosene burners.
Climate zone.	Time living in the HU. There may be cases of people hardly leaving their homes (the disabled), or not actually living there.
	% of income spent on energy
	HU allocated on 1st or top floor / north-facing.
	Indoor temperature and humidity
INCOME	
Average household income for the whole building.	Weighted average income.
Average rent in the building.	Rent.
Special rents per 100 HUs.	Whether or not this rent is special.
Average size of households.	Number of people in the household.
OTHER INDICATORS	
Several non-payments of the heating quota in the development.	Non-payment of heating quota.
Frequent issues involving damp from condensation.	Issues caused by damp from condensation: indicator of not turning the heating on.
Frequent issues involving thermal discomfort.	Subjective comfort: their answer when asked about the difficulty in maintaining a pleasant temperature.
Issues of co-existence.	Respiratory complaints: asthma, bronchitis, irritation, allergies and infections.
Number of households with school benefits.	No issues of co-existence.
Building with community care project (PIC).	No benefits in the energy poverty project last year.
Evictions per 100 HUs.	Assessment of family integration. Family criterion used by Red Cross.
	Belonging to a vulnerable group. The Red Cross exceptionally assists single-parent families, victims of domestic abuse , OAPs and young people.
	Contract subscribed by man / woman.
	Direct allocation.
	On loan to agencies (social).
	m^2 useful space per occupant of HU.
	Years living in the development.

An analysis of these indicators permits us to accurately discover situations of energy vulnerability.

At pool level, it is most pertinent to analyse the relationship between the building's characteristics and the energy vulnerability that may affect the tenant households.

This study has been possible thanks to the final dissertation presented by Silvia Pérez Bezos in her Master's on Research into Energy Efficiency and Sustainability in Industry, Transport, Buildings and Urban Development. Its title is *"Propuesta de priorización para la rehabilitación de edificios residenciales en situación de pobreza energética. Aplicación al caso de Bilbao."* [Proposal for the refurbishment of residential buildings in a state of energy poverty. Application to the case of Bilbao]

We have considered the matrix defined by Sánchez-Guevara (2015), which relates the equivalent cost of heating to the household's equivalent annual income:



An analysis is subsequently made of the influence of the building's physical characteristics with an impact on its energy performance, without considering the housing unit's location within it.

According to the level of influence of the different variables in the demand, a method has been designed for the approximate calculation of each household's overall heating consumption.

This method's application to 14 cases studied in Bilbao, all managed by ALOKABIDE, has obtained annual heating costs of between €250 and €560, with annual incomes of between €12 387 and €15 743. Two of the three cases with the highest heating costs correspond to neighbourhoods with the lowest annual incomes.

It is generally observed that these case studies have the following characteristics: 1) they are below the energy poverty line, but above the income poverty threshold, and 2) they are between the income poverty threshold and average income, spending between 5% and 10% of their income on energy, whereby it may be considered a vulnerable group.

Conclusions on energy poverty

ALOKABIDE's study reaches the following conclusions:

1.- ALOKABIDE needs to lay down **clear criteria for facilitating the detection of possible cases of energy vulnerabilit**y for their identification and treatment.

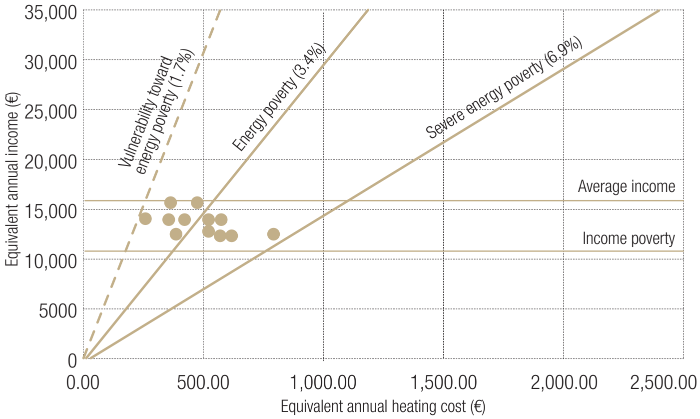
2.- The pilot schemes arranged by ALOKABIDE for ensuring minimal comfort in homes are working very well and are helping households in difficulties; nevertheless, the formal identification of the cases of need requires **making adjustments to improve their automation.**

3.- **Ensuring minimal comfort in all homes** is proving to be an innovative approach that will avoid segregating tenants and/or their differentiated treatment.

4.- ALOKABIDE's study has been restricted to those buildings that have implemented an AuGe system. There is therefore a need to **consider measures to ensure that the Energy Poverty Project extends to the whole of the public pool** managed.

Location and classification of the case studies into population groups

Graph assessing the energy poverty of the buildings analysed



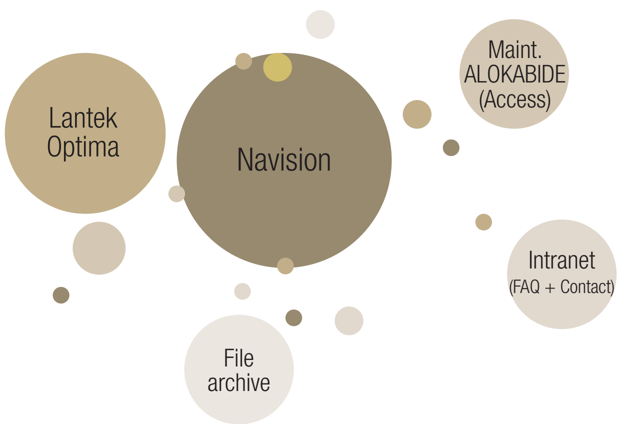
3.8. Public rental management: ALOKABIDE

3.8.1. Property management

The exponential growth of the public rental pool in the Basque Autonomous Community has been accompanied by the updating of management software tools. This means that the different operating areas in the public management of rentals (contracts, treasury, technical, social, or front-desk) will require customised control, monitoring and management tools.

This need increases in step with the size of the pool under management and the demands made of public management companies in terms of the monitoring and supervision of properties. From a technical perspective, ALOKABIDE does not have any specific tools for monitoring and supervising the maintenance of buildings that provide data on the performance of their amenities and/or the level of comfort in the homes.

Current map of ALOKABIDE applications



NAVISION

- Currently the main focal point for customer information and properties at ALOKABIDE.
- This system will remain in place, and requires a high level of integration with all the other tools.

