Evaluation report on the replication programme

D5.13

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Lead	Bax & Company
Contributor(s)	Exeleria
Reviewed by	EnergyPro, Exeleria
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1 Introduction

The DREEAM project aims to demonstrate an integrated renovation approach for energy efficiency renovation at the multi-building scale that can reduce the net energy demand by 75%. DREEAM focuses on the deep renovation of social houses managed by a single owner with a large portfolio of residential buildings enabling EU-wide replication opportunities and with high energy saving potential.

Renovation programmes of housing associations start often from a “need” basis analysis, developing solutions for specific buildings without considering the benefit of long-term integrated renovation at scale.

Within the DREEAM project, a new integrated approach is used to support cities and housing association in 1) upscaling their sustainability ambitions and planning their investment at portfolio level (building stock investment strategy service of the replication programme) 2) looking at optimised packages that balance renewable energy generation and energy reduction measures to maximise energy savings (multi-building energy renovation study of the replication programme).

1.1 Task 5.2

The task 5.2 aims to develop and promote the replication programme for EU cities and housing associations to perform a feasibility scan for multi-building NZE renovations. The DREEAM replication programme offers “vouchers” to cities and housing associations, consisting of a package of staff capacity and direct costs that Bax & Company and Exeleria allocate for validating/applying the DREEAM approach to third party sites. As task and WP leader, Bax & Company is responsible for planning and implementing the replication programme, as well as for the interaction with key stakeholders. As “services” of the replication programme, Bax & Company provides investment planning advice and recommendations while Exeleria performs the technical analysis to identify optimal options for multi-building renovations including a cost-benefit study. Promotion of the EU multi-city replication programme is supported by DREEAM partners and network organisations.

The specific ambition is to support 15 cities and/or housing provides in different EU countries with renovation planning, in order to both assess the interest and potential in various national settings, as well as to localise and validate the approach across the EU market.

2 The DREEAM replication programme

DREEAM's overall objective is to trigger large-scale renovations at NZEB standards in the social and public housing sector. Within the replication programme, project partners Exeleria and Bax & Company (BaxCo) have used the DREEAM optimisation tool and the investment planning service to help building owners (BOs) develop an integrated renovation programme tailored to their needs and ambitions. This support includes:

- Long-range sustainable Investment planning: the BO's end targets are used as the starting point in DREEAM´s backcasting approach to develop investment strategies that are both viable and sustainable, working back from policy ambitions to create realistic pathways of delivering those;
- Exploring renovation solutions: multiple technology combinations are analysed to identify the optimal solution that delivers the most economic, social and environmental benefits at the multi-building level.

Piloting the DREEAM results with different decision-makers is proof of its replicability. It is then much more likely that the approach will be adopted internally and applied to the entire building stock, beyond the initial sample. This boosts the use of innovative technologies on a more significant scale, which creates the conditions needed for a bigger and better market offering. Finally, through this programme, partners have the possibility to engage with a large number of building owners and create those "good leads" that are relevant for future exploitation of the project results.

Having delivered the portfolio-level investment pathways in 8 different countries within the replication programme, the building stock investment strategy service has demonstrated the value of multi-building renovation and the replicability of the DREEAM approach across Europe. On the other side, the multi-building energy renovation study has demonstrated the value of technology integration at multi-building scale under different financial, technical and environmental conditions.

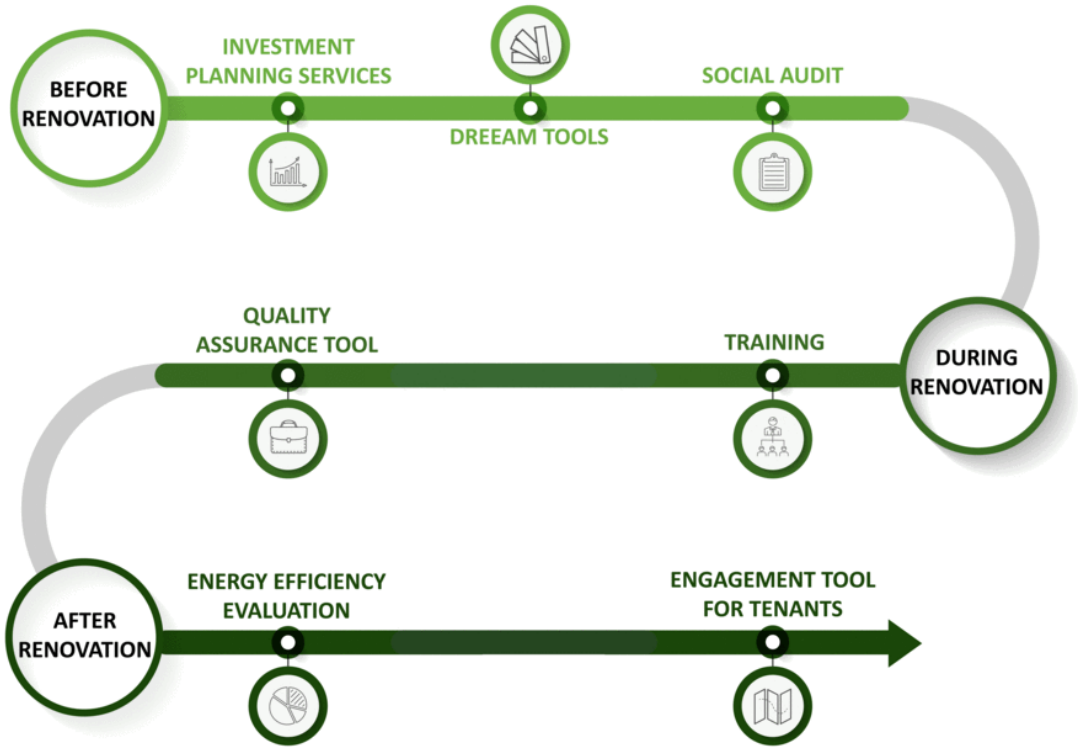


Figure 1. DREEAM replication services in the BOs' decision-making journey

Replication programme	Delivered
Multi-building renovation study	Riga (LV) – 2 sites Lviv (UA) – 6 sites Kriyvyi Rog (UA) – 3 sites
Portfolio investment strategy	De Alliantie (NL) Rotterdam (NL) Resonance (UK) Lublin (PL) Warsaw (PL) SYHA (UK) ATC Turin (IT) Riga (LV) Jelgava (LV) Valence Romans Habitat (FR) Strasbourg Ophea (FR) Armenia Social Housing Association (AM)

3 Building stock investment strategy

The first step of any building owner's decision-making process is strategy definition and investment planning. Bax & Company uses the project's data-driven backcasting approach to inform the BO's investment decisions and help shift the focus from a single building to scaled processes. With energy efficiency (EE) targets as the starting point, it is much easier to develop effective renovation strategies.

Working alongside DREEAM building owners, engaging with 30 housing associations and piloting the DREEAM replication service with 10 of them all led to a service that responds to current building owners' needs and address the challenges hindering the upscaling of EE renovation.

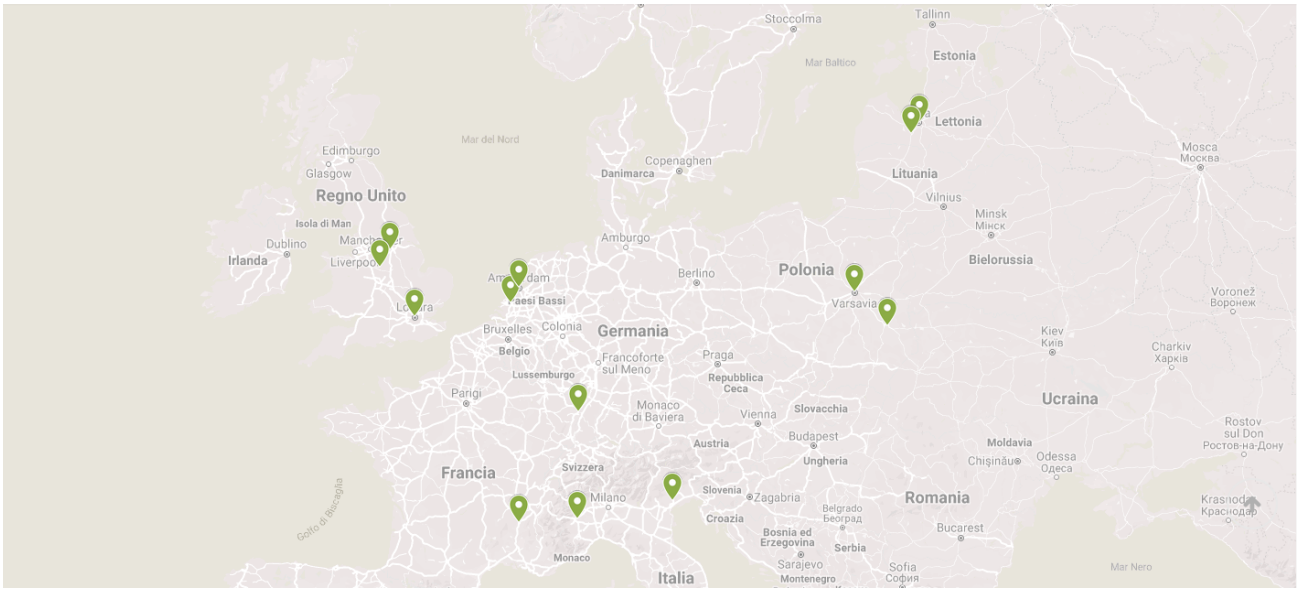


Figure 2. Building stock feasibility studies delivered in 8 EU countries.

3.1 The value of investment planning (service 1)

The investment planning services supports board-level decision-making about EE portfolio investments, thus demonstrating the value of multi-building renovation:

- **Tailored strategies for building owners –** the building stock investment service aligns with BO's priorities and existing development plan to promote long-term, positive investment;
- **Economy of scale** – By demonstrating the value of multi-building renovation, the service unlocks economy of scale: reduced cost of technology per unit, lower operational and capital costs;
- **Improved access to low-cost financing** – Long-term planning unlocks better financing terms and Access to national and European programmes versus the short-term financing based on available cashflow;
- **Upscaling renovation ambitions** – the analysis is particularly valuable for building owners with a particular sustainability push and/or are under financial or other constraints who need to upscale their investment in energy efficiency renovation. Sustainability targets are addressed at the board level for strategic decisions;
- **Enhanced value and performance –** overall system performance is improved by considering different technologies and aspects (economic/environmental) and programme implementation by following a long-term strategy

3.2 The impacts

Portfolio analysed: In the replication programme, we have worked with housing providers who collectively own over 700,000 dwellings spread across 8 European countries. Out of these, 300,000 dwellings were analysed, and investment scenarios were simulated for 150,000.

During the process, over 50 housing providers and cities have been approached and made aware of the potential of long-term investment planning. Within the co-operating entities, on average 4 to 5 professionals – typically including 1 or 2 decision-makers – were extensively involved. This means they are made aware of the importance and the viability of energy efficiency planning – especially where it creates synergy with reducing tenant's energy bills, and increasing building quality and comfort, and were trained in using available tools.

Several of the participants have used the approach as a direct input for, or as a second opinion on, long term investment planning. Some examples include;

- The city of Rotterdam has used the analysis to create a targeted go-to-market approach for different building owner types (private, social, commercial rent), and an EIB-supported €80M investment programme
- The maintenance company supporting Riga homeowner associations has used the analysis to develop a detailed renovation planning pathway for over 30% of the city's building stock, and approach the European Commission for process support funding, and a bank loan in the range of €30M.
- An Utrecht-based housing provider incorporated the analysis to define a better-informed renovation policy, both upgrading the minimum renovation qualities in its renovation policies, as well as moving away from near-zero energy renovations due to difficulties to sustainably finance as scaled programmes with such target
- More than five of the involved housing providers have changed internal analytical approaches and decision-making criteria. The most important of which has been is to see energy renovation in a broader perspective; that of tenant benefits. In particular, the use of energy bill reductions for tenants is considered a meaningful decision criterium. While not a direct cost-recovery component for the housing providers, it is considered part of the boarder mission to provide access to affordable housing, and reduce cost of living.

Potential CO_2 emissions savings: going beyond business as usual, the investment pathways proposed could increase housing providers' CO_2 savings by an average of 40%.

3.3 Feasibility scans and recommendations to building owners

3.3.1 De Alliantie, the Netherlands

With over 60,000 dwellings under management, de Alliantie is one of the largest housing providers in the Netherlands. With properties in the Amsterdam metropolitan area, de Alliantie aims to have an energy index of 1.25 by 2040 and be energy neutral by 2050.

Within the DREEAM replication programme, BaxCo has supported de Alliantie in developing alternative investment pathways, taking their ambitious sustainability ambitions as the starting point. By projecting de Alliantie's current investment strategy, the stated targets would not be met until 2043. Alternative strategies have been developed, focusing on deep renovations at a portfolio level, aiming for 5 label-step improvements. Such a programme would cover 9,882 dwellings at a cost of €225M, and achieve €109M in energy bill savings, with a 20% reduction in CO_2 use, making it more financially viable.

About

De Alliantie is a Dutch social housing provider with properties in the Amsterdam metropolitan area. With over 60,000 dwellings under management, it is one of the larger housing providers in the Netherlands. De Alliantie aims to have an energy index of 1.25 by 2040 and be energy neutral by 2050. More than 50% of De Alliantie's dwellings (over 32,000 units) are in multifamily buildings and the rest are mostly terraced houses. The majority of the stock was built between 1950s and 1990s, with a concentration of late 50s and mid 80s buildings. 60% of De Alliantie's stock has an energy label of C or below, and 37% is D or below. Dwelling are geographically clustered by type and age. These patterns suggest that there can be economies of scale in renovation – since buildings of similar archetype and year of construction will require similar interventions.

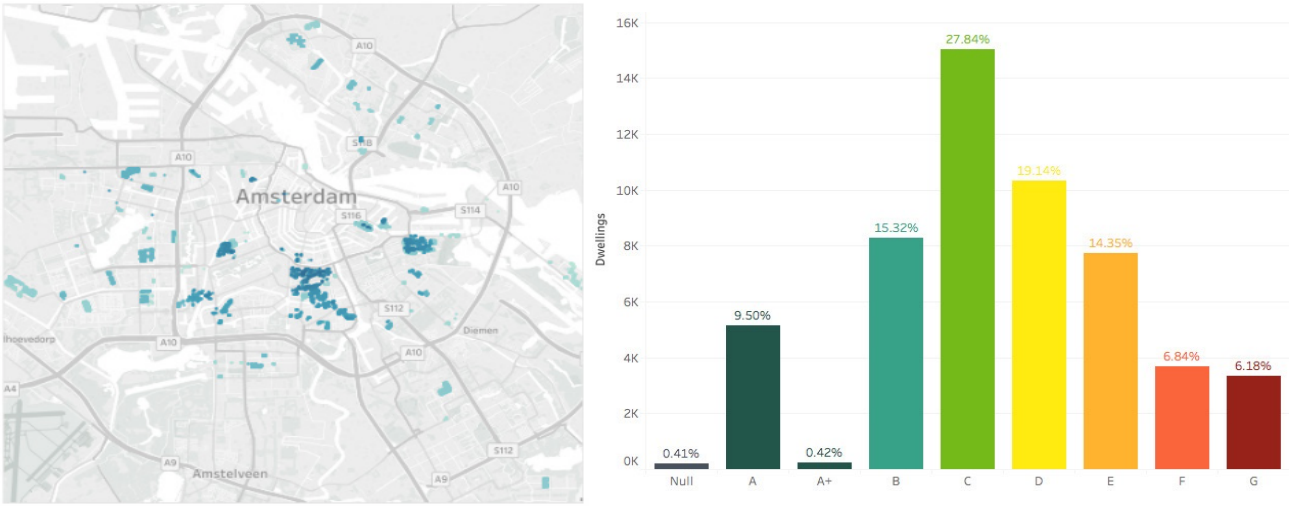


Figure 3. a) Age of the stock geographical distribution b) Stock energy label distribution

Renovation packages

For De Alliantie's stock, five renovation packages are proposed using the Energy Savings Browser created by the Netherlands Enterprise Agency. The browser compares the set of improvement measures against key indicators. Two main dwelling archetypes in De Alliantie's stock are defined: flats and houses. We focus on the most common

construction year within each group to develop estimates for shallow (1-2 label steps) and deep (3+ label steps) renovation packages. Thus, the renovation packages cover 29,090 units in the stock.

