



ZenN

Nearly Zero Energy Neighborhoods

Local energy retrofitting replication plans and knowledge transfer

D 6.2



Publisher

ZenN – Nearly Zero Energy Neighbourhoods

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Date

2017 – 10 -25

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Disclaimer

The research leading to these results has received funding from the Seventh Framework Programme (FP7/2007-2013) under grant agreement n° [314363].

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Foreword

This report is a deliverable of the project Nearly Zero Energy Neighbourhoods (ZenN). The project lasts from 2013 – 2017 and funded through EU's Seventh Framework Programme (FP7). In total, 12 partners from five countries are involved in the project: Tecnalia (Spain), CEA (France), IVL Swedish Environmental Research Institute (Sweden), SINTEF (Norway), ASM (Poland), NTNU (Norway), The municipality of Oslo (Norway), Debegesa (Spain), City of Eibar (Spain), Ville de Grenoble (France) EJ-GV (Spain) and the City of Malmö (Sweden).

In the ZenN- project, residential areas in Sweden, Norway, Spain and France will function as nearly Zero energy building (nZEB) renovation demonstration projects where a number of measures have been done in connection with large-scale renovations. The general objectives of the project are to demonstrate the feasibility (technical, financial and social) of innovative low energy renovation processes for buildings at the neighbourhood scale; identify and disseminate promising management and financial schemes to facilitate large scale replication and launch ambitious replication plans with the participation of local administrations.

Deliverable 6.2 presents the replication plans at city level.

Executive summary

The table below gives a summary of success factors and replication potentials connected to technical, economical, environmental and social aspect. The decision process has also been considered.

Type of aspects	Success factors and replication potential
Technical aspects	<ul style="list-style-type: none"> • Upgrading building envelope, ensure air-tightness. Also ensure sufficient ventilation (FR, ES) • Optimal control strategies for heating systems. Also ensure proper functioning (FR, SE) • Inform & train architects, engineers, contractors (FR, NO) • Quality control and sufficient commissioning of systems important (FR, NO) • PV systems successful (FR, NO, SE) • Ensure adequate data collection and storage (FR, NO)
Economical aspects	<ul style="list-style-type: none"> • Loan conditions could make a big impact (ES, SE) • Sustainable financing hard to establish (FR) • Long-term view on investments necessary, could be difficult with commercial property owners (SE) • Good coordination of the retrofitting work can save cost. Synergy with other planned investments in the neighbourhood can be beneficial (ES, SE) • Payback time demonstrated profitability (NO) • Analysis should be made of the risk to the tenants if the rent is increased (SE) • Green leasing contracts to residents being developed (NO)
Environmental aspects	<ul style="list-style-type: none"> • Result is sensitive to the choice of primary energy factors. This can also impact design choices (SE) • CO₂ storage in wood-based thermal insulation had a positive impact (FR) • Further reductions of heat loss in local thermal generation possible (FR)
Social aspects	<ul style="list-style-type: none"> • Focus on tenants' individual benefits (ES, FR, SE) • Provide guidance for funding applications for residents (ES) • Guidance and support after completion has impact on energy performance (FR, NO) • Engaging residents as contractors positive but difficult (SE)
Decision process	<ul style="list-style-type: none"> • Depending on the ownership structure, significant effort might be needed to convince owners (ES) • Experts answered owners' questions to help informed voting in buildings (ES) • Using existing energy infrastructure was a good bargaining point(SE) • Allow ambitious stakeholders to convince other decision makers (FR) • Good data is crucial to calculate increased property value for the building owner(s) (SE)

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2 Introduction

This report is a delivery of the project Nearly Zero Energy Neighbourhoods (ZenN). The project lasts from 2013 – 2017 and funded through EU's Seventh Framework Programme (FP7). This report is Deliverable 6.2 (D6.2) connected to WP6, Task 6.2, of which has given the premises for the replication plan in each city.

The aim of ZenN project is to reduce energy use in existing residential buildings and neighbourhoods and a number of measures have been implemented in connection with renovations in residential areas in selected cities in Sweden, Norway, Spain and France to become nearly Zero energy Neighbourhoods (nZENs).

The renovated buildings are front runners in each city and has a large potential for replication. This deliverable presents the replication plan for each city based on the lessons learned from each pilot project.

First step of this task is to analyse the initial replication plan defined by each city at the beginning of the project. The replication plan has then been improved and updated according to the results of the retrofitting. A comparative study makes the basis for experience exchange and knowledge transfer between demonstration projects.

2.1 Results gathered from WP3, D3.1

D3.1 evaluated the technical aspects of nearly Zero Energy Building Renovation in the participating demonstration districts in Malmö, Eibar, Grenoble and Oslo. The proposed measures and their integration in the whole district have been analysed by calculating a set of indicators, which are:

- Energy efficiency measures, considering the resulting balance between delivered energy and produced energy,
- Energy efficiency economics, including investment costs, payback time, and lifecycle costs, and
- Environmental performance, analysing the reduction of primary energy use and GHG emissions.

The evaluated indicators for the final technical approach to be implemented are presented in **Error! Reference source not found.** for each demonstration case. The calculated values for each demonstration case will later be compared to monitored values after renovation in Task 3.3 and presented in D3.3.

Table 2.1 Calculated values for indicators on energy efficiency, environmental performance and economy. Common EU factors are used for primary energy.

		Lorensborg, Malmö	Lindängen, Malmö	Mogel, Eibar	40 Arlequin, Grenoble	50 Arlequin, Grenoble	Økern, Oslo
Final energy	Before renovation [kWh/(m ² yr)]	131.6	161	119.5	176	180	384.2
	After renovation [kWh/(m ² yr)]	73.2	76.2	65.2	65.5	90	136.7
	Reduction [%]	44%	53%	45%	63%	50%	64%
Primary energy	Before renovation [kWh/(m ² yr)]	72	93	101.9	94	95	697
	After renovation [kWh/(m ² yr)]	45	74	46.3	41	51	214
	Reduction [%]	38%	20%	55%	56%	46%	69%
GHG emissions	Before renovation [kg CO _{2eq} /(m ² yr)]	20	25	24.6	10.2	10.4	52.7
	After renovation [kg CO _{2eq} /(m ² yr)]	11	13	13.1	4	5.3	21.2
	Reduction [%]	43%	46%	47%	61%	49%	60%
On-site generation	PV [kWh/(m ² yr)]	2.1	3.5		5.2		10.4
	Solar thermal [kWh/(m ² yr)]			10.5			
	Heat (biomass) [kWh/(m ² yr)]				27.2		
Economy	Total LCC in present value [€/m ²]	264	342	538	611	449	2080
	Payback time [years]	47	52	>50	>50	>50	39

2.1.1 Key Success Criteria for building nearly zero energy neighbourhoods

D3.1, ch 7 collects experiences and conclusions made by the involved partners from the technical evaluation of each demonstration district. These have resulted in a number of general recommendations for future similar projects, which are summarised in the following points:

Social aspects

- Involving all relevant actors in the retrofitting project at an early stage increases the possibilities of finding the best solutions. Relevant actors are for example the building owner, architect, energy and HVAC engineers, environmental experts and representatives from the tenants.
- To accomplish a nearly-zero energy building renovation, as defined in D3.1 ch 3, it is important that the building owner, with help from experts in the design team, set initial requirements and targets in terms of reduction in delivered energy, primary energy and GHG emissions.

Technical aspects (energy related)

- Thermal improvements of the building envelope should always be analysed and implemented if they are economically feasible. Reducing heat losses and thereby the energy demand is prioritised.
- Sufficient ventilation becomes crucial when the building envelope's insulation thickness and airtightness is increased. If the ventilation air flow is too low it will affect the indoor air quality and may create moisture related problems. This can be avoided by introducing mechanical ventilation to ensure an adequate airflow in the building.
- Paying attention to details in the design of retrofitting measures in the building envelope ensures both higher energy performance and a moisture-proof construction. Thermal bridges are reduced and problems with condensation and mould can be avoided. This does not necessarily entail higher costs for material and implementation, even though skill and precision is required from those who perform the renovation.
- Heat recovery from the exhaust air should always be considered, especially in Northern Europe where heat losses in ventilation represent a significant part of the energy demand. Mechanical exhaust and supply air ventilation with heat recovery (ESX) can efficiently reduce the heating demand in exchange for a small increase in electricity demand due to higher fan pressure and electricity needed for the heat exchanger, depending on the type. On the other hand ESX ventilation can be rather costly and the installation disturbing to the residents.
- Exhaust air heat pumps can sometimes be a cost-efficient alternative to ESX ventilation. However, a disadvantage is the significant increase in use of electricity, which usually affects the environmental performance negatively.
- Reducing energy for DHW becomes more important when the building envelope is well insulated. However, the calculated solutions for heat recovery from separated grey water investigated in this task have not proven to be fully economically viable yet.
- Renewable energy can easily be produced on-site, for instance by utilizing solar energy for electricity or heating. Renewable energy can also be a part of the connected energy system. The district heating systems in Malmö, Grenoble and Oslo are continuously increasing the share of renewable energy sources on a system level, which lower the carbon footprint for the city districts served by the district heating. Explore possible collaborations between building owner and energy supplier in finding the best possible solutions. Both parties are likely to gain from this and sub-optimisation at district level can be avoided.

3 Eibar (and Lower Deba Region)

3.1 Initial replication plan, Eibar

The Lower Deba region is characterized by strong human presence in the territory and by its industrial vocation. The human settlements and the infrastructures are located in the bottom of the valley, and in many cases they take up the hillsides. For this reason, the territory is in need of a holistic sustainable regeneration strategy.

In the 50-70's, Lower Deba region due to an industrial development, received many people from other regions of Spain and they built many dwellings. The average density in Lower Deba region is 119 dwelling/Ha; it is the highest density of Gipuzkoa, whose density is 77 dwellings/Ha. The density is alarming in Ermua and Eibar, reaching up to 186 dwellings/Ha in the first one. Municipal action has

focused towards the urban renewal between 40's and 80's districts, and the rehabilitation of existing residential buildings. These neighbourhoods have features of advanced obsolescence and face a generational changing process.

Based in population and ownership structures, the appropriate renovation processes will allow solutions based on the ability and the legal responsibility of the homeowners for the preservation of their buildings in correct conditions.

Regarding other issues, we have to overcome similar inertias. Two essential inertias are the energy crisis and the adaptation to climate change. The great challenge is to improve the energy efficiency of the enormous residential site built before the Spanish Thermal Insulation Act in 1979. This is a challenge in the Lower Deba region. The process of integral rehabilitation of district of Mogel will be a positive develop and will allow for replication in other processes of rehabilitation in several districts. The experience will be very helpful and the Lower Deba region, together with different institutions (Eibar City Council and Basque government), assume the management challenge.

The planned criteria for replication are:

- Integration of energy renovation with other interventions such as improving accessibility.
- Existence of neighbour associations.
- Social environment
- Interest of the buildings
- Access to financing

The priority action areas follow these criteria:

- Edifications built between 50's and 70's
- Linear blocks of flats supported in the hillside and buildings developed in height.
- Disordered urban development with impaired internal connections to the rest of the city.
- Dwellings do not have any insulation in their facades, elevator and central system of hot water and heating. They also do not have any active systems using RES.
- The most recent urban interventions have influenced on the district redevelopment improving district accessibility and connection with the town.

Based in these criteria, the following are the priority replication areas selected so far:

EIBAR:

- Amaña
- Legarre
- Jardines
- Matsaria
- Txonta
- Arragueta
- Urki
- San Cristobal
- Murrategi
- Bidebarrieta
- Santaines

ELGOIBAR:

- Olasogain - Viviendas De Sigma
- San Pedro
- Urasandi

ERMUA:

- Zerukoa
- San Lorenzo

SORALUZE:

- Ezozia-Gabolatz-Arraikua
- Loralde
- Asilo –Atxuri –Zubia

One example of the district listed above is District of Amaña.

3.1.1 District Of Amaña (Eibar)

Action timeframe: 2016-2020. 249 dwellings in thirty one blocks of flats (Ground floor + 4), and 530 dwellings in seven towers (Ground floor + 15).



Figure 3.1 District of Olasogain (Elgoibar): 153 dwellings in nineteen blocks of flats (Ground floor + 3)



Figure 3.2 District Of Zerukoia (Ermua): 250 dwellings in fifteen blocs of flats (Ground floor + 5, 6 or 10 storeys)



Figure 3.3 District of Ezozia (Soraluze - Placencia de las Armas) 225 dwellings in fifteen blocks of flats (Ground floor + 9 storeys)

In addition to these local replication plans, the Basque government, as a partner in the ZenN consortium, is supporting the Eibar Demonstrator as part of a pilot programme to provide input for the mass support of energy renovation actions in the Basque Country, as defined in the “*Plan estratégico de la CAPV de rehabilitación de edificios y Regeneración Urbana*” (Basque Country Strategic Plan for Building Renovation and Urban Regeneration)¹

¹ http://www.garraioak.ejgv.euskadi.net/r41-2208/es/contenidos/nota_prensa/nptv_20110202_rehab/es_nptv/adjuntos/plan_estrateg_rehab.pdf

3.2 Reconsidering the initial replication plan, Eibar

The initial replication plan is still considered valid, drafted at a neighbourhood scale as seen in the previous lines. Furthermore, the successful experience in Mogel provides complementary knowledge to the initial replication plan, further delving in more concrete aspects that can help in successfully replicating Mogel experience in the other neighbourhoods. These aspects are based on both barriers and success factors identified through the experience in Mogel, attending at technical, economic, environmental, social and decision-making factors.

3.2.1 Technical aspects

- What became a success and should be replicated to other similar projects?

In Mogel district, prioritizing neighbourhood level solutions above building level solutions allowed cost-efficiency and resource-efficiency of interventions, enabling the implementation of new systems and technologies that would have been less convenient in efficiency terms at a building scale. The projected retrofitting measures were focused on (1) reducing the space heating needs by insulating the envelope, (2) taking advantage of solar energy to produce domestic hot water and (3) improving the accessibility to the dwellings of the building since it was one of the major concerns of the neighbourhoods.

Table 3.1 Technical measures implemented in Mogel recommended for replication.

Measures implemented in Mogel	Why to be recommended for replication
Insulation of the building façade with an ETHI solution of 12cm EPS and roof with 20 cm of mineral wool.	The ETHI solution is recommended as it is a less-intrusive choice as the neighbours are not forced to leave their homes during the retrofit. Furthermore, the interventions in the exterior face of the facade are recommended from the energy perspective as they eliminate thermal bridges and leverage the thermal inertia of the building, beneficial for a continuous use of the building (residential), when the space conditioning is essentially during the afternoon-evening. The ETHI is a light solution that does not entail execution problems, even in poor constructive quality facades and load-bearing walls. This solution is also recommended as it improves the aesthetics of the building with the new envelope.
Replacement of old windows to double pane low-E windows.	The intervention has proved that windows replacement is the best cost-effective intervention, as its thermal transmittance is much lower than in the other facade elements, also representing a weak point for non-desired air infiltration. In addition, they better leverage solar gains, essential to reduce heat demand. The better orientation and exposure, the greater this potential will be.
Installation of a hot water production system by means of solar panels with central storage system.	Once the heat demand has been reduced to a minimum with the measures described above, it is recommended to install solar-thermal panels, as the heat demand becomes low and can be substantially covered by solar radiation.
Installation of elevators in the buildings and the replacement of common areas lighting to LED	The accessibility improvement through the installation of elevators has been one of the main reasons to convince neighbours about the benefits of the retrofit. For future replication it is advised to regard possible synergies between accessibility and energy retrofitting.

luminaires.	Furthermore, the shift to LED luminaires is highly recommendable, mainly when the old ones arrive to the end of their lifespan.
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Just through the envelope retrofit (facade, roof, and windows), a large reduction in heating demand is obtained. The expected energy saving with the application of scenario 1 was 47% when referred to final energy and 54% when referred to primary energy. Estimations were based on energy simulation of preintervention status and post-intervention taking inconsideration user behavior patterns. Therefore, from the energy efficiency perspective, these interventions are highly recommended for future replication.

- What could have been done better and how could this have been done?

On the other hand, some difficulties need to be borne in mind for further replication, learning from Mogel interventions. In order to implement such a holistic and demanding approach, qualified knowledge is essential for the optimisation of solutions, especially those connected to indoor air quality and tightness of the building envelope. Furthermore, these kind of technical interventions at a neighbourhood level require a large consensus within the group of stakeholders, including residents. This fact can represent a strong barrier, bearing in mind the highly fragmented ownership structure of Spanish housing sector.

