

# Improving the energy efficiency of apartment blocks

Low Energy Apartment Futures (LEAF)  
**Final Report**



March 2016

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# EXECUTIVE SUMMARY

This is the final report for the Low Energy Apartment Futures (LEAF) project; a three year European project that ran from March 2013 to March 2016. The project included eight partner organisations from six<sup>1</sup> European countries: Austria, France, Germany, Hungary, Sweden and the UK (England and Scotland).

The project aimed to tackle the energy efficiency of multi-occupancy apartment blocks across Europe. With 43% of Europeans living in apartments, improving the energy performance of these buildings is essential to reducing energy use, fuel poverty and CO<sub>2</sub> emissions. However, it is recognised that retrofitting these buildings can be very challenging due to the limitations of EPCs, technical difficulties and the number of stakeholders involved.

## Methodology

The LEAF project involved:

- Background research
- Developing engagement and technical toolkits to facilitate retrofit in multi-occupancy apartment blocks
- Working with 24 buildings to progress retrofit projects
- Carrying out evaluation on the case study buildings and engaging stakeholders to identify successes, challenges and barriers
- Developing a series of policy recommendations at EU and national levels

## LEAF toolkits

Resources produced as part of the project are a technical toolkit and engagement toolkit, aimed at supporting energy retrofit in apartment blocks. These are aimed at property managers, housing associations, local municipalities and resident associations. The engagement toolkit is a guidance document providing support and advice at each stage of the retrofit process and provides further sources of information. The technical toolkit includes a software tool allowing users to obtain tailored information on the measures recommended in their EPCs. It also provides guidance and information on what EPCs are, energy savings from communal parts of buildings, and the impact of resident behaviour and how this can be improved. For the UK and France, it also includes a facility to assimilate EPCs from individual dwellings into a whole block EPC. Feedback was obtained from potential users on the toolkits which highlighted their usefulness to a range of stakeholders.

## Results and lessons

The project worked with 24 case study buildings across six European countries. The LEAF partners



*Figure 1: Typical apartment block in Edinburgh, Scotland*

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<sup>1</sup> Seven countries are included but only six member states (Scotland and England count as one member state under the UK).

supported owners of the buildings to progress energy efficiency measure installs; and these practical examples provided useful lessons on the challenges, barriers and success factors to retrofitting such properties. All the buildings had multiple owners, and were a variety of ages, construction types and ownership models. By the end of the project:

- Ten had agreed or installed energy efficiency measures
- Nine were still in the decision-making process of whether to install measures
- Five had not made plans to install any measures

Of those that had agreed or installed measures, the energy savings achieved were sufficient to exceed targets set out at the start of the project: 35,199 kWh/year per building against a target of 23,000 kWh/year<sup>2</sup>. A further target to reduce CO<sub>2</sub> emissions from energy use by over 30% was only achieved in three out of ten buildings (where measures were installed or agreed).

The results highlight that it is feasible and possible to achieve significant savings in multi-occupancy apartment blocks. However the fact that the owners in many buildings are still deciding on whether to install measures shows that three years is, in many cases, not always a sufficient time period to make decisions on energy efficiency retrofit. These buildings, and the five buildings that decided not to proceed with any measures, highlight the significance of barriers to retrofit in multi-occupancy apartment blocks.

Those barriers are numerous but core themes are:

- **Funding and finance:** a lack of finance or willingness to invest, lack of Government subsidies or changing funding landscape, long payback periods.
- **Motivation and engagement:** a lack of interest or motivation from owners and other key stakeholders.
- **Property and regulatory issues:** insufficient regulation to incentivise energy efficiency improvements and regulation limiting measures in protected buildings.
- **Communications and decision-making:** difficulty establishing and maintaining contact with the owners or decision-makers, or challenges with decision-making. Lack of appropriate and sufficient information on energy efficiency measures.

The barriers differed from country to country, but many of the issues encountered were the same or similar. Likewise, the project found successes in similar situations, such as where:

- Owners were well-motivated to retrofit their properties
- Funding could be obtained, including loan funding
- Private or social landlords were obliged to improve the energy efficiency of their properties
- Sufficient information and support was provided that enabled the project to develop

## Policy recommendations

The results and lessons from the project informed a series of policy recommendations at both the EU and national level. These call for:

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<sup>2</sup> Although the 'per dwelling' targets were not achieved because the number of dwellings in the buildings, on average, was much greater than anticipated.



- Improvements to EPC methodology and applicability
- Changes to the format and content of EPC reports
- Improvements to public funding schemes and expansion of financial support initiatives
- Introduction of more stringent minimum standards
- Improved information provision on low carbon retrofit
- Support for, and upskilling of, the workforce including accreditation schemes
- Implementation of maintenance plans and improved management structures in multi occupancy buildings

## Conclusions

Overall the project has highlighted the sheer complexity of retrofitting multi-occupancy apartment blocks and the number of barriers that must be overcome to proceed with projects. Whilst the specifics vary between countries, the key problems are similar across the European countries investigated. However the project also demonstrates that significant energy savings are possible where the right conditions exist and where sufficient support is provided.

For retrofit to happen on a large scale, the barriers identified here must be removed or reduced. The project has demonstrated practical ways in which some barriers can be minimised, for example through impartial support and advice. It has created toolkits to help stakeholders further this process and shared lessons with stakeholders across Europe. However, it also shows that improvements to EPCs are needed to fully realise their potential to drive retrofit, and that policies at the EU and national level must provide a supportive framework that incentivises and actively pushes for retrofit. Without these changes, retrofit of apartment blocks, which can result in significant energy consumption and CO<sub>2</sub> emission reductions, is unlikely to happen on a greater scale.



*Figure 2: Previous case study building in France*

# 1 INTRODUCTION

Low Energy Apartment Futures (LEAF) was a Europe-wide project which aimed to improve the energy efficiency of apartment blocks under multiple ownership. Funded by the European Union's Intelligent Energy Europe (IEE) programme and local organisations in each country, the project ran for three years: March 2013 to March 2016. The project was run by a consortium of eight organisations from six<sup>3</sup> different countries; these are listed in [Section 1.2](#).

The aim of LEAF was to identify and overcome key barriers to retrofitting apartment blocks, including shortcomings of Energy Performance Certificates (EPCs) and the difficulties of engaging multiple owners. This was achieved by working with case study buildings, creating resources for others to use (the LEAF toolkits) and forming policy recommendations.

This final report provides an overview of what the project achieved, its results and key lessons.

## 1.1 Aims and objectives

The key objectives of LEAF were to:

1. Demonstrate that EPCs can be used to produce whole-building action plans which deliver over 30% CO<sub>2</sub> savings for apartment blocks
2. Demonstrate how additional CO<sub>2</sub> savings can be delivered for communal areas and common building systems (heating, lighting and renewables)
3. Demonstrate how owners of individual dwellings within apartment blocks can collectively agree, commission and secure finance for the delivery of whole-building action plans
4. Remove barriers to the adoption of whole-building action plans to enable significant CO<sub>2</sub> savings, demonstrating they can be compatible with policy objectives related to preserving historic urban buildings.

In order to achieve these objectives the project planned to:

- Produce toolkits to support key stakeholders in identifying suitable energy efficiency measures and progress them to install
- Work with 24 case study buildings to demonstrate how retrofit projects can take place and pilot the toolkits
- Draw on findings from the case study buildings to create a list of policy recommendations for national and EU policy makers.

The methodology adopted is outlined in [Section 2](#).