LANTEK Optima

- Tool to be replaced, and where a record is currently kept of all customer dealings: contacts, internal process under way, issues…
- This currently combines the management of technical issues (preventive and corrective) as well as administrative and social matters (only those related to a housing unit, building or housing association).
- It includes the basic management of suppliers.
- External suppliers and technical services have user access to consult their work orders and report on the jobs undertaken.
- It is the main tool of the Call Centre.

Building maintenance database

- Application developed in Access that currently records technical information on buildings as required for preventive maintenance: service providers, lifts, heating, renewables, etc.

Koordinatu:

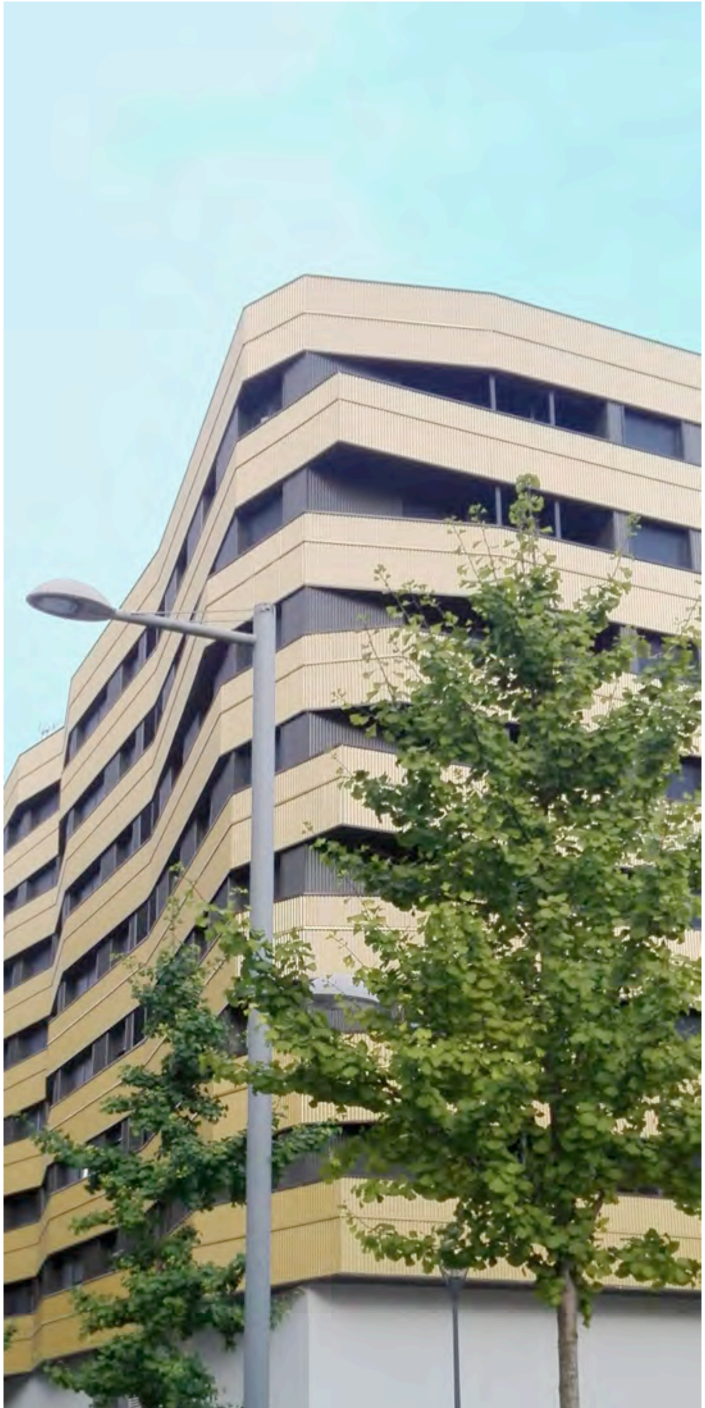
- A Mutualia prevention tool that processes the paperwork and legal obligations of subcontracted companies.

Intranet (FAQs + Contacts)

- The aim is to withdraw this tool, which will be replaced by CRM.
- It contains a small knowledge database and a basic solution for managing contacts .
- It also includes software for processing the approval of Purchases and Contracts.

Management of documents - Zetadocs

- There is currently no centralised system for the management of documents; each solution relies on its own archive of documents.
- This is seen as an overall project to be addressed at a later stage.
- NAV has software for the automated dispatch of communications (over 300 model templates/letters) that are filed in Zetadocs.
- Lantek also has paperwork attached to issues and tasks that is stored on shared network pathways.



There are basically two types of housing units under management:

BIZIGUNE housing

Managed within the framework of the Bizigune scheme for unoccupied housing, whereby owners receive a monthly rental through a user contract. ALOKABIDE manages the housing unit as a social rental property, providing tenants with a t**roubleshooting and rental management service (LAU).** As regards these units, and the block as a whole, ALOKABIDE coordinates the resolution of problems of co-existence and/or extremely complex cases of damage in communal areas, as well as the collection of surcharges made by the housing association.

Public housing
(PUBLIC OR SHARED OWNERSHIP)

Managed by ALOKABIDE according to the following model: tenants pay a social rent to ALOKABIDE, and a quota to the HOUSING ASSOCIATION, likewise incurring the cost of individual consumptions of electricity, gas and water. The quota paid to the housing association includes the maintenance of communal facilities, and its amount depends on the specific characteristics of the building in question.

In all cases, ALOKABIDE provides **its tenants with a complete service** within the framework of the LAU, paying for those repairs that are not due to misuse or a lack of ordinary maintenance, both in each home and in the overall building.

Accordingly, it liaises with the estate managers for each housing association to collect the surcharges corresponding to its property (as per percentages of ownership), within the framework of the Horizontal Property Law, as well as the management of non-payments of quotas and consumptions of hot water and heating.

ALOKABIDE also supervises the different maintenance contracts that the housing associations subscribe and which are reflected in the quota (boiler room, ventilation, fire-fighting measures, automatic doors, lifts, etc.) to guarantee the housing is in the best possible conditions and protect against fraudulent charges or unnecessary costs being passed on to tenants.

ALOKABIDE's status as a public company hinders the contracting of repairs attributable to the owners regarding facilities in those buildings where the maintenance is contracted by the housing association.

3.8.2. Management of housing associations

At the level of housing associations, ALOKABIDE organises and prepares the buildings it manages to ensure that when tenants take up residence, the arrangement of housing associations, supplies and amenities is as efficient as possible; so it **coordinates the contracting of different estate managers for each housing association,** taking charge in those associations owned by ALOKABIDE. This office entails representing the housing association when contracting work and services, taking legal action for the payment of debts, and acting as its legal agent.