3.2.2 Economical aspects

- What became a success and should be replicated to other similar projects?

Regarding economic terms of interventions, the additional financing sources from ZenN project provided added value to the retrofitting, achieving more ambitious energy targets with the same already planned investments. Besides the search of these kind of additional financing sources, the Basque Government subsidised the interest rate of loans, easing the investments on the retrofit.

Another recommendation to be replicated is the connection of the energy efficient renovations with other previously requested installations and modifications of the buildings, such as the installation of elevators, which can become a synergy for the involvement of the residents in the financing scheme of the intervention. The potential synergy between energy efficiency and accessibility must be explored, as residents can easily perceive a much greater upgrade in their daily life, even before the execution of works.

The close assistance of experts in both technical and economical aspects is highly recommendable for excellence and viability of interventions, as DEBEGESA and the construction company involved in Mogel case.

-What could have been done better and how could this have been done?

In Mogel case, the payback time of interventions is quite long (>50 years), being possible that the financial benefit will impact on future generations. This difficulty is connected to the little engagement of the banks in the project, as many of them did not provide competitive offers with low interest rates. In this case, the banks adopted a traditional perspective rather than assessing the market position and image incentive that comes along with the participation in such projects. An additional barrier to be borne in mind for further replication is the vulnerable economic situation of some owners, mainly due to unemployment, who were unable to take a loan. This situation becomes quite problematic when a big part of the contribution falls into the individual owners' resources, even if in this case, the total subsidy of the first stage of Mogel project reached 55% of the average retrofit/dwelling:

Table 3.2 Average investments per dwelling in Mogel case and connected subsidies.

Stage of Mogel project	Total average cost per dwelling	Institutional subsidies per dwelling
1st stage	35.000€/dwelling	Basque Government: 14.213€/dwelling ZenN project (EU): 4.400€/dwelling City administration: 911€/dwelling
2nd stage	35.000€/dwelling	Basque Government: 15.000€/dwelling ZenN project (EU): 4.400€/dwelling City administration: 1.000€/dwelling

3.2.3 Environmental aspects

Environmental targets were to reduce the energy consumption from pre-intervention status in 55% referred to primary energy, and 47% to GHG. However, monitoring results show the improvement is slightly lower than expected. Space heating represents the major deviation from the specific targets.

Data shows that 80% of dwellings use heating to warranty indoor air temperature during winter, and in general, tenants feel an increase of comfort, with lower energy consumption.

The final specific space heating average values are close to 40 kWh/m², the targeted value for new buildings which were constructed under the regulation in force at the time of project definition. It can be therefore considered a reasonable good value, taking into account that main retrofitting activity has been façade insulation. A higher value would have been achieved if window substitution would had been carried out for the whole building, as well as if the floor slab would have been insulated.

3.2.4 Social aspects

- What became a success and should be replicated to other similar projects?

With regards to social aspects, in the next paragraphs are explained some lessons learned from the process of integral rehabilitation of the neighbourhood Mogel, which can be used to replicate the initiative.

The residents of Mogel became much more supportive of the renovation and energy efficiency measures, once they could see the output of the completed renovation of the initial buildings. Therefore, showing immediate benefit of an energy efficiency renovation, through examples of similar renovated buildings, may have facilitated in the convincing process to gain support for such renovation. Building on previously identified motivation initiated by the residents, such as accessibility, is another lesson learnt; in Mogel this became a starting point for the energy efficiency renovation.

The actions from Debegesa and the neighbours committee were crucial to convince initially sceptical residents to support the process. The various communication strategies, were initially only successful in gaining support from residents in certain buildings, not all. The neighbours committee had a strong knowledge of the residents and used targeted communication actions, such as key persons who would be receptive among residents; and approaching residents in buildings who the neighbours committee believed would vote in favour of the renovation. The neighbours committee consistently used these communication actions to articulate information and to get neighbourhood approval.

The involvement and empowerment of the residents supported this process.

A process involving different buildings entails a significant increase in complexity, when apartments within the buildings have individual owners. In some cases, there were multiple owners due to inheritances (e.g. an apartment with 8 owners) and in other cases, there were different opinions within one apartment (e.g. voicing different opinions during the meetings depending on whether the husband or wife would participate). Group decisions made by owners in one building could also be influenced by the response of the whole building owner group. One impact of this decision making process was the vote to not approve the elevator renovation in the early stages of the process (2006-2008). This came about when owners of one group of buildings withdrew the decision to renovate the elevator while owners in another building had already approved the renovation works. In the case of Mogel, the owners who were against the renovation works joined in a counter-pressure group. The decision-making process in Mogel is based on a majority vote, and the decision would be mandatory for all residents of the building.

Additional support measures were needed for funding/legal requirements, e.g. one neighbour needed support with the legal necessary documents required from the Basque Government to apply for funding. Payment difficulties were solved on an individual basis. In one case, an owner couldn't pay for the renovation and the neighbours of his building involved his sons in the payment of the renovation. In other case, one of the owners who was unemployed was involved in the construction team.

Once a successful example is executed (demonstrator), it would contribute to leverage the process amongst residents in other building in the area. A strategy to foster this replicability in other similar energy efficiency renovation projects is to make a special effort through a first case to show the possibilities and outputs of energy efficiency measures in renovation to show what can be achieved through investment.

Residents of Mogel were sceptical of the energy efficiency measures but realised the benefit once the renovation was complete. Similar projects could learn from this experience by promoting energy efficiency benefits early in the project, through connecting energy efficiency with impact on user comfort.

The renovation works achieved much more than expected by residents (and all of the stakeholders involved). Improvements included not only accessibility but also:

- Aesthetics: the improvement of the building appearance can be checked in Figure 2, which was a consequence of the insulation installed.
- Energy efficiency: the building has been updated with energy efficiency measures.
- Comfort: the neighbours declare an increase in comfort and quality of life connected to the energy efficiency measures and the improvement of accessibility.
- Increased property value: the improved energy performance has yet to be measured, but combined with the other measures the value of the property has already increased.

All of these factors have contributed to stop the socio-economic deterioration of the neighbourhood. The former appearance of the buildings and their lack of accessibility did not contribute to attract young couples with children, and the neighbours' concerns before the renovation was the departure of the original population and the attraction of marginal population to the neighbourhood contributing even further to its socio-economic deterioration. The Mogel renovation has contributed to stop this process, instead transforming the neighbourhood in an attractive place for living due to its accessibility, energy efficiency and renovated appearance.

3.2.5 Decision process

- What became a success and should be replicated to other similar projects?

Proper management and communication with neighbours is necessary before and during the process of making and reform.

During the entire process, the neighbours committee worked with continuous, convincing and joint action to reinforce the common objective of the renovation and address differences of viewpoints arising from the residents in terms of supporting the renovation. The committee had a crucial role in filtering technical information and decisions in order to speed up the renovation process, which included involving all the neighbours in decisions such as the selection of the construction company.

There was strong and continuous support from a group formed by the neighbourhood committee. This group included Debegesa, Architects, a Legal Advice company (who did not participate in the whole process of the renovation but whose contribution was crucial for the process) and the Municipality. The aim of this group was to respond to the different kinds of concerns that arose among residents. For example, one of the concerns of the residents was the demolition of the stairway which they believed would cause the building to crumble. The Architect was responsible for answering technical questions while Debegesa and the municipality responded to funding questions, etc. The type of actions performed by this group consisted of:

- Informative collective meetings with all the neighbours, organized in a municipal location and open to the residents of all the buildings.

- Participation in the information or decision-making meetings of the neighbourhood communities: each building had their own meetings for decision making with all the owners of the building when necessary. The group formed by the neighbours committee would attend the meetings when necessary to inform the residents of each building of important matters or to solve arising concerns (technical doubts or concerns about the renovation, doubts about funding or legal aspects, etc.).

- Inform and support individual owners when they required it. Both Debegesa and the neighbours committee attended to resident's concerns or doubts by phone, meetings, etc.

- An informative event over one weekend to provide a communication channel to the residents to enable them to ask for individualized information about the different topics of concern (legal, economical, technical, administrative, etc.). This event motivated the residents to personally attend meetings in order to address some concerns or doubts in private.

- The Debegesa, neighbourhood committee, the architect and municipality group left technical and economic information about the renovation in residents' mail boxes. The information was previously discussed and agreed by the group and finally signed and mailed by the neighbours committee.

- What could have been done better and how could this have been done?

Communication with residents was a key factor for this demonstrator and despite the different communication activities promoted by the various stakeholders it is considered that the communication should be improved.

The communication strategies deployed in Mogel, were not always sufficient to engage residents' support for the renovation process. Residents, who lived in the basements of the buildings, were principal components of a counter pressure group that was against the renovation work, as they did

not need the lift to the same degree as the other residents. Some interviewees highlighted, that the refusal of the basement owners to participate in the renovation was poorly managed, as no negotiation alternatives were considered. One interview proposed two kinds of alternatives, that could have been promoted to convince them:

·Try to include problems, that affect these dwellings in the renovation, such as humidity.

·Decrease their economical contribution to the renovation work.

Given the above, it is necessary for the following replications to have a more intense communication with neighbours to address their concerns and needs, in order to decant neighbours to support the process.

In addition, consider a greater presence and activity of the presidents of the portals (legal representative of each portal) in meetings with the aforementioned group work and the neighbourhood committee. In fact, they are the leaders in the portal meetings where important decisions are made.

3.3 Updated replication plan, Eibar

The replication plan will include areas in Eibar, Soraluze, Elgoibar and Ermua as presented below.

NEIGHBORHOODS IN EIBAR:

1. AMAÑA
2. LEGARRE
3. URKI
4. TXONTA

NEIGHBORHOODS IN SORALUZE:

1. EZOZI BIDEA
2. TXURRUKEN GOIKOA

NEIGHBORHOODS IN ELGOIBAR:

1. OLASOGAIN
2. URAZANDI

NEIGHBORHOODS IN ERMUA:

1. SAN LORENZO
2. ZERUKOA
3. SANTA ANA
4. OKIN-ZURI
5. ONGARAI
6. GRUPO SAN IGNAZIO

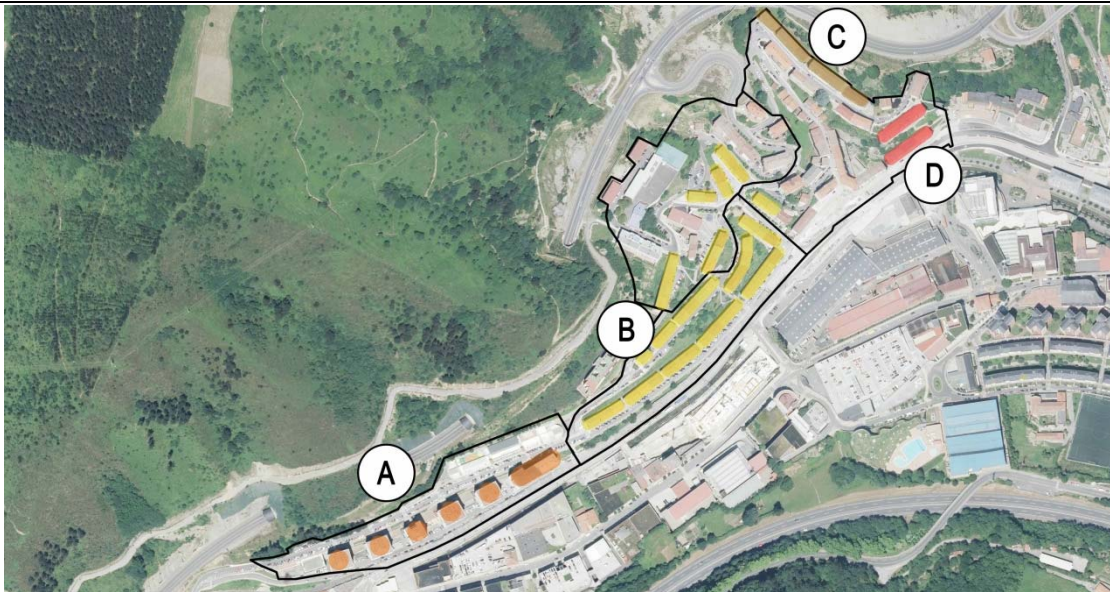
3.3.1 NEIGHBORHOODS IN EIBAR

1. AMAÑA
2. LEGARRE
3. URKI
4. TXONTA



Figure 3.4 Areas in for replication in Eibar

1_ AMAÑA



A_ Tiburzio Anitua kalea 21-31

NUMBER OF
BUILDINGS/
DWELLINGS

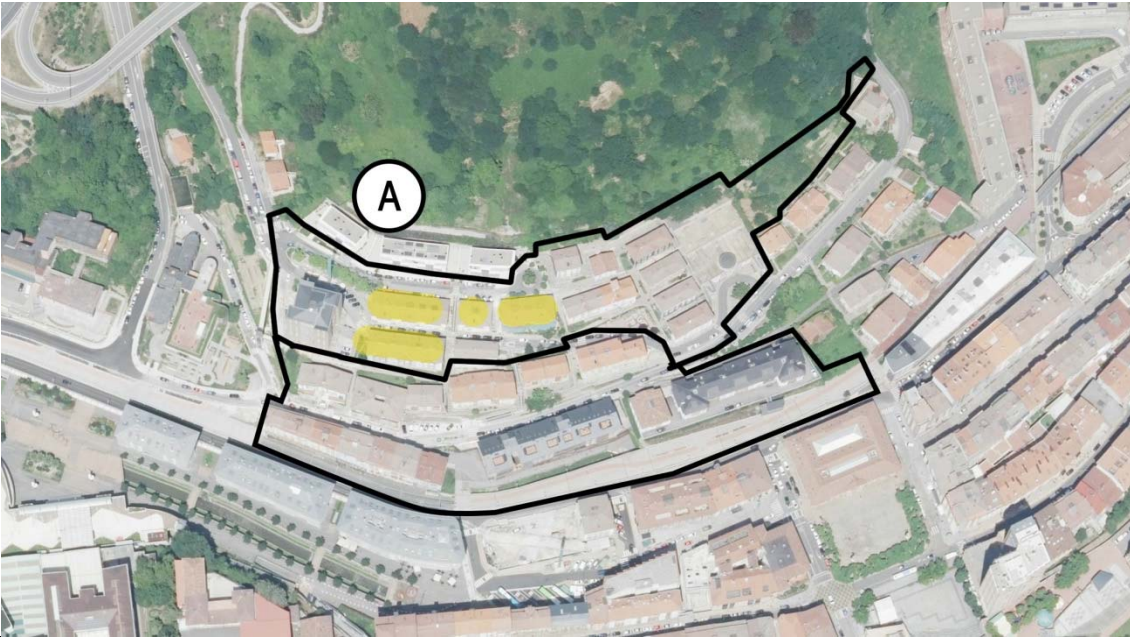
7 Buildings
6 Towers
532 Dwellings

BUILDING TYPE

GF+15, 6 dwelling/floor

	<p>BUILDING YEAR</p>	<p>1972</p>
<p>B_ Tiburzio Anitua kalea 4-20; Ziriako Agirre kalea 1-12; Bustindui-tarren kalea 1-20; Asola Igartza kalea 2-8; Artegieta kalea 2-4</p> 	<p>IDENTIFIED OPORTUNITY</p>	<p>Central heating</p>
<p>NUMBER OF BUILDINGS/ DWELLINGS</p>	<p>BUILDING TYPE</p>	<p>48 Buildings 16 Housing blocks 399 Dwellings</p>
<p>C_ Wenzeslao Orbea kalea 1, 3, 5, 7, 9, 11, 13, 15, 17</p> 	<p>BUILDING YEAR</p>	<p>1964</p>
<p>IDENTIFIED OPORTUNITY</p>	<p>NUMBER OF BUILDINGS/ DWELLINGS</p>	<p>No elevator installation</p>
<p>BUILDING TYPE</p>	<p>BUILDING YEAR</p>	<p>9 Buildings 4 Housing blocks 94 Dwellings</p>
<p>D_ Wenzeslao Orbea kalea 14, 16, 18; Amaña kalea 2, 4, 6</p> 	<p>IDENTIFIED OPORTUNITY</p>	<p>No elevator installation / Neighborhood association related to community elevators</p>
<p>NUMBER OF BUILDINGS/ DWELLINGS</p>	<p>BUILDING TYPE</p>	<p>6 Buildings 2 Housing blocks 55 Dwellings</p>
<p>BUILDING YEAR</p>	<p>IDENTIFIED OPORTUNITY</p>	<p>1964</p>
<p>IDENTIFIED OPORTUNITY</p>	<p>Neighborhood association related to community elevators</p>	<p>GF+4, 2 dwelling/floor</p>