Flats – shallow and deep renovation

Renovation groups by type and label	Number of Buildings	Most common year	Renovation target	Renovation package
CD Flats	11022	1980s	Shallow (to C)	1
EFG Flats	6121	1970s	Deep (to A)	2
CD houses	6765	1945	Shallow (to A)	3
EFG houses	5152	1945	Deep (to C)	5
TOTAL	29090			

Most of De Alliantie's units are flats built in the 1980s and 1990s. Retrofit costs for these range from €11,600 (shallow) to €14,367 (deep) per unit.

Houses – shallow, moderate and deep renovation

A deep renovation of a house can reduce energy use by 75%, and cost €51,400. At a calculated monthly energy bill reduction of €229, the total savings are €68,700 over 20 years.

Investment strategies & Impacts

De Alliantie aims to increase its portfolio's average energy index (EI) from 1.75 to 1.25 and generate CO2 savings of 20%. This section uses a custom investment-planning model to project the impact of various investment strategies on key financial and energy indicators over an investment period of 15 years. The pathways allow De Alliantie to explore: the impact of continuing current strategies, the impacts of increasing the annual renovation budget, and the cost/energy savings trade-offs of different renovation ambitions. Projecting De Alliantie's current investment strategy over the long term using a shallow-renovation approach shows that the stated targets will not be met until 2043, 11 years after the deadline. To meet its energy targets, De Alliantie can perform shallow renovations on many units, or deeper renovations on fewer units. When following a strategy of shallow renovations, the objectives would be reached by increasing annual investments from €13.8M to €20M. This would achieve 20% CO_2 use reductions by improvements. Such a programme would reach 9,882 dwellings at a cost of €225M, and achieve €109M in energy bill savings, with 20% CO_2 use reductions. The deep renovation pathway is more financially-viable.

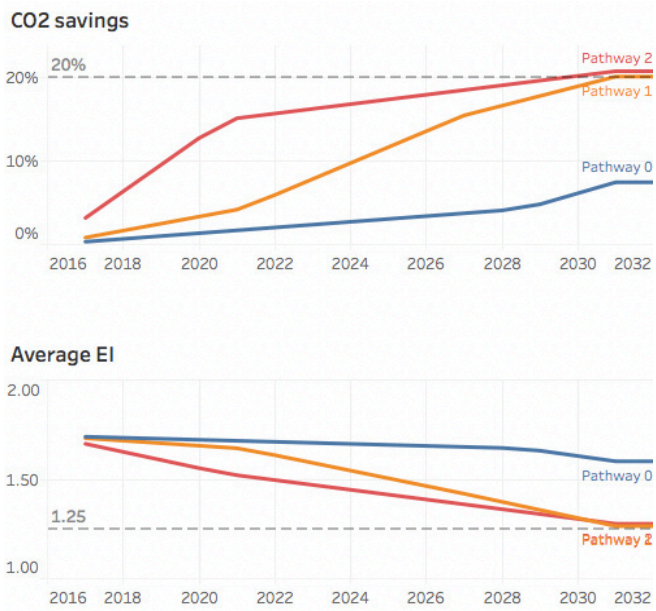


Figure 4. Investment scenario analysis

Conclusions & recommendations

Currently 60% of De Alliantie's stock has an energy label C or below. De Alliantie aims to have an energy index of 1.25 by 2040 and be energy neutral by 2050.

Potential for multi-building renovation

Similar buildings in the stock could achieve total energy bill savings of €16.9 million. An alternative strategy focuses on deep renovations, aiming for 5 label step improvements using alternative procurement strategies, bundling projects at larger scale. Comparable approaches show significant benefits in per-unit costs, increased quality and reduced overhead costs.

Recommendations

More detailed and accurate results could be achieved by: completing the data missing related to EPC and energy index; expanding the number of architypes and renovation options included; by validating actual costs and benefits based on De Alliantie's experiences; and/or by aligning impact with current "real options" which would allow for the costing programs currently being discussed at strategic level.

3.3.2 Gemeente Rotterdam, the Netherlands

For the first time, the DREEAM building stock investment strategy service of BaxCo has linked Rotterdam's homeownership databases with dwelling type, energy labels, and geolocation. The city of Rotterdam is the 2nd largest of the Netherlands, with a population of over 630,000 people and over 310,000 dwellings.

The analysis has helped the city to enhance its sustainability programme, Rotterdam Duurzaam, by pinpointing districts ideal for renovation, and even individual landlords and homeowners who would benefit the most from energetic renovation. The European Investment Bank now supports this targeted approach with a €3M ELENA grant.

About

The city of Rotterdam is the second largest of the Netherlands, with a population of over 630,000 people and over 310,000 dwellings. The city of Rotterdam wanted to assess quality of its building stock and obtain insights into building renovation strategies based on ownership and building type.

Data collection and analysis

The municipality's dwelling ownership and tenure database were connected to the national energy label database, showing that:

- The stock consists mostly of post-war terraced houses and low-rise multi-family complexes, about 35% has energy label C, about 45% is in the D-G range.
- The ownership structure shows a significant presence of social housing providers, with 220,000 dwellings (71%), followed by owner-occupiers (47,000, 11%). Small-scale commercial rental (<100 units) own 9% of the market, large-scale commercial rental 2%, and institutional investors around 3%.

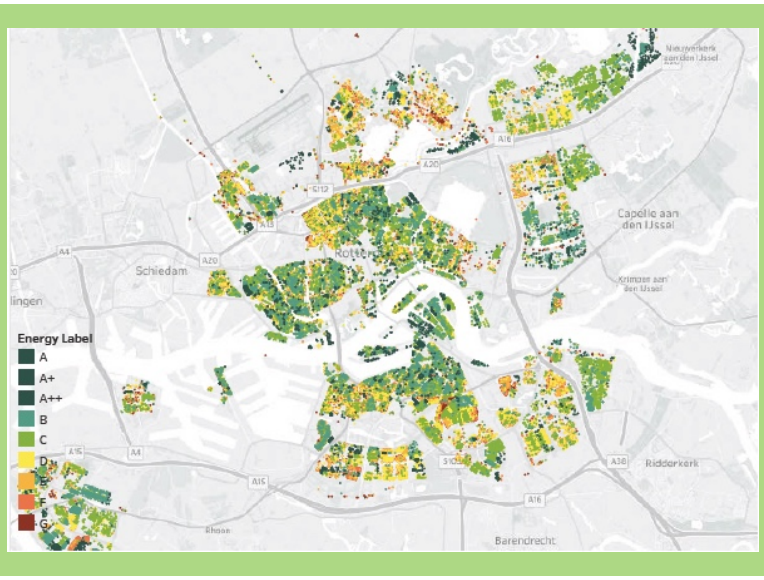
Owner Type	Buildings	% of Total
Corporaties	220,009	70.73%
Eigenaar bewoner	46,973	15.10%
Verhuur <100	28,518	9.17%
Institutionele	7,900	2.54%
Verhuur 100+	5,333	1.71%
Gemeente	1,241	0.40%
Overig	1,091	0.35%
Grand Total	311,065	100.00%

Energy Labels

Energy Label	Buildings	% of Total
A++	83	0.03%
A+	60	0.02%
A	23,872	7.67%
B	39,040	12.55%
C	112,742	36.24%
D	73,471	23.62%
E	29,707	9.55%
F	18,217	5.86%
G	13,873	4.46%
Grand Total	311,065	100.00%

Figure 5. a) Ownership profile of the Rotterdam stock b) Energy profile of Rotterdam stock

The Rotterdam city map shows energy quality of dwellings. Typically, lower quality dwelling re located in the northern parts of the city (such as Schiebroek, Noord, het Lage land), and sections in the south (Pendrecht, Lombardije and others).



Analysis of market structure

Ownership type and quality

Analyzing ownership type and building quality shows building quality varies significantly between groups. Most low-quality buildings are owned by social housing providers. Commercial landlords, both small and large, typically manage the lowest quality stock. Owner-occupier homes on average have the highest building quality (mostly due to recent year of construction).

Owner Type	Total	D	E	F	G
Corporaties	220,009	56,140	18,417	9,200	4,368
Eigenaar bewoner	46,973	10,479	5,827	4,062	3,341
Verhuur <100	28,518	5,061	3,967	3,746	5,184
Institutionele	7,900	593	222	333	99
Verhuur 100+	5,333	939	1,160	770	744
Gemeente	1,241	113	55	61	84

Figure 6. Rotterdam's portfolio analysis: ownership vs energy performance

Opportunities for multi-building renovation

The analysis shows that main opportunities for district (multi-building) renovation are in the south of the city, with either social housing providers or groups of small commercial landlords.

Sample Detail

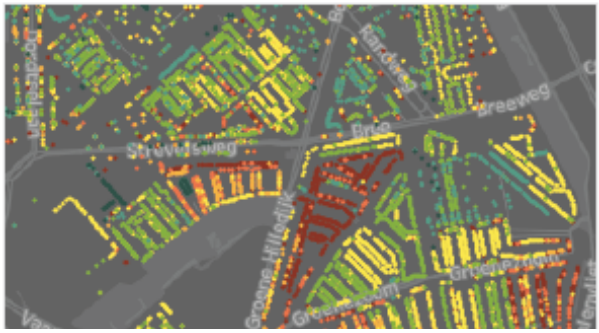


Figure 7. Detail of Vreewijk district

Example sectorial analysis: landlords

The analysis has identified the largest private landlords and has singled out those with particularly poor building quality, allowing design of targeted support schemes.

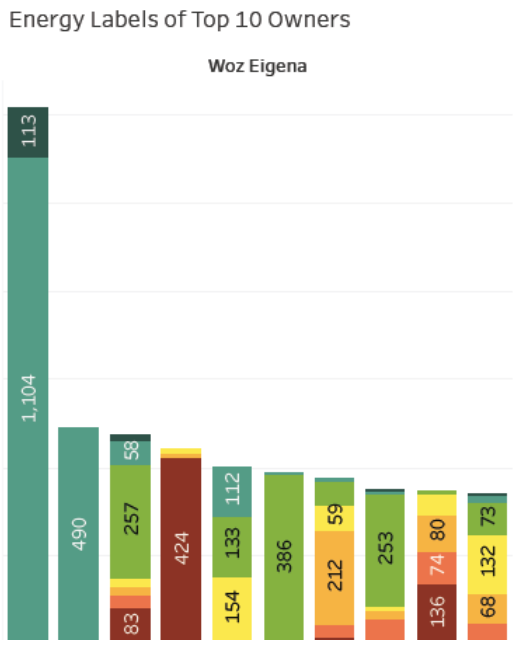


Figure 9. Sample stock quantity and quality per owner

Action taken by Rotterdam

The analysis has been used by the Sustainable Rotterdam (Duurzaam Rotterdam) programme, contributing to the following actions;

For private homeowners, in particular those organized in Home Owner Associations, a tailored Figure 8 has been produced. CO_2 savings & energy index projections of an investment pathway ´technical assistance´ programme has been created with the support of the European Investment Bank (through a €3M ELENA grant). The provides external expertise to prepare ambitious renovation projects*:*

- Institutional investors have been identified as a target group. Organisations will be approached individually with proposals and subsidies for roof-mounted PV, or technical assistance for deep renovation.
- With social housing providers, district-based renovation programmes are being planned and coordinated

3.3.3 Resonance, (UK)

This British social impact investment company manages a number of funds, such as the Real Letting Property Fund (RLPF) consisting of 259 dwellings in the Greater London area. Within the replication programme, the building stock investment strategy service by BaxCo has supported the development of different investment pathways enabling this building owner to pursue their environmentally responsible strategy to prevent fuel poverty and increase tenants' living standards. By investing £100,000 over 5 years, this building owner would be able to increase the 83% of their portfolio performance up to EPC C.

Background

A British social impact investment company manages a number of funds, such as the Real Letting Property Fund (RLPF), consisting of 259 dwellings in the Greater London area. It pursues an environmentally responsible strategy in order to prevent fuel poverty and increase tenants' living standards. This strategy aims to improve the average portfolio EPC rating from D to C.

Data collection and analysis

A comprehensive dataset was built combining information from technical and financial datasets shared by the BO, showing that:

- More than 88% of the RLPF's dwellings are low-rise buildings
- The majority of the flats were built after 1950, more than 50% between 1950 and 1970.

- The stock has an overall good energy performance; 40% have EPC label C and 38% EPC label B.

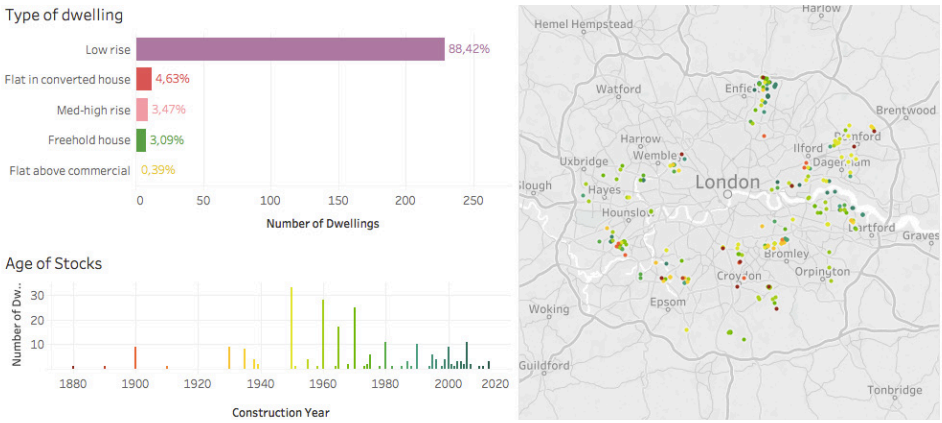


Figure 10. Distribution of the age of the building owner's stock and dwelling types.

Renovation Packages

The dwellings of the stock are mainly low and mid-rise flats which have been grouped according to their energy performance (spanning 3 main energy labels) in three main target groups *(Table 1).* Dwellings belonging to the same target group usually share similar construction characteristics and energy standards, enabling the identification of all interventions necessary to achieving the established energy efficiency targets.

Renovation package	Renovation groups by type and label	Number of Buildings	EPC	Renovation target
1	Flats	20	E	shallow/deep
2	Flats	88	D	shallow/deep
3	Flats	120	C	shallow/deep
	TOTAL	228		

Figure 11. Overview of renovation packages developed

Shallow renovation: does not necessarily involve an EPC label improvement and costs £550-690.

Deep renovation**:** entails an EPC label jump, higher energy savings but also higher investment costs (£2,700-£4,000).