Nevertheless, as regards those buildings owned by the Basque Government and those owned jointly with private owners, their legal representation poses various legal complexities that may hinder the future management of refurbishment work.

The management assignment that regulates ALOKABIDE's operations in the pool owned by the Basque Government does not entitle it to take charge of the housing associations of these buildings, which means a potential grey area when implementing future refurbishment projects.

Regarding the constitution of the housing association, pursuant to the Horizontal Property Law, the owner, in this case the Basque Government, could delegate this power to the Estate Manager; nevertheless, this delegation in cases of refurbishment projects appears to go beyond the management of financial, legal or technical matters that correspond to the Estate Manager.

Neither does it seem clear whether, through this management assignment, ALOKABIDE can delegate these powers to another person (e.g., the estate manager), who is not a true owner. This means that a non-resident owner might not recognise ALOKABIDE as a grantor of powers.

There is therefore **a need to decide upon and nominate the person that is to be put in charge of the housing associations of buildings belonging to the Basque Government,** totally irrespective of whether they are managed by ALOKABIDE, and more specifically, in those associations that might involve refurbishment projects.

3.8.3. Lessons learnt in refurbishment management

Following the path marked out by the Directorate for Housing and Architecture through the application of the Science, Technology and Innovation Plan, a strategic initiative has been undertaken called ZEB “smart refurbishment”.

Three projects were rolled out in 2017, initially the Basic Refurbishment Projects, including the contributions made by the technical studies that cater for part of the innovation and zero energy, as well as smart home technology for housing units and wholesale accessibility to buildings.

Subsequently, helped also by the results of the tests conducted by the Quality Control Laboratory, these studies have been adapted to the Operating Performance Projects, which have finally been put in place in 2019, with the calls for their tender to be issued shortly, whereby they will be undertaken in 2020.

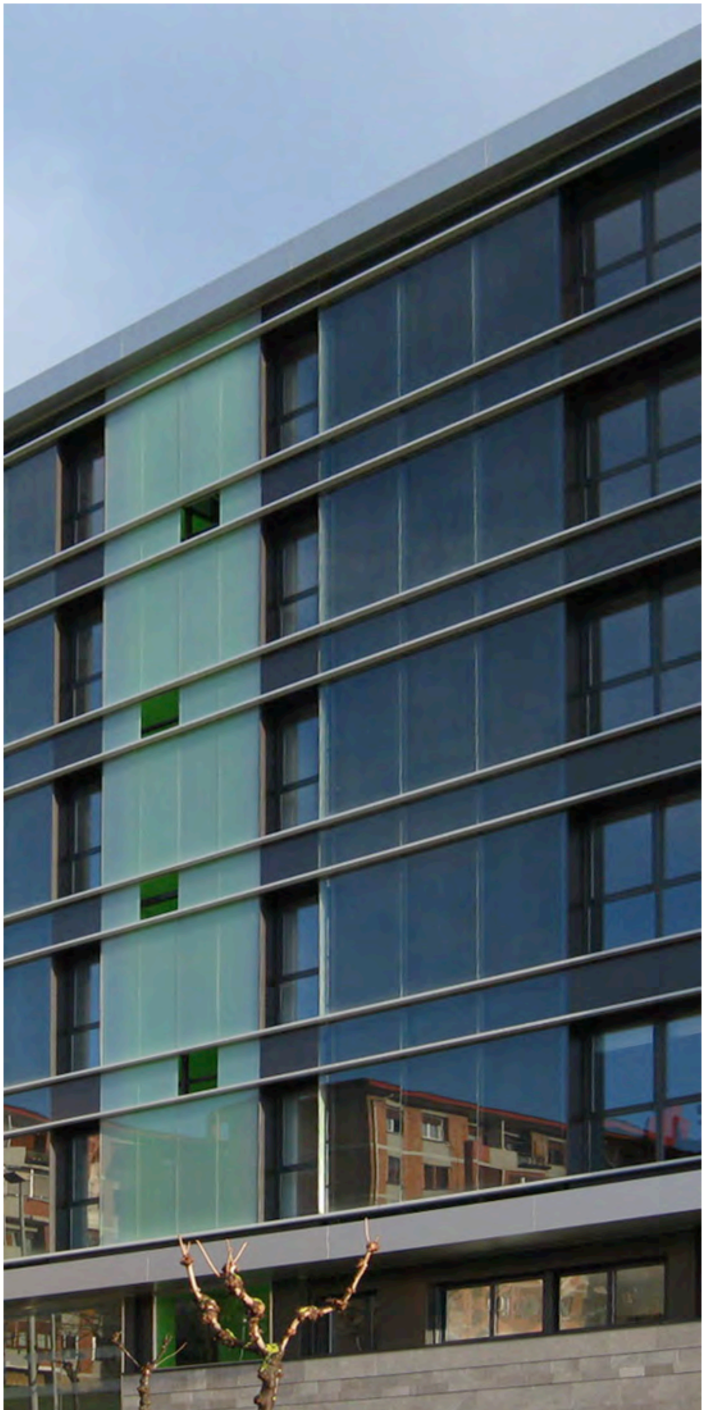
The implementation of these projects is expected to provide interesting experiences with a view to developing the strategy rolled out by ALOKABIDE, involving smart, efficient and sustainable refurbishment for the “transformation” of the public rental pool, from a situation of significant energy consumption to one of zero consumption.

The following goals were considered initially:

1.- INCREASE ENERGY EFFICIENCY. This basically involves improving the conditions of comfort inside the homes affected. This means finding more efficient and affordable energy refurbishment solutions from a cost-effective perspective and comparing these solutions. This has ultimately provided a masterclass on the management model for refurbishing housing when the building is not wholly under a single ownership.

2.- GUARANTEED ACCESSIBILITY. Finding sustainable, prefabricated accessibility solutions (use of wood or similar) for buildings without them.

3.- DIGITAL TRANSFORMATION. This does not only mean monitoring buildings and homes, as it goes beyond that, and will end up with the implementation of BIM in the pool.



There is an overlap with other goals, such as **encouraging the use of renewables** (the buildings considered here are to be fitted with photovoltaic solar, solar thermal and aerothermal panels) as well as **eradicating energy poverty** (this analysis of the buildings has detected cases in which the heating is never turned on, so there may be cases of this nature).