2_ LEGARRE



A_ Legarre-Gain kalea 3, 5, 7, 16, 18, 20, 22, 24, 26



NUMBER OF BUILDINGS/
DWELLINGS

9 Buildings
4 Housing blocks
81 Dwellings

BUILDING TYPE

GF+4, 2 dwelling/floor

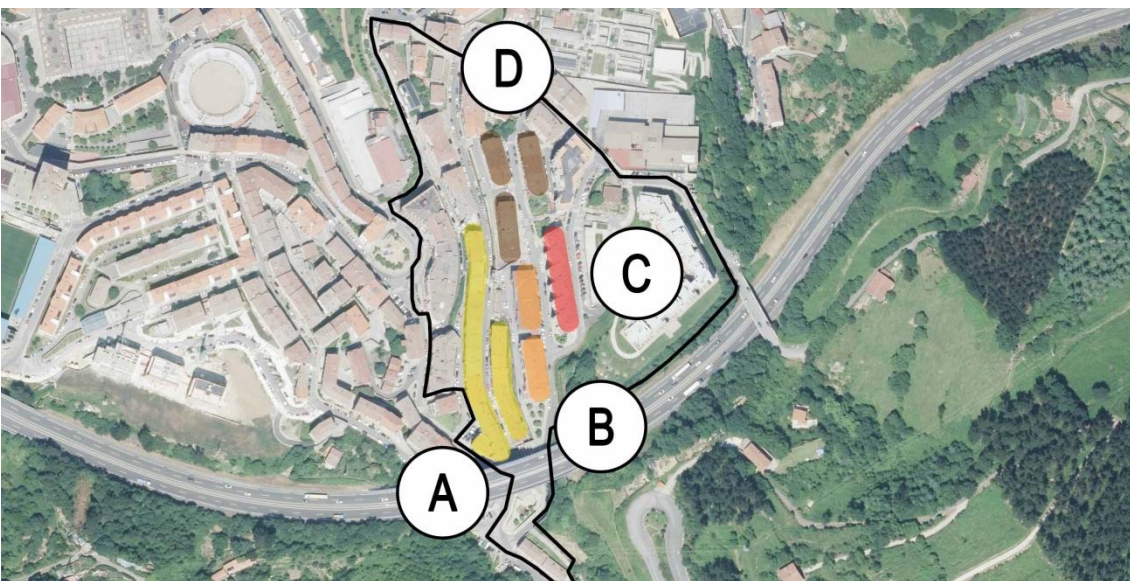
BUILDING YEAR

1957

IDENTIFIED OPORTUNITY

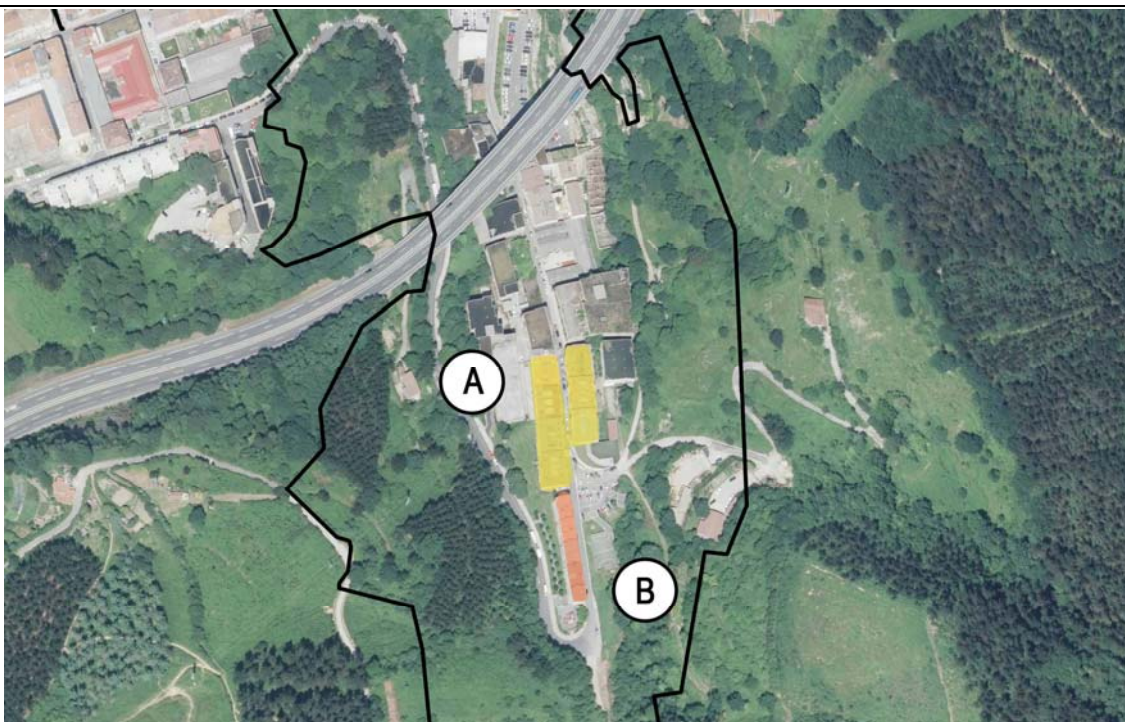
No elevator installation

3_ URKI



A_ Urki kalea 1-9, 11 	NUMBER OF BUILDINGS/ DWELLINGS	10 Buildings 2 Housing blocks 160 Dwellings
	BUILDING TYPE	GF+5, 3 dwelling/floor
	BUILDING YEAR	1965
	IDENTIFIED OPORTUNITY	No elevator installation
B_ Polonia Etxeberria kalea 20-26 	NUMBER OF BUILDINGS/ DWELLINGS	4 Buildings 2 Housing blocks 80 Dwellings
	BUILDING TYPE	GF+4, 4 dwelling/floor
	BUILDING YEAR	1963-64
	IDENTIFIED OPORTUNITY	No elevator installation
C_ Polonia Etxeberria kalea 9, 11, 13 	NUMBER OF BUILDINGS/ DWELLINGS	3 Buildings 1 Housing block 72 Dwellings
	BUILDING TYPE	3B+GF+6, 4 dwelling/floor
	BUILDING YEAR	1977
	IDENTIFIED OPORTUNITY	-
D_ Polonia Etxeberria kalea 3, 5, 7, 8, 10, 12, 14, 16, 18 	NUMBER OF BUILDINGS/ DWELLINGS	9 Buildings 3 Housing blocks 101 Dwellings
	BUILDING TYPE	B+GF+4, 2 dwelling/floor
	BUILDING YEAR	1954
	IDENTIFIED OPORTUNITY	No elevator installation

4_ TXONTA



A_ Txonta kalea 25, 27, 29, 36, 38, 40, 42



NUMBER OF BUILDINGS/ DWELLINGS	7 Buildings 2 Housing blocks 127 Dwellings
BUILDING TYPE	GF+4, 4 dwelling/floor
BUILDING YEAR	1961
IDENTIFIED OPORTUNITY	No elevator installation

B_ Txonta kalea 44, 46, 48, 50, 52



NUMBER OF BUILDINGS/ DWELLINGS	5 Buildings 1 Housing block 38 Dwellings
BUILDING TYPE	GF+4, 2 dwelling/floor
BUILDING YEAR	1958
IDENTIFIED OPORTUNITY	No elevator installation

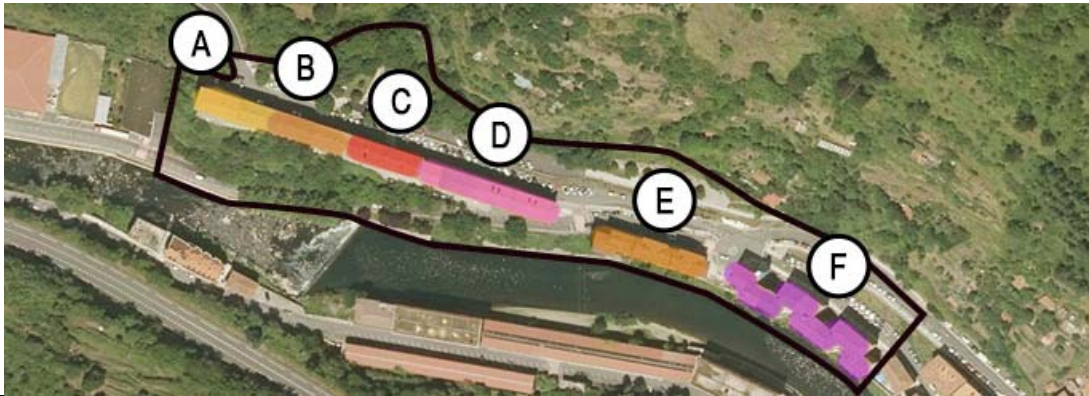
3.3.2 NEIGHBORHOODS IN SORALUZE

- 1. EZOZI BIDEA
- 2. TXURRUKEN GOIKOA




Figure 3.5 Neighborhoods in Sorluze

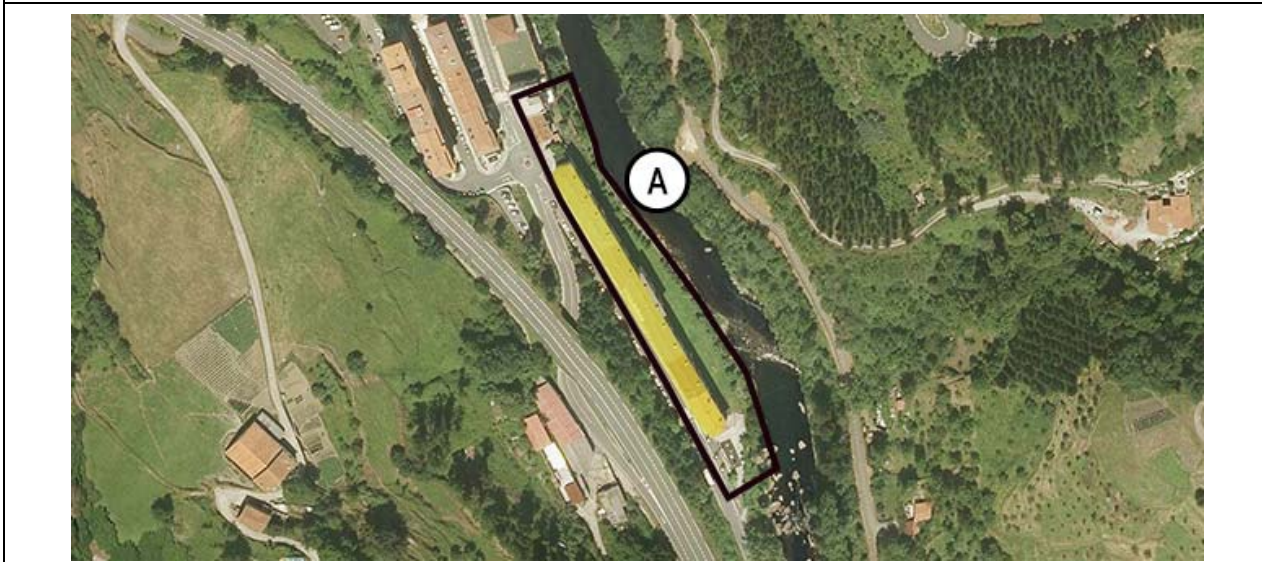
1_ EZOZI BIDEA:



A_ Ezozí bidea 32, 34 	<table border="1"> <tr> <td>NUMBER OF BUILDINGS/ DWELLINGS</td> <td>2 Buildings, 1 Block, 28 Dwellings</td> </tr> <tr> <td>BUILDING TYPE</td> <td>4B+GF+5, 6 dwelling/floor</td> </tr> <tr> <td>BUILDING YEAR</td> <td>1973</td> </tr> <tr> <td>IDENTIFIED OPORTUNITY</td> <td>No elevator installation. Big moisture problems.</td> </tr> </table>	NUMBER OF BUILDINGS/ DWELLINGS	2 Buildings, 1 Block, 28 Dwellings	BUILDING TYPE	4B+GF+5, 6 dwelling/floor	BUILDING YEAR	1973	IDENTIFIED OPORTUNITY	No elevator installation. Big moisture problems.	
NUMBER OF BUILDINGS/ DWELLINGS	2 Buildings, 1 Block, 28 Dwellings									
BUILDING TYPE	4B+GF+5, 6 dwelling/floor									
BUILDING YEAR	1973									
IDENTIFIED OPORTUNITY	No elevator installation. Big moisture problems.									
B_ Ezozí bidea 28, 30 	<table border="1"> <tr> <td>NUMBER OF BUILDINGS/ DWELLINGS</td> <td>2 Buildings, 1 Block 20 Dwellings</td> </tr> <tr> <td>BUILDING TYPE</td> <td>3B+GF+5, 2 dwelling/floor</td> </tr> <tr> <td>BUILDING YEAR</td> <td>1971</td> </tr> <tr> <td>IDENTIFIED OPORTUNITY</td> <td>No elevator installation. Big moisture problems.</td> </tr> </table>	NUMBER OF BUILDINGS/ DWELLINGS	2 Buildings, 1 Block 20 Dwellings	BUILDING TYPE	3B+GF+5, 2 dwelling/floor	BUILDING YEAR	1971	IDENTIFIED OPORTUNITY	No elevator installation. Big moisture problems.	
NUMBER OF BUILDINGS/ DWELLINGS	2 Buildings, 1 Block 20 Dwellings									
BUILDING TYPE	3B+GF+5, 2 dwelling/floor									
BUILDING YEAR	1971									
IDENTIFIED OPORTUNITY	No elevator installation. Big moisture problems.									
C_ Ezozí bidea 24, 26 	<table border="1"> <tr> <td>NUMBER OF BUILDINGS/ DWELLINGS</td> <td>2 Buildings, 1 Block 32 Dwellings</td> </tr> <tr> <td>BUILDING TYPE</td> <td>4B+GF+5, 2 dwelling/floor</td> </tr> <tr> <td>BUILDING YEAR</td> <td>1970</td> </tr> <tr> <td>IDENTIFIED OPORTUNITY</td> <td>No elevator installation. Big moisture problems.</td> </tr> </table>	NUMBER OF BUILDINGS/ DWELLINGS	2 Buildings, 1 Block 32 Dwellings	BUILDING TYPE	4B+GF+5, 2 dwelling/floor	BUILDING YEAR	1970	IDENTIFIED OPORTUNITY	No elevator installation. Big moisture problems.	
NUMBER OF BUILDINGS/ DWELLINGS	2 Buildings, 1 Block 32 Dwellings									
BUILDING TYPE	4B+GF+5, 2 dwelling/floor									
BUILDING YEAR	1970									
IDENTIFIED OPORTUNITY	No elevator installation. Big moisture problems.									
D_ Ezozí bidea 16, 18, 20, 22 	<table border="1"> <tr> <td>NUMBER OF BUILDINGS/ DWELLINGS</td> <td>4 Buildings, 1 Block 52 Dwellings</td> </tr> <tr> <td>BUILDING TYPE</td> <td>4B+GF+5, 2 dwelling/floor</td> </tr> <tr> <td>BUILDING YEAR</td> <td>1969-71</td> </tr> <tr> <td>IDENTIFIED OPORTUNITY</td> <td>No elevator installation. Big moisture problems.</td> </tr> </table>	NUMBER OF BUILDINGS/ DWELLINGS	4 Buildings, 1 Block 52 Dwellings	BUILDING TYPE	4B+GF+5, 2 dwelling/floor	BUILDING YEAR	1969-71	IDENTIFIED OPORTUNITY	No elevator installation. Big moisture problems.	
NUMBER OF BUILDINGS/ DWELLINGS	4 Buildings, 1 Block 52 Dwellings									
BUILDING TYPE	4B+GF+5, 2 dwelling/floor									
BUILDING YEAR	1969-71									
IDENTIFIED OPORTUNITY	No elevator installation. Big moisture problems.									
E_ Ezozí bidea 10, 12, 14 	<table border="1"> <tr> <td>NUMBER OF BUILDINGS/ DWELLINGS</td> <td>3 Buildings, 1 Housing block 30 Dwellings</td> </tr> <tr> <td>BUILDING TYPE</td> <td>2B+GF+5, 2 dwelling/floor</td> </tr> <tr> <td>BUILDING YEAR</td> <td>1966</td> </tr> <tr> <td>IDENTIFIED OPORTUNITY</td> <td>No elevator installation</td> </tr> </table>	NUMBER OF BUILDINGS/ DWELLINGS	3 Buildings, 1 Housing block 30 Dwellings	BUILDING TYPE	2B+GF+5, 2 dwelling/floor	BUILDING YEAR	1966	IDENTIFIED OPORTUNITY	No elevator installation	
NUMBER OF BUILDINGS/ DWELLINGS	3 Buildings, 1 Housing block 30 Dwellings									
BUILDING TYPE	2B+GF+5, 2 dwelling/floor									
BUILDING YEAR	1966									
IDENTIFIED OPORTUNITY	No elevator installation									
F_ Ezozí bidea 2A, 2B, 4, 6, 8	<table border="1"> <tr> <td>NUMBER OF BUILDINGS/ DWELLINGS</td> <td>5 Buildings, 1 Housing block 54 Dwellings</td> </tr> <tr> <td>BUILDING TYPE</td> <td>3B+GF+5, 2 dwelling/floor</td> </tr> <tr> <td>BUILDING YEAR</td> <td>1959-66</td> </tr> </table>	NUMBER OF BUILDINGS/ DWELLINGS	5 Buildings, 1 Housing block 54 Dwellings	BUILDING TYPE	3B+GF+5, 2 dwelling/floor	BUILDING YEAR	1959-66			
NUMBER OF BUILDINGS/ DWELLINGS	5 Buildings, 1 Housing block 54 Dwellings									
BUILDING TYPE	3B+GF+5, 2 dwelling/floor									
BUILDING YEAR	1959-66									