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<sup>3</sup> Seven countries are included but only six member states (Scotland and England count as one member state under the UK).

## 1.2 Project partners

The LEAF project had eight partner organisations (known as ‘partners’):

- [ALE Lyon](#)- France
- [Centre for Sustainable Energy \(CSE\)](#) - England, UK
- [Changeworks](#)- Scotland, UK
- [e7](#)- Austria
- [Energiaklub](#) - Hungary
- [FLAME](#)- France
- [Fraunhofer Institute for Building Physics \(IBP\)](#) - Germany
- [Uppsala University](#) - Sweden

The partners worked as a consortium with Changeworks as the overall project co-ordinator. Other partners led specific sections of work; however, all had the opportunity to contribute towards each work section.

## 1.3 About this report

This is the final report of the LEAF project and details the overall methodology, results, lessons learnt and resources developed as part of the project. The sections are:

- [Section 2](#): Methodology – what happened in the project
- [Section 3](#): Background – why the project was carried out and what our background research showed
- [Section 4](#): Toolkits – the resources produced
- [Section 5](#): Case study buildings – an overview of the work carried out with case study buildings, including results and lessons
- [Section 6](#): Results and findings from the project
- [Section 7](#): Policy recommendations produced from the project
- [Section 8](#): Conclusion

For most of these sections there is further information available on the LEAF website in the form of reports or resources. Links to these are provided where relevant.

## 2 METHODOLOGY

The LEAF project was carried out using the following methodologies and approaches.

### 2.1 Background research to inform creation of toolkits

The partners carried out background research into topics necessary to inform the creation of the LEAF toolkits:

- Multi-occupancy apartment blocks – prevalence in each country, what type of buildings
- Planning legislation
- Financing e.g. subsidies available
- EPCs
- Barriers and opportunities to retrofitting measures
- Policies
- Energy information services in each country

The research was led by Uppsala University – they created a framework which was used by each partner to analyse the situation in their country and gather the necessary data.

Partners provided input based on their practical experience on the barriers faced in every country. Uppsala University then compiled two reports: [Background context in each partner country](#) and [Recommendations for toolkit development](#).

A brief summary of the background findings is in [Section 3](#).

### 2.2 Creation of toolkits

The background research, in terms of the context and requirements in each country (e.g. EPCs, barriers, etc.), informed the creation of the LEAF engagement and technical toolkits.

The engagement toolkit was created by Energiaklub and the technical toolkit by the Fraunhofer Institute IBP. They developed the main structure and content of the toolkits and each partner adapted these versions to their own specific needs in their country.

Feedback was sought in each country on the usefulness and user-friendliness of the toolkits through the evaluation. Some revisions were then made.

More information on the toolkits can be found in [Section 4](#).

### 2.3 Case studies

LEAF involved work with 24 case study buildings; four per participating country. These were chosen to represent a range of multi-occupancy apartment blocks in terms of construction, age, protected status (i.e. historic building) and ownership model. All had multiple owners.

The LEAF partners worked with their case study buildings to progress and where possible, install energy efficiency measures. This started with initial householder engagement, energy surveys, identification of measures, collecting information to support decision making and encouraging owners to agree measures. More details on these case studies, their outcomes, successes and challenges are in [Section 5](#).



It was originally intended that the LEAF toolkits would be piloted on the case study buildings to illustrate real life examples. However the timescales made this impossible as work with the case studies started at the beginning of the project (due to the foreseen length of time to progress projects) and the toolkits were not complete until later in the project. However, the partners were able to use their experience of working with the case studies to develop the toolkits and pilot them on examples and with potential users.

## 2.4 Evaluation

The consortium carried out a multi-pronged evaluation of the project:

- **Quantitative analysis:** analysis of the energy, CO<sub>2</sub> and monetary savings from the case study buildings' recommended, agreed and installed measures.
- **Participant surveys:** surveys were sent to all the residents and owners of the case study buildings. The surveys were created by the lead evaluation partner, e7, but adapted and translated by each partner. They were carried out in a variety of means such as post, online and phone.
- **Stakeholder feedback:** partners gathered stakeholder feedback through interviews and workshops. Feedback was gathered on the toolkits, barriers and opportunities in retrofitting multi-occupancy apartment blocks and policy recommendations (below). Stakeholders included housing associations, local authorities/municipalities, policy makers and energy agencies.

An overview of the evaluation results is in [Section 6](#).

## 2.5 Policy recommendations

Based on the lessons emerging from the case studies and the final results, a series of policy recommendations were formed. These are at national and EU levels, and a series of reports outlining these are available on the LEAF website.

A summary of the policy recommendations is in [Section 7](#).

## 2.6 Communicating our results

Key to the success of the project was engaging with key stakeholders in each country and sharing details of the project, results and lessons. Stakeholders were identified in each country and partners undertook a range of communication activities including presenting at events and conferences, online promotion and newsletters.



*Figure 3: Stakeholder workshop in Edinburgh, UK*

## 3 BACKGROUND

### 3.1 Why apartment blocks?

With rising energy prices and international efforts to tackle climate change, improving the energy efficiency of homes across Europe is increasingly important. As such, the EU has committed to a 20% reduction in EU emissions by 2020 from 1990 levels<sup>4</sup>.

Energy use in homes currently makes up a quarter of energy-related greenhouse gas emissions in Europe<sup>5</sup>; reducing this can be achieved through energy retrofit and behaviour change. Reducing household energy consumption benefits residents by making their homes cheaper and easier to heat. This is particularly significant as almost 10% of households in Europe cannot afford to heat their home adequately<sup>6</sup>.

43% of all Europeans live in apartments<sup>7</sup>, so addressing energy efficiency in these buildings is essential in meeting climate change, energy efficiency and fuel poverty targets. However these buildings are notoriously difficult to retrofit.

### 3.2 Background research findings

Before starting to develop the LEAF toolkits and commence work with case study buildings, the LEAF project carried out background research. This identified the differences and similarities between partner countries in terms of: national and local policies and legislation, prevalence of multi-occupancy apartment blocks, the EPC situation and finance mechanisms. National targets and EPC legislation tended to be similar due to the fact that they are based on shared EU directives, namely the Energy Performance of Buildings Directive (EPBD).

#### Ownership models

The background research highlighted differences and similarities between the ownership models and the decision-making within apartment blocks; something which influences whether and how energy efficiency improvements are progressed and managed.

Austria, France, Germany and Hungary have systems where residents own their apartment but some sort of owner association is legally required. This owner association, or the community, is responsible for the communal areas of the building and decisions concerning the whole building. Often an elected group of residents represent the owner association and sometimes external property managers work with the management, in cooperation with the resident's representatives. Residents can vote on decisions during general assemblies, normally held once a year.

In Sweden housing cooperatives are common. This is the single legal owner of the building and the residents are all members of the cooperative. It is represented by the elected board of members; sometimes they use external property management companies as well.

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<sup>4</sup> European Commission (2013)

<sup>5</sup> European Environment Agency (2011)

<sup>6</sup> EU Fuel Poverty Network (2013). This refers to the 27 EU member states.

<sup>7</sup> Eurostat, European Union (2011)

How decisions are made is usually regulated in legislation. In England, however, it is regulated in the leasehold agreement and in Scotland, normally the title deeds.