Three developments were chosen from the Basque Government's housing pool, with the aim being to refurbish them according to criteria of energy efficiency and sustainability. The brief was to test the different solutions for refurbishing the pool and acquiring first-hand experience of the problems that might arise in the building-work.

The developments were selected **on the basis of criteria of energy and accessibility.** According to this analysis of the housing pool, these buildings would be classified within Class E (no lift, with heating, and energy rating E), which required a comprehensive overhaul in terms of energy efficiency and improved accessibility.

They are as follows:

- **21 housing units in Amurrio (Álava/Araba).** They involved three buildings without a lift, with commercial premises on the ground floor, with three upper floors containing 6, 9 and 6 housing units, and with boxrooms in the attic. They date from 1994, with individual gas boilers, and an E energy rating.
- **8 housing units in Ortuella (Bizkaia).** The construction of this building began in 1902, and it was initially designed to be a local police station. It was fully refurbished in 1990 as a housing block. It has a rectangular layout, consisting of a ground floor and three floors above, with the top floor being added in 1931. It does not have a lift. The heating is electric, although there is a considerable divergence of methods among all the housing units. In 2017, it was entered in Ortuella Council's Catalogue of Listed Buildings. It has an F/E energy rating.

- **12 housing units in San Sebastian - Donostia (Iturritxo Buildings).** This is an early 20th-century edifice with commercial premises on the ground floor and four floors above. There is no lift and the distribution differs on each floor. It has a timber structure. The property has damp problems, caused by rising damp on the ground floor and by the state of the roof on the top floor. It does not have an energy rating.

The study of the possible work (new building methods and materials) to be carried out on the buildings, as well as its potential extrapolation to the rest of the pool, involved the **collaboration of the University of the Basque Country's Higher College of Architecture - Escuela Técnica Superior de Arquitectura de la Universidad del País Vasco,** which conducted several studies on the buildings' characteristics, analysing the work options and studying the application of these options to other buildings in the pool. Another partner was the LCCE Laboratory for Quality Control in Building, which conducted several tests for improving the analysis.

The initial goal of the nZEB (smart refurbishment of buildings according to criteria of Almost Zero Energy Consumption) was to develop models and original solutions in the field of refurbishment, and particularly in energy refurbishment, which would lead to truly revamped buildings with almost zero energy consumptions, seeking to conduct R&D&i applied to real cases.

The projects undertaken include monitoring the buildings to discover the conditions of comfort they achieve in the end. Furthermore, two of the projects, Ortuella and Amurrio, have involved BIM models, which means this methodology can be included in the management of buildings. Account has also been taken of the fact that the three developments are not publicly owned in their entirety, which restricts the possibilities of intervening (in Amurrio, this affects the commercial premises on the ground floor; one of the housing units in Ortuella belongs to a private owner, and in San Sebastian-Donostia, four out of the 12 housing units do not belong to the Basque Government).

The challenges ahead:

- To gather expertise and proven solutions in working on the refurbishment of buildings, with a view to incorporating this know-how into the design of the overall work strategy for the housing pool arranged by ALOKABIDE.
- To improve the living conditions of the buildings in question (accessibility, energy efficiency, safety and security).

The goals involving the acquisition of expertise have been achieved through the studies conducted, comparing different work solutions and the performance of pilot schemes in BIM.

The benefits:

- For tenants: improved conditions of comfort in buildings, guaranteed accessibility, and energy savings (economic cost).
- For ALOKABIDE: lower costs and better building management, as well as monitoring tenants' conditions of comfort.

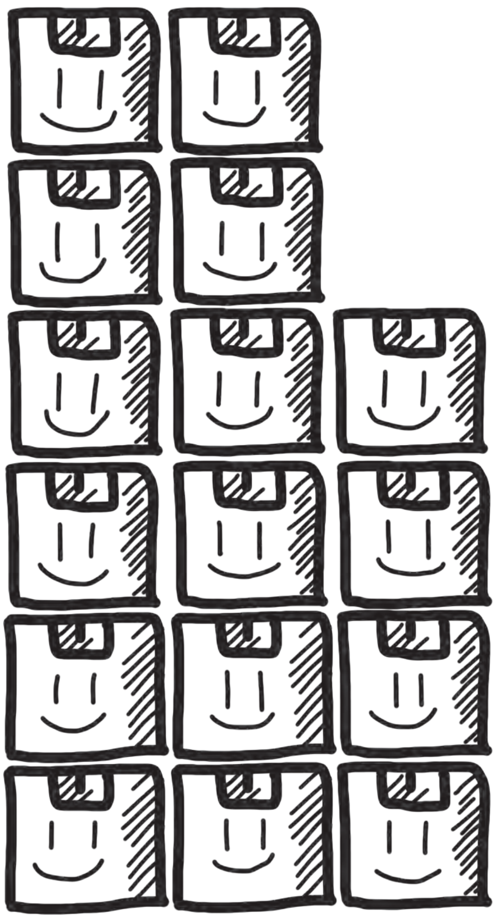
As a result, the following tools and technologies have been developed in PCTI 2017:

- BIM models.
- Monitoring systems.
- Energy studies.

Indicators

- Energy rating of buildings.
- Percentage of use of renewables in the three developments.
- Use of BIM methodology in building management.

4. CONCLUSIONS AND BASIC STEPS TO BE TAKEN



Energy, and the comfort it brings, is the highest cost incurred by the occupants of social housing. The average cost is €800/€1,000 for households with limited incomes. The first data forthcoming from this analysis enable us to conclude that **there is still a long road ahead as we make our way towards an energy efficient housing pool that is also socially equitable.** It is therefore essential to identify the result expected in the management of the use of energy and establish the potentially most significant focal points.

Is it really true to say that the building of subsidised housing in recent years has involved the design and building of housing units for rental? In theory, the buildings are sufficiently efficient, yet… has this meant that such efficiency has been passed on to tenants? Do we know what the most appropriate level of comfort is for social housing?

How many resources do we allocate to the different energy matters? Are tenants aware of the efforts the Basque Government has made and continues to make?

For almost two years, we have sought to establish a general view of the public housing stock in the Basque Country and analyse the use of energy in rented accommodation. The aim has been to **identify the impact on management stemming from the use of energy** and establish the potentially most significant focal points that mark out the road ahead.

The Plan ZERO Plana has begun with a data analysis involving both buildings and tenants, which has opened new fields of innovation. As regards the energy situation, new opportunities have appeared for improving the design of housing related to oversizing or situations of inequality. In short, facilities in the future will need to be more closely aligned with tenants' requirements.