	<p>IDENTIFIED OPORTUNITY</p>	<p>No elevator installation (Except ezozi bidea 8)</p>
---	------------------------------	--

2_ TXURRUKEN GOIKOA



<p>A_ Txurruken kalea 1-7</p> 	<p>NUMBER OF BUILDINGS/ DWELLINGS</p>	<p>7 Buildings 1 Housing block 64 Dwellings</p>
<p>BUILDING TYPE</p>	<p>SB+GF+3, 2 dwelling/floor</p>	
<p>BUILDING YEAR</p>	<p>1960</p>	
<p>IDENTIFIED OPORTUNITY</p>	<p>No elevator installation</p>	

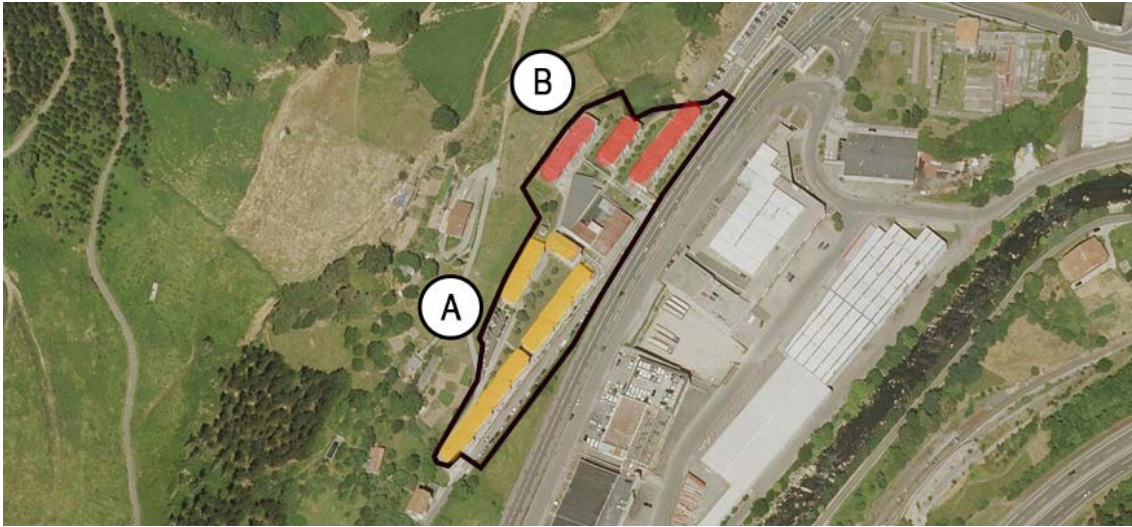
3.3.3 NEIGHBORHOODS IN ELGOIBAR

- 1. OLASOGAIN
- 2. URAZANDI
- 3. URRUZUNO



Figure 3.6 Neighborhoods in Elgoibar

1_ OLASOGAIN



A_ Eulogio estarta kalea 11-20



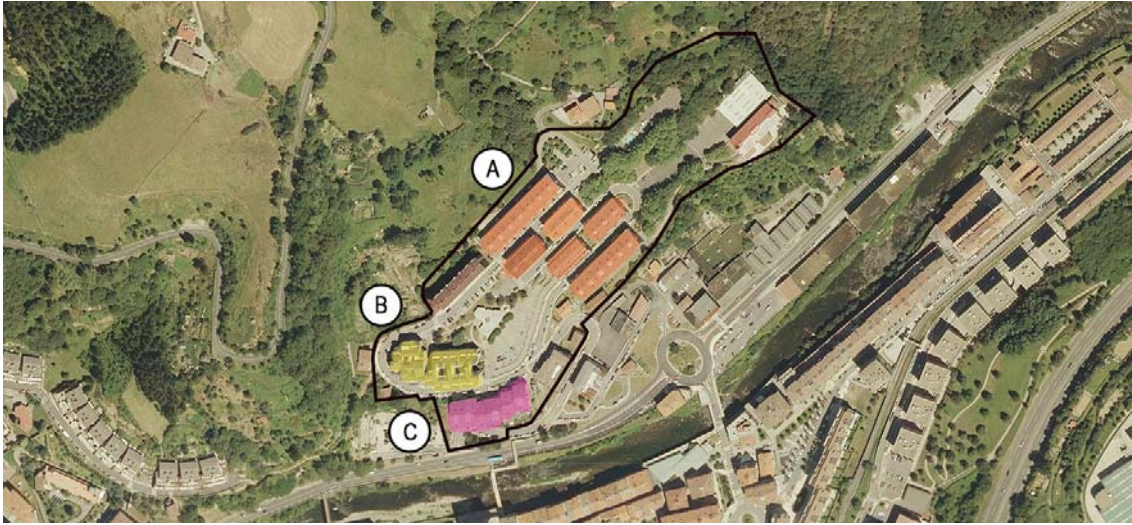
NUMBER OF BUILDINGS/ DWELLINGS	10 Buildings 4 Housing blocks 81 Dwellings
BUILDING TYPE	GF+3, 2 dwelling/floor
BUILDING YEAR	1956
IDENTIFIED OPORTUNITY	No elevator installation

B_ Eulogio estarta kalea 1-9



NUMBER OF BUILDINGS/ DWELLINGS	9 Buildings 2 Housing blocks 72 Dwellings
BUILDING TYPE	GF+4, 2 dwelling/floor
BUILDING YEAR	1962
IDENTIFIED OPORTUNITY	No elevator installation

2_ URAZANDI



A_ Urazandi kalea 30, 32, 34, 49, 51, 53, 55, 57, 59, 61; Kalamua kalea 2, 4, 6, 10, 12, 14, 15, 17, 19, 21, 23, 25



NUMBER OF BUILDINGS/ DWELLINGS	22 Buildings 6 Housing blocks 207 Dwellings
BUILDING TYPE	3B+GF+3 / GF+6, 2-4 dwelling/floor
BUILDING YEAR	1975-79
IDENTIFIED OPORTUNITY	No elevator installation in 18 buildings from 22

B_ Urazandi kalea 20, 22, 24, 26



NUMBER OF BUILDINGS/ DWELLINGS	1 Buildings 1 Housing block 96 Dwellings
BUILDING TYPE	5B+GF+6-8, 3-8 dwelling/floor
BUILDING YEAR	1974-75
OTHER NEEDS OF REHABILITATION	-

C_ Urazandi kalea 9, 11, 13, 15, 17, 19



NUMBER OF BUILDINGS/ DWELLINGS	6 Buildings 1 Housing block 60 Dwellings
BUILDING TYPE	4B+GF+3, 2 dwelling/floor
BUILDING YEAR	1973
IDENTIFIED OPORTUNITY	No elevator installation

3_ URRUZUNO



A_ Iñigez karkizao kalea 1-5



NUMBER OF BUILDINGS/ DWELLINGS	5 Buildings 1 Housing block 62 Dwellings
BUILDING TYPE	GF+3, 2-4 dwelling/floor
BUILDING YEAR	1957
IDENTIFIED OPORTUNITY	No elevator installation

3.3.4 NEIGHBORHOODS IN ERMUA

- 1. SAN LORENZO
- 2. ZERUKOA
- 3. SANTA ANA
- 4. OKIN-ZURI
- 5. ONGARAI
- 6. GRUPO SAN IGNACIO



Figure 3.7 Neighborhoods in Ermua

1_ SAN LORENZO (ARI)



A_ Gipuzkoa hiribidea 56, 58



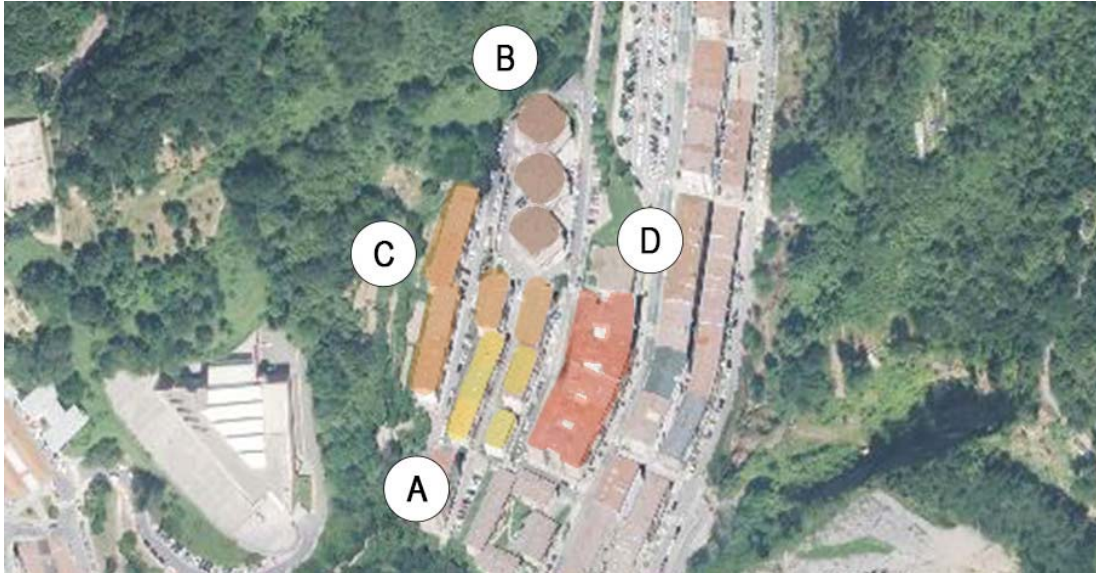
NUMBER OF BUILDINGS/ DWELLINGS	2 Buildings 1 Housing blocks 128 Dwellings
BUILDING TYPE	GF+8, 6-10 dwelling/floor
BUILDING YEAR	1965
IDENTIFIED OPORTUNITY	-

B_ Gipuzkoa hiribidea 14, 16, 18



NUMBER OF BUILDINGS/ DWELLINGS	3 Buildings 1 Housing blocks 96 Dwellings
BUILDING TYPE	GF+6, 8 dwelling/floor
BUILDING YEAR	1965
IDENTIFIED OPORTUNITY	-

2_ ZERUKOA



A_ Zerukoa 1 kalea 1,3; Zerukoa 2 kalea 1, 3, 5



NUMBER OF BUILDINGS/
DWELLINGS

5 Buildings
3 Housing blocks
55 Dwellings

BUILDING TYPE

GF+5, 2-3 dwelling/floor

BUILDING YEAR

1964

IDENTIFIED OPORTUNITY

No elevator installation in
Zerukoa 1 kalea 1,3 and
Zerukoa 2 kalea 3

B_ Zerukoa 2 kalea 7, 9, 11



NUMBER OF BUILDINGS/
DWELLINGS

3 Buildings
3 Housing blocks
66 Dwellings

BUILDING TYPE

GF+5, 4 dwelling/floor

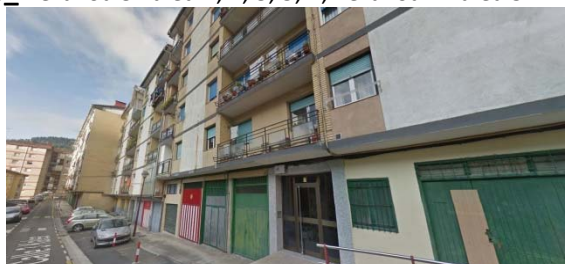
BUILDING YEAR

1974

IDENTIFIED OPORTUNITY

-

C_ Zerukoa 3 kalea 1, 2, 3, 5, 7; Zerukoa 2 kalea 5



NUMBER OF BUILDINGS/
DWELLINGS

6 Buildings
4 Housing block
99 Dwellings

BUILDING TYPE

GF+5-6, 3 dwelling/floor

BUILDING YEAR

1968

IDENTIFIED OPORTUNITY

No elevator installation in
Zerukoa 3 kalea 2


D_ Zerukoa 1 kalea 2, 4, 6; Zubiaurre hiribidea 35, 37

NUMBER OF BUILDINGS/
DWELLINGS

5 Buildings
1 Housing block
164 Dwellings

BUILDING TYPE

GF+8, 4 dwelling/floor

	BUILDING YEAR	1966
	IDENTIFIED OPORTUNITY	-

3_ SANTA ANA



A_ Santa Ana 1 kalea 2, 4, 6; **Santa Ana 2** kalea 1, 2; **Santa Ana 3** kalea 1-3



NUMBER OF BUILDINGS/ DWELLINGS	6 Buildings 4 Housing block 64 Dwellings
BUILDING TYPE	GF+3, 2 dwelling/floor
BUILDING YEAR	1962
IDENTIFIED OPORTUNITY	No elevator installation

4_ OKINZURI



A_ Okin-zuri kalea 3, 5, 7, 9, 11, 13



NUMBER OF BUILDINGS/ DWELLINGS	6 Buildings 1 Housing block 96 Dwellings
BUILDING TYPE	GF+4, 4 dwelling/floor
BUILDING YEAR	1966
IDENTIFIED OPORTUNITY	-

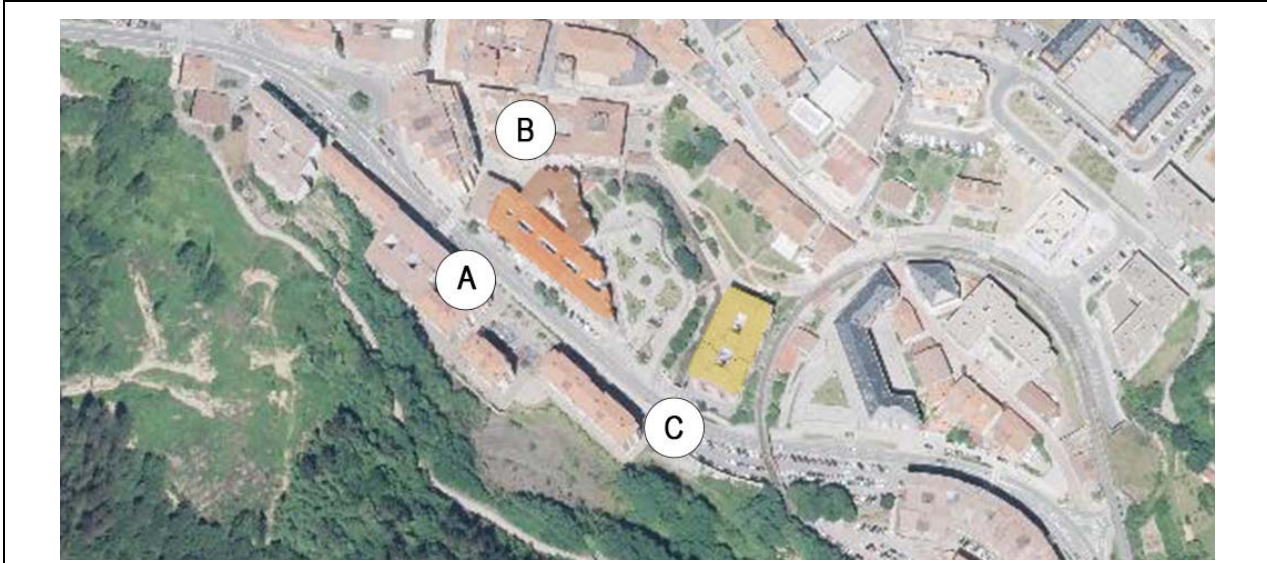
5_ ONGARAI



A_ Ongarai auzoa 1-15

NUMBER OF BUILDINGS/ DWELLINGS	15 Buildings 5 Housing blocks 369 Dwellings
BUILDING TYPE	(1-3)B+GF+5, 4 dwelling/floor
BUILDING YEAR	1968