### **Barriers to retrofit**

In all participating countries it was found that apartment blocks were likely to have lower energy efficiency ratings compared to other kinds of buildings. The reasons identified were:

1. Technical issues
2. Agreement issues
3. Financial issues
4. Behaviour of residents

The technical issues described in the different countries vary, since constructions and systems are different. However, it is common for the property condition to be worse than in other buildings because it is often difficult to make decisions regarding communal areas. Particular difficulties with retrofitting apartment blocks that were highlighted included:

- Hard-to-treat wall constructions e.g. bricks, stone and/or concrete, or solid walls
- Windows
- Heating systems (individual, centralised/communal and issues with user control)
- Domestic hot water
- Poor performance of old systems
- Natural ventilation

The research found that agreement and financial issues usually go hand-in-hand. For example, a common problem was lack of funding and interest in the maintenance and improvement of communal areas of the buildings. Lack of maintenance can lead to a general poor condition of the whole building envelope, and makes residents prioritise urgent works. Many countries highlighted the decision-making process as being slow.

While subsidies may be an opportunity to finance retrofitting projects, it may also be a barrier if the financing schemes are complicated and/or short term.

A lack of knowledge among residents on how to save energy through behaviour changes was reported from all countries. Problems reported from the partner countries were:

- High indoor temperatures in homes
- No individual control system of heating systems (e.g. Hungary)
- Lack of understanding of modern control systems (e.g. UK)
- Residents do not make financial savings from energy savings due to setup of bill payments (e.g. Sweden)

These background findings were crucial in highlighting the context of apartment blocks (for example, how blocks are managed and who the toolkits should be aimed at) as well as common barriers to retrofit that the toolkits must address.

## **FURTHER INFORMATION**

More project context is available in the [background reports](#) on the LEAF website.

## 4 LEAF TOOLKITS

This section provides an overview of the toolkits produced as part of the LEAF project: namely the engagement and technical toolkits. Both have been designed as support and guidance documents to help key stakeholders make apartment blocks more efficient.

### 4.1 Engagement toolkit

#### Purpose of the toolkit

The goal of the engagement toolkit is to raise awareness of the benefits of retrofitting apartment blocks and provide a 'helping hand' to individuals who want to launch these investments but do not know where to start or how to persuade residents.

The guide summarises the most important steps of the planning and decision making process, the stakeholders who should be involved, as well as the challenges and difficulties that might arise while preparing or implementing the project. It offers potential solutions for these actions, provides best-practice guidelines and recommendations to aid decision-making.



The toolkit aims to help the audience in project preparation, communication and management but cannot replace the role of a project manager or the expertise of experts.

#### Target audience

The guide is developed primarily for people with the job of coordinating the low energy retrofits of apartment blocks under multiple-ownership. This varies between different countries but includes: common representatives, chairs of housing co-operatives, property management companies and landlords. It is also useful for private owners who are ready and keen to initiate a retrofit project with their neighbours, although this was not the main target audience.

#### Toolkit versions

The toolkit is available as a common European version, which can be adapted to any European country. Specific country versions are available for the LEAF partner countries: Austria, France, Germany, Hungary, Sweden and the UK.



The European version contains overall guidance and basic recommendations for retrofit. This content and structure was then developed for use as national versions. The country specific versions include information on best practice, national or local regulation, local advice and support, and further sources of information.

## Feedback from the target audience

The LEAF partners disseminated the toolkit to the target audience in a number of ways including local meetings, via local networks and newsletters. Positive feedback was received from the target groups who described the toolkit as a 'roadmap' with a collection of key steps and list of necessary involved experts which could help in the coordination of retrofit projects. Some recommendations for improvement were used to refine the toolkit.

### FURTHER INFORMATION

The [engagement toolkits](#) can be downloaded from the LEAF website.

## 4.2 Technical toolkits

### Aim of the toolkit

The aim of the technical toolkit is to support decision making in multi-occupancy apartment blocks on a technical basis and therefore complement the engagement toolkit. Users can support their decisions by looking at the potential for behaviour change or the implementation of technical measures.

At the start of the project the intention was to create a toolkit which assimilated EPC data from multiple dwellings in a block to create a whole building EPC, including recommendations for communal areas of the building. However it quickly became apparent that such a tool was not required in most of the LEAF partner countries because EPCs at the individual dwelling level are only regularly carried out in two countries (UK and France). Therefore the scope of the toolkit was changed to focus on a tool that provides technical assistance and adds information to the existing EPCs (multiple dwellings or whole block), including potential savings from communal areas. Nevertheless a communal EPC tool was created for France and the UK, as planned. This assimilates multiple individual dwelling EPCs into a whole block EPC and is available as an excel tool on the [LEAF website](#).

### Toolkit versions

The technical toolkit is available in a customised version for the six different participating countries: Austria, France, Germany, Hungary, Sweden and the UK<sup>8</sup>. It is available on the [LEAF website](#) and has been designed to be easy to use, so a full tutorial is not required. Support is however available via an introductory webcast and the instructions given within the toolkit itself.

### Target audience

The toolkit was designed for building owners, owner communities, facility managers as well as energy consultants, architects and building managers. The exact audience varies between the different countries, depending on the stakeholders involved in retrofit.

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<sup>8</sup> The UK version covers England and Scotland



## **Feedback from the target audience**

Feedback from potential users highlights that the toolkit is considered a useful addition to the existing energy retrofit procedure of an energy efficiency consultancy; with users finding the description of the measures particularly helpful. Feedback from the UK and France states that the communal EPC toolkit is useful in assimilating multiple individual EPCs.

## **The toolkit content**

The toolkit contains four sections:

**A. What is an Energy Performance Certificate (EPC)?**

**B. Recommended improvement measures in EPCs**

**C. Impact of user behaviour**

**D. Possible additional savings**

Each section provides guidance on that topic and has been adapted to the national situation and format of EPCs. Details of each section are provided below.

### **A. What is an Energy Performance Certificate (EPC)?**

This section is a downloadable PDF document for each partner country that provides guidance on EPCs. It answers the following questions:

- What is an EPC?
- What is the aim of an EPC?
- Who issues an EPC?
- How much does an EPC cost?
- How long is an EPC valid?
- Are EPCs comparable throughout Europe?
- Do EPCs use measured or calculated energy values?
- Where can you find further information on EPCs?

### **B. Recommended Improvement Measures on EPCs**

Section B provides information about technical measures that are suggested in EPCs. This is an interactive software tool that the user inputs data into and receives a tailored PDF document detailing their results.

The main objective of this section is to provide additional information on the recommended measures such as: a detailed description of the measure, its suitability, what has to be considered while installing or implementing this measure and which permissions are usually required. In many countries, the EPC only provides the name of a measure, making it difficult for non-technical experts to understand what the measure is and what else has to be considered. The toolkit is therefore designed to add valuable information which is crucial for decision-making.

## Using the toolkit

This part of the toolkit does not carry out any energy performance calculations, but uses the information from an existing EPC to calculate a simple payback period. Therefore the tool requires input data from an EPC including:

- The measures recommended in the EPC
- Size of the measures (if known)
- Costs of investment (if known)
- Energy use before and after (if known)



EPCs are different in every country and the tool has been designed for use in a number of countries. Therefore not all EPCs will contain all the information detailed above. A guidance document in the toolkit helps the user see where this information is provided on the EPC or if it is not, how it can be calculated. Information on payback periods will only be given if the EPC does provide the required figures. The section can also be used for general information without an EPC or to look at measures which are not mentioned in the EPC.

For users in the UK and France, it also provides the **communal EPC tool** which produces whole building recommendations based on EPCs for individual apartments.

A screenshot of the user interface is shown below.