The energy efficiency value

As the Real Lettings Property Fund aims to provide move-on accommodation for homeless individuals and families, this social investment impact company maintains its rent prices below the market rate. The average rent is 26% per below market rate. The market rent prices included in the data were calculated by comparing each property from the portfolio to the closest property match currently available on the rental market based on their indication. As shown in Figure 2. There is no direct link between the energy label quality and the rent price. Assessing the financial impact of energy efficiency interventions, rental values usually remained the same before and after renovations, while the dwelling value increased (estimation based on average 2016 RICS valuations per label).

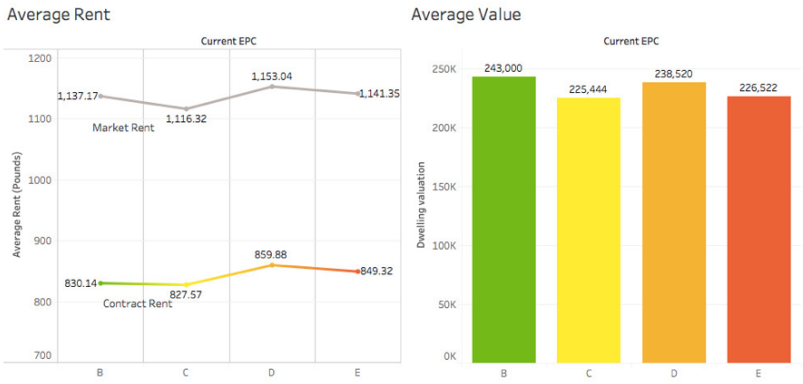


Figure 12. Average rent and value prices per energy label.

Investment pathways

The projection of the current investment practices in energy renovation shows that investing £100.000 over 5 years will bring 87% of the portfolio up to an average SAP score 73 (EPC C). By prioritising the dwelling groups with the poorest energy performance, this building owner would renovate 91% of the stock to EPC label C allocating the same investment. Alternatively, a deep renovation strategy with a higher annual investment of £65,000 would increase the average SAP score of the portfolio up to 75 and double the lifetime CO2 savings.

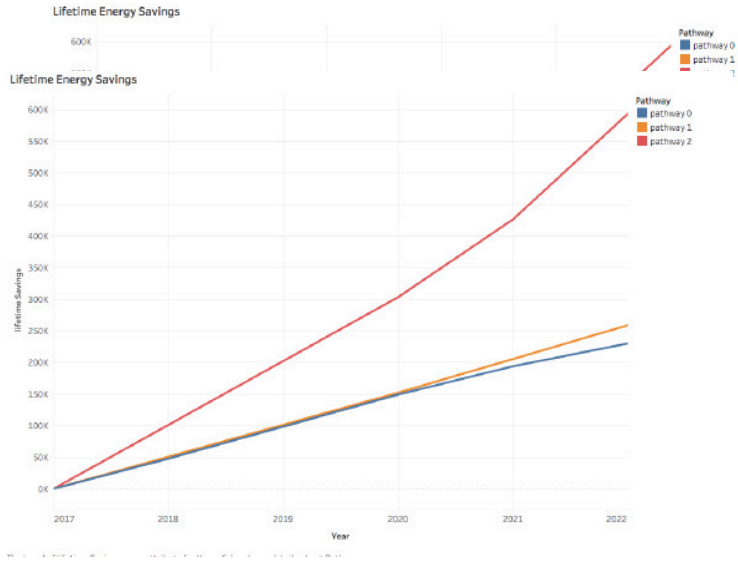


Figure 13. Lifetime energy saving projections of different pathways.

Social impact and financial returns

Investment strategies are often a trade-off between financial and social return. Improvements in living conditions need to be maximised while investment has to be recoverable through stock appreciation. Stock valuation before and after renovation has been estimated and projected according to the investment pathways developed. Pathway 2 generates the highest energy and CO_2 savings while still having a positive return on investments thanks to the stock's appreciation, related to better efficiency.

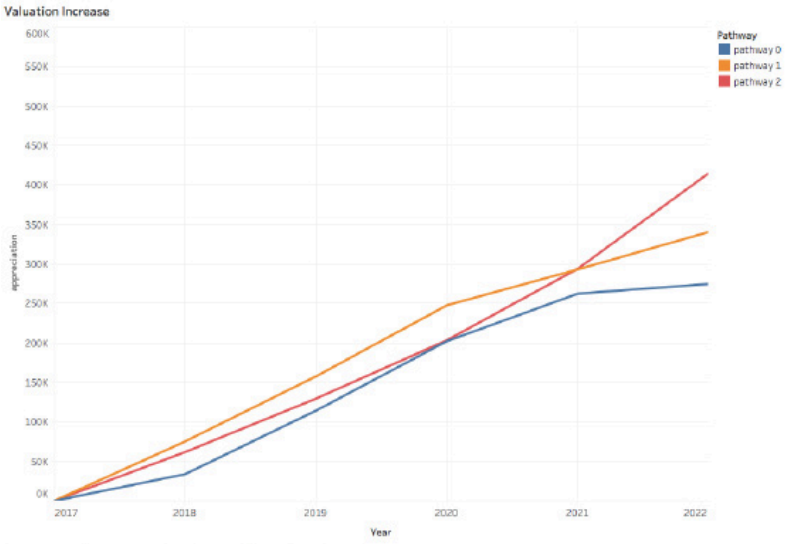


Figure 14. Valuation increase projection.

3.3.4 South Yorkshire Housing Association (UK)

With 6,000 dwellings under management, predominantly in South Yorkshire, SYHA is an award-winning, not-for-profit organisation governed by a voluntary board. SYHA is committed to a sustainable future. The business's Sustainability vision is: "We will embed environmental, social and economic sustainability in all our operations. We will lighten our environmental footprint, help our customers to do the same and support communities by tackling fuel poverty". Providing an energy-efficient property portfolio is one important element of delivering this vision. Gordon Watts, SYHA's Sustainability Manager said, "Delivering energy-efficient, low carbon homes which are affordable to heat is an important issue for SYHA, brought into sharper focus by the UK Government's recent commitment for the UK to be net-zero carbon by 2050. Support from the DREEAM project is helping us to develop our forward renovation strategy to deliver our ambitions".

The alternative investment pathways developed as part of the DREEAM replication programme outline the benefits of a long-term renovation strategy and allow SYHA to plan their stock investments to achieve their long-term sustainability vision.

About & policy background

SYHA is a housing association that for over 40 years has been providing quality local living; retrofitting, renovating, designing and building homes throughout the city region, also providing care and support, helping vulnerable people to remain independent. Over 4,000 of the houses are for rent and around 2,000 of the other properties include support from SYHA specialized staff working to help end homelessness for good in the Yorkshire region.

In line with the UK government's Clean Growth strategy and the Fuel Poverty strategy, SYHA has the aim of upgrading the average EPC of its portfolio up to D by 2024 and C by 2030.

Portfolio overview

For this analysis, SYHA and BaxCo have collaborated to build a cross-cutting dataset with technical and financial data from 4,276 dwellings in SYHA's portfolio.

The analysis of buildings characteristics showed that 70% of the SYHA analysed building stock are houses, mostly mid-terraced and semi-detached with gas central heating.

Overall the building stock is quite recent, with about 60% of dwellings being built after 1995. This is well reflected in the building energy performance, with a very high share of households with EPC label C or B (+68%).

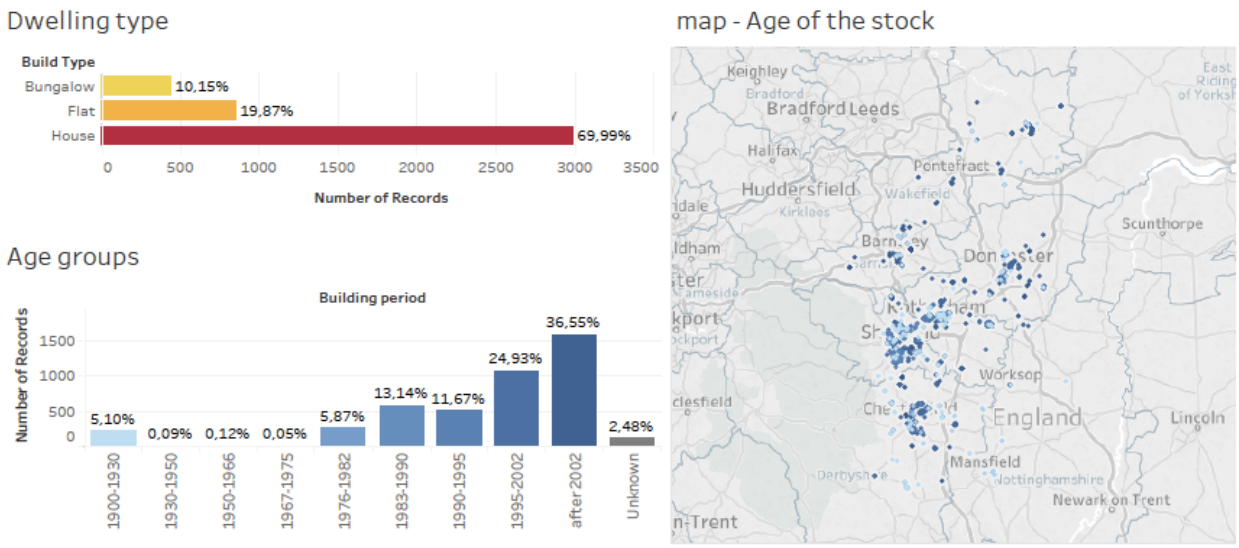


Figure 15. Overview of archetype and age of the stock.

By linking dwelling type and energy quality, the majority of the stock with the highest potential for improvements are mid-terraced and semi-detached houses with an EPC label E (3.16%) and D (20.23%).

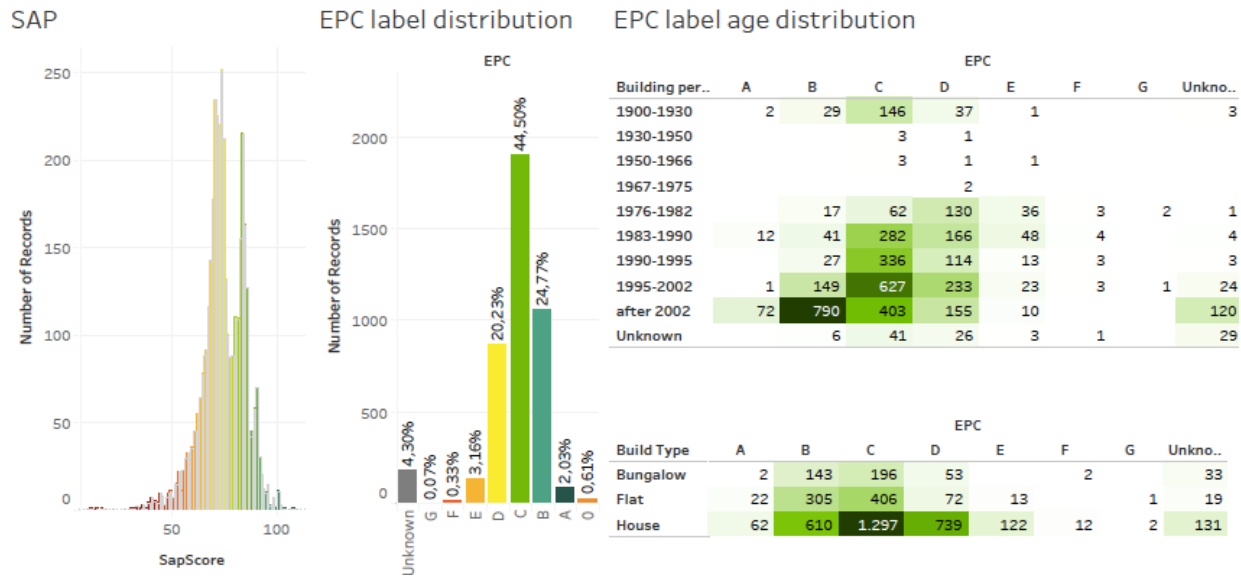


Figure 16. Energy performance analysis of SYHA building stock.

Investment scenario and sustainability ambitions

SYHA's current practices in energy efficiency renovation follow a component replacement approach, investing about £100,000/year. The upgrading of the properties is undertaken on an opportunistic basis, when the components are damaged or outdated. Following the current practices, SYHA will not be able to achieve their

sustainability targets and would implement single technologies without consider optimal integration at multi-building scale.

BaxCo has analysed alternative investment scenarios to enable the achievement of the SYHA sustainability targets:

- A shallow renovation with a budget of £300,000/year
- A deep renovation with a budget of 2M/Year

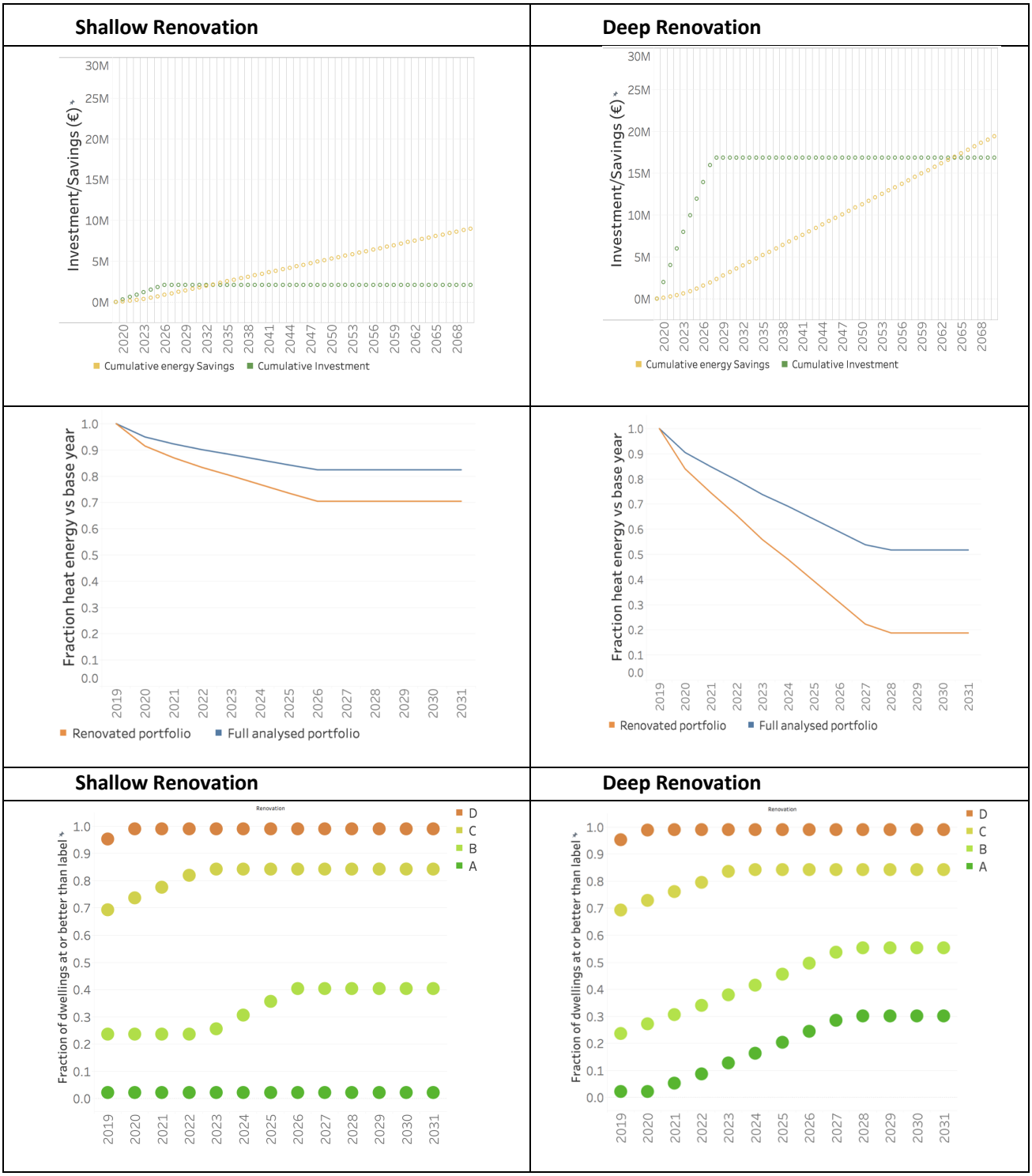


Figure 17. SYHA scenario analysis: investment, EPC label change and heat consumption projections.