	<p>IDENTIFIED OPORTUNITY</p>	<p>No elevator installation in Ongarai 11</p>
<p>B_ Ongarai auzoa 17, Aldapa kalea 6, 8</p> 	<p>NUMBER OF BUILDINGS/ DWELLINGS</p>	<p>3 Buildings 2 Housing blocks 96 Dwellings</p>
<p>BUILDING TYPE</p>	<p>GF+7 / B+GF+8, 2/4 dwelling/floor</p>	
<p>BUILDING YEAR</p>	<p>1974</p>	
<p>IDENTIFIED OPORTUNITY</p>	<p>-</p>	

<h2>6_ GRUPO SAN IGNACIO</h2>		
		
<p>A_ San ignazio etxetaldea 1-5</p>	<p>NUMBER OF BUILDINGS/ DWELLINGS</p>	<p>5 Buildings 1 Housing block 90 Dwellings</p>
<p>BUILDING TYPE</p>	<p>GF+5, 4 dwelling/floor</p>	
<p>BUILDING YEAR</p>	<p>1960</p>	
<p>IDENTIFIED OPORTUNITY</p>	<p>-</p>	

		
<p>B_ San ignazio etxetaldea 5-8</p> 	<p>NUMBER OF BUILDINGS/ DWELLINGS</p>	<p>3 Buildings 1 Housing block 36 Dwellings</p>
	<p>BUILDING TYPE</p>	<p>GF+6, 2 dwelling/floor</p>
	<p>BUILDING YEAR</p>	<p>1960</p>
	<p>IDENTIFIED OPORTUNITY</p>	<p>No elevator installation in San Ignacio 8</p>
<p>C_ Bizkaia hiribidea 2, 4, 6</p> 	<p>NUMBER OF BUILDINGS/ DWELLINGS</p>	<p>3 Buildings 1 Housing block 90 Dwellings</p>
	<p>BUILDING TYPE</p>	<p>GF+7-8, 4 dwelling/floor</p>
	<p>BUILDING YEAR</p>	<p>1976</p>
	<p>IDENTIFIED OPORTUNITY</p>	<p>-</p>

4 Oslo

4.1 Initial replication plan, Oslo

The Norwegian partners are involved in two main replication channels in Norway, which can be used to multiply the experiences from the ZenN project, and the Økern renovation pilot in particular, among a wide range of stakeholders and projects:

- a) FutreBuilt: a 10 years programmes of Oslo and Drammen municipalities
- b) Framtidens Byer: The Cities of the Future programme in Norway

a) Future Built

FutureBuilt² is a ten-year program with a vision of showing that it is possible to develop carbon neutral urban areas whilst maintaining high quality architecture. The goal was to complete about 30

² Rusten, B., Stoknes, S. (2011). FutureBuilt – a program for realising best practise climate effective architecture and city areas. Conference proceedings of the SB11 World Sustainable Building Conference in Helsinki, 18-21 October 2011. Available on USB.

pilot projects – urban areas as well as individual buildings – with the lowest possible GHG emissions. These pilot projects will contribute to a healthy city environment, whilst the process itself will contribute to competence building and innovation.

The process and the results of the pilot projects will be conveyed both to Norwegian and international markets throughout the duration of the program. The communication will be continuous, and the documentation, sharing of experiences and on-site exhibitions related to the different projects will take place as they are being completed. The program lasts from 2010 till 2020, and projects will be completed throughout the entire period.

FutureBuilt was originally an initiative of The National Association of Norwegian Architects together with the Norwegian State Housing Bank. The cities of Oslo and Drammen were invited to join the process, because dedicated local authorities is necessary in order to achieve good results.

FutureBuilt has now expanded into a collaboration consisting of nine partners; The municipal authorities of Oslo and Drammen, the Norwegian State Housing Bank, Enova (a state company formed to promote environmentally friendly restructuring of energy consumption and generation in Norway), Transnova (a state program established to reduce GHG-emissions from transport), Green Building Alliance, the Ministry of the Environment, National Office of Building Technology and Administration and the National Association of Norwegian Architects. FutureBuilt has also become part of the governmental program Cities of the Future.

Pilot projects

FutureBuilt has sought out developers, both public and private, who are thought to have an interest in actualising pilot projects. Importance has been placed on finding strategically interesting projects. This could mean a large developer, a good location or that it is a type of project which is important to include in the project portfolio. The response has been great and as of March 2011 there are 13 building projects in the portfolio.

Competence development

FutureBuilt has prepared for a broad program for competence development and sharing of experiences. The involved developers are guided through the planning-, project- and building process with continuous dialogue, quality assurance, workshops for the project teams, access to expertise on material use, energy and transport, development of quality plans and GHG-accounts. Field trips are offered with the purpose of getting acquainted with the experiences of other countries. Germany and Austria are particularly interesting destinations in this regard.

FutureBuilt arranges tours to building sites and completed pilot projects to disseminate experiences within the industry. Seminars related to energy, materials, transport and plans for quality monitoring are offered to the involved developers and other interested parties.

The yearly conference is the arena for summing up the program, presenting the showcase projects and to discuss the way forward.

Communication

FutureBuilt is a communication project, in that the showcase projects are used as pioneers and inspiration to make changes in the entire industry. Continuous communication by online updates and regular newsletters is therefore important. The communication work in both CopenhagenX and IBA-Hamburg has served as inspiration for FutureBuilt. Arranging a more organised exhibition will be relevant at a later stage in the program period, but with 4 completed showcases to date a continuous display and communication is sufficient.

Developers

The developers (public and private) that enter FutureBuilt will receive a significant competence boost and become profiled as innovative, future-orientated and socially responsible actors. The developers will receive:

- Free support from field-specific experts in the areas covered by the quality criteria
- Offers on competence development through FutureBuilt's program for professional development which entails project gatherings, field trips, seminars and breakfast meetings
- Assistance to attain various subsidies (esp. within energy)
- Offers on linking of the pilot project to relevant R&D projects
- Swift and flexible municipal administration
- Reputation building and media profiling

Oslo and Drammen municipalities

Oslo and Drammen municipalities use FutureBuilt as a tool for urban development. The areas of Strømsø and Furuset were initially important urban development areas, in which FutureBuilt is being used to give a new direction for the urban development work. There is considerable political interest in both municipalities to find good tools and methods in working for a more climate-friendly urban development.

The municipalities also use FutureBuilt to improve their position as developers, and half of the pilot projects are accordingly public building projects. The municipalities wish to be frontrunners, and in this way contribute in developing the market for climate effective building.

Politicians perceive FutureBuilt as a specific and measurable way of working with climate related questions. FutureBuilt gives physical results providing good opportunities for profiling and media coverage.

Additionally, the city government of Oslo has ambitious plans to make Oslo a more climate neutral city. The target is to reduce the greenhouse gas emissions by 50 % (from 1990 level) by 2030. To reach its target the city government plans to:

- Promote climate neutral architecture using showcase projects through FutureBuilt.
- Further developing of the climate and energy funds, in order to stimulate building owners and developers to take actions to reduce the use of energy, especially in the existing building stock.
- All new public buildings should be built according to passive house standard or achieve energy class A.
- Phase out all use of fossil fuel in Oslo's energy production and increase the use of renewable energy.

The city of Oslo has ambitious plans for a more energy efficient city and will use policy and financial tools to achieve its targets. This will make the replication of the project possible.

b) Cities of the Future

Governed by the Ministry of Environment, the Cities of the Future programme³, which runs from 2008 to 2014, aims to create urban environments that facilitate low-emission lifestyles, combining high quality of life with climate change adaptation and low greenhouse gas (GHG) emissions. The Norwegian Cities of the Future programme encompasses 13 cities and their suburban regions: Oslo, Bærum, Drammen, Sarpsborg, Fredrikstad, Porsgrunn, Skien, Kristiansand, Sandnes, Stavanger, Bergen, Trondheim and Tromsø.

Norwegian municipalities are to a large degree depending on intensive co-operation with regional and national governments, industry, non-governmental organisations and inhabitants to drastically reduce their greenhouse gas emissions. Building on past experiences as well as ongoing and new

³ Framtidens Byer. The Norwegian Cities of the Future programme. <http://www.framtidensbyer.no>

initiatives, Cities of the Future provides a robust framework in which this co-operation can be intensified and tested to the fullest, aiming to reduce GHG emissions of the participating cities by 24% in 2020 and 35% in 2030 compared to 1991. Combined with the anticipated large rise in population, GHG emissions per capita are expected to reduce by 60% from 1991 to 2030⁴. The 13 participating cities and their suburban regions cover about half of Norway’s population, and will provide a good example for the other cities and regions in Norway.

The Norwegian Government is represented in the programme by 4 Ministries: the Ministry of Environment, head of the programme, the Ministry of Transport, the Ministry of Oil and Energy, and the Ministry of Local Government and Regional Development. In addition to the 13 cities, the Norwegian Association of Local and Regional Authorities and the Confederation of Norwegian Enterprises became partners in the programme in 2009. Furthermore, a wide range of organizations, research and educational institutions, and industries participate in the programme, in direct co-operation with their respective cities.



Location of the cities participating in the Cities of the Future / Framtidens Byer programme in Norway

Figure 4.1 Location of the cities participating in the Cities of the Future/Fremtidens Byer programme in Norway

The next table shows an overview of the main features of the national programme.

Table 4.1 Overview of the main features of the national programme.

⁴ CIVITAS (2010) Framtidens Byer statusrapport 2010. CIVITAS AS. Available for download at <http://www.framtidensbyer.no>

	Norway
Duration	2008-2014
Number of Cities	13 + suburban regions
Main Aim	Urban environment that facilitates environment-friendly lifestyles combining: <ul style="list-style-type: none"> • high quality of life • low GHG emissions
Scope and Leverage Effect	Urban and regional level, plus new neighbourhoods
Stakeholders	<ul style="list-style-type: none"> • Initiated by Norwegian government, run by Ministry of Environment • Including Ministries of Transport, Oil and Energy, Local Government and Regional Development • Municipalities participate voluntarily
	<ul style="list-style-type: none"> • NGOs, research and educational institutions, local communities etc
Topics / Sectors	<ul style="list-style-type: none"> • Land use and infrastructure • Stationary energy • Waste and consumption • Climate adaptation

A short summary of the main features of the three national programmes for urban regeneration

Topics and Sectors

The Norwegian programme Cities of the Future programme is based on four pillars in which each participating city is expected to develop and implement transition strategies: Land use and infrastructure; Stationary energy use; Waste and consumption; and Climate change adaptation. Each city is free to determine the measures and methods it employs in each of the four areas, with some overarching priorities.

Stationary energy use in new, existing and historic buildings, on building and district scale, is the most relevant pillar in relation to the ZenN project. Plus energy, low emission standards for new buildings are combined with a high degree of adaptation to local climate, site and users in order to reduce energy demand to the largest extent possible. Generation of excess renewable energy can be used to compensate for existing and historic buildings with a lower energy performance. Existing buildings are renovated energy-efficiently and equipped with renewable energy systems, within reasonable boundaries provided by concerns for cultural heritage and functionality. Further synergies are attempted achieved by planning multi-purpose buildings and building groups. Functions such as kindergartens, schools and community centres are to be located in shared facilities, to reduce the thermal envelope and corresponding energy demand, to enable exchange between buildings with complementary energy loads, and encourage intergenerational encounters and understanding.

Success factors

A vital success factor for the programme is the multilevel governance and stakeholder participation, i.e., collaboration between national level, cities, regions, industry, NGOs, research,

local communities, and other actors at different institutional levels with competences and every-day experiences on urban environmental, social and economic matters. Studying and transferring their experiences – positive and negative – will be able to contribute to the creation of local and institutional capacity related to nZEB renovation also in the ZenN participating nations as well as on European level.

4.2 Reconsidering the initial replication plan, Oslo

Økern nursing home was successfully selected as a pilot project in the FutureBuilt program. At the 2015 FutureBuilt conference, the conference participants visited Økern nursing home to see the renovated building.

The initial replication plan is focusing on the channel's for replication – not the replicability of the solutions.

4.2.1 Technical aspects

- What became a success and should be replicated to other similar projects?

All the passive measures and the energy production solutions has been a success and have already been replicated to other projects.

It is profitable to reduce the energy demand of the building by 60-70 % when renovating it. In addition - roof areas could be used for energy production. The PV installation has worked properly and could be said to a success.

- What could have been done better and how could this have been done?

The lighting system did initially not function as planned. The solutions were new at the market and had not been tested properly. Combined with a very short testing period for the technical solutions (due to a delay in the project) the solution was not working when the tenants moved in. This is unfortunate because of the risk for the users to get a negative impression of the functionality of the technical solutions.

When it comes to the monitoring equipment there has been a lot of obstacles on the way. The monitored data has a lot of errors and needs to be filtered to get the right impression of production and consumption results. The SCADA system did not work as first thought and a lesson learned is that monitoring equipment must be well defined at an early stage of the project.

- What has been learned?

This was the first building Omsorgsbygg has where PV's have been installed. The experience has been positive and Omsorgsbygg has since then replicated the PV solution and installed PVs on the roofs of three more buildings (kindergartens and residents for seniors). Omsorgsbygg has enacted a new strategy where one of the measures to reach the city's environmental goals is to use the roof area of new buildings for energy production. This would not have been possible without the learning from the ZenN project.

4.2.2 Economical aspects

- What became a success and should be replicated to other similar projects?

The financial scheme has been a success. The total cost of 17 MNOK (for the energy efficiency measures and energy production) had a payback time of 7, 5 years after including the support from the Norwegian state and the EU. The most important lesson learned is that these measures are profitable.

- What could have been done better and how could this have been done?

A part of the scheme has been to develop and implement “green leasing contracts” for the tenants at Økern and in other buildings, to finance energy efficiency investments. This is still under development and will be implemented from 2016/2017.

4.2.3 Environmental aspects

- What became a success and should be replicated to other similar projects?

The energy production system has been a success and should be replicated to other projects as we will need to provide more clean energy for the transport sector. Passive measures should always be the first measures you do as it saves energy and provides more comfort for the tenants.

- What could have been done better and how could this have been done?

The LCC analyses made by SINTEF suggest that it would have been more cost efficient to go even further on the passive measures, which in next term would have been improved the outcome related to environmental issues.

4.2.4 Social aspects

- What could have been done better and how could this have been done?

The testing period was too short. It took almost a year to correct all the errors. This has nothing to do with the energy efficiency measures, however many of the tenants connected the technological problems with the energy targets. Another problem was that the employers did not have time to learn the systems properly. They were very busy moving the tenants

- What has been learned?

It's important to take the time to properly test out the technical systems. Automatic lighting systems have to be adapted to the user group.

4.3 Updated replication plan, Oslo



Figure 4.2 Økern nursing home before and after renovation

Since the renovation of Økern has been finished for a long time (since 2014), the most important replication has already been done. The project has gained massive attention in Norway with press coverage and presentations at conferences and has resulted in an increased focus on both energy savings in nursing homes and renewable energy production on buildings.

The main goals of the project was to prove that renovation into more energy efficient buildings with energy production could be financial plausible. The goal was to reduce the energy demand by 66 % and in addition apply photovoltaic (PV) on the roof to provide the building with 10 % of its energy need. This resulted in 790 m² of photovoltaic panels, creating the largest PV panel park in Oslo.