Name/address of the building:  
Apartment block B

**Package of measures: Information to be taken from EPC**

Package 1 Package 2 Package 3 Package 4 Package 5 Package 6

**Selected Measure(s)**

Roof room insulation  
Low energy lighting  
Hot water cylinder insulation

Add Measure Delete measure

Size of measure  
300.00 l cylinder content

Cost of measure  
29.10 £/l

LEAF database: minimum 6.00 £/l  
LEAF database: maximum 90.00 £/l

**Energy savings of measure/package of measures:**

**Heating energy:**

**Main heating fuel 1:**  
gas

Energy use before 54,890.00 kWh/yr  
Energy use after 36,124.00 kWh/yr  
Energy tariff 0.034 £/kWh

Figure 4: Input screen for the UK version of Section B

For each measure, the following information is provided:

- Description of the measure
- Suitability i.e. what types of properties measures are suitable for
- Warnings i.e. considerations
- Permissions i.e. where planning permission is required
- Improvement target i.e. for example, particular U-values that must be reached for building standards

As Part B of the toolkit is adapted to EPCs in different countries, a different number of recommended measures are included in the national versions<sup>9</sup>.

### **C. Impact of the user behaviour**

This section of the toolkit allows users to add information about the energy using behaviour and habits of building residents to find out what impact this could have on the energy use of the building. It also explains why a calculated EPC can result in higher or lower energy values than those shown on actual household energy bills. This section additionally provides further tips and advice on how to reduce energy use in a building through behaviour change.

There are many different factors by which the residents can influence the energy consumption of a building. The resulting guidance document introduces them in more detail. Since it is likely that user behaviour of other residents in a block is mostly unknown, the LEAF project has broken down the various factors into a few key indicators. Using these indicators, the user can make a broad assessment of their energy consuming habits in order to identify each apartment as a possible 'over-consumer' or 'under-consumer'.

### **D. Possible additional savings**

This section of the toolkit provides further advice on how to save energy in a residential apartment block aside from measures included in (most) EPCs. This includes consideration of areas of the building such as:

- Heating of communal stairways
- Lighting energy use in common areas and outside of the building
- Electrical energy use of elevators / lifts

## **FURTHER INFORMATION**

The toolkit is available to use for free on the [technical toolkit page](#) on the LEAF website.

<sup>9</sup> The number of measures is as follows: United Kingdom: 33; Austria: 24; France: 38; Germany: 41; Hungary: 19; Sweden: 29.

## 5 CASE STUDY BUILDINGS

### 5.1 Approach

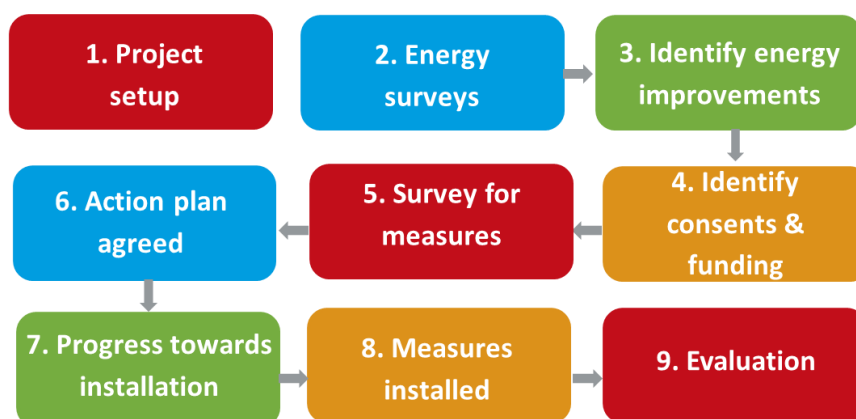
The LEAF partners worked with 24 case study buildings in the six partner countries to progress energy retrofit (Table 1). This part of the project provided invaluable lessons on the successes, challenges and barriers to retrofit, and demonstrated that significant energy and CO<sub>2</sub> emissions savings can be achieved from installed measures.

**Table 1: Overview of LEAF case studies**

Country	Location	LEAF Partner	No. of case studies
Austria	Vienna	e7	4
France	Lyon, Montpellier, La Tronche, St Etienne	ALE Lyon and FLAME	4
Germany	Aachen, Berlin, Bonn, Stuttgart	Fraunhofer IBP	4
Hungary	Budapest	Energiaklub	4
Sweden	Visby	Uppsala University	4
UK (England)	Bristol	CSE	2
UK (Scotland)	Edinburgh	Changeworks	2

The buildings were chosen to include a range of different ages, construction types, tenures, management structures and property sizes.

Figure 1 shows the process each case study building went through, although not all proceeded to installation. The LEAF partners supported this process, providing information on energy efficiency measures, engaging residents and supporting decision-making.



*Figure 5: Case study installation process*

Details of all the case studies are provided in the following sections of this report, grouped by partner country. Each section contains an overview of the case studies, results and lessons.

### FURTHER INFORMATION

For more information about all of the LEAF case studies, including full reports, go to the [case studies page](#) on the LEAF website.

## 5.2 Austria

### Overview of the case studies

The Austrian LEAF partner, e7, worked with a total of five case studies, although one 'dropped out' after a short while and this one is not shown in Table 2. It was replaced by another case study, and work with a further two was intermittent during the project.

**Table 2: Overview of the Austrian LEAF case studies (all located in Vienna)**

Case study	Endemanngasse - high-rise buildings	Endemanngasse – terraced buildings	Schillgasse	Neuwaldeggerstraße
<b>Construction</b>	Lightweight concrete	Lightweight concrete	Lightweight concrete, thin insulation layer	Lightweight concrete
<b>Date of construction</b>	1981	1981	1974	1974
<b>Number of dwellings</b>	Three high-rise buildings, 120 apartments	18 terraced houses	2 blocks – 30 dwellings in total	2 blocks – 15 dwellings in total
<b>Ownership</b>	Building developer is the majority owner who rents the apartments and less than half of the dwellings are privately owned (owner-occupied).		Privately owned; 15 owner occupied 14 rented 1 caretakers' flat	Privately owned
<b>Protected status</b>	None	None	None	None

### Motivations

The participation of the Endemanngasse buildings was organised by a building developer who is the majority owner of the buildings and responsible for managing the properties. They were interested to implement energy efficiency measures at the start of the project, but were not able to agree on renovation action with the private owners. In Schillgasse the property management organised participation in the project to explore whether it would help engage private owners in discussions about energy efficiency measures. The trigger for this was necessary maintenance work, and it was therefore felt the work could be carried out together. In the fourth case study (Neuwaldeggerstraße), it was hoped that the project would engage all residents in energy efficiency. Residents were motivated to install energy efficiency measures if public or federal subsidies were available.

### Results

Of all the Austrian case studies, Schillgasse has made the most progress. The owners' community has agreed to insulate the top floor ceiling, as well as the basement and garage ceilings along with necessary maintenance work which covers the renewal of the roof covering and the plastering of the façade. These measures are expected to lead to an annual energy saving of approximately 76,000 kWh and reduce their CO<sub>2</sub> emissions by almost 18 tonnes. Per dwelling, fuel bills are expected to reduce by €150 per year and the EPC rating is expected to improve from a 'C' to 'B'.

Residents of Neuwaldeggerstraße have not agreed to implement any measures as of yet but the final voting will take place in May 2016. They are likely to replace the old gas heating



boiler constructed in 1986 with a more efficient gas condensing boiler but have not yet decided whether to proceed with external wall insulation. By implementing all recommended measures they could reduce energy consumption by approximately 187,000 kWh per year and their CO<sub>2</sub> emissions by 44 tonnes.