The challenge of climate change has to be interwoven with the provision of housing that caters for the needs of people that are both consumers of energy and generators of CO_2 emissions. This all involves **fostering the digitisation and efficiency of our services** and ensuring they uphold people's wellbeing. Furthermore, this needs to be undertaken through the definition of an ideal model for the holistic management of energy in social housing that will drive the automation of processes and data.

4.1. Scope

The Basque Government's public rental housing pool consists of 136 buildings in which it holds over 50% ownership, as well as almost a further 100 in which it holds a minority co-ownership, with an overall total of more than 7700 public housing units spread across the three provinces that make up the Basque Autonomous Community.

This is a large number of buildings/properties with a wide variety of installations, which means a raft of different situations for tenants: very different heating bills between buildings, homes that are more or less inefficient, deployment of renewables that reduce energy costs, or their absence, etc.

4.2. Condition and state of repair

The public rental pool's general state of repair is good because it has been arranged by the public company ALOKABIDE. Although it is also true that the analysis of corrective and preventive maintenance has identified certain issues (in management) whose sphere of action is complemented by the scope of the Plan ZERO Plana. Therein lies the interest in crossing the data on the more salient pathologies with the different findings of the analyses of the buildings' accessibility and energy efficiency.

4.3. Energy Efficiency

The analysis on energy refurbishment needs indicates that **67% of the housing units in the pool require a medium level of attention,** while 15% require a high level, and only 2% call for a full overhaul (including accessibility).

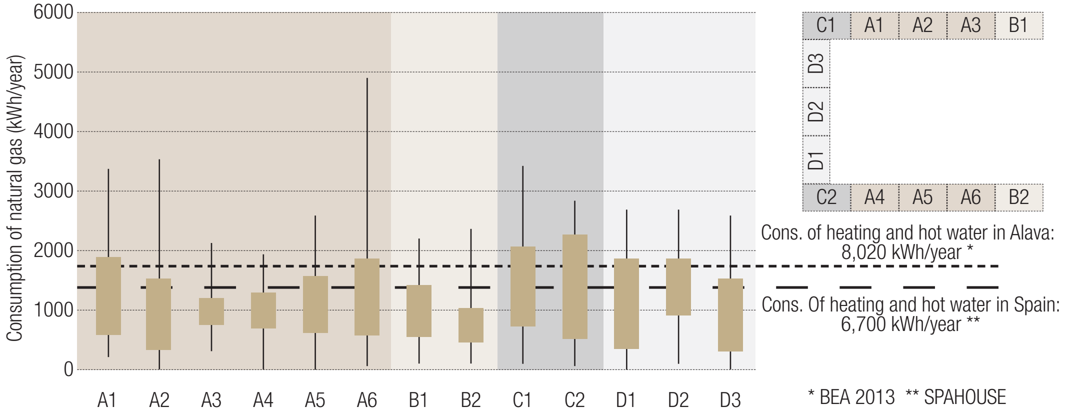
The energy assessment of the public rental housing pool has been informed by the energy audit involving 11 representative buildings, reflecting the stock's complexity, being classified as follows: three levels of energy efficiency (high A-B, medium C-D and E-F-G), two types of installation for heating and hot water (communal or individual), and two climate zones (temperate C1 or cold D1E1).

This overall audit has combined the following: analysis of real energy consumptions through bills, assessment of envelopes and installations, review of EPCs, and calculation of the potential of different improvement measures.

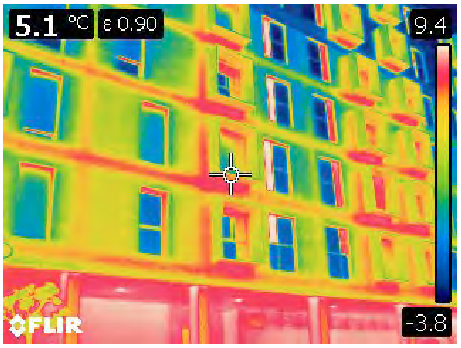
A large number of energy bills and readings have been collected that have enabled us to analyse the true energy demand of housing units of this kind.

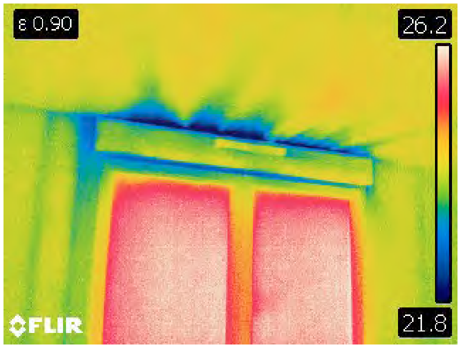
The analyses of true consumptions are of considerable interest:

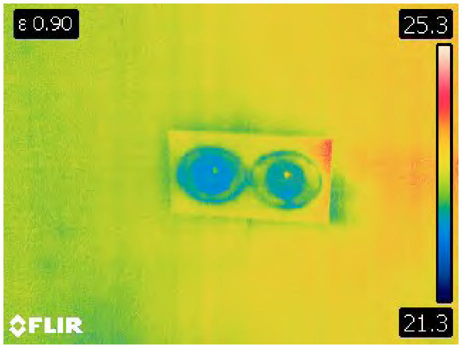
- The consumption of electricity is half of the nationwide average. Approximately 1,800 kWh/y compared to 3,487 kWh/y.
- In those units with an individual boiler, the consumption of natural gas is 30% lower. 5,633 kWh/y compared to 8,020 kWh/y.
- In terms of communal boilers, heating consumption is 40-70% lower than specified by the EPC.
- The consumption of hot water in units with communal boilers is 20-40% higher than specified by the EPC.
- The seasonal performance of communal systems drops sharply, for three main reasons: real demand is much lower than that provided for in the design, heat losses in recirculation, and the system's inefficient operation.



Analysis of the annual consumption of natural gas by entrances for 228 social rental homes, climate zone D1.







Additional infrared inspections of facades and blower door airtightness tests.

In addition, inspections have been conducted using infrared (IR) thermography and blower door tests. Numerous thermal bridges have been found, despite the reduced use of heating confirmed by the bills. Varying levels of airtightness have been recorded, with n50 from 2.2 up to 7.2 ren/h. Significant air seepages may crucially require more heating in the home.

These readings have allowed **prioritising maintenance tasks** for addressing issues of condensations and thermal discomfort; with assessment of the need to refurbish those envelopes with enough insulation, but with significant thermal bridges or incoming air.