The energy renovation of the buildings gave the project an extra cost of 16 M NOK. The ZenN project and Enova covered about 8 M NOK of the extra cost. However as the buildings now consumes less energy there is an annual saving of 1,7 M NOK on the energy bill, giving the project a payback time of 7,5 years. Omsorgsbygg is working on a green leasing contract scheme within the ZenN project in order to finance the investment made for the energy efficiency measures with the energy savings.

1. Energy efficiency measures in nursing homes

Using the example of Økern nursing home, Omsorgsbygg has proven that investing in energy efficiency measures in nursing homes is financial beneficial for the municipality with a payback time in less than 8 years. This has resulted in:

- 23 M NOK in the 2015 budget allocated to energy efficiency measures in nursing homes. This is the first time any funding has been allocated to energy efficiency measures in public buildings. The funding has been used to do energy efficiency measures on four additional nursing homes, reducing the collected energy demand by a little less than 5 GWh/y.
- 36 M NOK has been allocated to energy efficiency measures in nursing homes in the 2016 budget.
- In the city's new energy strategy there is a goal to roll out green leasing contracts in all projects/contracts in order to finance energy efficiency measures in public buildings.

2. Photovoltaic panels on the roof

Økern nursing home is the largest PV project in Oslo and the knowledge and production results are available to everyone that has an interest. There is still little knowledge about grid connected PV panels in Norway and ZenN has been an important project, demonstrating that we can produce energy from the sun this far north. This has resulted in:

- Omsorgsbygg is currently planning three more large scale PV systems on roofs and facades of our buildings
- As the first municipality in Norway, Oslo has launched a scheme to help finance PV panels on private housing
- The city council is allocating 20 M NOK a year to apply PVs on public building.

5 Malmö

5.1 Initial replication plan, Malmö

The City of Malmö is in a stage of initiation a broad initiative towards the housing and construction sector. After a number of years where a number of initiatives have created tremendous changes when it comes to new built houses, the time has come to approach the owners of existing buildings. A large number of buildings in the post-war building stock are in a bad shape and in a big need for renovation. The same buildings do often have bad energy performances. The new initiative will be in a form of stakeholder groups with property owners, construction companies, financial instates etc. The ZenN project will create valuable insight and therefore be closely followed by the stakeholder group.

The actions implemented in the Malmö demo project and also in the demos in the other cities will be closely followed and disseminated in workshops, by webpages and by written information.

The aim is that the actions implemented in the project will be seen as mainstream and implemented in future renovations in the building stock. Year 2020 should all renovations be done in order to assure energy reductions 50 % or above.

5.2 Reconsidering the initial replication plan, Malmö

5.2.1 Technical aspects

- What became a success and should be replicated to other similar projects?
- The technical performance of the overall retrofitting program has been near the expectations when relating to the energy and environmental results achieved in total. The final energy demand reduction of 40 % (with a possible improvement when individual billing of domestic hot water has been implemented) is relatively close to the calculated 53 %. Since the primary energy reduction was 33 % compared to the calculated 27 % (higher reduction than expected) and the climate impact reduction was 38 % compared to the calculated 46 %, the overall performance could be described as near or in line with the expectations.
- The exhaust air heat pumps have been monitored displaying a COP of 4.1, which is an efficiency of high technical standard. The monitoring has though also displayed that the heat pump solution work at a smaller scale than expected, i.e. both a lower electricity use and lower heat recovery than expected in the simulation stage. This means that it does not contribute as much as expected to a final energy decrease. Still, due to the primary energy factors for district heating and electricity (see D3.3 and D3.4), this smaller scale of the solution is beneficial for the primary energy reduction. If the same amount of heat that is recovered by the heat pumps would instead have been delivered from the district

heating grid, this would have implied a slightly lower primary energy consumption than the primary energy consumption caused by the heat pumps' operation electricity.

- The metered generation of PV electricity was higher than expected, 3.5 kWh/(m²*year) compared to 3.1 kWh/(m²*year) in the simulation, implying a technically successful solution. A normal-year correction method described in D3.3 imply that the generation could be lower other years (29 % more global solar radiation at a horizontal surface in Malmö during the monitoring year than a normal year). This still implies that the average generation will be at least in line with the expected also years ahead.
- The performed property electricity retrofitting measures have improved the building energy performance more than according to the simulation. The sub-metering system indicates that especially the lighting electricity use is very low.
 - What could have been done better and how could this have been done?
- The individual billing system for domestic hot water is a demanding measure to implement, and could not be implemented on time during the project. The actual metering system was installed in time to give sub-metering data for the monitoring analysis, but with long delays. The process from an implemented metering system to an implemented billing system has proved to be a time consuming task. Overall, a better plan and an earlier implementation would have been needed.
- It is difficult to evaluate from the monitored data if a larger scale of the heat recovery system would have been technically possible (as expected in the calculation). If focusing on further final energy reduction, an evaluation of the possibilities for doing this is recommended.
- The general difficulties with adjusting the heating system have been illustrated and the average apartment temperature varied between approximately 21.3 and 21.6 °C during the heating season of October to April in the 3 high-rise apartments, which were the ones studied. They therefore seem slightly over-tempered since the property management aims for 21 °C as a continuous average during the heating season. The higher placed apartments (floor 6-8) also, without exceptions, had a lower average temperature than their lower placed equals (floor 2-5) for all the apartment categories (gable apartments, single-sided and double-sided). To achieve more even average temperatures between the different groups of apartments, adjustments/optimisations on more levels of the heating circuits probably has to be done.
 - What has been learned?
- A general outcome is that the combination of measures applied give significant energy reductions both in a final and primary energy perspective. Even if applying exhaust air heat pumps (which do not contribute to primary energy consumption in these prerequisites), a rather balanced solution could be achieved where reductions are made in both perspectives.
- Conformity between calculated and monitored electricity generation by the PV cells is high.
- The sub-metering system of property electricity has given a good overview of the performance of the technical installations. Any malfunctions in the system will be very simple to detect if continuing to make a follow-up of the data. Also, the general performance could easily be compared with expected values on e.g. a yearly basis.
- The indoor temperature metering data give a clear view of the heating-system adjustment needs.

- The full implementation of individual metering and billing of domestic hot water could be very time consuming. Preparations to handle possible delays are important.

5.2.2 Economical aspects

- What became a success and should be replicated to other similar projects?
- The measurements of the renovated buildings have not yet been carried out for a full year. Therefore the full potential of the energy efficiency measures is not visible. Despite that, the costs have already decreased with more than 40 %. It is expected that the energy savings targets will be reached and with that the costs reduced even further.
- The experiences from the Lindängen buildings will be used by Trianon when other buildings are renovated, and that is already initiated as there are plans to improve the energy profile of all the other buildings. When a property is energy renovated, the relevance of all measures implemented within ZenN are taken into account and evaluated, from window exchange to heating system.
 - What could have been done better and how could this have been done?
- The procurement was done too much for one product or area at the time. If they had been done in a more coordinated way there would have been more economies of scale, and the entire project would have been cheaper and cost efficient.
 - What has been learned?
- It has become obvious that it is not needed to do large investments in order to reach large savings.
- There is a risk that investments like these leads to increased rents. That in turn might lead to tenants moving since they cannot afford to stay. Therefore, an analysis of the target group should be carried out, and the investments adjusted according to their ability to pay rent.
- The Trianon model, with modest increases of rent and a long-term view on the ownership is difficult to apply for companies that e.g. need to deliver financial reports every quarter.
- The buildings, as well as the society, become more sustainable through these measures.

5.2.3 Environmental aspects

- What became a success and should be replicated to other similar projects?
- The overall combination of measures should be seen as generally successful in relation to the expected values for the retrofitting project. The primary energy reduction is somewhat higher than expected and the climate impact reduction is near the expected (see values in Chapter 5.2.1 above). Considering that further savings will be possible e.g. when the individual billing system of DHW is implemented, the environmental performance should be seen as a success in relation to what would have been possible.
- In a primary energy perspective, the smaller scale than expected of the exhaust air heat pump solution is a success due to the primary energy factors applied (see Chapter 5.2.1 for further explanations).

- The PV cells have generated electricity according to the expectations, and should be a reliable solution to implement for a better environmental performance of similar neighbourhoods.
- The measures implemented that have decreased the property electricity demand (LED illumination installations, new elevator engines, more efficient laundry room machines, new ventilation fans etc.) are important environmental contributions of the project. They are especially important in a primary energy perspective due to the high primary energy factor of electricity.
 - What could have been done better, and how?
- Overall, the total heat demand has not decreased as much as expected (probably partly due to the incomplete implementation of the IMD system for domestic hot water, see point below). The monitoring analysis show that the higher space heating demand compared to the calculation depends on a lower heat recovery from the exhaust air heat pumps as well as on lower total savings from the other heat system measures combined (new heat stations, new heat exchangers, new pumps, system adjustment and window exchange). For example, heating system adjustments on more levels than of the heating circuits would help to furtherly decrease the heating demand and thereby the environmental impact.
- A full implementation of the IMD system during the project time would have increased the saving incentives for the tenants during the monitored period, and could have increased the DHW use and environmental impact more.
- Possible improvements to increase the environmental reliability of the exhaust air heat pump solution could be seen from the monitoring data. The reliability would increase if applying heat pumps with an even higher COP than 4.1. A COP of 5 would have meant an approximately neutral effect of the heat pumps in a primary energy perspective (see further descriptions in D3.4). Also, by ensuring a purely renewable operation electricity supply for the pumps (e.g. completely from local electricity generation), the environmental reliability should also be improved in the climate perspective.
 - What has been learned?
- A general learning is that the overall solutions and retrofitting measures combined in Lindängen should have very good potential in an environmental perspective also for similar cases, in terms of significantly reduced primary energy consumption and climate impact.
- If having resources to evaluate the monitored energy data, similar or even more extensive metering systems as applied at Lindängen, are very recommendable in future retrofitting projects for analysing the environmental performance and improvement possibilities. The detection of any deviations from calculated performance for each technical installation is clearly simplified, and further environmental improvements will be possible thanks to the monitoring results displayed.
- The property electricity measures have been very successful in an energy perspective compared to calculations, and should be very recommendable for replication. The reducing effect in a primary energy perspective with a reduction in the electricity demand is much higher than from reducing the district heating demand (due to the primary energy factors), which is savings from the electricity measures are especially important in an energy perspective.

5.2.4 Social aspects

- What became a success and should be replicated to other similar projects?
- The social terms in the contracting work (engaging resident in the contractor work) has been described very positively by terms of on-site work by the contractors and others. It has been given attention in media. The information door-to-door by local informers has been described as a very positive alternative compared to the contractor themselves informing door-to-door. The contractors of window exchange expressed positive opinions on the collaboration with these residents, also, staff on site, contractors and the consultant and have described positive opinions on the social aspect.
- The aesthetical and comfort (according to building owner) improvements of the buildings has been described as a “lift” for the area, means an improved living standard for the residents and more attractive apartments. It has been generally described by the facilities manager/janitors that when access is needed to the dwellings it is strategic to always include some measure which is an *obvious benefit* to the tenants. According to most of the stakeholders (residents, staff on site, contractors and the building owner) the area is advanced in a positive way, mostly aesthetically, through the retrofitting project.
- The local informers/social contracting.
- The local event with energy team. Builds knowledge on energy systems and engagement for energy efficiency.
- Making sure there is aesthetical improvements and not only technical, in these renovation projects. Makes it a social lift instead of just energy-wise.
- What could have been done better and how could this have been done?
- The process for engaging the local residents has been difficult, and described as problematic, as oppose to the actual work on-site with the local resident. The process could be eased up, it was performed through “Arbetsförmedlingen”.
- Apart from the social work engagement, the residents have almost not been involved at all in the renovation. An event organized by the contractors for technical installation has been described as a success, especially happenings connected to children has been described as successful.
- What has been learned?
- Local informers are positive for the work on site (simplifies the access to apartments etc.) and make the renovation process socially valuable.

5.2.5 Decision process

- What became a success and should be replicated to other similar projects?

There has been a “good bargaining position” for the real estate company for improving their district heating solution, which could serve as a model for future projects. The opportunity that has been considered; to change thermal energy solution to a geothermal heat pump solution made it possible to instead keep district heating and improve the contract for this district heating, by replacing the old

common heat station with one new modern heat station connected to every building. As the alternative heating solution arises and district heating is challenged, this decision process arises, where a more efficient district heating solution can be obtained through good bargaining positions.

- Quoted from D4.3: “One of the simplest financing schemes with no major difficulties in financing and good results was the Swedish demo site in Malmo. With a sole owner of the property – The Trianon company, there were no incompatibilities in the decision processes concerning the retrofitting. All plans were made by the same investor. What is more Trianon company did not have difficulties in obtaining funds for this venture due to a low LVR and consequently good loaning possibilities.” “In case of a very clear ownership structure, where only one owner is managing the buildings (as in the case of Malmo in Sweden) and has all the required funds for the renovation, the financial model is very simple and clear.”
- The inclusion of counting on increased property value is something that should increase the replication of these projects, should give more positive calculations of the investments.
 - What could have been done better and how could this have been done?
- Hard to evaluate before some years of operation whether decisions and process were good or not.
- There could have been a better material to use for decision-making in terms of performing the energy calculations. These have been hard to perform (required a lot of uncertain assumptions), according to the consultant for energy calculation, due to a lacking of sub-metered data to base the calculations on etc.. As a consequence, it has been hard to make assured propositions of measures. (The decision information is important for the decision process and needs to be detailed enough...)
 - What has been learned?
- For a property company with good financial space (loan possibilities etc.) it should be good to decide on similar retrofitting measures as been done in this project. Calculated property value increase should preferably be included. Both the building owner and consultant of energy calculations have described that many property owners have the difficulty to see the profitability of this.
- The EU grant has been viewed as important to do the replication in this scale. This calls for the importance of generally having more financial security in doing this type of measures.
- Decisions can be formed successfully in innovation platforms between building owner and energy service contractors, as described by the energy service contractors.
 - What should be replicated to other projects?
- A simple and clear decision process can with success be replicated if the investment calculations are carried out with a full overview of e.g. increased property value. If only the correct decision information is at hand, a simple decision process could be beneficial.
- There are good possibilities to bargain about improved efficiency in district heating delivery for property owners, since some (“new”) alternatives give competition for district heating.

5.3 Updated replication plan, Malmö

The so called “Trianon case” has gained massive interest in Malmö and in Sweden. Many property owners and decision makers on local and national level have listened to the story on how to combine non-invasive energy efficiency measures with out-of-the-box financial thinking and social aspects in order to reach a substantial decrease in energy use. In that way, the replication has kind of lived its own life during the ZenN project.

5.3.1 Plan for replication

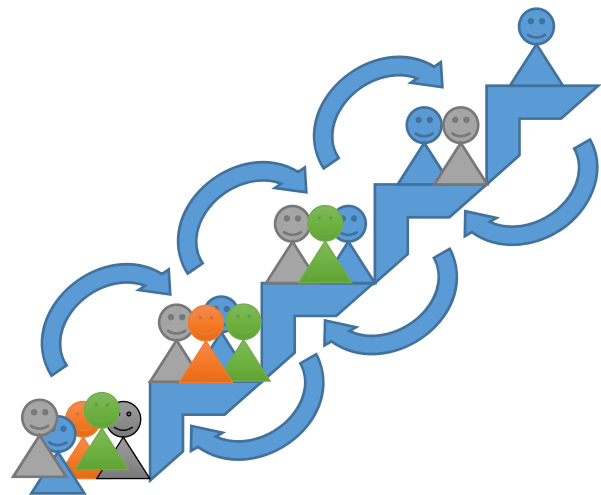
In order to make sure that the dissemination continues, and that it actually leads to replication, a number of key actions at local level have been identified:

Strengthened energy advisory function from the City administration. There will be increased personnel resources, and the Trianon case is an important part of their tool box. There is also a web-based tool under development, which will give automated but individual advice. This will be launched during Q4 2017.

Supporting applications for funding. There is a possibility to apply for national funds for financing of ambitious energy efficiency measures. The city will help property owners with these applications, and combine that help with information on the possibilities identified within ZenN. This approach will be tested in a city district with start Q3 2017. If it is successful, it will be geographically enlarged during 2018.

One district at a time. The City of Malmö is cooperating with the property owners’ association in the challenged area Sofielund. Through the deep contact with the property owners their challenges and wishes become apparent and can be addressed properly. The idea of non-invasive and cost-efficient energy renovation is highly attractive to them. This is an on-going initiative, that will be spread to other districts from 2018 and onwards.