The Endemanngasse case studies have not committed to implementing any measures as of yet. Work with these residents finished in early 2015 due to a tense situation between the owners' community and the property management.

### **Key challenges, barriers and successes**

One issue encountered during the project was the inaccuracy of EPC calculations. For the properties in Endemanngasse, three different EPC calculations were carried out and each showed a different heat energy demand (57.65 kWh/m<sup>2</sup>a, 71.96 kWh/m<sup>2</sup>a and 95.63 kWh/m<sup>2</sup>a). This difference was because of different assumptions of the building construction. However it lowered residents' trust in the EPC as a whole and the calculations of the prospected energy savings.



*Figure 6: Endemanngasse case study, Austria*

Residents of the other projects had hardly or never looked at the EPC. However EPC calculations are important as they are the basis for how much funding buildings are granted. Also, energy consumption figures calculated by the EPC are very close to a building's real energy consumption which should help secure the trust of residents in their EPC's calculations.

Cost effectiveness was a key challenge within the Schillgasse and Neuwaldeggerstraße case study buildings. Both had moderate energy consumption levels during recent years, compared to the EPC rating and they further benefit from low gas prices. Accordingly, calculated payback times for energy efficiency measures are very long.

To achieve an agreement in the Schillgasse case study, the requirement for necessary maintenance works meant that costs were shared. This cost sharing meant the owners' community realised they needed to take advantage of the offer or otherwise incur additional costs at a later stage.

Furthermore, available public funding contributed to engage the owners.

## 5.3 France

### Overview of the case studies

In France, the case studies were delivered by FLAME (Federation of Local Energy Agencies) and four Local Energy Agencies. The buildings were located in four different parts of France: Montpellier, Lyon, Grenoble and Saint Etienne. One building 'dropped out' during the project so a replacement was found, meaning that a total of five buildings were worked with (the four live case studies are shown in Table 3).

**Table 3: Overview of the French LEAF case studies**

Case study	44 rue Chevreul	Les Mouliniers	Le Clémenceau	1 rue Guildbaud
<b>Location</b>	Lyon	Saint Etienne	Montpellier	Grenoble
<b>Construction</b>	Clinker concrete	Concrete	Solid concrete	Concrete
<b>Date of construction</b>	Early 1900s	1951	1958	1960
<b>Number of dwellings</b>	14	4	8	14
<b>Ownership</b>	Mix of owner occupiers and private landlords			
<b>Protected status</b>	Not protected but within 500m of a protected building	None	None	None

The buildings chosen as case studies were relatively small; the largest has 16 dwellings. This was intentional because the project was focusing on EPCs; larger buildings in France, with communal heating systems, would require thermal audits which are more useful and precise than EPCs.

All the case study buildings were heated by individual systems (for example, one gas boiler per flat). The oldest building was built at the beginning of the 20th Century and the others were built between 1950 and 1975.

### Motivations

In all of the buildings, energy retrofit started within one or a small group of owners. Then the others needed to be convinced. Within these small groups the motivations differed: for one group it would be the need for maintenance works such as leaks in the roof, in the other it would be a concern about property value in the market and attention to building appearance.

In these buildings, even when subsidies were integrated in the calculation, the payback time was very long.

### Results

Two buildings did install measures and one is still to reach a decision. In Saint Etienne, significant energy savings were achieved (72%). The owners of the building decided to carry out all of the recommended measures because subsidies were very high for a short time and to increase the property value. This is in a context where energy ratings from EPCs are used to negotiate the price or the rent of dwellings.

In Lyon, the main motivation that led to energy performance works is required maintenance (leaks in the roof).

Owners in the case study buildings are still thinking about measures having taken a while to make decisions and proceed. This is because they only meet once a year at a general assembly.

### **Key challenges, barriers and successes**

The French case studies highlighted that engaging and convincing residents needs time and resources. It was found that owners need different types of support: technical, communication and financial. The local energy agencies helped them with those different aspects by carrying out the EPC, helping them find installers or engineer for the works, liaison with professionals, offering advice and support at the owners meeting, assisting in the creation of communication documents, informing local energy agencies and helping the owners with subsidies and zero interest loans. However to help other buildings do the same, the French partners looked to maximise the resources provided through the engagement toolkit.



*Figure 7: Moulinier case study, France*

Despite this, it appears that EPCs are not enough to convince owners in terms of improvement measures and potential savings. EPCs are useful to raise awareness about energy consumption but as the feasibility and the measure cost information are imprecise, an opinion and a quote from an installer or an engineer for the works is necessary.

Finally, the case studies highlighted that the project lifespan of three years was insufficient to take these buildings to the point of installation. The projects involved several steps (for example: initial queries, thermal audits, suggesting measures, carrying out the works and evaluation after the works) and these steps need a longer timeframe. Crucially, all the steps have to be accepted by the general assembly that only takes place once a year; this has a significant impact on delaying project timescales.

## 5.4 Germany

### Overview of the case studies

The Fraunhofer IBP team worked with four case studies in Germany, as shown in Table 4.

**Table 4: Overview of the German LEAF case studies**

Case study	Klosterweiher	Bartningallee	Zandnerstraße	Schlüsselwiesen
<b>Location</b>	Aachen	Berlin	Bonn	Stuttgart
<b>Construction</b>	Solid pumice brick wall, reinforced concrete ceilings	Steel structure / reinforced concrete; prefab wall panels	Solid pumice brick wall, reinforced concrete ceilings, prefab façade panels	Brick walls, reinforced concrete ceilings
<b>Date of construction</b>	1970	1957	1970	1964
<b>Number of dwellings</b>	60 (10 houses x 10)	60	59	34
<b>Ownership</b>	Privately owned	Privately owned	Privately owned	Privately owned
<b>Protected status</b>	None	Listed building	None	None

### Results

A variety of measures were recommended and progressed:

- **Klosterweiher (Aachen):** Loft insulation was installed in all 10 houses and the replacement of the glass brick staircase façade with a contemporary high insulating window façade system is planned. A way for successful decision making process among the owner community was found, mainly due to personal conversations with owners and the owner community advisory council by the architect.
- **Bartningallee (Berlin):** The main strategies used were to improve user behaviour and individual energy efficiency measures; this was developed together with the property management company and the owner community advisory board.
- **Zandnerstraße (Bonn):** During the last year of the LEAF project the owner community agreed to exchange the old oil heating with new gas heating and this measure is planned to be installed shortly after the end of LEAF, after the heating season 2015/16 is over. This measure is not particularly expensive, but its effect on the energy consumption reduction will be considerable with around a 20% reduction expected.
- **Schlüsselwiesen (Stuttgart):** Due to a change in the property management company of the complex, there was a particular delay and difficulties because of the need to restart the consultation process with the new manager. Several recommendations were provided to the owners in the building by the project, which were strengthened and strongly supported in their argument by good public funding opportunities for the owner community, due to the local funding schemes available in Stuttgart. Finally, a large package of retrofit measures has been agreed by the owner community: a complete insulation action of the entire envelope (including loft insulation) and a thermal heating system exchange.

## Key challenges, barriers and successes

Around 10 – 30% of the case study buildings' dwellings are owned by "large owners"; these are owners who own more than one apartment, usually 5-10, and rent them to different types of residents. The project revealed that these owners are usually quite driven to undertake energy retrofits due to their long term financial and subjective interest in keeping their properties technically up-to-date, comfortable and with low annual energy costs.