This indicates that the operation and maintenance of energy installations are complex matters. The design of these installations means they are normally oversized, within a scenario of theoretical consumptions that is far removed from the reality of a profile of energy used defined by low energy consumption and thermal discomfort. The heating distribution system does not match the demand. The parasitic consumption used to keep the circuit hot for guaranteeing the availability of heating incurs a high energy and financial cost that is charged to the user, and it corresponds to a system in which the tenant has not chosen their housing unit.

Generally speaking, **the installations in public rental buildings are considered to be too complex for their operation and maintenance,** and just simplifying the distribution installation would lead to some saving.

In sum, they are oversized, as they have been designed for a scenario of maximum values that is very far from the reality of a profile of very low energy use. The heating distribution system is not consistent with demand, as mentioned in the preceding paragraph.

Basic steps to be taken for energy efficiency

It is deemed expedient to consider the energy required for hot water and heating separately, as following the appropriate refurbishment of these buildings for Almost Zero Consumption, the needs in heating are going to be very low. In the future, the very low trend in heating consumptions will call for different and separate management models for heating and hot water.

Faced with this new energy scenario, everything revolves around decarbonising the economy, and this means **electrifying our housing pool and doing so, furthermore, with renewable energies.** As part of the public administration, we need to ensure that all our housing units use energy with a renewable origin and that their occupants, subject to a regulated rate (PVPC), receive a green supply.

This even means contemplating the use of electric radiators, even though a priori the direct use of electricity for heating is thermodynamically inefficient, but it would be avoiding the major distribution losses involved in the heating system, reducing the cost for each household.

This option will reduce the size of boiler rooms or even eliminate the need for them altogether, as they would be required solely for the production of hot water. As the regulation of the electricity market advances, and with it the legislation on self-consumption, it will be interesting to monitor the steady introduction of photovoltaic solar energy.

4.4. Renewables and self-consumption

Against this background of guaranteeing the public housing stock's energy efficiency and achieving the goal of decarbonisation, the **development of existing renewable energy installations** today in the public pool as the system's "understudies" necessarily requires an **innovative boost to give them a "starring role".** In this process, **scenarios of self-consumption,** in which users benefit from the production of these renewable systems, are vital for the Plan ZERO Plana's strategy.

Along these same lines, **the new legislation on photovoltaic installations** and the Plan ZERO Plana's strategic approach, regarding the consideration of the integral public rental service, open the door to innovative schemes for **generating electricity in vast energy farms close to the buildings,** instead of production systems within the building itself and the atomisation of services (management and maintenance); aspects that will be addressed in subsequent documents.

4.5. Accessibility

Numerous non-compliances with the rules have been detected. Nonetheless, the pool's level of physical accessibility is generally high. The buildings with the biggest obstacles to accessibility were built prior to Decree 68/2000.

The most restrictive obstacles are related to physical accessibility, with vertical displacement being the most prominent; nevertheless, only a very small number of buildings do not have a lift. The pool's level of sensory accessibility is generally low.

The accessibility chain depends on the state of each one of its links. In our case, the consideration of ageing has not been decisive, as the average age of our tenants is below the average for the Basque population as a whole.

In terms of communal areas, the entrance and stairway tend to be problematic areas.

As regards the gender perspective, landings are used in our pool as extensions of the home, as a workplace, normally for women, and in terms of protection from attacks and threats, their perceived safety needs to be improved for women to see and be seen.

Basic steps to be taken in accessibility

A priority would be to carry out work on buildings with shortcomings in vertical displacement. In second place, all the main entrance doors into the building that do not meet the statutory requirements for minimum free width should be altered, as well as adapting their opening for people with little strength. Whenever possible, the main entrance door should open inwards .

Thirdly, automatic lighting activated by sensors should be installed throughout the housing pool, including lights outside the entrance, within the entrance itself, on stairways, on the landings on each floor, in passageways to boxrooms and garages, and in the garages themselves. The work should also be designed to ensure the minimum levels of lighting required by law.

What alterations are needed for those people facing difficulties in accessibility living in the social public rental pool? The aim is to conduct fieldwork on the social housing stock managed by ALOKABIDE, which are home to people facing problems of accessibility, studying their needs in relation to the use of their own homes -depending on the nature of their disability and their degree of dependence. These will provide criteria for helping to decide between adapting a home or recommending the occupants' transfer to another housing unit.

Is it worth altering the home if the neighbourhood itself is inaccessible? The idea is that the fieldwork suggested above should include an analysis of the building's immediate urban surroundings, studying both its needs in relation to those surroundings and the degree of urban accessibility. The aim is none other than to assist in the decision-making regarding the recommendation for the transfer of occupants: those with a disability that can fend for themselves might benefit from the alterations made to their homes, while the same measures might have little impact if the immediate surroundings are not accessible or no short-term improvements are expected.

It would be convenient to cooperate with local agents in the field of social services. The first step would involves introducing a mechanism for "triggering an alarm" in ALOKABIDE as soon as municipal or provincial social workers apply or acknowledge a certain degree of dependence to someone living in the social housing pool. The introduction of this protocol should help to take further steps in this direction: for example, including information in decision-making on the expected development of a person's disability, whenever possible.

Liaising with other departments in the Basque autonomous administration. Example: "Euskadi Lagunkoia".

Cooperation with other **administrations.** The decision-making that considers individual circumstances -e.g., the need to move home due to an increase in the degree of dependence- should include social workers -e.g., council and/provincial staff that assess an individual's degree of dependence-. It seems sensible to introduce procedures that allow creating areas for collaborating or sharing information with these agents.

Collaboration with other **professional profiles.** There is a need to undertake more complex work affecting both the building and its occupants , and even on the immediate urban surroundings. This would involve ALOKABIDE's ongoing cooperation with professionals in the fields of sociology and public health -and even the hiring of these profiles- to design, undertake, oversee or assess this work.

Involvement of **participants in the building work and the supply and installation** of materials. This would involve training and instructing trades and manufacturers in order to increase their impact, in such matters as metal carpentry (entrance doors, handrails, banisters), lifts, detection and communication systems (automatic lighting, intercoms), signage, and post boxes. What's more, this measure's benefits will extend beyond the project's own specific boundaries.

Engagement of tenants. Although it seems complicated, it is possible to engage tenants in the improvement of their homes. In fact, it is understood that the degree of involvement of people and communities in decision-making is a basic requirement for their wellbeing. The fact that this is perceived as being extremely challenging may be associated with the limitations derived from our professional profiles, which are largely technical.