Conclusions and recommendations

Shallow and deep investment pathways were modelled to evaluate their impact on EPC performance, energy savings and CO_2 emissions.

By investing £300,000/year over 7 years and following a shallow renovation approach, SYHA would be able to bring all their properties to EPC label D by 2025 (meeting the UK target) and 90% of the properties to EPC label C by 2030. Increasing their effort to £2M/year would facilitate a deep renovation programme unlocking about 20% of CO_2 savings and saving 60 kWh/m^2.

SYHA is an ambitious social housing association with a strong sustainability commitment and ambitions as demonstrated by its sustainability manager Gordon Watts. In order to upscale their renovation programme and meet the UK energy efficiency targets, SYHA would consider utilising a financing mechanism with a favourable interest rate and exploit existing subsidies such as the renewable heat inventive. The main national financing scheme currently running to finance energy efficiency interventions in the housing sector is the Energy Company Obligation (ECO) through which obligated suppliers promote "primary measures" such as heat generator replacement.

3.3.5 ATC Piemonte Centrale, Italy

With over 30,000 dwellings under management spread across the Turin metropolitan area, Atc del Piemonte Centrale is one of the largest housing associations in North West Italy. Building stock investment strategy services will inform the organisation's decision-making process about upscaling opportunities. The alternative investment pathways will outline the benefits of a long-term renovation strategy and offer them a clear overview of the different options.

About

ATC del Piemonte Centrale (ATC PC) is one of the largest public social housing associations in the North West of Italy, providing affordable housing to low income citizens, with an average renting price lower than €100/month. ATC PC manages over 30,000 dwellings spread across Turin Metropolitan area. As a not-for-profit organisation, they fund their expenses for maintenance and dwelling upgrades from rental revenue. Due to limited funding they are not able to currently upscale their renovation programme and will therefore use the results of this analysis to discuss with the Regional Government the need for additional financing.

Portfolio overview

ATC currently does not use an ICT asset management system and, therefore, has a limited understanding of the current conditions of their housing stock. The portfolio assessment and data visualisation exercise carried out by BaxCo in the context of the replication programme represents a very useful tool for this BO, helping identifying clusters of buildings and prioritise EE interventions.

Apartment blocks, "fabbricati in linea", represent the 78% of the building stock while multi-family and single houses are very limited. Most of the dwellings (+60%) is served by central heating system. Over the past years, some households have been already renovated and the heating system replaced with individual gas boilers (20%).

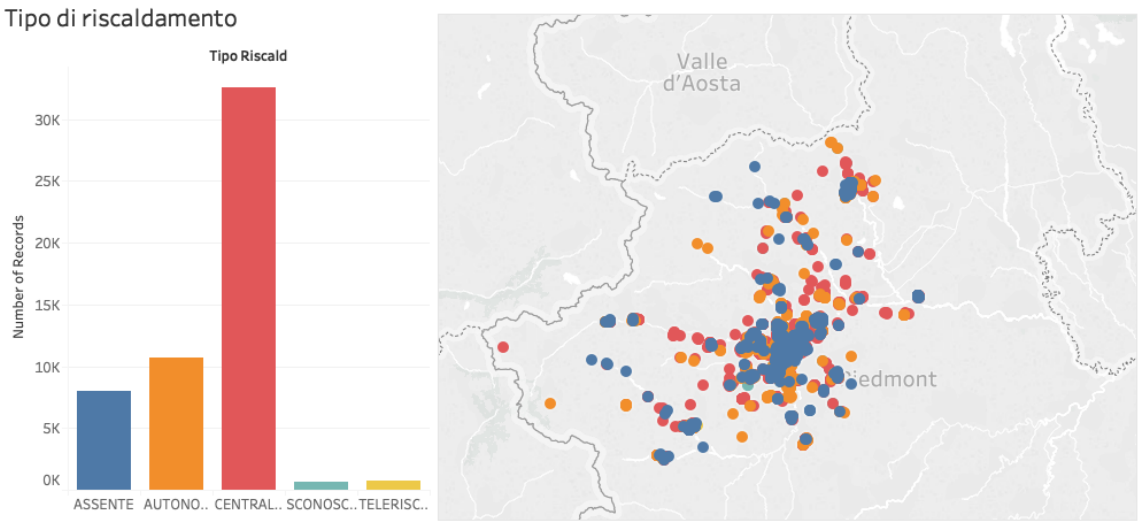


Figure 18. Heating system distribution of ATC PC portfolio.

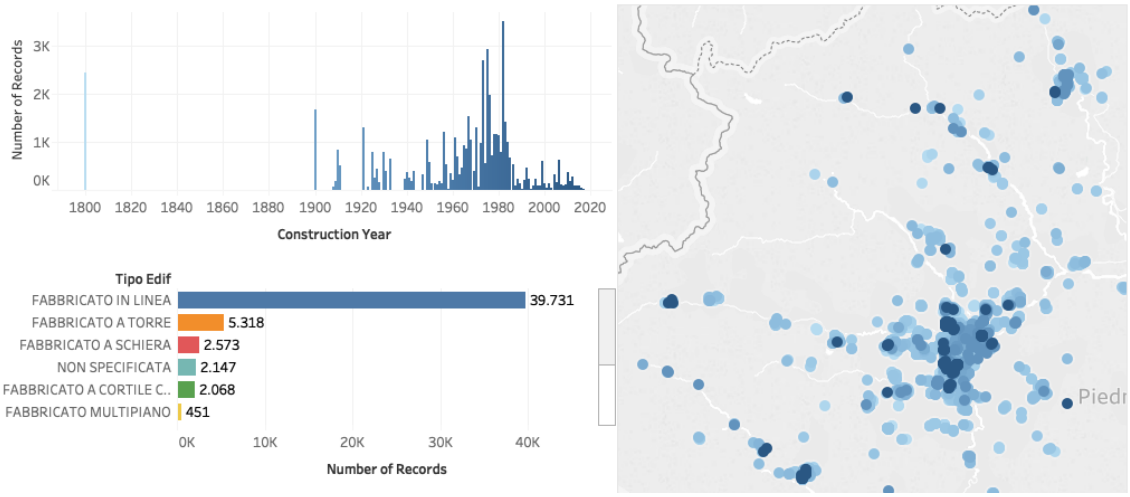


Figure 19. Archetypes and construction period of ATC PC building stock.

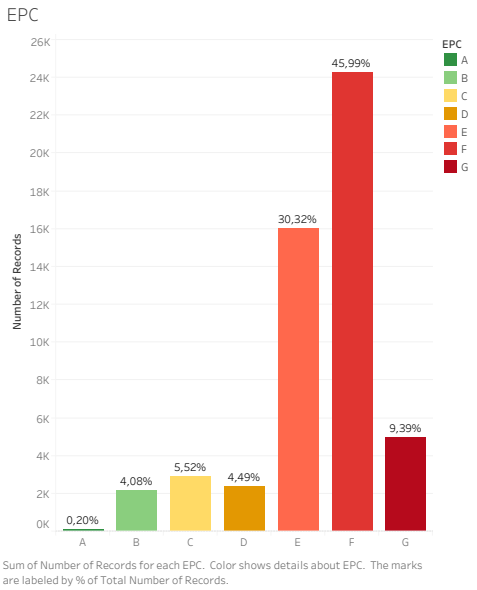


Figure 20. Energy performance of ATC's portfolio.

The construction period of the housing stock range between 1900 and 2000, with the majority being built in the period between 1960-1990.

ATC PC's building stock is characterised by a very poor energy performance. More than 50% of the portfolio has an EPC label F or G, 30% is EPC label E. As previously mentioned, ATC tenants are mainly low-income and vulnerable citizens. To fight fuel poverty and lower the energy bills of their tenats, ATC should implement a large scale and ambitious renovation programme that would require a very relevant investment volume.

Renovation packages

In discussion with the asset manager and the energy manager of ATC PC, BaxCo identified 4 target groups with highest priority for energy efficiency improvements by combining dwellings characteristics (heating type, archetype and construction period) and energy performance:

- Target group 1: apartment blocks built before 1945 with central heating system and EPC label F: 4,053 dwellings;
- Target Group 2: apartment blocks built between 1946 and 1960 with EPC label G and central heating system: 3,604 dwellings;
- Target Group 3: apartment blocks built between 1961 and 1975 with EPC label F and central heating system: 9,944 dwellings;
- Target Group 4**:** apartment blocks built between 1976 and 1990 with EPC label E and central heating system: 10,482 dwellings.

For each of the target groups identified, two alternative renovation strategies were developed:

- Shallow renovation: package of measures requiring lower budget leading to increasing EPC label by 2-3 steps;
- Deep renovation: package of measures entailing higher costs and more invasive refurbishment measures, leading to higher energy performance.

Table 1. Overview of the target groups.

		Architype / Target Group			
		Apartment block			
EPC	Tipo Riscald	"before 1946"	1946-1960	1961-1975	1976-1990
E	CENTRALIZZATO			10.482	
	AUTONOMO			3.987	
	ASSENTE			325	
	TELERISCALDAMENTO			20	
	SCONOSCIUTO			197	
F	CENTRALIZZATO	4.053			9.923
	AUTONOMO	89			3.347
	ASSENTE	2.803			152
	TELERISCALDAMENTO	42			
	SCONOSCIUTO	92			195
G	CENTRALIZZATO		3.604		
	AUTONOMO		443		
	ASSENTE		829		
	TELERISCALDAMENTO		2		
	SCONOSCIUTO		20		

Conclusions and recommendations

As already presented by Exeleria to ATER Treviso in WP2, the average cost of a shallow renovation package leading to an EPC label B in Italy is between €25,000 and €35,000€ depending on the archetype. The implementation of deep renovation measures for achieving EPC label A could rise up to €60,000 - €70,000, considering the installation of PV and renewable heating sources such as heat pumps, solar thermal and district heating.

Looking at a large-scale renovation programme, ATC Piemonte Centrale could invest >€10M/year for 10-20 years if funds were available.

The BO will use the results of this analysis to:

- Explore potential long-term investment strategies enabling recovery of the investment;
- Discuss with the regional government about the need to set up sustainable financial instruments for scaling up their EE renovation.

The potential entity of the investment programme, ATC PC could be supported by the ELENA technical assistance programme and other European funding such as Project Development Assistance etc.

3.3.6 Warsaw, Poland

The city of Warsaw is the largest Polish city, owning 6,325 residential buildings consisting of 7,799 dwellings. The building stock assessment showed that 67% of the stock was built before 1967 and 75% has a very poor energy performance. Warsaw currently faces an urgent need to upgrade many of its residential buildings to modern standards. Taking a long term, goals driven perspective allows for increased ambition levels while meeting financial constraints.

The long-term renovation strategies of the selected housing stock developed by BaxCo with NAPE have been finished and discussed with the City Hall officers responsible for drafting climate mitigation strategies. The financing options of using their own funds and EU support either for preparation of the projects (ELENA) or to co-finance the modernisation (EU Structural & Cohesion funds, EIB) have been also presented. BaxCo with the support of NAPE explored a number of renovation options.

Deeper investigation of the energy performance of the buildings located in Warsaw showed uncertainty of data and the necessity of better control of energy use within them. The City of Warsaw is especially interested in the creation of a database concerning technical conditions and energy performance of residential buildings in order to better identify the energy efficiency potential and to introduce an energy management system into municipal housing stock.

About Warsaw

In this analysis, 301 of the 6,325 residential buildings owned by Warsaw municipality were considered, consisting of 7,788 dwellings (381,829m^2 out of a total 3,326,402m^2).

Building stock analysis

The 67% of the analysed building stock (301 buildings) was built before 1967. 75% of the floor area has a poor energy performance (an energy rating D or worse).

The geographical distribution of the dwellings across the municipality shows the presence of clusters of buildings with high potential for economies of scale.

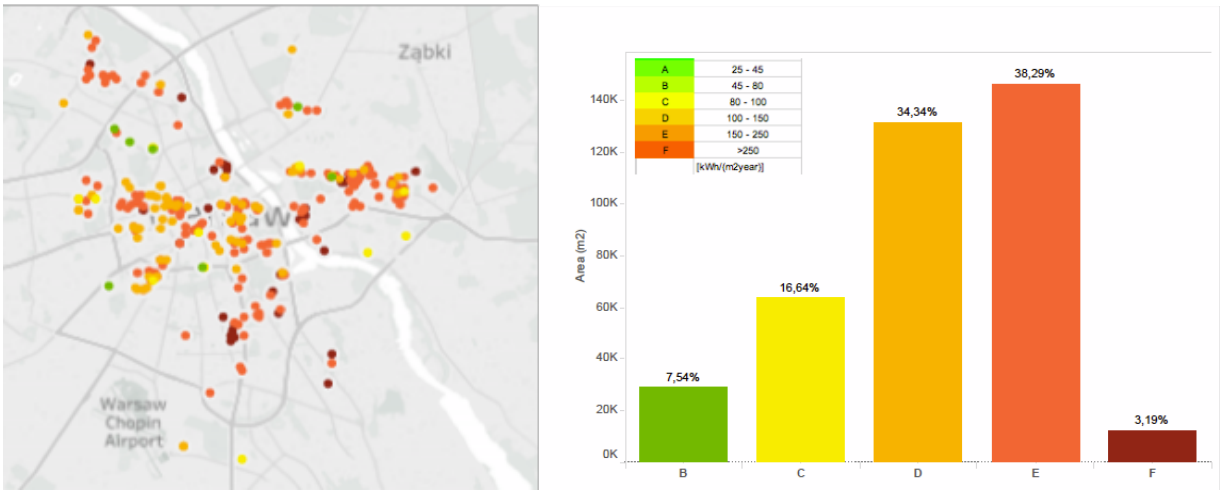


Figure 21. Geographical distribution of Warsaw's building stock by energy rating.