The situation is different for "single owners" who only own one flat that they live in. Often these owners are of pensioner age or lower-income families and their motivation towards energy retrofit comes up against serious barriers; for example, the difficulty to pay for measures with long payback times. Long



*Figure 8: Klosterweiher case study, Germany*

payback times appeared to be a particular problem for elderly residents, but their motivation was more focused on improving indoor comfort.

Communication with the owners occurred via property management companies and ownership community councils and required frequent and intensive communication with these organisations. However the negotiation process during the consultation was often protracted and quite challenging; owners often had strong opinions which weren't always practically or scientifically founded. It was also challenging to convince owners of the feasibility of installing works but engagement levels grew where the energy retrofit measures package was built around the needs and the financial/organisational ability of the owners.

It was often found that the individual energy retrofit measures (e.g. internal wall insulation, window upgrades, smart home systems) resulted in a higher interest amongst the "single owners". However given the high numbers of owners in each of the buildings, it is highly complicated to consult every single owner on undertaking different energy retrofit measures.

In general, the EPCs did not have a significant role in advising the owner communities. This was due to the incomplete section of the EPCs which provides advice about measures.

The public funding schemes in Germany are often very attractive from a financial point of view. Nevertheless the relatively complicated and protracted proposal period which should mainly be carried out by the property management companies was a barrier to their application. However this is not part of the property management's defined list of activities, which are outlined by law and it is also not necessary for the owner communities to pay for these improvements. The LEAF project helped them to combine attractive local public funding programmes to motivate the owner community to undertake the energy retrofit measures, as for example in Schlüsselwiesen, Stuttgart.



## 5.5 Hungary

### Overview of the case studies

There were four case study buildings in Budapest, managed by LEAF partner Energiaklub. The buildings are located in different parts of Budapest: two smaller buildings from the Buda side and two from Pest. In total the buildings have 194 dwellings.

An overview of the case studies is in Table 5. The buildings were chosen to represent a range of buildings in terms of different building technologies, heating system, size and legal framework.

**Table 5: Overview of the Hungarian LEAF case studies (all located in Budapest)**

Case study	Dolgozó út 2.	Deres u. 10/D.	Ond Vezér street 9-11.	Galántai street 4.
<b>Construction</b>	Thin concrete wall	Brick combined with concrete wall	Industrial prefabricated concrete system	Concrete and brick combination
<b>Date of construction</b>	1966	1968	1972	1970
<b>Number of dwellings</b>	36	13	131	14
<b>Ownership</b>	The legal form of the living community is a <i>housing association</i> : apartments are privately owned, the common areas and common parts of the building (walls, basement roof, elevator) are owned by the association.	The legal form of the living community is a <i>condominium</i> : apartments are privately owned, the owners share the responsibility (and maintenance common costs) for the common areas and common parts of the building (walls, basement roof).	<i>Housing association</i> : the apartments are owned by private persons, the common areas and common parts of the building (walls, basement roof, elevator) are owned by the association.	The legal form of the living community is a <i>condominium</i> : apartments are privately owned, the owners share the responsibility (and maintenance common costs) for the common areas and common parts of the building (walls, basement roof).
<b>Protected status</b>	None	None	None	None
<b>Energy usage</b>	275 kWh/ m <sup>2</sup> a	219 kWh/ m <sup>2</sup> a	111 kWh/ m <sup>2</sup> a	318 kWh/ m <sup>2</sup> a
<b>Energy saving potential</b>	62%	50%	15%	58%

### Results

The building owners received whole building EPCs that identified appropriate measures. In addition, the retrofit plan included cost calculations of recent and theoretical after-retrofit energy demands, estimated investment costs and payback periods of the retrofit. The

documents were supported with thermal imaging analysis, which helped to visualize the weak points of the buildings, heat losses and thermal bridges.

The technical documents were delivered to the owner's representatives and easy-to-understand summaries were disseminated to the owners. Beyond the written documents in two buildings, the results of the EPC and the additional economical information of the retrofit plan were presented and discussed with the audience.

The saving potential is high: 50-62% energy and CO<sub>2</sub> could be saved in the buildings by upgrading the building envelope. In one building which had already had some energy efficiency measures installed, the consumption could still be reduced by 15% through the installation of solar collectors and additional insulation to pipes and the staircase.

Despite the attractive saving potentials, the owner communities were not able to implement the recommended measures during the project time. Three communities postponed the decision until state subsidies become available, and one community decided not to refurbish because of the high risk of taking out a bank loan.

### **Key challenges, barriers and successes**

The main barrier experienced with the Hungarian case studies was the lack of financing. Due to the long payback periods and the high capital requirements of retrofit, projects will not proceed without financial assistance (direct subsidy and attractive bank loans).

The case studies also showed the need for owner or resident communities in multi-occupancy apartment blocks to receive substantial support. The size and costs of projects show the necessity to involve external experts from a number of fields: energy experts, project managers and also financial expertise are necessary to prepare and implement the investment.

A lot of positive lessons were collected during the project. One of them was the openness and interest of the involved residents to retrofit (evidenced by the volume and type of questions received).

The main goal of the technical documents and information materials was to ensure the communities could make informed and responsible decisions. The LEAF project helped them to become aware of their opportunities and this in itself is a success that may lead to installations in the future.



*Figure 9: Dolgozó case study, Budapest*

## 5.6 Sweden

### Overview of the case studies

Four case studies were carried out in Visby in Sweden (Table 6). These are situated in a UNESCO World Heritage Site.

**Table 6: Overview of the Swedish LEAF case studies (all located in Visby)**

Case study	Kommendantsbacken	Visborgsgatan	Södertorg	Hästgatan
<b>Construction</b>	Stone/brick and timber	Brick	Brick	Brick
<b>Date of construction</b>	1885	1902	1910	1910
<b>Number of dwellings</b>	9	9	13	16
<b>Ownership</b>	Housing cooperative			
<b>Protected status</b>	In conservation area	In conservation area	In conservation area	Listed

All four case study buildings are owned by housing cooperatives; a common form of ownership in Sweden where all residents own a share of their whole building and thereby own the right to their apartment. Residents pay a monthly fee which covers maintenance costs, interest on any loans the cooperative may have, heating, water and communal electricity. However, the breakdown of these costs is not specified. An elected board of members in the cooperative is responsible for making any decisions regarding the building. Every year there is at least one general assembly at which elections take place and any decisions requiring input from the whole cooperative are made.

### Motivations

The cooperatives in the above buildings were selected and asked to participate in this project because of their location in the old town and management structure. Residents' motivations to participate in the project varied; however, most wanted to save energy and increase the comfort of their homes. One of the cooperatives, Kommendantsbacken, was particularly motivated to upgrade their electric boilers which are used to heat three of the apartments, whereas all the other apartments are heated by district heating.

### Results

A number of the windows at Visborgsgatan were upgraded in Spring 2015. So far, however, only the windows facing the garden, behind the house, have been upgraded. The cooperative is planning to upgrade the remaining windows next year.

The heat circulation pump at Hästgatan was changed shortly after the Energy Performance Certificate (EPC) survey was conducted, at the consultant's recommendation. In addition, the cooperative in this building renovated a number of the windows on the attic floor. The cooperative in this case was looking to improve comfort in the building – for example, reducing the draughts and cold felt from the windows. However in doing these improvements, it also resulted in energy savings.