Peer-to-peer learning. There will always be a difference between property owners when it comes to a number of factors concerning energy efficiency investments: interest, financial situation, ambition, capability, etc. The City of Malmö wants to try an approach where more advanced property owners support others through inspiration, courage, experiences and examples. The ones receiving support will later on be giving support to yet other property owners. See figure. This approach is not realized as of now. The City needs external funding for implementing the initiative, and will apply for that during 2018.



5.3.2 Potential for replication

Technical replication. Most of the technical installations in the buildings are directly transferrable to other buildings. Others are more or less specific for buildings with similar preconditions.

- Exhaust air heat pump is beneficial in houses with a relatively high heating need and with a mechanical exhaust air system. It is also possible to introduce such a system in order to be able to recover the heat.
- Changing to high-performance windows is a relatively expensive measure, and might not always be financially sound. If there is a need for exchanging windows, the extra cost for higher performance is not that large. But from a technical perspective it is replicable in any house with lower-performing windows. It is important, though, to make sure that the building has proper ventilation if it is made more air-tight.
- New heat exchangers can be introduced in houses with a connection to a district (or local) heating network. If the heat is produced locally, there is no need for heat exchanging in this way.
- Measures connected to adjusting the heating system (circulation pumps, radiators etc) are often both easy and cost-efficient. Many systems are not properly fine-tuned, something that leads to heat leakage.
- Replacing older equipment with newer most often leads to electricity savings. If the purpose also is to decrease costs, a thorough analysis needs to be done so that the investment is not higher than the cost savings. From an environmental perspective there should also be an analysis on the environmental cost for the new product in relation to the decreased environmental impact from its usage.
- Photo-voltaics are technically feasible in all houses. They are especially useful in areas with a high electricity need that correlates with high sun irradiation. For example in buildings in sunny and warm areas where air conditioners are installed. Even if it is technically possible, it might still not be recommendable in a specific building. Factors that needs to be taken into account are e.g. positioning of the house, shadowing, roof inclination and maximum load on the roof.

Economical replication. For the property owner, the financial situation of the project has been positive. This is partly due to the stable economic foundation of the company, enabling advantageous loans. This is of course a recommended situation to start with, but not one that is replicated in itself. The other important financial part of the Lindängen refurbishment project has been the inclusion of future increased property value in the calculations by the property owner. This made the decision to invest easier. This way of looking on investments could be transferred to other property owners; in general, more refurbishment projects would be realized if the decision makers were more willing to change their ways to calculate e.g. return on investment. Another factor to consider regarding the replication potential is that the property owner has a long-term view on the investments. This means that the model is not directly replicable by a commercial property owner noted on the stock exchange market, since they are often forced to deliver results several times per year.

Social replication. In general, the social aspects of the project could be replicated at any location. The social contracting, forcing contracting companies to hire locally, could be used by any actor at any place. One potential exception is actors obeying to the rules on public procurement, where it could be difficult to apply such a requirement. This needs to be tested. The idea to include aesthetical and comfort improvements along with the technical ones in order to make the inhabitants more content with their living conditions is probably universal and should be considered

in any refurbishment project. The result in Lindängen shows that tenants that are more involved in their surroundings don't move as often, something that is of high value to the property owner.

Decision process replication. In this case, the decision process has been fairly simple, since there is only one owner. Therefore, many decisions have been straight-forward and there is not much to learn in terms of replication. There is one aspect that might be replicated, though. Originally the plan was to replace the district heating with a heat pump, due to financial reasons. When this was communicated with the energy company a dialogue was initiated, leading to the district heating not being replaced but instead updated; and to a more attractive contract for the property owner. The replication potential lies in the flexibility from both sides before a final decision is taken and in the willingness to find a common (and innovative) solution.

6 Grenoble

6.1 Initial replication plan, Grenoble

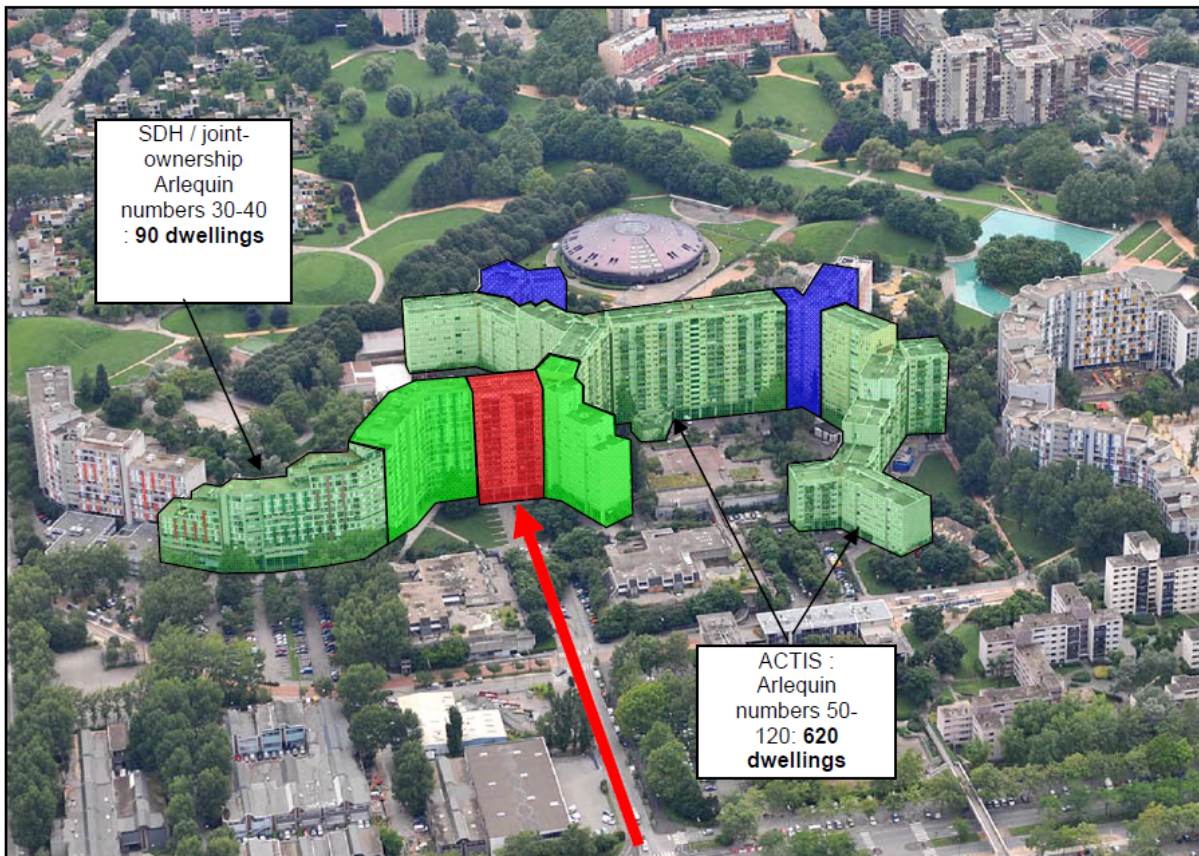


Figure 6.1 Illustration of the area and buildings to be renovated

The first step of the local replication plan from 2016 to 2020, will address the other buildings of the Arlequin plot with:

- 90 dwellings of the "Arlequin numbers 30 / 40",
- 620 dwellings of the "Arlequin numbers 50 / 120",

Globally, on the 2 first steps with the retrofitting of the dwellings owned by individual private jointowners, the replication potential in year 2020 should be as described hereunder:

- The co-ownership "Arlequin numbers 30 / 40" with 244 dwellings,

- The co-ownership "Arlequin numbers 50 / 120" with 951 dwellings.

In 2020, the local replication potential is equivalent to 1 200 dwellings all in the ARLEQUIN plot. After year 2020, the replication will address the totality of the 1800 dwellings as shown in the picture above.

This plan will be supported by the local dissemination actions as described in WP6, and maximizes the potential to be extended to the extensive stock of buildings of the same typology that can be found in France.

6.2 Reconsidering the initial replication plan, Grenoble

The replication plan can involve a possible extension to the whole VILLENEUVE area of Grenoble and of Echirolles.

The ARLEQUIN replication plan has still a target to retrofit 1650 dwellings more on the basis of the Zen-N experimental feedbacks.

The newly identified potential replication area is the Essarts-Surieux area of the city of Echirolles, which is located in the neighbourhood of ARLEQUIN. A total amount of 1500 dwellings has to be retrofitted in that area.



Figure 6.2 Picture of the Essart-Surieux area in Echirolles

6.2.1 Technical aspects

Some technical items has been identified as very critical to reach ambitious energy performances and comfort. These items have been studied thanks to dynamic energetic simulation tolls and other retrofitted building monitoring data. These are hereunder listed:

- Thermal bridges correction,
- Air tightness of building envelope,
- Heating control strategy with efficient technical solutions,
- Hydraulic architecture of heating water and DHW distribution.

The onsite feedback helps in understanding successful solutions and problematic ones. The analysis is based either on Zen-N experience, either on similar retrofitting operations.

- Thermal bridges correction: the architects and the firms have accepted to correct initial design on singular point, which have been identified. The technical solutions have been satisfactory. Nevertheless, it has been detected a missing correction concerning the mechanical interface between an outdoor stairways on one wall of Arlequin 40. The architect has forgotten to supply to MANASLU the drawings and the problem has been detected during a control visit, but it was too late to apply a corrective solution. The architects should be informed and trained to thermal bridge impact very early in the project cycle.
- The air tightness should be understood by all the people acting during dwelling retrofitting. Unfortunately, too many actors have not been trained to this new problematic and keep on behaving as before with former methodology and products. Such a problematic should be taken into account for next retrofitting projects with more training sessions of onsite workers.
- Usual heating control systems are not well adapted to allow a good indoor temperature regulation. In fact, in France, the usual system consists in thermostatic valves in each room with a global heating temperature water regulation. Such system should be completed with a 2 way valve controlled by a room temperature sensor, to ensure actual temperature control. This should be explained to design engineers, stakeholders and execution firms.
- Ventilation system are not studied and installed with enough care. It has been observed that in the case of extraction systems, the number of air inlets by rooms has not be checked by the firms and the engineers in charge of the design. After the commissioning checking by MANASLU, some inlets will have to be added, and others will have to be closed. This shows that ventilation of dwelling is not considered as critical by actors of building retrofitting.
- Monitoring system is very new for execution firms, especially in dwelling retrofitting. The installation of meters is common but monitoring data transfer and treatment are not known at all, even if Building Management System integrator have been involved, the necessity to get clean monitoring value data base has been difficult to obtain. This new monitoring field with singular activity concerning metrology and data base treatment has to be handled and managed more safely for the future projects.

- What has been learned?

- Architects should be informed and trained to thermal bridge impact and correction,
- All the retrofitting actors should be trained to know what is air tightness impact and how solve this problem in retrofitting project, with an adapted quality control process,
- Engineers and execution firms in charge of HVAC have to be informed about actual efficient heating control system to avoid inefficient system choice, and about ventilation system commissioning plan to be apply to warranty indoor air quality,
- Dwelling building retrofitting world actors are not yet involved by a warranty process for energy performance. Air tightness tests and other commission actions still need to be generalized.
- Quality of the work does not fit with initial target, and a commissioning actor is needed to control it in order to avoid bad surprise,

The, for the next envisioned retrofitting project, a commissioning work will be initiated at the beginning of the project to benefit of all this experience. This will be done in the frame of a French national action plan named PIA ANRU. The basis of the work to be done is described hereunder:

- Monitoring of the Arlequin 40 and 50 during an additional year to get more experimental data,
- Preparation of a References Manual in order to disseminate the ZenN experimental feedback (technical, economical, methodological, etc...) to retrofitting actors (stakeholder, architects, engineering firms, execution firms, etc...),

The energy monitoring to start this summer and next fall will give us a good feedback of obtained performances. Unfortunately, today, it is not possible to compare initial values and real ones.

6.2.2 Economical aspects

The renovation was a part of the national program of urban renewal for la Villeneuve. Consequently, the financing clauses were defined by the general and financial regulations of L’Agence nationale pour la rénovation urbaine (National Agency for Urban Renewal - ANRU).

SDH was responsible for the renovation of the “40 Galerie de l’Arlequin” (154 dwellings). The operating costs amounted to 83 000€ per dwelling, reaching a total of 12 900 000€.

The diagram presented below shows the proportion of funding sources applied by SDH. As indicated in the graphic subsidies received and taken loans constitute the majority of acquired funds (respectively 43% and 37% of the budget). SDH provided 1/5 of the investment cost.

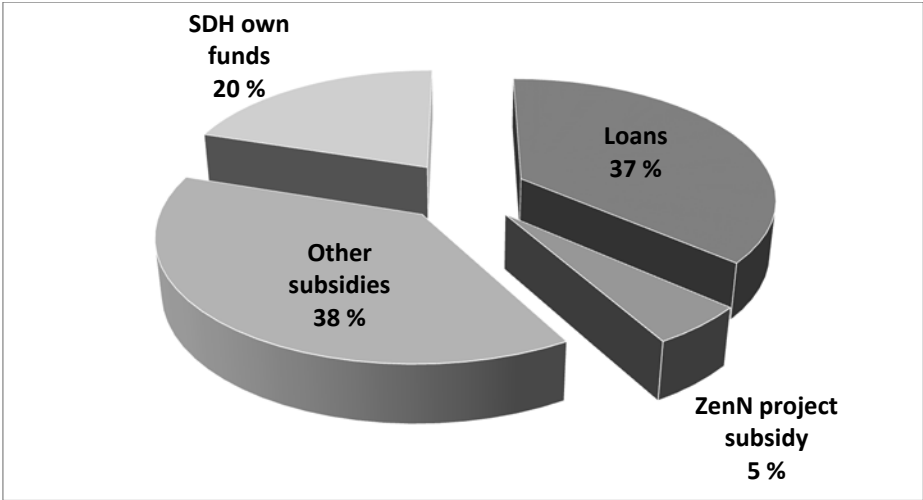


Figure 6.3 Share of SDH financing sources

ACTIS was in charge of the renovation of the East and West of the “50 Galerie de l’Arlequin” (89 dwellings). The operating costs of ACTIS amounted to 75 281€ per dwelling. The renovation costs of the 89 dwellings in the East and West of the “50 Galerie de l’Arlequin” amounted to a total of 6 700 000 €.

The diagram presented below shows the proportion of funding sources gathered by ACTIS. As indicated in the graphic – subsidies received constitute the majority of funds (51% of the budget). ACTIS own funds covered almost 1/4 of the total investment cost. The responsibility for raising the funds for the retrofitting fell to the building owners (SDH and ACTIS) and the city of Grenoble. The funds were mainly public, from both the national and local levels.

- What has been learned?

All the financing sources were essential to achieve the goals established in the project. ANRU's financing was the largest, while the additional influence of the ZenN financing was related to the opportunity to conduct more intensive, deeper energy efficient renovation. The financing of the project was enabled by the commitment of all the financial partners, but the cost for both ACTIS and SDH is perceived as high, and mostly higher than the initial forecasts.

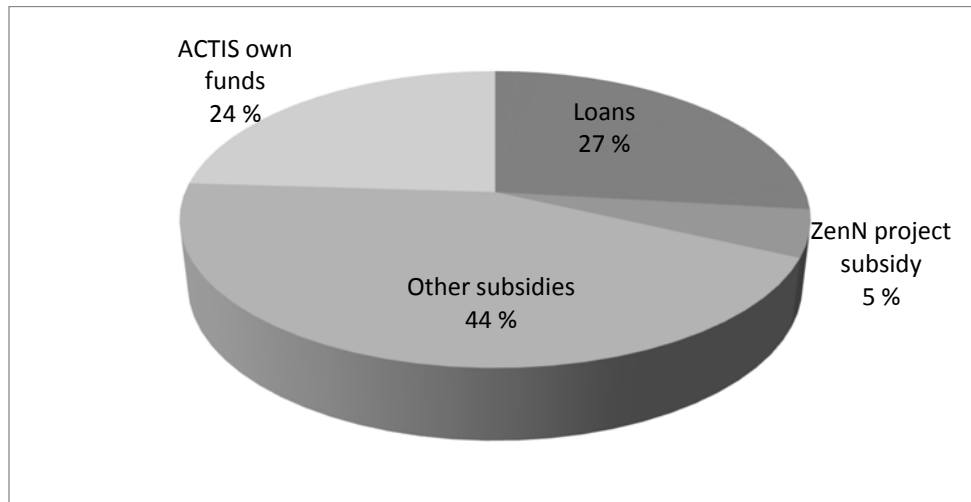


Figure 6.4 Share of ACTIS financing sources

Several parameters influenced the investment level badly and became an unexpected cost. Among those was the increased VAT level from 1st January 2015 and the new regulations on asbestos complicating the intervention of the workers (included in the SDH costs).