	-1900	1900-1..	1920-1..	1946-1..	1967-1..	1986-1..	1993-2..	2003-2..	2008+
Apartment block					22,655		37,253	23,660	26,657
Multi family house	15,737	29,385	114,150	96,683	11,107	1,163	892		
Terraced house	370		1,494	624					

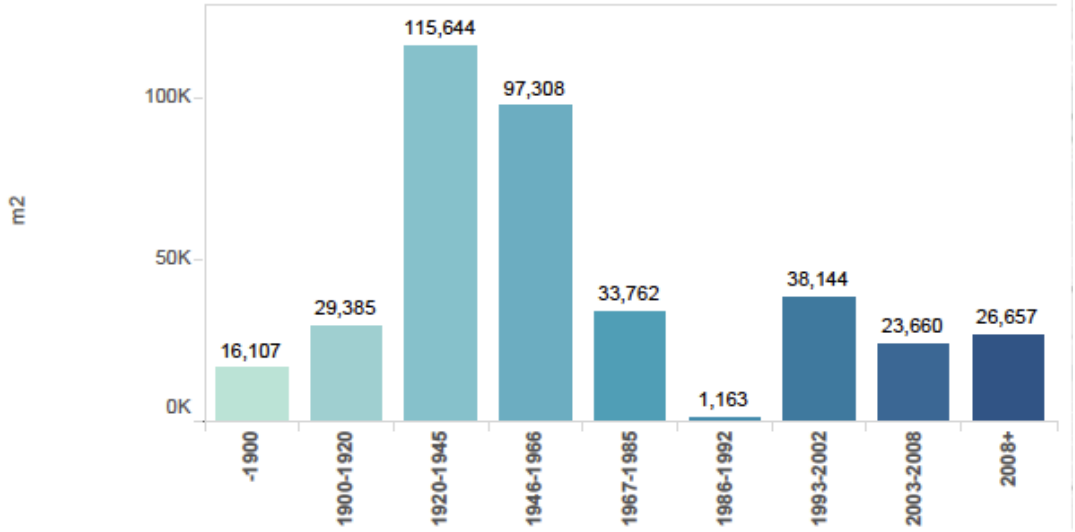


Figure 22. Overview of portfolio characteristics: archetype and age of the stock.

Renovation Packages

Warsaw municipality currently invest about 18ML PLN annually in energy efficiency measures, 10% of the overall renovation investment potential. BaxCo in collaboration with NAPE developed shallow and deep renovation packages for the four target groups identified.

A shallow renovation approach would upgrade the energy rating up to D, reaching an average heat consumption of 97 kWh/m^2, compared to an average start point of 167 kWh/m^2.

A deep renovation approach would upgrade the energy rating up to C, reaching an average hear consumption of 73 kWh/m^2.

Investment Strategies & Impacts

Taking a long term, goals driven perspective allows for increased ambition levels while meeting financial constraints. Warsaw currently faces an urgent need to upgrade many of its residential buildings to modern standards.

Both the shallow and deep renovation strategies were modelled and projected over different time scales in order to analyse their potential economic and environmental impacts:

- Adopting a shallow renovation strategy would allow an energy consumption reduction of over 30% over the analysed stock, or nearly 50% over the renovated stock after only 6 years. Investing 10M PLN/year would unlock savings of about 640 PLN per renovated household.
- The deep renovation strategy could offer a consumption reduction of 40%, by investing 10ML PLN/ year over 9 years. This would enable a CO_2 emissions reduction of 37% and about 830 PLN of energy savings per renovated household.

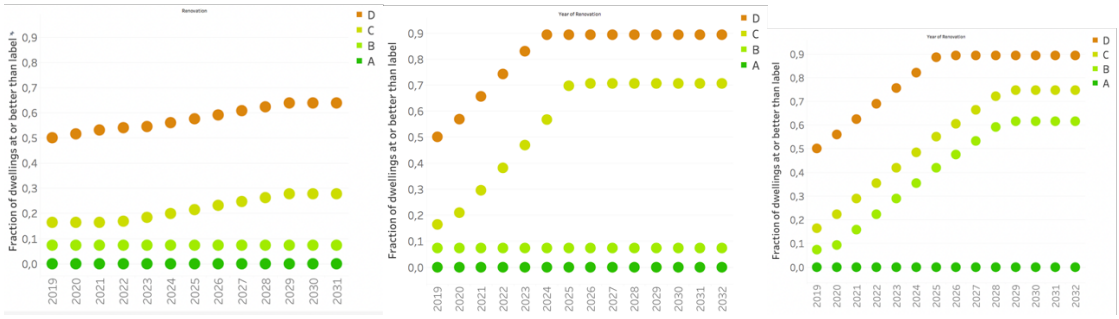


Figure 23. Energy Label Change - Total investment vs Savings (Current Plan, Shallow and Deep Renovation)

Next steps

The detailed analysis of heat load and heat consumption of 306 residential municipal buildings in Warsaw was developed by NAPE and shared with B&C to support the development of the city's long-term investment strategy. The final results of the scenario analysis were presented by NAPE to the decision-maker along with potential financing instruments enabling the implementation of these renovation strategies.

3.3.7 Lublin, Poland

Within the replication programme, NAPE and BaxCo supported the municipality of Lublin to analyse and identify the buildings with the highest potential for return on energy efficiency investments. The portfolio analysis has shown that Lublin's current residential building stock is very energy inefficient, with over 70% of the analysed portfolio consuming more than 300 KWh/m^2 annually. This offers a significant opportunity to upgrade the residential building stock in a very cost-effective manner. By taking a long term, goals driven perspective, Lublin can dramatically decrease residential building energy consumption, offering modernised housing and significant energy savings to tenants, while meeting regional, national and European policy objectives.

About Lublin

In this analysis, 62 of the 792 residential buildings controlled by Lublin municipality were considered, consisting of 1,021 dwellings. This portfolio was analysed to identify the buildings with the highest potential for return on energy efficiency investment. Over 70% of the stock was built before 1950 and over 70% of the portfolio consumes more than 300 KWh/m^2, demonstrating a clear need for renovation and the high potential for energy efficiency savings.

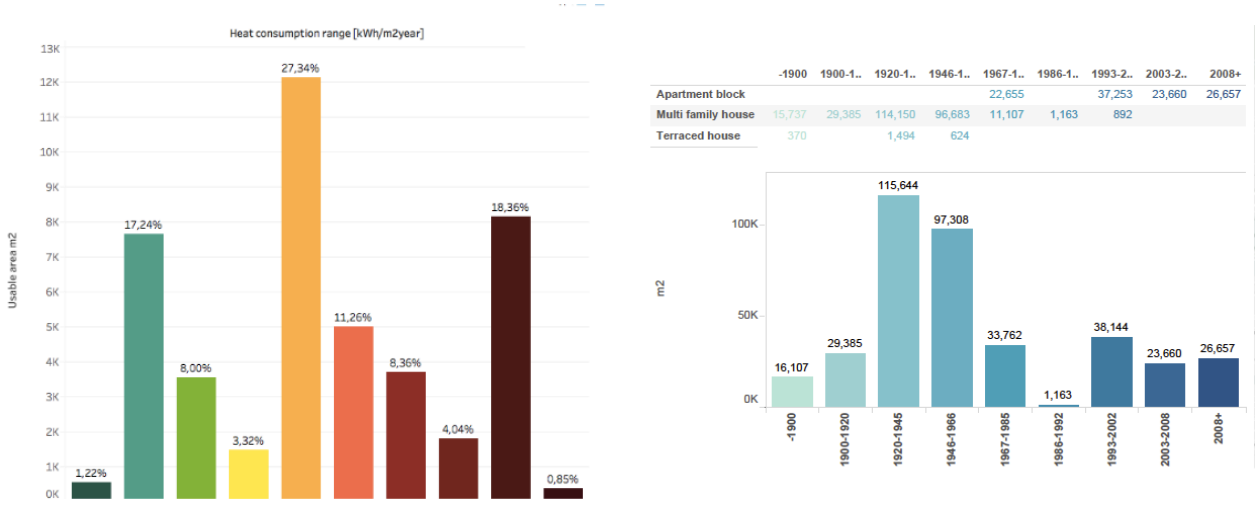


Figure 24. a) Distribution of m2 per energy rating b) Analysis of the archetypes and age of the stock

Renovation Scenarios

According to the DREEAM Polish partner NAPE, the Municipality of Lublin does not currently invest in energy efficiency. Around 3M PLN are spent annually on building renovation, but it is understood that none of this is directed towards energy efficiency measures.

Four target groups of similar dwelling types with similar energy performance were identified and renovation packages developed in collaboration with NAPE. The investment scenario analysis was carried out considering two alternative renovation strategies:

A shallow renovation strategy requiring the investment of 1.7M PLN annually over 10 years with the aim to reduce heat consumption of each dwelling type below 130 kWh/m^2, compared to an average starting point of 300 kWh/m^2.

A deep renovation strategy leading to an overall investment of 2M PLN over 14 years achieving a heat consumption lower than 100 KWh/m^2 and realising energy saving of up to 214 KWh/yr per m^2.

Investment Strategies & Impacts

The impact of various investment strategies on both financial and energy indicators was projected and analysed. With a shallow renovation approach, and a budget of 1.7M PLN annually, there is the potential for a reduction in energy consumption of nearly 60% across the whole analysed portfolio. The strategy would require 10 years to implement and offers reductions in CO_2 emissions of over 70% and average customer energy savings of 460 PLN per household (500 PLN per renovated household).

With a deep renovation strategy, and a budget of 2M PLN annually, there is the possibility to reduce energy consumption across the whole analysed portfolio by nearly 70% over 14 years of investment. The strategy also offers CO_2 emissions reductions of over 75% and customer energy savings of 660 PLN per household (720 PLN per renovated household).

Next steps

The final report describing the results of the scenario analysis was delivered to NAPE who presented it to the municipality's decision-makers. NAPE will continue the collaboration with Lublin in the development of their long-term renovation programme and make sure that the suggestions developed within the DREEAM replication programme will be considered and adopted.

3.3.8 Jelgava, Latvia

Within the replication programme, BaxCo has supported the municipal housing management company in Jelgava, Latvia to develop the organisations' long-term investment planning approach. The organisation manages over 430 municipal buildings (approximately 14,000 dwellings) mostly built between the 1960s and 1980s. It is currently considering building over 200 new dwellings in the coming years. Up to now, the houses have not been renovated and the organisation is looking for ways to scale the uptake of retrofits. The Jelgava municipal housing group is unique as they run advanced data management services that allow for detailed analysis of houses energy performance. The building stock investment strategies provided by BaxCo has allowed them to link their data and financial capacity with realistic renovation options.

Portfolio overview

In this analysis, 218 of the 430 residential buildings managed by JNIP (Jelgavas Nekustamā Īpašuma Pārvalde SIA) in city of Jelgava (Latvia) were considered. This portfolio represents 470,000 m^2 of a total 989,000 m^2.

The buildings were built between 1920 to 1993. The age of each of the buildings owned is presented graphically here, shown by the total floor area of each age group. An important point to note is that over 92% of the stock area was built before 1990, and that 91% was built during the Soviet period. Overall, the portfolio has a very poor energy performance: 92% of the portfolio is an E label or worse.

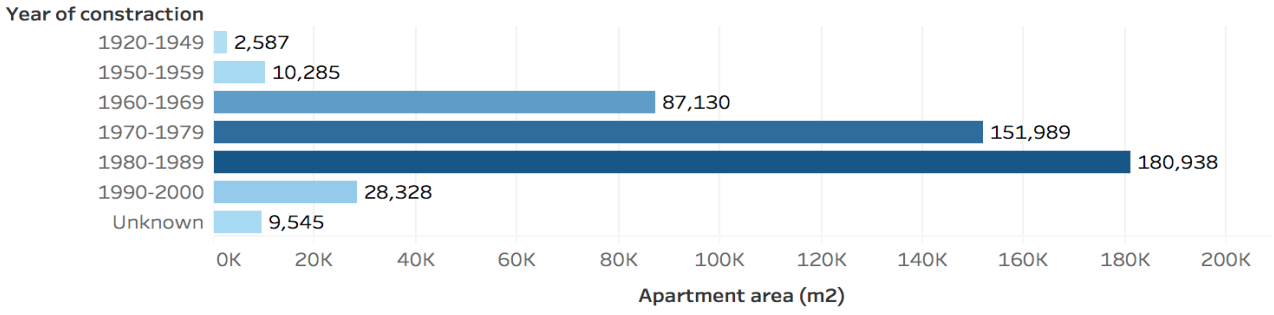


Figure 25. Construction periods vs building area

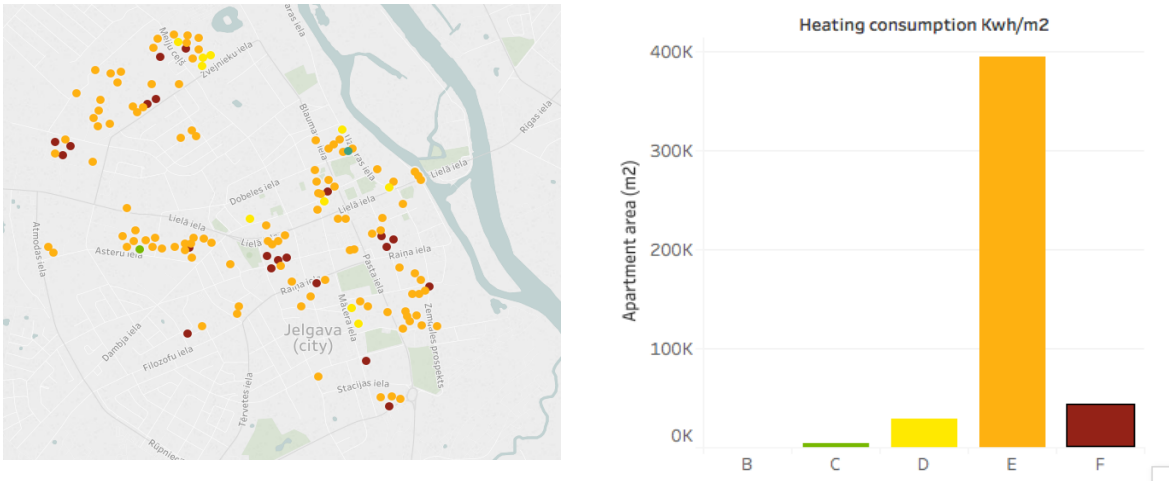


Figure 26. a) Geographical distribution of dwellings per energy rating b) energy rating per m²

Renovation scenarios

JNIP manages €2M worth of energy efficiency investment annually in the Jelgava city, mainly used for the implementation of energy efficiency measures.

Shallow renovation scenario

Four target groups of similar dwelling types were identified and renovations simulated to energy rating C. Heat consumption for each dwelling type was targeted to reach an average of 60-79 kWh/m², compared to an average starting point of 131 kWh/m². An annual budget of €10M was allowed for energy efficiency investment.

Deep renovation scenario

The Deep Renovation strategy was developed to achieve an energy rating B. Heat consumption for each dwelling type was targeted to reach 40-59 kWh/m². An annual budget of €10M was allowed for energy efficiency investment.

Conclusions and recommendations

Adopting a focused shallow renovation approach, with increased budget up to €10M annually, would allow an energy consumption reduction of over 38% over the analysed stock. Additionally, such renovations would offer a near 36% reduction in CO_2 emissions from the residential building stock. These investments would also ensure an average energy bill reduction of €102 per household annually.

The deep renovation strategy represents an even more ambitious approach, which can offer, with an annual budget of €10M, energy consumption reduction of 54% over the whole stock, and 46% over that which is renovated, requiring 9 years to complete. The strategy also offers CO_2 reduction of nearly 49% and average customer energy savings of 143 EUR.

Regardless of the approach chosen, investments in energy efficiency are an investment for the future. The more ambitious a municipality can be now, the better the return on investment available in the long term. However, the approach should be carefully considered, so as to ensure the maximum benefit from the money spent.

Focusing on particular target groups of similar houses is a good approach, as it eases and reduces the capex and Opex thanks to the economy of scale and better technology integration. This allows the targeted benefits, energy and CO_2 reductions to be achieved with lower cost. As the analysed stock represents only 50% of the total dwelling area managed by the municipality, around €20M annually would be required to achieve the same results across the whole building portfolio.