## Key challenges, barriers and successes

The project highlighted some of the limitations with Swedish EPCs:

- Residents considered the EPCs as quite unhelpful because the explanations of the energy saving measures (their costs and their benefits) are not very easy to understand, for example the savings are presented as “cost per saved kWh”
- Unless the EPC assessor provides detail on investment costs and savings, it is hard for residents to evaluate and compare measures suggested in the EPC
- Measures that have positive impacts other than financial ones, such as lower CO<sub>2</sub> emissions or increased comfort, are discarded and not shown on the EPC
- The EPC does not account for measures to reduce electricity use

However one good aspect of Swedish EPCs is that, in a couple of the case studies, the EPC highlighted the poor state of the ventilation system which led to them being cleaned and repaired.

Communication with the Swedish case studies was reasonably straightforward because the majority of boards have monthly meetings where decisions are made. Naturally where the investment costs are higher the decision-making process is more complicated and takes a longer time. Communication with one of the case study buildings was difficult and contact was eventually lost.



*Figure 10: Kommendantsbacken case study, Sweden*

One major barrier was that because the heating in these buildings is centralised and divided equally between residents, any savings on the energy bill go unnoticed by residents. The heating cost is incorporated in to the monthly fee which remains unchanged even if real costs vary from year to year. This creates a culture in which there is a lack of incentive to save energy. If investment costs are high, however, residents' fees are increased to pay for the installation of a new measure.

Some of the case study buildings have proceeded with measures and in a couple of cases they decided to take a step-by-step approach (rather than install a number of measures at the same time). While not optimal in terms of short term energy savings, it may be more affordable or acceptable to residents and thus facilitate a practical way forward.

The success of these case studies was partly due to the information provided to the housing co-operatives. This included short reports with the results of building surveys and calculations on the most appropriate measures. These were handed out to the board, inviting further discussions.

The final barrier encountered was the limitation to what measures can be installed due to the buildings' protected status and cultural value.

## 5.7 UK (England)

### Overview of the case studies

The two case studies in Bristol, England are outlined in Table 7.

**Table 7: Overview of the English LEAF case studies (all located in Bristol)**

Case study	Manilla Road	College Court
<b>Construction</b>	Solid stone wall	Cavity wall
<b>Date of construction</b>	Pre-1900	1950s
<b>Number of dwellings</b>	4	19
<b>Ownership</b>	3 apartments are managed by a letting agent, one is owner-occupied	Fully privately owned: owner occupier and privately rented.
<b>Protected status</b>	None	Conservation area

The College Court property is managed by a board of directors, who have appointed a management company to manage day-to-day maintenance.

### Motivations

In the case of Manilla Road, a key motivation was on the part of the letting agent who, aware of forthcoming regulatory requirements regarding the energy efficiency of privately rented accommodation, was seeking to capitalise on available grant funding. The single owner occupier was motivated by improving the comfort of their home and reducing their fuel bills. In the case of College Court, much of the motivation came from one individual owner occupier and building director who sought to improve the comfort of her home, reduce running costs and improve the building's environmental performance. Other residents and the building directors became motivated once a good funding offer was secured.

### Results

In Manilla Road, the focus of the project was on installing solid wall insulation but it did not manifest because of restricted funding options (and funding rapidly reduced through the project term). Draught-proofing was installed in one apartment and home visits were undertaken with each apartment, meaning there are likely to be behaviour changes. Predicted savings on energy demand, CO<sub>2</sub> emissions and fuel bills of the installed measures are all beneath 1%. Low energy lighting, heating controls and a boiler replacement are all measures that the management company intends to install at a later date (hopefully in the next three years). This would result in greater savings: 4,096 kWh, 2.13 tonnes of CO<sub>2</sub> savings, and £507 in annual fuel bill savings for the whole block.



*Figure 11: Manilla Road, Bristol*



In College Court, the focus of the project was on installing cavity wall insulation (CWI) but this was not installed due to a leaking roof. However the board of directors still intend to pursue this, hopefully in the next six months. If CWI is installed, this will result in an annual bill saving of £2,618 and CO<sub>2</sub> saving of 13.2 tonnes (an 11% saving). LED light bulbs were also installed in three of the dwellings.

### **Key challenges, barriers and successes**

In both cases, EPCs were used as a starting point to understand what measures could be installed. However, not all measures identified within the EPCs were actually viable options (e.g. gas condensing boiler suggested in College Court where there is no gas), and whilst used as a starting point, the EPCs were not referred to other than at this early stage.



*Figure 12: College Court, Bristol*

Having the Centre for Sustainable Energy (CSE) as an independent intermediary who could advise on the measures recommended through the EPC, and communicate and liaise with potential installers, was beneficial and progressed potential installations faster than would have otherwise happened.

The availability of funding was a key motivating factor in both case studies. In the case of Manilla Road, the ever-shifting funding landscape massively impeded the potential for this project. The presence of a funding offer, albeit one that rapidly reduced over the course of the project, held out hope for the residents and meant that they were unwilling to proceed at the level of offer provided. In the case of College Court, the availability of significant funding was critical for securing broader buy-in.

Communication and engagement were simpler in Manilla Road, where there was a single point of contact for three of the four dwellings (the management company), and one engaged owner occupier. Engagement was much more difficult in College Court, where an individual owner occupier (and building director) was very engaged, but where there was little interest from the remaining residents and building directors. This demonstrated the difficulty of energy efficiency improvements being made where residents are not the investment decision-makers of the building.

The lack of a wide pool of case studies for retrofit improvements on multiple occupancy buildings means that there isn't a vast amount of experience of this work within the delivery/installer market. This makes cost estimations or quotes very difficult and variable, which impacts upon engagement with residents (both in terms of having a clear 'offer' to present to them and their trust in the installers).

In the case of building issues, the fact that College Court had a leaking roof, which had been a problem for 6 years, and which ultimately impeded the installation of CWI, highlights the importance of good building maintenance, as well as decision-making structures which support this.

## 5.8 UK (Scotland)

### Background

There were three case studies in Edinburgh, as outlined in Table 8. The third case study was cancelled during the project with a replacement chosen.

**Table 8: Overview of the Scottish LEAF case studies (all located in Edinburgh)**

Case study	Telford Road	Spey Terrace	William Street
<b>Construction</b>	no-fines concrete	Solid stone	Solid stone
<b>Date of construction</b>	1950s	Pre-1919	Pre-1919
<b>Number of dwellings</b>	12	9	7
<b>Ownership</b>	Part owned by a housing association, part private (owner-occupied and private rented)	Part owned by a housing association, part private (owner-occupied)	Fully privately owned (owner-occupied and private rented)
<b>Protected status</b>	None	In a conservation area	In a conservation area and a listed building

### Motivations

The housing associations who part own the first two blocks are motivated to improve the energy efficiency of their properties to meet minimum energy efficiency standards for social housing in Scotland, help tenants reduce energy bills and improve comfort. The private owners in all three blocks had varying levels of motivation but the biggest motivator was to reduce energy bills. Secondary motivations were improving warmth and comfort, and improving the appearance of their homes.

### Results

In all three case studies, EPCs were carried out in individual dwellings which identified a comprehensive list of improvement measures. In all three case studies this included wall insulation, heating upgrades, heating controls, low energy lighting and window upgrades. However, apartments which were social housing already had a higher energy efficiency rating.

Telford Road was the only case study to install measures. External wall insulation, loft insulation and boiler upgrades in some properties was all fitted. This resulted in significant savings of 28% in fuel bills and 33% in CO<sub>2</sub> emissions.

No measures were installed in the other two case studies. In Spey Terrace, the housing association plans to install some measures in the upcoming years, as part of cyclical maintenance programmes and double glazing upgrades. Contact was lost with the private owners and it is not known what they plan to install.