What if the most difficult barriers for the accessibility of disabled people are within their own homes? Accordingly, and once the most serious issues have been resolved (alterations made to buildings with shortcomings in vertical displacement), the aim is to respond to this question before continuing with further building work on communal features.

4.6. Profile of energy use

To conclude, it may be said that the public rental housing pool is experiencing dynamics that are difficult to manage, as the thermal installations are not aligned with the use made of them, which is defined by a scarce use of energy that leads to situations of thermal discomfort and a high level of non-payments. A service model needs to be introduced that empowers tenants rather than the building. Homes are required that cater for more advanced, innovative, engaging and social formulas.

4.7. Rental management: ALOKABIDE

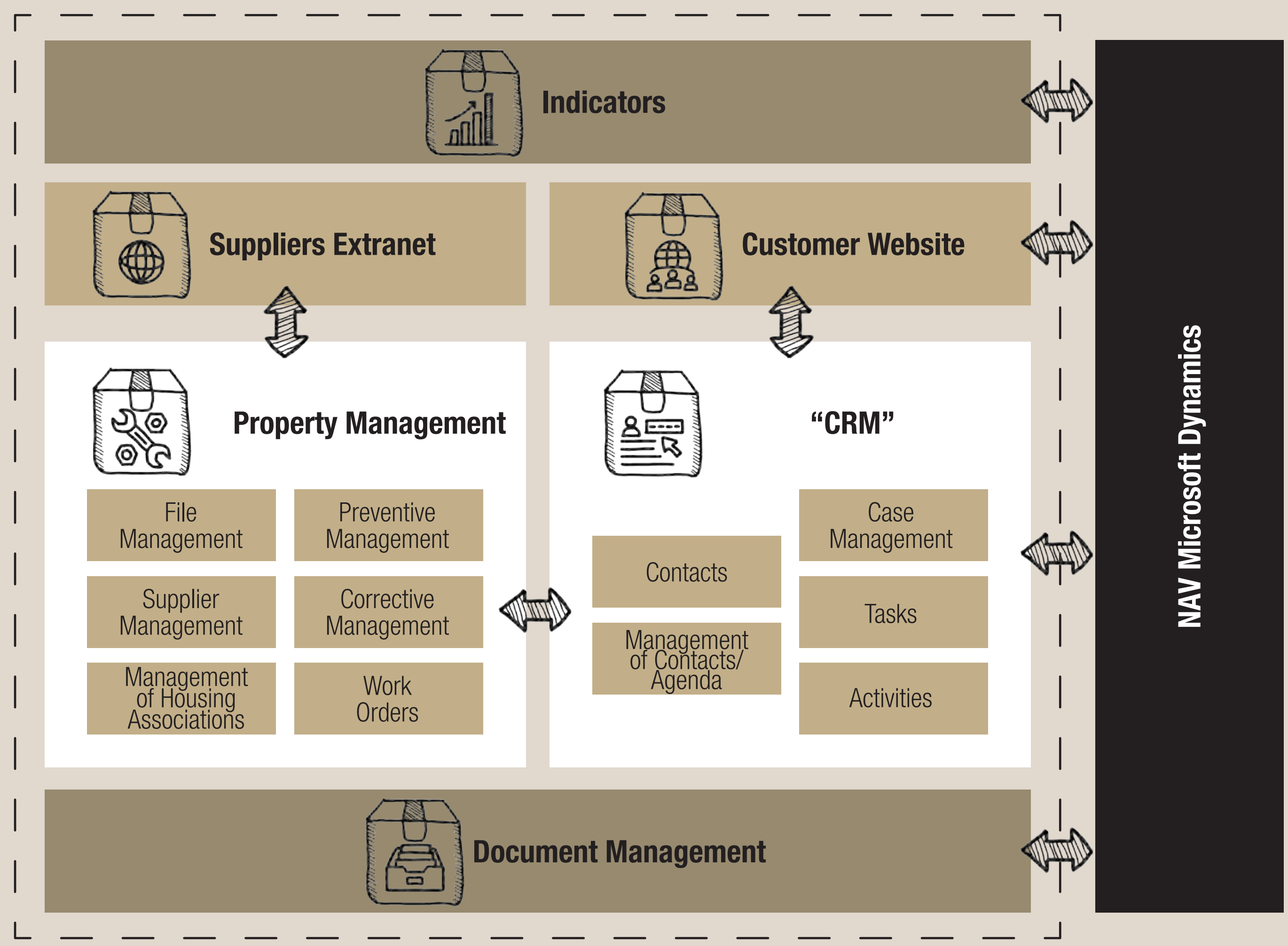
4.7.1. Property management

The public stock's efficient management requires the public agency involved to be given new tools that meet current and future needs regarding the modelling and maintenance of the housing pool it manages, and which account for the bulk of its operations.

- **Property management.** Overseeing all those components of the inventory of properties managed by ALOKABIDE (mainly buildings and housing units).
- **Preventive maintenance.** Automation of the preventive maintenance plans for properties and the management of preventive actions.
- **Corrective maintenance.** Drafting and management of all the corrective actions involving the properties under management.
- **Management of work orders.** Creation and automatic assignment to suppliers of work orders, reporting on tasks undertaken, and their current state.
- **Management of suppliers.** Maintenance of suppliers, endorsements, filing of bids submitted, tenders awarded, indicators of consumptions, dedication, service quality, etc.
- **Management of consumptions.** Record of consumptions in the buildings, with functions for gathering both automatic and manual readings, which allow basic analyses to be made of the data logged.
- **Management of energy efficiency.** Definition of buildings, energy audits, and surveillance of energy performance.
- **Management of supplies.** Management of a building's supplies, designated suppliers, and setting of communal quotas.
- **Integrations with BIM.** Tools for extending property management to include the BIM models provided by VISESA or other independent agencies. Enabling BIM uses that can be accessed through other ALOKABIDE solutions.
- **Website for suppliers/mobile apps.** Mobile tools for suppliers and technical services that may interact remotely with the platform, with the option of working offline (consultation of work orders, task reports, etc.).

The solution is to be implemented with measure that reflect high capabilities in the management of properties, flexibility for personalised service, and a good performance dealing with large volumes of information.