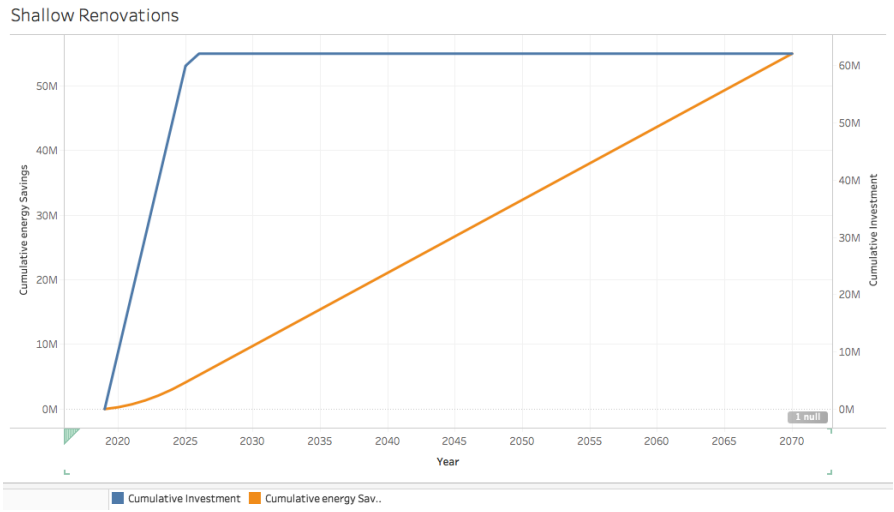


Figure 27. Cumulative energy savings and investment for Shallow Renovation scenario

3.3.9 Riga, Latvia

Within the replication programme, BaxCo has supported the biggest municipal housing management company in Latvia, Riga. The company was established to ensure the management of multi-apartment residential buildings in accordance with uniform principles and improve the quality of services provided by the municipality in the management of residential buildings. In total, the company is servicing about 167,000 clients. More than 4,200 residential buildings (total area of over 8 million. square meters) are under the company's management.

The Riga municipal housing group is unique as they were hoping to accelerate the rate of the refurbishment 4-fold over the coming 4 years. Their goal was to renovate around 1,000 building in Riga by end of 2022. This would mean investments in energy efficiency in a range of EUR 460M. The building stock investment strategies provided by BaxCo has allowed them to link their long-term renovation plans with European green financing

Portfolio overview

In this analysis, 115 of the 4,200 residential buildings managed by RNP (Rīgas namu pārvaldnieks) in city of Riga (Latvia) were considered. This portfolio represents 361,117.5 m^2 of a total 8M m^2. This portfolio was analysed in order to identify the buildings with the highest potential for return on energy efficiency investment.

The building stock (115 buildings) range from buildings built in 1960 to 1980. An important point to note is that all of the stock was built before 1990 in the Soviet era (figure 27).

The breakdown of energy rating by m^2 floor area of the stock shows that over 95% of the portfolio is an E label or worse. For reference, new builds are usually required to be NZEB. The graph shows the clear need and value of renovating the stock, given the huge potential for energy cost savings (Figure 28). The average heat consumption for the entire stock is 124.4 kWh/m^2.

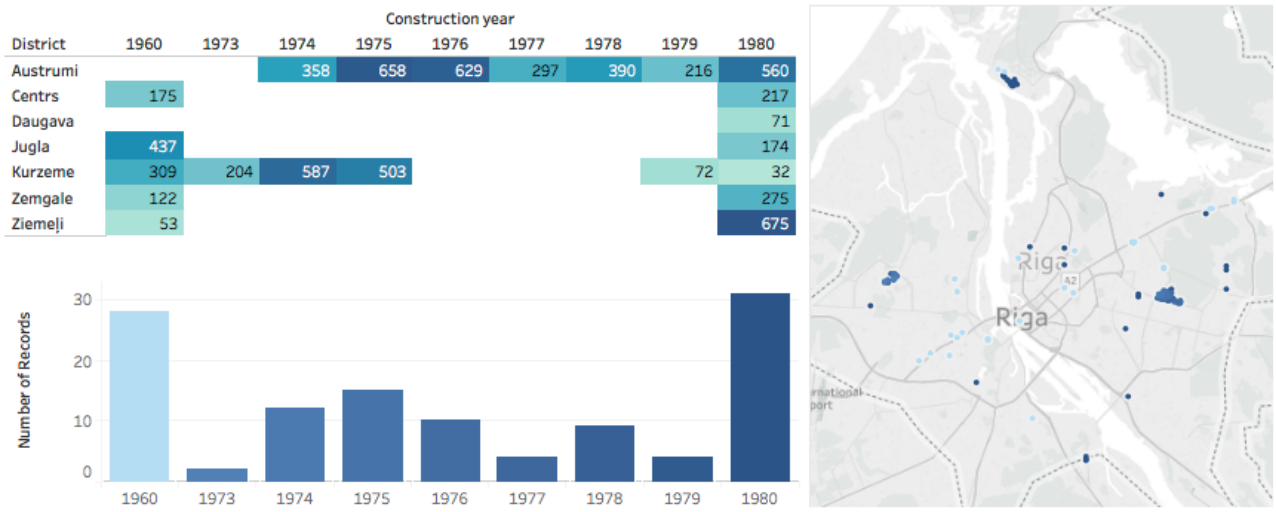


Figure 28. Figure 1 Year of construction and building area (m2)

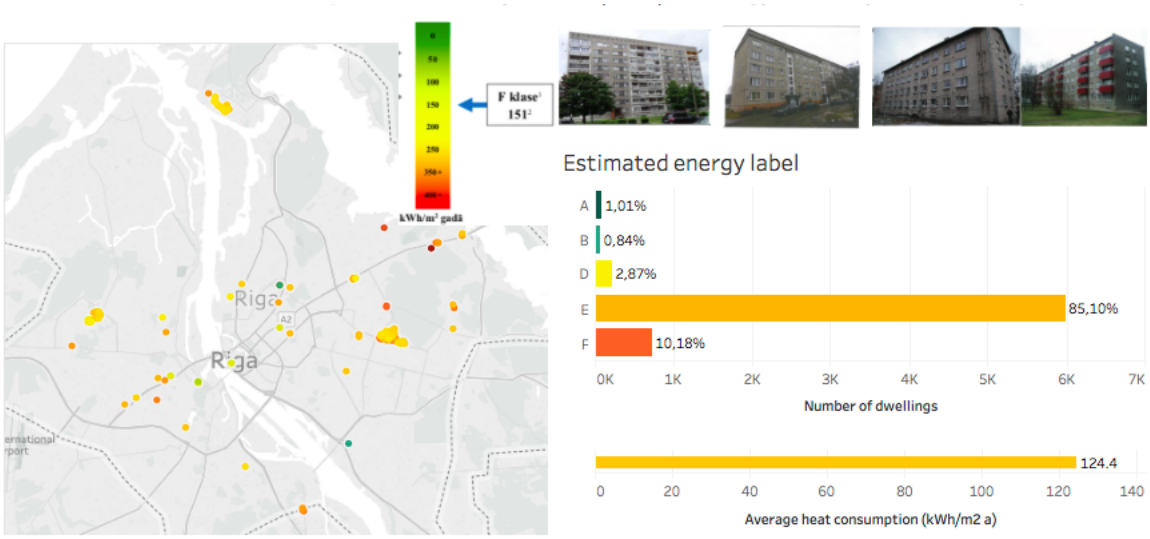


Figure 29. Geographical distribution of the building stock analysed and related energy performance.

Renovation scenarios

Current investment practices

Riga's current investment in renovation measures is higher than in many other Latvian cities. In Latvia over 90% of renovation costs are spent directly on energy efficiency measures. Riga manages yearly around €3M worth of energy efficiency investment in EE, mostly spent on insulation, window and heating system upgrades.

Shallow renovation scenario

Four target groups of dwellings with similar characteristics were identified. Renovation packages were developed to achieve energy rating C. Heat consumption for each dwelling type was targeted to reach an average of 60-79 kWh/m^2, compared to an average starting point of 131 kWh/m^2. An annual budget of €10M was considered.

Deep renovation scenario

A Deep Renovation strategy was modelled with the aim to achieve energy rating B. Heat consumption for each dwelling type was targeted to reach 40-59 kWh/m^2. An annual budget of €10M was allowed for energy efficiency investment.

Conclusions & recommendations

Taking a long-term, goals-driven perspective allows for increased ambition levels while meeting financial constraints. Riga currently faces an urgent need to upgrade many of its residential buildings to modern standards. Current efforts in energy efficiency renovation, while significantly ahead of many cities across Latvia could be scaled and focused to ensure optimised public investment, significant energy bill reductions and a future-ready housing stock.

Adopting a focused shallow renovation approach, with a budget of €10M annually, would allow an energy consumption reduction of over 38% over the analysed stock. Additionally, such renovations would offer a near 33% reduction in CO_2 emissions from the residential building stock. These investments would also ensure an average energy bill reduction of €96,12 per household annually.

The deep renovation strategy represents an even more ambitious approach, which can offer, with an annual budget of €10M, energy consumption reduction of 54% over the whole stock, and 47% over that which is renovated, requiring 9.85 years to complete. The strategy also offers CO_2 reduction of nearly 49% and average customer energy savings of €133.

3.3.10 Valence Romans Habitat, France

The two main social housing corporations of Department Drôme in France merged in 2016 to create Valence Romans Habitat (VRH), which manages over 10,000 units. In France, the national target is integrally labelled housing stock B+ by 2050. Another objective is to reach a 38% energy consumption reduction in social housing stock by 2020 (in comparison with 2010). In this aspect, a lot still needs to be done.

VRH wanted to critically review the Strategic Portfolio Plan (PSP) realised in the early time of the merging and add the energy policy objectives in the approach, a part that was missing until now. They also wanted to be able to develop renovation packages for standardised building target groups to improve their efficiency. Working with BaxCo, an accurate renovation plan was designed for 40% of the housing stock distributed across four priory target groups. A carbon emission reduction strategy was also tested to simulate the impact of energy source change in the district heating networks.

About

Two social housing corporations of Department Drôme in France merged in 2016 to create Valence Romans Habitat (VRH), which manages over 10,000 units.

In this analysis, the 10,162 housing units owned by social housing corporation Valence Romans Habitat were considered. This portfolio was analysed in order to identify 4 homogeneous target groups of buildings with highest need of renovation and biggest numbers.

Portfolio overview

The age of construction of the building stock range from 1930 to 2018, with 70% of the buildings built between 1949 and 1989 and 15% after 2016. 87% of the portfolio has an energy label D or better. The whole stock can nearly be equally split between two predominant heating modes: district heating (mostly fuelled by natural gas today) and individual gas boiler, respectively 42% and 49%.

Looking at the geographical distribution of the dwellings we can recognise two main areas correspondent to the 2 historical corporations located in Valence and in Romans with cluster of buildings having similar energy performance.

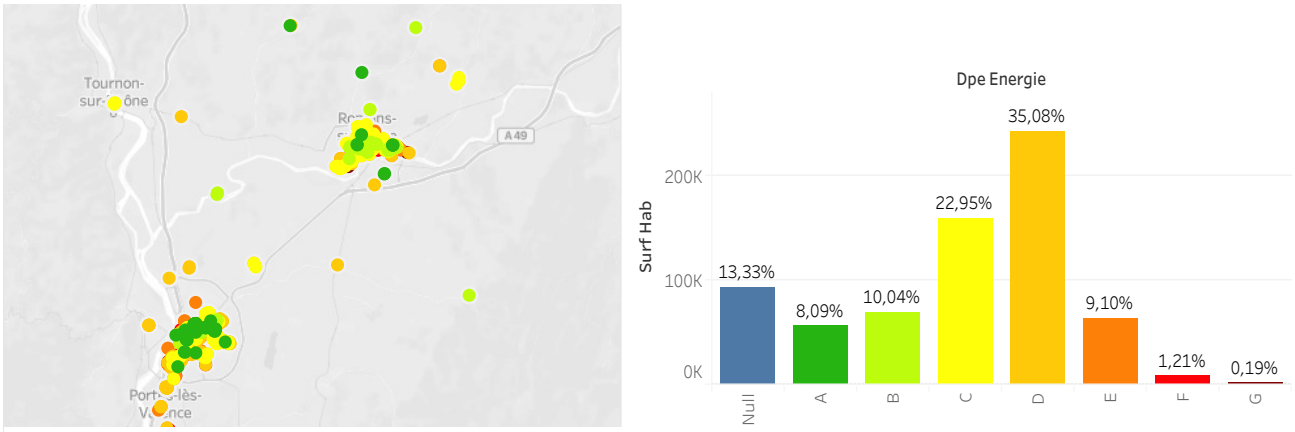


Figure 30. a) Geographical distribution of the dwellings by energy rating b) Distribution of energy rating by floor area

Renovation scenarios

Four target groups of similar dwelling types were identified, corresponding to 3,594 units, about 50% of the stock with energy label worse than B. Renovations packages were simulated to reach energy rating C.

This BO currently plans to renovate a maximum of 210 dwellings per year to EPC label B, investing about 3.8M€ in insulation, ventilation systems, window and heating systems upgrade. Two alternative renovation strategies were modelled:

- The C2025 Scenario: the whole targeted stock aims to be renovated up to EPC label C by 2025;
- B2030 scenario: the targeted stock aims to be renovated up to EPC label B by 2030.

Investment strategies & impacts

Impacts on economic and energy indicators were analysed by projecting the current investment practices and the two alternative scenarios proposed with BaxCo's scenario models:

- The 'Current plan' scenario allows already an energy consumption reduction of 33% but only in the long run: 17 years period (maximum €3.3M investment / year). These investments would ultimately ensure an average energy bill reduction of €547 annually per renovated household, at constant energy price in comparison to 2019, and 7,415 ton of CO_2 savings.
- The scenario C2025 allows an energy consumption reduction of over 23% after only 6 years. These investments would enable energy bill reduction of €373 annually per renovated household. This scenario would require a high pace of renovation (740/year) which exceed by far the maximum capacity of the BO and it is therefore not viable.
- The B2030 scenario would allow to upgrade the 61% of the targeted portfolio to and EPC label B by investing €4.7M annually over 11 years. This would unlock savings of €636 annually per renovated household.

Conclusions and recommendations

The B2030 scenario is an ambitious but reasonable investment strategy with a payback period of 26 years, a renovation rate of about 320 household per year and a reasonable annual budget increase compared to the current maximum investment (+23%).

Suggestions:

- Improve data quality by e.g. assigning a data manager.
- Increase internal resources and external expertise to enhance yearly renovation capacity and performance, quality level through technical assistance programmes such as ELENA.

- Standardisation, new contract models such as integrated renovation of Energy Performance Contract are also tools to be used to improve the organisation performance.

3.3.11 Strasbourg Ophea, France

Ophéa is one of France's largest social housing providers, managing 20,000 housing units, mostly apartment blocks built between 1950 and 1980 (so-called “grands ensembles”), located in the Eurométropole de Strasbourg Area. Two-thirds of the housing stock has an energy label of D or worse whereas the national law has set the objective of label B+ by 2050. Another objective is to reach a 38% energy consumption reduction in social housing stock by 2020 (in comparison with 2010). To reach these targets, a lot still needs to be done.

Based on its latest Strategic Portfolio Plan (PSP), Ophéa is considering investing an average of €30M€ a year in energy renovation for its portfolio in the coming 10 years. This investment forecast takes into account technical issues and comfort as well as energy performance but does not refer specifically to energy policy objectives. The DREEAM approach helps Ophéa in several ways: it allows them to review the method of the PSP critically and focus on energy objectives. It is also a way to organise the coming massive renovation effort of the next years in the most cost-efficient way, thanks to the typology determination method and clustering approach of DREEAM, reducing costs/ units, increasing renovation ambitions and attracting new financing from national and European levels.