However, a precise analysis of the real cost will have to be made at the end of the work, to identify expenditure items responsible for cost overruns, and to work by the same on optimizing the technical and economic model.

This is all the more necessary as the most important difficulty regarding the financial side of the energy efficient renovations is related to the lack of sustainability of the financing over the time. The ANRU convention was signed for a defined period of time (2008-2015). It is now finished and still the new National Program of Urban Renewal (NPNRU) is not yet operational and is also limited in time (2017-2025). Furthermore, the financing clauses of the NPNRU, defined by the new general and financial regulations of L'Agence nationale pour la rénovation urbaine (National Agency for Urban Renewal - ANRU), are less favourable than the former. In the absence of exemption from the ANRU, this could affect the ambition of the future program.

6.2.3 Environmental aspects

The environmental targets should be reached after retrofitting as no major disturbance has been identified. Only the one year monitoring will confirm it. The probability to even progress in that field is potentially feasible in a second step according to modification work to be done on the Urban District Heating Network.

On the basis of first onsite feedbacks, the first conclusions are:

- The positive impact of thermal insulation of building facades, with an even higher impact for insulation products made of wood. It is the case for the ARLEQUIN 40, with industrial panels made with a wooden structure, inducing CO₂ storage capacity. Such solution should be replicated for façade with the same kind of construction typology for which, the facade can be substituted.
- The onsite solar energy generation is managed in an industrial way without major difficulties. The design and building integration has been done without major difficulties. Nevertheless, an unexpected industrial default has been identified, and panels have to be changed during winter 2015 /2016. Consequently, photovoltaic energy is an industrial solution, with proven results, but with the necessity to keep an eye on quality and actual on-site performances to check on-site efficiency and lifetime.
- The Urban District Heating Network is already feed with biomass. Consequently, the heat has a low environmental impact. Nevertheless, the improvement of the network efficiency is with the possibility to reduce global thermal losses. Such a potentiality will be studied during years 2016 and 2017 to launch experimental improvement work locally of the network. The identified improvement are :
 - Modification of the connection of substation to the high pressure loop in order to reduce temperature of feedback to the heating production site.
 - Integration of storage systems at the level of the sub-station to shift peak demands during winter season. Such a proposal has already been proposed at the beginning of Zen-N project by MANASLU, but energy cost modification did not help in choosing this solution at that time.
 - Integration of renewable energy with creation of low pressure loops locally. This kind of solution will be easier in the neighbourhood like other sectors of VILLENEUVE in Grenoble and in Echirolles, as the ARLEQUIN did not offer good condition for this. For example, the possibility to integrate heat recovery on grey water has been studied by MANASLU at the beginning of the Zen-N project, but distances were to long between the heat recovery system and the substation to be efficient.

- What has been learned?

- Thermal insulation has a strong and positive environmental impact and should be replicated to other projects and generalized.
- Solar photovoltaic systems can be integrated without any major difficulties, but a commissioning work from the study to the onsite monitoring should be made, as for any other technical works, in the frame of other projects.
- Urban District Heating Network performance has to be improved with integration of renewable energies and a better global efficiency. Reliable solutions to be evaluated will have to be duplicated to the other projects.

The energy monitoring to start during summer and fall 2016 will give us a good feedback of obtained performances. Unfortunately, today, it is not possible to compare initial values and real ones.

6.2.4 Social aspects

Considering works in an occupied site, the preparation period had been long to reduce the duration of the works.

Tenants were informed about the project throughout its duration:

- Before the work started, the nature and benefits of the project were presented and explained, preparing the construction phase ;
- During the work, residents were continuously informed and efforts were made to minimize negative impacts on daily life: such as setting up transition apartments, operational rehousing when necessary, fastening the processes of intervention, pay attention to complaints with recruitment of a full-time person, etc. ;
- The inhabitants of the neighbourhood were also consulted and received a wide range of information in the framework of the Urban Renewal Project (URP).

The system put in place by ACTIS, SDH and City of Grenoble worked quite well, although tensions have recently arisen due to the duration of the works, and noise caused by certain interventions (sawing concrete slabs for example).

A few months from completion, residents seem to carry a positive outlook on the transformation of both 40 and 50 Arlequin. But only a precise assessment will confirm whether or not this impression.

After the work finalized (in the months to come in our case), it will be necessary to accompany the inhabitants. Tenant behavior can constitute between 30 and 40% of the energy gains. There is a further need to develop a general awareness on other matters that will sustain the investment: the production and management of waste, for instance, or the installment of satellite aerials on the facades.

6.2.5 Decision process

- What were the major challenges?

- First: To convince the social landlords, ACTIS and SDH, to increase their level of ambition of their operations by signing up alongside the city in the experimental project ZenN.
- Setting up intervention processes on very specific, complex and inhabited buildings. It was particularly difficult in the case of SDH. Indeed, it was necessary to invent, in partnership with companies, an efficient process for the removal and replacement of the facades on a high building (15 floors). The elaboration of new prefabricated elements of façade demanded the conception of several prototypes before starting the phase of industrial production and installation.
- Matching the ZenN calendar with the urban renewal project of the district, which is part of a specific convention between the French State and subnational authorities (Région, Département, Métropole) has been challenging. For the addresses in co-ownership (80 and 100 Arlequin) this has been impossible to achieve in project deadlines. The heavy interventions necessary on the real estate required the conduct of preliminary studies, co-organized between the public authority and the homeowner associations, as well as finding of further public funding in order to gain the vote of the co-owners on the work.

- What has been learned?

- The ZenN project allowed the Grenoble demonstration site to go further in its energy use reduction strategy. The improvement of energy efficiency was the motivation and one of the priorities for ACTIS and SDH ;
- Regarding the decision making process, the resolutions concerning participation in the ZenN project were made jointly. The decision of a more ambitious level of retrofitting was made by the Municipality of Grenoble and the building owners. The public establishments in charge of social housing – Société Dauphinoise pour l'Habitat (SDH) and Société de gestion d'habitations à loyer modéré (ACTIS) decided to perform retrofitting at the “low-energy building” retrofitting level. Therefore, the role of the Municipality was to convince both these organizations that the ZenN project funding was an opportunity to develop an exemplary renovation in social housing, in term of energy consumption but also in term of project management ;
- The project is not over but its success has been conditioned by:
 - a strong political will, which gives an impulse to the process and brings the different actors together ;
 - a fruitful cooperation between the “technicians”, the project owners (social landlords), the companies and the project leader. The project leader must lean on experts (in this particular case “Manaslu”) in order to be able to initiate, coordinate and monitor ;
 - the good quality of the work, which depends on :
 - the training of the workers (the “compagnons”) to make the process of fabrication efficient
 - exchanges with the manufacturer during the prefabrication (SDH)
 - unexpected tests on the construction site to readjust things before the delivery of the construction ;
 - a continuous dialogue with residents (see before)

6.3 Updated replication plan, Grenoble

The main aim of the two building refurbishment sites of 40 and 50 ARLEQUIN was to experience technical, financial and juridical solutions to be replicated at the neighborhood level (social and private housing).

In order to ensure the knowledge transfer between social landlords and co-ownerships, a consortium of architects and specialized consulting firms was recruited in 2015 by the City of Grenoble, to help co-ownerships in programming / estimating their future work. The findings of its studies are expected in the coming weeks. They should feed into the future “co-ownerships backup plan”, being developed with the French state. This plan is expected to provide significant funding, required to vote the work by co-ownerships.

In September 2015, cities of Grenoble, Echirolles and Grenoble-Alpes Métropole jointly answered to “Programme d’Investissement d’Avenir - Villes et territoires durables” (Future investment program “Durable cities and territories”) national call launched by ANRU (Urban Renewable National Agency), with a retrofitting strategy based on the Zen-N knowledge. The perimeter of the proposed project includes the whole ARLEQUIN buildings, which represents approximately 1 300 housings, but also the

whole ESSARTS and SURIEUX buildings (Echirolles, approximately 1 500 housings), with two main objectives:

- develop management, exploitation and appropriation tools to ensure over time real performance and quality of use ;
- define and implement a strategy for an energy and economic optimization at the neighborhood level, with several possibilities relating to the heating system (heat storage, connection to the return water circuit, etc.).

The project proposed by the cities of Grenoble, Echirolles and Grenoble-Alpes Métropole, is one of twenty winners selected at national level by the Prime Minister.

At the end of a consultation launched in May 2016, Manaslu was given the studies to be conducted in two phases:

1. june-december 2016 : capitalization on the ZEN N project, defining goals for energy performance and quality of use, proposal of design, implementation and operation tools to ensure the real performance of future renovations with an optimized technical and economic model, development of a prototyping and deployment plan ;
2. 2017-2019 : demonstrators, deployment and evaluation

This study should help consolidate the ongoing refurbishment program across Arlequin (public and private housing), but also the Villeneuve of Echirolles (Essarts-Surieux), which represents a total of about 3000 housings.

Other cities in the Greater Grenoble, and even in France, might be interested in this global approach of energy issues applied to “disadvantaged urban area”.

Finally, the City of Grenoble and its sub-contractor MANASLU Ing. also engaged a transfer of the knowledge gained in Zen-N to the Metropolis of Grenoble. This latest has started a new retrofitting action plan for residential communities called “Mur/Mur 2”, with the study of the technical referential for different levels of energy consumption target. This study is made in cooperation with MANASLU Ing., which has been in charge of the Zen-N technical solutions choice. Consequently, the Zen-N solutions will be the references so as to reach the highest level of energy performance for residential communities. A potential of 5 000 dwellings in residential co-ownerships has been identified in the frame of this project.

7 Comparative study of the replication potential

This chapter presents a comparative study of the demonstrated renovation projects and related replication potential.

7.1 Technical aspects

- Upgrading the building envelope, especially regarding air-tightness, has been a crucial measure where it was deemed necessary. This introduces some challenges, because even through simple measures like replacing the windows, ventilation becomes more important for the indoor air quality. The buildings in Mogel do not have a centralized ventilation system, and indoor air quality depends on individual user behaviour. The upgraded air-

tightness of the envelope makes it very important to inform the residents about optimal ventilation.

- Optimal adjustment of heating systems can be an easy and cost-efficient measure. Many systems are not properly fine-tuned, leading to heat leakage. This was identified as a crucial measure at Arlequin. At the same time, proper functioning should be ensured. In Lindängen, monitoring indicated systematic differences in temperature between the top and the bottom of the buildings.
- Architects, engineers and contractors may be unaccustomed to the requirements of new and efficient solutions. Adequate training and information must be provided to prevent mistakes.
- Quality control and an adequate testing period is important. A fault was detected in the PV installation at Arlequin. At Økern, an inadequate testing period led to non-working lighting systems when the building was taken in use.
- Økern, Lindängen and Arlequin have installed PV systems as part of the project. This has been mentioned in all three projects as very successful, and it has already been replicated by Omsorgsbygg in Oslo.
- Care must be taken to set up communications with Building Management Systems and meteorology stations that can ensure sufficient access to data and safe data storage. Challenges with data handling have been experienced in Arlequin and at Økern.
- In Lindängen, an individual billing system for domestic hot water was very demanding to implement. A better plan and earlier implementation is recommended.

7.2 Economical aspects

- The cost and payback time of the project depends on the loans available. For Lindängen, with one financially strong owner, advantageous loans could be achieved. For Mogel, on the other hand, with individual low-income owners, banks did not provide competitive offers, and even with subsidies from the Basque Government, the payback time was quite long (>50 years) and could be carried on to future generations.
- Most projects rely on subsidies (51% in the Arlequin case), and this presents some lack of sustainability over time, as subsidy programs can have a temporary duration. The level of ambition is not attainable without some subsidy, so for replication it is important to map the available funding. Several of the projects combined multiple sources of funding
- Replication potential is highest when the property owner has a long-term view on investments and can accept a longer payback time. This can be a challenge with commercial property owners noted on the stock exchange market, for instance. It is recommended to focus on the future increased property value, such as return on investment, to the property owner(s). This makes the decision to invest easier. When accounting for all subsidies, the payback time of the Økern project was 7.5 years, which is a useful demonstration of the profitability of the project.
- Good planning and coordination of the retrofitting at a neighbourhood level can save cost and resources. Combining the retrofitting with other planned or desired installations in the neighbourhood can also benefit from synergy. In Eibar, several buildings were retrofitted simultaneously and this made the process more efficient. The renovation was also done together with improvement of accessibility in the buildings and in the neighbourhood common areas. For Lindängen, it was observed that the entire project would have been

cheaper and more cost efficient if the procurement had been done in a more coordinated way.

- An analysis of the target group should be carried out to decide whether the increased rent following the rehabilitation could pose a risk to the tenants. In the Lindängen case, investment was done with a long-term view, but this is not easy to replicate, and the risk could become higher in other projects. Green leasing contracts are being developed by Omsorgsbygg in Oslo as a means of additional funding for future projects, but this has not been tried for the current project.
- Publicity and support from local administration can make a big difference for further replication. In Malmö and Sweden, the Lindängen project has gained massive attention as "the Trianon case". This has impacted the city administration, which has strengthened their energy advisory resources and are using experience from the ZenN project.

7.3 Environmental aspects

- When several energy carriers are used for the same energy service (such as space heating), the GHG emissions and primary energy can be especially sensitive to changes in the user profile. At Lindängen, lower usage of a heat pump meant higher usage of district heating, and this lowered the primary energy use compared to estimates, but increased the final energy use compared to estimates.
- At the design stage, the primary energy factors used can make an impact on design choices, and indicate which energy carriers it is most effective to reduce. At Lindängen, where an exhaust air heat pump was installed, a COP of about 5 is necessary for the heat pump primary energy to be lower than that of the available district heating. However, if the heat pumps were ensured to be using local renewable electricity, then this drastically changes the calculation.
- Arlequin reported a positive impact from using wood-based thermal insulation alternatives. This induced CO₂ storage capacity in the building.
- Local heat generation with biomass is what enabled the Arlequin project to achieve a high renewable energy share. Being generated locally, the environmental impact was low, but further environmental gains could be achieved by reducing losses in the heating system.

7.4 Social aspects

The pilot projects involve a range of different social situations; multiple owners in high-density, low-income area (Mogel), separate building owners (Arlequin), a single owner of a residential complex (Lindängen) and public ownership (Økern).

- An effort was made to present the benefits the measures would have to the residents or users involved. Raised comfort, a social lift and increased property value were some arguments used. It could be very important to consider how different residents receive different benefits from the renovation – basement owners do not benefit from an elevator, for instance, causing some resistance in Mogel.
- Also in Mogel, guidance was provided to residents for applying for funding and filling the legal requirements for application.
- In Lindängen, an attempt was made to engage residents for contractor work. This received positive feedback, but was also described as problematic, as there was low involvement.

- Continued support to residents and users after completion is important. For Arlequin, tenant behaviour was estimated to be able to provide 30-40% of the energy gains. At Økern, not enough time was allotted for the staff to learn the new systems properly.

7.5 Decision process

- The number of owners varied between the projects. In Mogel, the ownership model made for a challenging project, and significant effort was made to convince multiple owners to join the project. Each building would vote over the propositions. Initiative was taken to hold meetings and events, and residents were given phone numbers to contact experts involved with questions on technical and funding matters.
- In Grenoble, decisions were made jointly between building owners and the municipality. There was political will to achieve a high ambition in energy performance and this helped convince the owners to agree to join the ZenN project. Arranging meetings between more interested and less interested stakeholders was therefore a good strategy.
- For Lindängen, a real estate company was the single owner of the buildings. Being able to reuse existing infrastructure became a good bargaining point, as a district heating station could be retrofitted to geothermal.
- Having appropriate investment calculations showing the increased property value can make the decision process simpler. For Lindängen, better material to use for performing the energy calculations would have been beneficial. The available data had many uncertainties. Detailed data should be used for these calculations when this is available.