The new ideal situation for ALOKABIDE follows a system's diagram similar to the one below:



- **Property management tool**
  - Definition and organisation of properties.
  - Preventive maintenance.
  - Corrective maintenance.
  - Management of work orders.
  - Management of buildings' energy efficiency.
  - Management of consumptions and supplies.
  - Management of suppliers.
  - Website for suppliers and mobile tools.
  - Interfaces required with BIM, ERP and CRM.

- **CRM**
  - Main pillar for the systemisation and unification of customer support services.
  - 360º view of customers.
  - Management of all customer interactions.
  - Management of issues and tasks (administrative and technical).
  - Management of schedules and calendars.
  - Knowledge database.
  - Interfaces required with Call Centre, ERP and Property Management.

- **ERP - NAVISION**
  - Administrative management of customers and contracts.
  - Software for the management of internal processes:
    - Contract due dates.
    - Special rent applications.
    - Rent renewal applications.
    - Relocations.
    - Debt collections.
    - Novation.
  - Standard communications manager (templates).
  - Interfaces with CRM and Property Management.

- **Document Management**
  - Planned future integration with Basque Government software for the management of documents.
  - Interfacing with all ALOKABIDE software.

- **Customer software**
  - Planned customised development in future stages, once ALOKABIDE's new systems' map has been consolidated and there is a model of integrated data across the different systems.

- **BI solutions**
  - Planned implementation of a market software for the analysis of indicators in subsequent stages.

- **Others**
  - Koordinatu (interface for integration with the management of suppliers).
  - Intranet? (It is not clear whether one will be needed in the future).

The diversity of tools foreseen for supporting ALOKABIDE's specific needs suggests an additional effort will be required in the development of a powerful arrangement of interfaces involving all of them, guaranteeing the immediate availability of data wherever needed and avoiding the repetition of information, as occurs at present.

4.7.2. Energy management

Generally speaking, the management of energy within the actual homes is in each tenant's hands, and they do not receive sufficient support from the Basque Government, whereby there is a need to **find ways of helping users** to be sure of contracting the best energy rates and/or applying for the social subsidy, if necessary.

Our tenants consume in a very efficient manner, but they do so out of necessity. We are not aware of the conditions of comfort this entails. The difference between homes can be very large (greater or lesser efficiency, absence or presence of renewables, etc.), and a tenant has to manage those that correspond to the housing unit they have been allocated.

What's more, energy poverty, understood to mean a household's inability to afford a minimal amount of energy to cover their basic needs, is a growing reality in our housing pool, whereby there is an urgent need for a protocol to identify these cases and act accordingly.

Basic steps to be taken in energy

A service model needs to be introduced that empowers tenants rather than the building. Homes are required that cater for more advanced, innovative, engaging and social formulas to guarantee **the greatest comfort at the most affordable cost possible.**

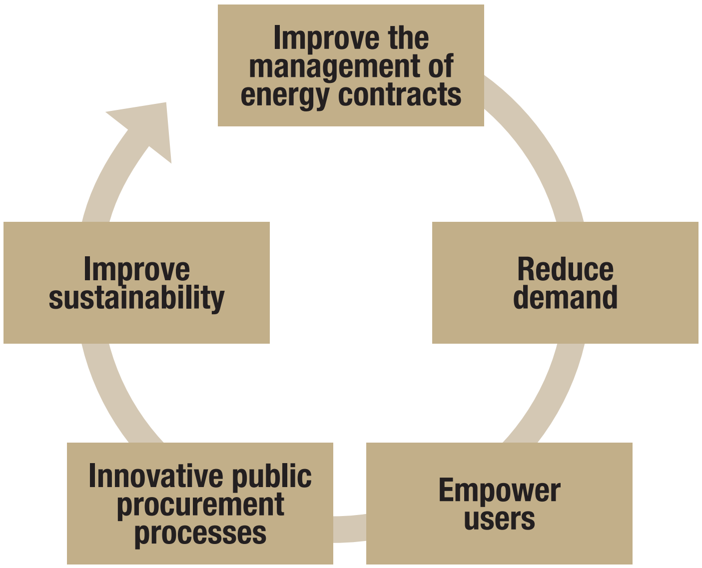
On the basis of controlling the energy consumption of the installations in our buildings, the capture of data and remote monitoring, we can advance in search of our properties' energy efficiency. It is essential for manufacturers, installers and tenants in social rental housing to make good use of technology as a solution for general issues.

Accordingly, tools are required for **acquiring, analysing and controlling the equipment installed,** with the aim being to reduce unnecessary consumption and obtain both financial benefits for our users and environmental ones for Basque society as a whole. Comfort and energy saving will only become possible through the use of the IoT (Internet of Things). This technology may help, moreover, **to control and monitor the safety and security of our buildings and homes,** by detecting intruders in unoccupied housing units, which will undoubtedly reduce the number of squatters and the issues of co-existence arising from this growing social problem.

The priority is the need to improve all facets of energy management, as well as streamline resources. It seems essential to generate "knowledge" (Data/ Model) and a more effective and mainstream system is which users are "supported".

We need procedures that are agile, straightforward and swift for contracting and terminating utilities, with the necessary information for generating profiles of behaviour and statistics, with the energy supply being sustainable, with the cost of utilities being as affordable as possible, with accompanying advice, recommendations and messages about unusual consumptions, and with flexible payment methods.

From a tenant's perspective, ALOKABIDE should provide a direct advisory service and/or an information channel on performances, consumptions, and costs. The availability of procedures that are agile, straightforward and swift in the processes of contracting and terminating utilities should allow the real-time control of consumption, cost and financial impact, with the provision of advice, recommendations and messages on unusual consumptions; with methods of payment that are flexible and adapt to each situation, behaviour, consumption and payment possibilities, with the information on consumptions, costs and circumstances being accessible, clear, and sufficiently understandable for everyone occupying the same building.



In sum, the Plan ZERO Plana should address the future of the public rental pool in the Basque Country with a view to guaranteeing its continuity, while at the same time tackling the challenge of climate change. This will require the alignment of environmental goals with the provision of housing that meets people's needs, as they are in turn consumers of energy.

In other words, prioritising a service and not just the renting of housing. This all needs to adopt the perspective of a specific **model of social management of energy in rented accommodation,** fostering the digitisation and efficiency of our services together with people's wellbeing. A paragon is required for the integral management of energy in social housing to **boost the automation of processes and data,** thereby reducing energy consumption for both tenants and the Basque Government, with a balanced use of public resources, in all cases at the most affordable price.

alokabide

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Berrilan BIM

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quality of life in architecture

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ERAIKUNE
Construction Cluster

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