About Ophea & portfolio overview

Ophea is a French social housing provider in the Eurométropole de Strasbourg. With over 20,000 dwellings under management, it is one of the largest housing providers in the East of France. Ophea aims to have an energy label of C for 75% of its stock by 2025 and consume 50% of renewable energy by 2030.

87% of Ophea’s dwellings are in apartment blocks, 68% of which were built between 1949 and 1981, which in itself corresponds to a typical priority of energy renovation public policies.

35% of Ophea’s stock has an energy label of C and 43% of D, 9% worse than D, with an overall average energy performance better than the average French stock. The GHG emissions current performance is quite negative with an average label E, due to the strong dependency on gas.

About 85% of the housing stock uses collective heating system (either at building, cluster or district level), mostly collective gas boiler and a growing share of units connected to various heating networks.

Dwellings are geographically clustered by type, age and heating mode (OPHEA agencies distribution allows an efficient geographical analysis). These patterns suggest that there is high potential for economy of scale if a multi-building renovation approach would be applied. Buildings of similar archetype and year of construction will indeed require similar interventions.

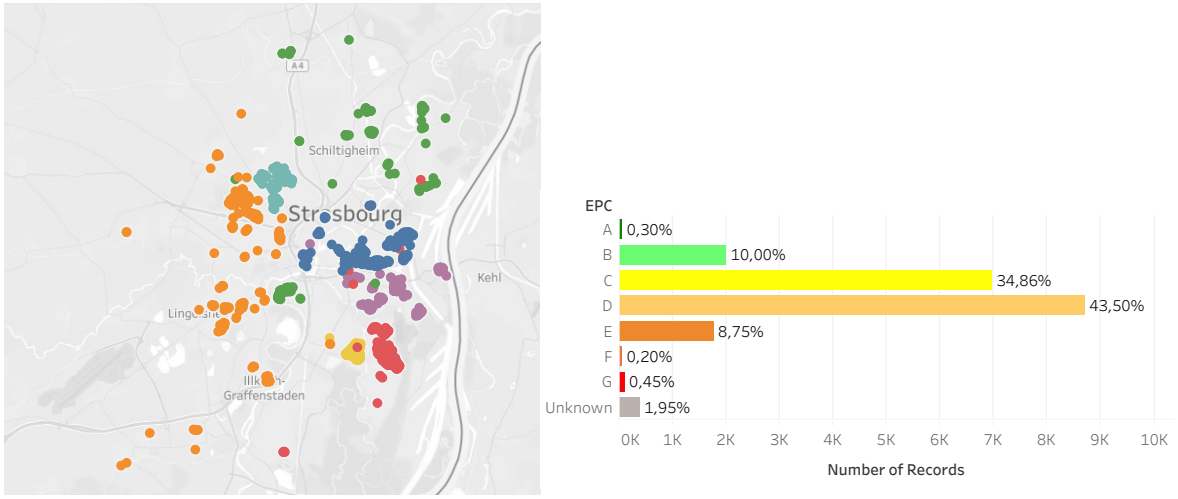


Figure 31. a) Geographical distribution of OPHEA stock by Agency b) energy label distribution

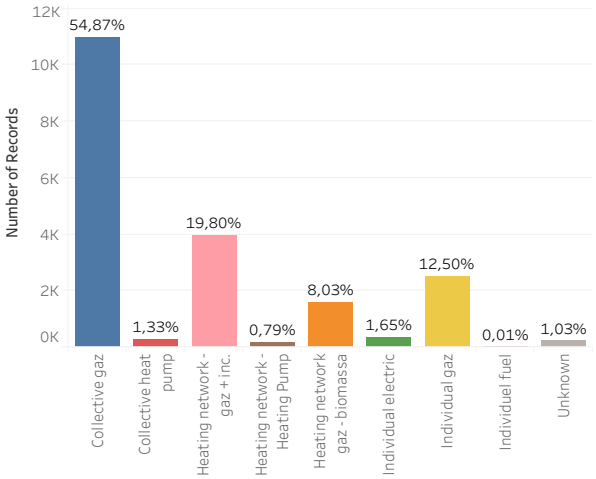


Figure 32. Heating typology distribution

Data quality

Our analysis reveals some gaps in the data of OPHEA:

- Energy label are to be updated for about 15% of the stock, mainly because of renovations undertaken in the last 6 years.
- GHG label, energy consumption and GHG emissions are missing for 25% of the stock.
- Floor area is missing for 10% of the stock.
- The energy monthly costs paid by the tenants directly or indirectly could not be used in the analysis.

Renovation target group

Through the DREEAM strategic portfolio analysis method, we could proceed to a detailed characterisation of building typologies in order to determine 4 aggregated renovation target groups allowing multi-building & large-scale (> 1,000 units each) renovation programmes.

Typologies OPHEA Strasbourg Centre	Surface	#unités	Avg surface
Collective Gaz 49 - 67 D	**48.360**	744	65
HN Gaz Biomassa 49 - 67 D	**30.192**	444	68
Individual Gaz 15 - 48 D	**21.831**	383	57
Individual Gaz 15 - 48 E	**12.376**	221	56
Collective Gaz 15 - 48 E	**13.050**	174	75
Collective Gaz 49 - 67 E	**15.762**	222	71
Typologies OPHEA Strasbourg Hautepierre	**Surface**	**#units**	**Avg surface**
HN Gaz Incineration 68 - 74 C	**132.273**	1863	71
HN Gaz Incineration 75 - 81 C	**39.168**	544	72
Typologies OPHEA Ostwald → Elsau	**Surface**	**#units**	**Avg surface**
Collectif gaz 75 - 81 D	**39.168**	328	65
Typologies OPHEA Strasbourg Neuhof	**Surface**	**#units**	**Avg surface**
Collective Gaz 49 - 67 D	**95.420**	1468	65
Typologies OPHEA Strasbourg Neudorf	**Surface**	**#units**	**Avg surface**
Collective Gaz 15 - 48 C	**25.130**	359	70
Collective Gaz 15 - 48 D	**38.180**	460	83

Figure 33. DREEAM topology analysis

The following target groups (prioritised by energy label and size) allows to create a targeted renovation program corresponding to 40% of the to-be-renovated stock (C or worse):

- Collective gas 49 - 67 D Neuhof (1,468 units)
- HN Gas Biomass 68 - 74 D Elsau (849 units)
- HN Gas Incineration 68 - 81 C West (2,407 units)
- Collective gas 49 - 81 C North (1,851 units)

Other aggregation strategies can be chosen, allowing up to 50% of the portfolio to be renovated.

Investment Strategies & Impacts

Due to the late start of the study, the renovation packages and the investment scenarios could not be simulated before the end of DREEAM project. Nevertheless, OPHEA has already a planned investment strategy for the next 7 years:

- €30M excluding VAT per year in renovation.
- at least €12M exc. VAT per year in energy efficiency measures.
- Around 700 units renovated each year.
- Development of heating networks and renewable energies;
- As much as possible target of label “BBC Rénovation” (105 kWh/m^2/year ~ C+).

This is a very ambitious plan but not yet specifically connected to climate-energy targets.

Recommendations

Potential for multi-building renovation

The portfolio analysis already shows a high potential for massive renovation and standardization. Comparable approaches show significant benefits in per-unit costs, increased quality and reduced overhead costs.

If continued, the investment scenario analysis would allow Ophea to explore:

- the impact of continuing current strategies;

- whether the current route allows OPHEA to meet its climate-energy objectives, and if not which adjustments are required;
- the impacts of increasing the annual renovation budget;
- and the cost/energy savings trade-offs of different renovation ambitions.

Recommendations

- Complete the data missing, especially related to EPC and energy consumption;
- Increase the number or enlarge the content of target groups;
- Achieve an investment simulation allowing to fine-tune the investment strategy;
- Test the possibility to increase renovation ambition to reach label B and further;
- Launch pilots for deep renovations and passive renovations (model Energiesprong) to test technical and financial aspects;
- Improve program development capabilities through extended internal and external technical assistance (for example through the EIB subsidy ELENA – covering 90% of the costs of Energy Efficiency program development).

3.3.12 Looking outside the EU – Armenia

In June 2018, BaxCo led a workshop about "Upscaling energy efficiency investments" at the Social Housing Festival in Lyon. During the session, BaxCo has presented the results of the replication programme and highlight the value of long-term portfolio renovation strategies for BOs. As a result of the session, BaxCo got in contact with the Armenia Social Housing Association who was strongly interested in the DREEAM project and in particular in BaxCO's approach to investment planning.

ASBA-SHF supports communities to foster energy efficiency improvement in Armenia, both in residential sector and in public buildings/infrastructure. They are also working to establish a real social housing sector in Armenia.

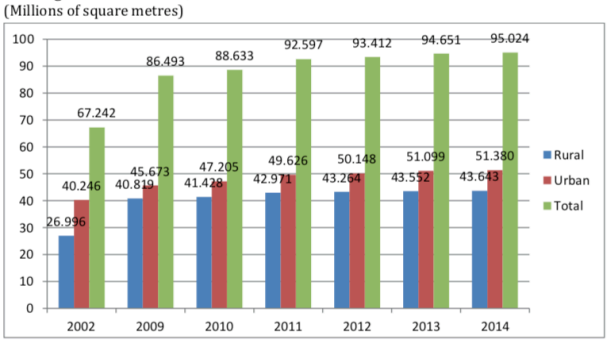
As conclusion of the work carried out in the replication programme, BaxCo performed a brief analysis on the Armenia Housing Association building stock in order to assess the potential to replicate and "export" the DREEAM multi-building approach to non-EU countries with similar challenges.

The housing sector in Armenia

The Republic of Armenia has approximately 800,000 households with a population of nearly 3 million.

- A majority of the building stock corresponds to collective housing: 440,000 dwellings in multi-family buildings.
- Approximately 60% population lives in urban area (35% population in Erevan)
- 95% of housing is individual owned: very little collective organisation.
- An estimated 50% of the population is considered as living in energy poverty.

Housing stock in Armenia, 2002 and 2009–2014
(Millions of square metres)



Source: Armenia, National Statistical Service (NSS), *Statistical Yearbook of Armenia 2015*, Table 146, "Housing Stock." pp. 186-187. Available from http://armstat.am/file/doc/99493628.pdf

Most buildings were constructed during the 1960s, 1970s & 1980s to Soviet standards. About 50% of housing stock is quite old and in poor physical condition, with the need of deep renovation addressing both energy efficiency and seismic resistance reinforcements.

99% of the housing stock is privately owned and there are no large-portfolio owners comparable to social housing corporations in the European Union.

Condominiums don't exist in most of the collective housing sector. There are some in Yerevan and large cities (Gyumri, Vanadzor) but most are in bad shape and are not trusted by tenants. There is a new draft law on condominums and maintenance of multi-apartment buildings drafted by the Urban Development Committee, which intends to improve the current situation by allocating a new important role to the property management companies. However, this law has yet to be discussed and finalised.

According to ASBA-SHF, the most critical issue to trigger large-scale renovation programs is the organisational capacity. Technical aspects don't represent any specific challenge for replication or scaling-up (quite homogeneous building archetypes from Soviet Union period help but upgrading seismic resistance is an issue) and (international) donors and investors are already showing interest.

While there are some experiments with regards to technical modelling for EE renovations (UNDP, EU projects) and several loan products for individual households available in the market, the main route to full EE renovation of multi-family building stock is capacity building for homeowners' associations and handling of the non-bankable status of 'common spaces'.

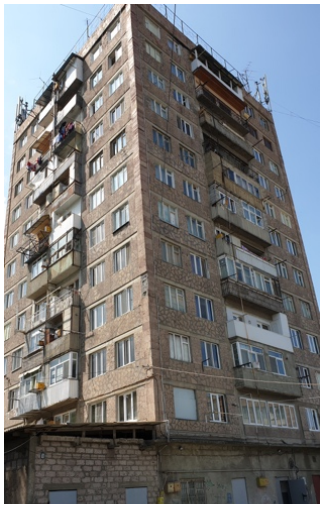
Major studies and projects in the field of Energy Efficiency.

- Integral renovation of privately-owned multi-stories building blocks on only two pilot cases (one illustrated below). A lot was invested to explore best possible renovation options. This demonstration case is the basis used to create regulation for building renovation.
- EU project INOGATE to create energy-efficient public and residential buildings.
- KfW created a financial scheme for individual households to provide affordable loans for energy efficiency: http://www.nmc.am/en:

Individual loans have been available since 2014, up to €6,000, with a 12% interest rate, and additional grant bonuses up to 15% of the amount. Up to now, approximately 1,500 owners have made use of this possibility.

- UNECE Country Profiles on Housing and Land Management for Republic of Armenia was published in 2017.
- AFD has launched in 2019 a strategic study on housing finance and sustainable residential housing in Armenia.

Predominant typologies in urban collective housing (source YUSAC)	
Masonry building bricks 'Tuf' local stone made (3 to 5 stories building), built from 1940 to 1970. *It is often difficult to externally isolate and change façade because of irregularities or heritage protection. Seismic resistance must be checked individually. 2 sub-categories would then emerge.* ➔ *estimated 20% of the national multi-family house stock*	

Prefab Steel - reinforced concrete and external layer 'Tuf', built from 1970 – 1990, with large panels and no concrete square structure. *Those are considered very seismic resistant (resistance level 9).* ➔ *estimated 30% of the national multi-family house stock*	
Prefab Steel- reinforced concrete and external layer 'Tuf' 1970 – 1990, concrete square structure + integrated panel *Seismic situation is to be checked individually. 2 sub-categories would then emerge.* ➔ *estimated 30% of the multi-family house stock*	

On basis of data provided by Vanadzor municipality, BaxCo could already provide a good oversight of the housing stock in this city:

Vanadzor data first analysis:

Concrete, prefabricated buildings

1. Multi-apartment concrete buildings (6, 9 and 12 floors), built during 1969-1985 – 120 buildings.
2. Multi-apartment concrete buildings (3-4-5 floors), built during 1990-1996 (after the earthquake, with stronger design) – 312 buildings.
3. Multi-apartment concrete buildings (1-2 floors), built during 1969-1985 – 63 buildings.

Stone-made buildings (local construction material: 'tuf')

1. Multi-apartment stone building (3-4-5 floors), mostly built 1960-1989 – 384 buildings.
2. Multi-apartment stone building (1-2 floors), mostly built 1960-1989 – 73 buildings.
3. Multi-apartment stone buildings (4 floors) , built during 1989-1995 (after the earthquake, with stronger design) – 70 buildings.

Renovation packages

A central decision criterion is the level of seismic resilience:

- For damaged buildings, BaxCo has suggested a shallow renovation approach with ROI < 10 years, or no renovation.
- For consolidated or easily re-inforceable ones, BaxCo has proposed a deep renovation approach.

Based on the discussions with the BO, BaxCo estimated that an investment of €5,000 (exc. VAT) per dwelling can lead to a qualitative integral retrofit of a 30-unit building, corresponding to up to 50% energy consumption reduction. Given the very high (and probably increasing) monthly energy costs in Armenia (the standard is €50 a month) due to an extreme climate, BaxCo has foreseen efficient business cases with ROI easily inferior to 20 years.

Additional information and potential pilots in Armenia are needed to get additional valuable technical and financial insights.

In particular, special attention should be focused on seismic resistance issues, in order to distribute investment between energy efficiency measures, structural renovation and demolition.

Suggestions going forward

Based on the first results, BaxCo has suggested the following next steps to the Armenia Housing Association, following a DREEAM like approach that would allow the upscaling of their current EE renovation programme and the achievement of the 75% of the energy consumption:

1. Carry out pilots for integral renovation packages for collective housing building, exploring new investment/ decision making process with homeowners associations, civil society organisations and local authorities.
2. Develop a complete investment strategy at municipal level (probably in Vanadzor).
3. Design large-scale investment programs in energy renovation of collective housing for the biggest municipalities (Vanadzor, Yerevan, Gyumri).
4. Develop collective loans provided by NMC and guaranteed by a public fund.
5. Attract (European/ international) funds for large scale investment programs and associated technical assistance.

4 Multi-building energy renovation study

Within the DREEAM replication programme, Exeleria has carried out the "multi-building renovation study" for 3 different cities in Ukraine and Latvia, analyzing a total stock of 11 buildings located in:

- Lviv, Ukraine (30.056 m2)
    - Cyryla i Metodego 29
    - Czerwonej Kaliny 53
    - Jawornickiego 7
    - Lazarenki 27
    - Hetmana Mazepy 7a
    - Hetmana Mazepy 13
- Krivyi Rog, Ukraine (15.884 m2)
    - Myru Ave 31
    - Myru Ave 46
    - Haharina Avenue 1
- Riga, Latvia (7.111 m2)
    - Dzelzavas iela 101
    - Ogres iela 10

To carry out this assessment, Exeleria applied the DREEAM tool. This tool allows to obtain in a Pareto diagram a combination of possible renovation measures from the multi-scale point of view, which can be analysed according to different parameters such as economic, energy, environmental, etc.

For each component of the building, 3 different solutions were considered to show different solutions taking into account the development level of each measure. Thanks to this, the tool can combine them with each other and select the most optimal depending on the parameters chosen by the building owner. The following table represents an example of the renovation solutions selected for one of the buildings:

Table 2. Overview of combination of different technical solutions

Component	Option 1	Option 2	Option 3
External wall (W/m2K)	0,18	0,20	0,23
Roof (W/m2K)	0,14	0,15	0,16
Floor (W/m2K)	0,14	0,15	0,16
Window (W/m2K)	0,70	0,90	1,10
Photovoltaic (KWp)	10,0	20,0	30,0

The DREEAM Tool give us an output of many different combinations for the proposed renovation components. It generates an excel file with possible combinations of all the components that form each renovation pack and the results from the calculation of the simulation: demands, consumption, costs, savings, efficiency, investment, etc.

From this analysis arises the need to select which of all the solutions shown is more optimal, that means, which implies a better balance between both desired target parameters.

These optimal solutions are found from the cloud of points obtained that helps to define a clear curve of results. The following graphics represent an example of comparison between **PB** and **energy savings** obtained for the group of buildings.

4.1 Feasibility scans and recommendations to building owners

4.1.1 Lviv, Ukraine

The stock of building was composed of the following:

Table 3. Lviv's buildings analysed by Exeleria in the replication programme

Address	Number of floors	Total heated surface (m^2)
Cyryla i Metodego 29, 79000 Lviv	3	872
Czerwonej Kaliny 53, 79000 Lviv	9	6.563
Jawornickiego 7, 79000 Lviv	5	2.626
Lazarenki 27, 79000 Lviv	5	5.077
Hetmana Mazepy 7a, 79000 Lviv	9	9.325
Hetmana Mazepy 13, 79000 Lviv	14	5.593
		30.056

In the following bubble diagram are represented all the renovation concepts highlighting the selected by the tangent line in the pareto diagram:

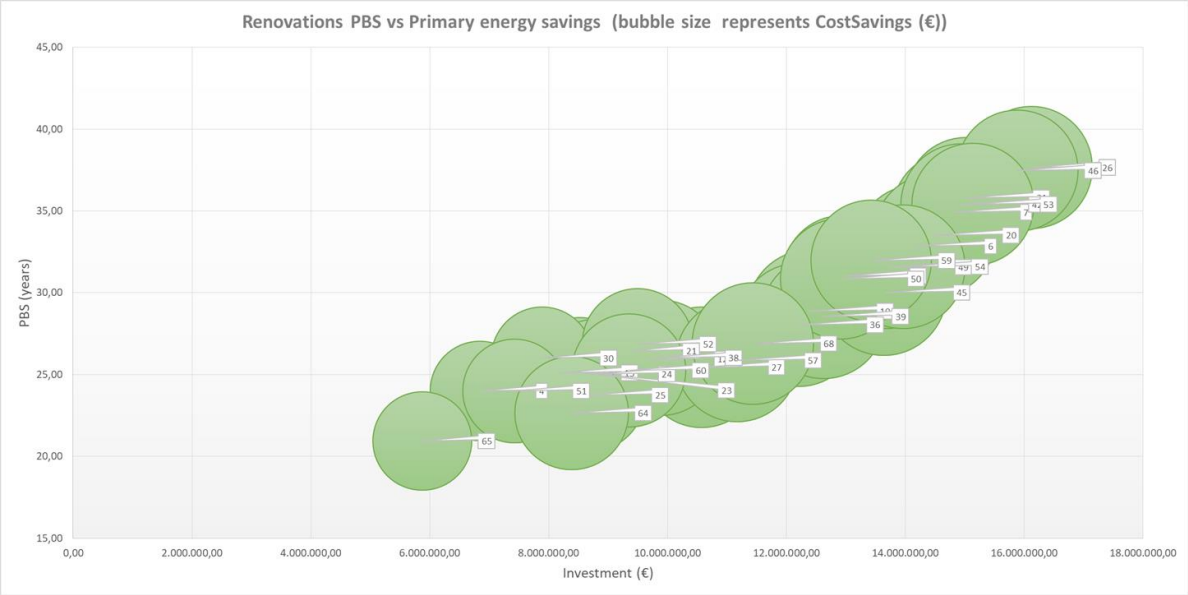


Figure 34. Optimal renovation concepts resulted from the application of the DREEAM tool to Lviv's buildings.

4.1.2 Krivyi Rog, Ukraine

The stock of building was composed of the following:

Table 4. Krivyi Rog's buildings analysed by Exeleria in the replication programme

Address	Number of floors	Total heated surface (m^2)
Myru Ave 31,50000 Kryvyi Rih	9	10.592
Myru Ave 46,50000 Kryvyi Rih	5	4.222
Haharina Avenue 1, 50000 Kryvyi Rih	4	1.070
		15.884

In the following bubble diagram are represented all the renovation concepts highlighting the selected by the tangent line in the pareto diagram:

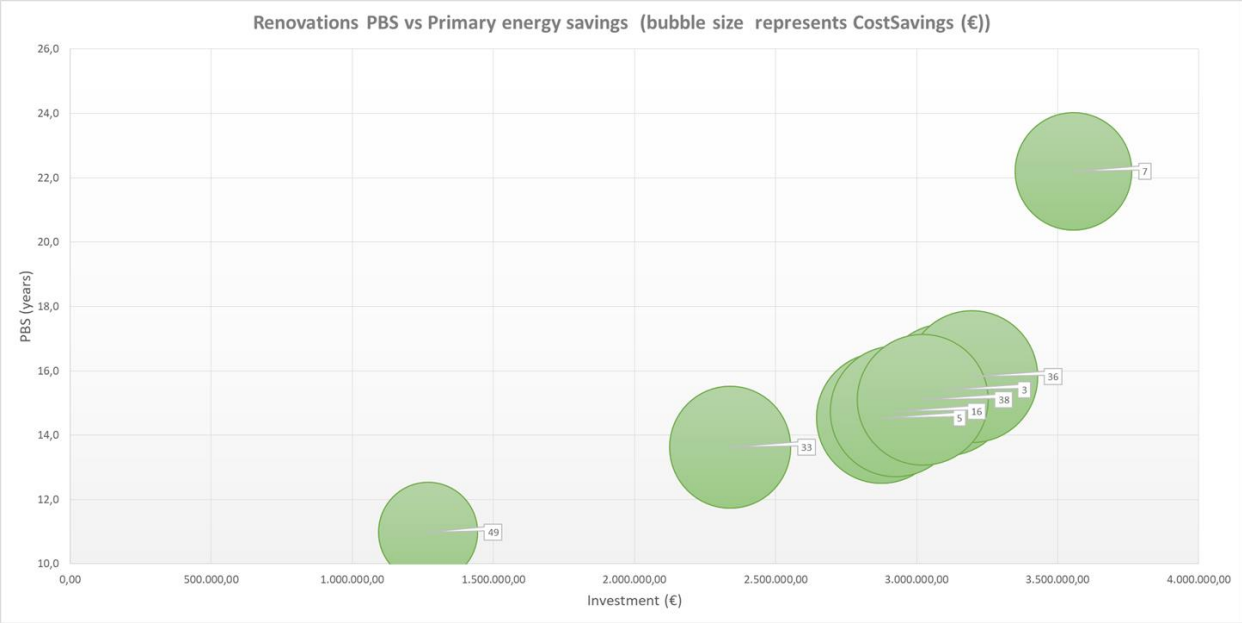


Figure 35. Optimal renovation concepts resulted from the application of the DREEAM tool to Krivyi Rog's buildings

4.1.3 Riga, Latvia

The stock of building was composed of the following:

Table 5. Riga's buildings analysed by Exeleria in the replication programme

Address	Number of floors	Total heated surface (m^2)
Dzelzavas iela 101,LV-1084 Riga	6	2.553
Ogres iela 10, LV-1019 Riga	10	4.558
		7.111

In the following bubble diagram are represented all the renovation concepts highlighting the selected by the tangent line in the pareto diagram:

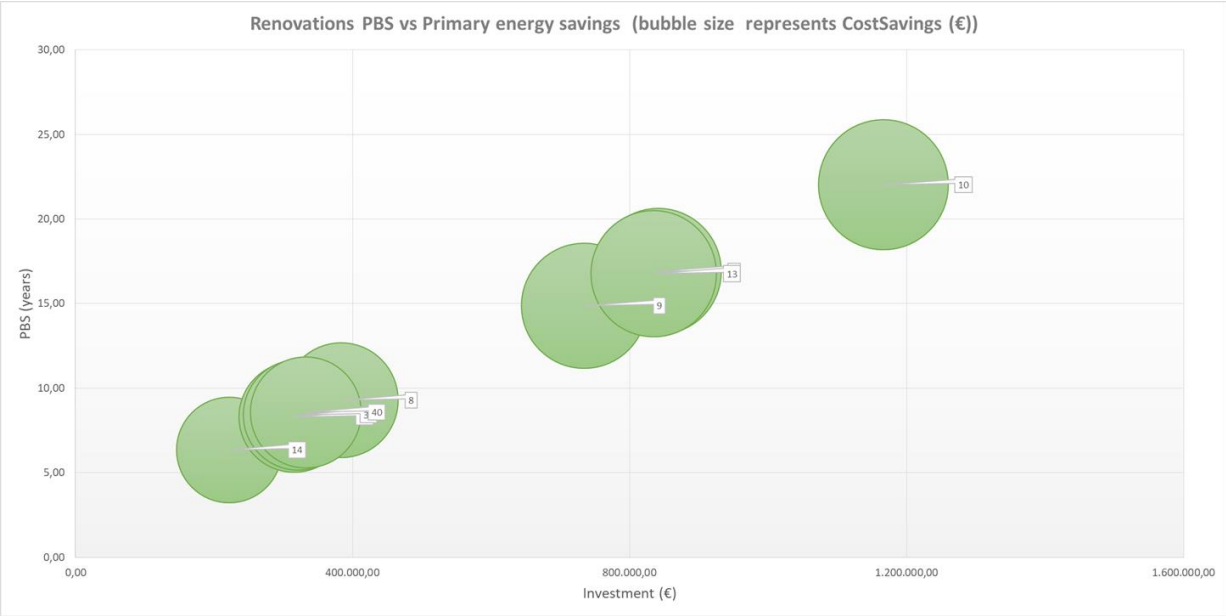


Figure 36. Optimal renovation concepts resulted from the application of the DREEAM tool to Riga's buildings

5 Conclusions

This deliverable aims to summarise the results of the DREEAM replication programme, reporting the main outcomes from each of the studies carried out and sharing the key conclusions regarding both the process and the next steps.

By collaborating with different organisations such as NAPE, IWO, EFL, EURHONET, BaxCo and Exeleria engaged with more than 100 building owners out of which 15 benefitted from the services of the replication programme.

The method was successfully used by and/or transferred to local centres of expertise; NAPE in Poland (Lviv case), and IWO for the Riga case.

The preparation phase of the analyses took several months due to the slow internal decision-making process of the BOs and the fragmented / low-quality data available. BaxCo had to spend a significant amount of time compiling different datasets and cleaning them as well as to involve the right housing association's staff in the review of the analysis and provision of inputs (high effort interaction).

From the implementation of the different analysis and the market engagement process it resulted that:

- The DREEAM approach and in particular the DREEAM tools are suitable for analysing large portfolios of multi-building dwellings. Smaller organisations in Spain for example, own dwellings across the cities and do not have multi-building sites to be renovated that are suitable for DREEAM large-scale approach for residential NZEB renovation. The main factor that reduces the construction of social housing is the lack of budget in the public administration and organisations mainly focus on the property. Additionally, small organisations also face barriers to experiment with innovative approaches to renovations and modernisations of their stocks.
- The DREEAM portfolio renovation planning approach is suitable for larger portfolios (>5,000 units), in areas where regulation or policy does not provide strict criteria on housing provider's actions. This means that countries without a centralised build-operate-manage approach do not have entities sufficiently large (e.g. Spain). In other countries, financial means are very tight (e.g. United Kingdom), while in others performance criteria are well defined, and ambitious – making solution design a straightforward process (e.g. Sweden).

Support to design long-term energy efficiency renovation investments strategy is highly relevant for housing associations with a heterogeneous portfolio, where different building types and construction periods dramatically increase the number of options.

- Candidates such as the city of Rotterdam, ATC Turin, and Warsaw used the insights of the investment scenario analysis to design their large-scale renovation programme.
- Institutional arrangements in some countries make access to long-term, low-cost finance a much less of a barrier. In the UK, access to a mature lending market is relatively low-cost, whilst in Sweden, the Netherlands and Germany publicly secured loans are available with very long maturities and further reduced interest rates.
- To have a clear picture of the current status of their portfolio, to develop sustainable investment strategies and optimised renovation packages, data quality is extremely important for building owners. However, BOs resulted to have very poor availability and quality of data and typically needed to collate information from different sources requiring high effort and time. Most of the housing provider found the short-term value of the exercise an overview of current data quality, and data points considered to be valuable from an expert point of view.

6 Annex I: events

During period 3, BaxCo has presented the results of the feasibility scans performed in the replication programme to a number of international events:

Event	Event Description – BaxCo contribution
ISEC Conference October 2018 Graz,	*International forum for industry, research and energy policy with focus on renewable energy systems and resource efficiency.* Presentation of the replication programme and of the building stock investment strategy service approach and first results
TIMEPAC Conference January 2019 Brarcelona, ES	*Workshop on Innovative Methods and Tools to Facilitate the Implementation of Energy Efficiency Strategies and Action Plans* Presentation of the replication programme and of the building stock investment strategy service approach and first results
Social Housing Festival June 2019 Lyon, FR	*ISHF 2019 focused on the importance of access to decent housing for all, to celebrate the long tradition of public, cooperative and social housing and its key role in addressing current and future housing challenges* Presentation of the results of the DREEAM replication programme and of BaxCo approach to sustainability investment planning
STUNNING event September 2019 Paris, FR	*STUNNING Project final conference (Bringing together 10 European related projects in the field of energy-efficient building renovation)* Presentation of the results of the DREEAM replication programme