In William Street, the owners did not install any measures during the project but are pursuing smaller measures in their dwellings such as low energy lighting and draught proofing.

### Key challenges, barriers and successes

The first barrier encountered was establishing contact with private owners. This was straightforward where a third partner had initial contact with the owners e.g. Edinburgh World

Heritage or the housing associations involved. It was, however, more difficult where no third party existed and contact was not initiated with all owners.

Maintaining contact with residents was also challenging. This was often due to residents' lifestyles such as being away from home for extended periods or where homes were only used for part of the year. In all cases, engagement was time intensive and required regular effort from Changeworks and their partner organisations. The absence of management companies in multi-occupancy apartment blocks in the UK (which is the standard) makes this engagement more difficult.

In Telford Road engagement was carried out by Home Energy Scotland – a free, impartial energy advice service which is delivered by Changeworks in South East Scotland. They used a multi-pronged approach to engage residents (letters, door-knocking and events), which was successful in reaching all residents.



*Figure 13: Telford Road case study, Edinburgh*

Funding played a key role in engagement and motivation. Where a major funding opportunity existed (Telford Road), efforts were made to take advantage of this opportunity and ultimately all residents signed up for the measures. However difficulties were even faced in getting residents to sign up to a free offer. In the other cases where funding opportunities were more limited, owners had less motivation to install measures. In part, this appears to be due to an expectation that there may be funding available in the future.

Ultimately a lack of interest and motivation in energy efficiency was the main barrier the project faced. Social landlords are required to improve their properties to meet minimum energy efficiency standards and are also keen to reduce tenants' fuel bills where possible. On the other hand, private owners do not have the same driver, although they would benefit from reduced bills and benefits such as increased comfort. Private landlords have even less incentive since it is largely the tenant who will benefit from improvements (known as the 'split incentive').

The project illustrated that EPCs are useful in identifying recommended measures for households. However they are not user-friendly, do not contain recommendations on communal areas and provide insufficient information on the suitability of measures in certain property types, or even do not recommend suitable measures. Thus, householders need additional support to understand what measures they can undertake and how.

The project also highlighted that there are practical limitations to the measures that can be installed in pre-1919 tenement blocks in Scotland, especially given planning restrictions on what can be installed in conservation areas and listed buildings. There are a range of options but some measures are more complex and expensive than measures in 'easy-to-treat' housing.

## 6 RESULTS AND FINDINGS

This section provides an overview of the results and lessons from the LEAF project.

### 6.1 Case study results

The LEAF project worked with 24 case study buildings. Before the project started it was anticipated that this would include a total of 240 apartments (10 apartments per building); however, some buildings were larger than expected and the project included 716 dwellings. Table 9 outlines the project targets set out before the project start, along with the actual results. These relate to number of installs and the resultant energy and CO<sub>2</sub> savings.

**Table 9: Overview of project objectives vs. outcomes**

Targets	Achieved in project
Measure progress: <ul style="list-style-type: none"> <li>• 20% buildings commit to full building action plan (5)</li> <li>• 50% buildings commit to partial delivery action plan (12)</li> <li>• 30% buildings commit to low-cost and/or behaviour change measures (7)</li> </ul>	➤ <i>Target partly achieved</i> <ul style="list-style-type: none"> <li>• 10 buildings have committed to full building or partial delivery action plans (5 have agreed and 5 have installed)</li> <li>• 9 buildings are still in decision (e.g. final vote still to take place)</li> <li>• 5 buildings have decided not to install measures</li> </ul>
One building commits to passive house standard	➤ <i>This target was not achieved- deemed not technically or economically feasible</i>
Primary annual energy savings of: <ul style="list-style-type: none"> <li>- 552,000 kWh</li> <li>- 24,000 kWh per building</li> <li>- 2,300 kWh per dwelling</li> </ul>	➤ <i>Target achieved overall but not per dwelling</i> <ul style="list-style-type: none"> <li>- 844,767 kWh</li> <li>- 35,199 kWh per building</li> <li>- 1,180 kWh per dwelling</li> </ul>
Annual CO <sub>2</sub> emissions savings of: <ul style="list-style-type: none"> <li>- 132 tonnes</li> <li>- 6 tonnes per building</li> <li>- 0.55 tonnes per dwelling</li> </ul>	➤ <i>Target achieved overall but not per dwelling</i> <ul style="list-style-type: none"> <li>- 233 tonnes</li> <li>- 9.71 tonnes per building</li> <li>- 0.33 tonnes per dwelling project</li> </ul>
Annual renewable energy generation of: <ul style="list-style-type: none"> <li>- 67,200 kWh</li> </ul>	➤ <i>Not achieved</i> <ul style="list-style-type: none"> <li>- No case studies progressed renewable energy</li> </ul>
Demonstrate that buildings can achieve CO <sub>2</sub> savings of over 30%	➤ <i>Partially achieved – this was only achieved in three out of ten building with installed or agreed measures</i>

The results show that after three years, 10 out of 24 buildings were able to commit or install energy efficiency measures. Nine others were still in progress. The five that did not commit to any measures highlight that the barriers to progression are significant. This is especially interesting since the owners of these buildings were motivated, at least, to join the project.

The results also show that the overall primary energy and CO<sub>2</sub> saving targets have been achieved from the case studies, although the 'per dwelling' target has not. However more energy savings are likely as many building retrofits are still 'in progress'. The renewable energy target was not met; largely because projects were focusing on energy efficiency measures first (as should be the case with retrofit projects). The Passive House target was also not met because this was, in many cases, technically not feasible and beyond the scope of the stakeholders involved in others.



## 6.2 Successes and challenges from the case studies

This section outlines key findings from the project based on experience of the case studies, surveys carried out with LEAF participants (building residents and owners) and research with wider stakeholders. This evaluation enabled key barriers and motivations concerning building renovation action to be gathered as well as evaluating the LEAF toolkits.

### Barriers and success factors

From the case study residents' points of view, the availability of subsidies was the most significant motivation for installing energy efficiency measures, followed by a desire to reduce their energy costs and fix structural damages.

Success factors within the case studies included having a good strategy to provide information to residents as well as attractive funding schemes. Similarly, lack of information about technical solutions and a lack of finance were identified as key barriers. Other barriers experienced included low interest in energy retrofit, engaging private landlords and financial and legal issues.

Barriers and success factors are discussed further in [Section 7](#) which outlines the project's policy recommendations.

### EPC evaluation

Views on EPCs were gathered, since EPCs play a major role in energy retrofit. From the perspective of owners, residents and stakeholders involved in LEAF, EPCs are seen as having a limited impact in terms of triggering retrofit in multi occupancy buildings. The quality of EPC recommendations and difficulty residents faced in understanding EPCs was seen as a major weakness. Nevertheless, some aspects of the EPC are assessed as positive, such as the presentation of energy performance ratings (e.g. A to G) which enables a good understanding of the energy efficiency of the building as a whole.

### Toolkit feedback

Feedback was also gathered on the usefulness and effectiveness of the LEAF toolkits ([Section 4](#)). The feedback highlighted the need for information about building retrofit action, which the technical toolkit provides. Further elements of the technical toolkit were considered useful, such as the guidance document about the impact of user behaviour and the document outlining additional savings. The engagement toolkit was seen as useful in providing accurate supporting information on the whole retrofit process.



## FURTHER INFORMATION

The full Results and Evaluation report can be downloaded from the [results and evaluation page](#) on the LEAF website.

## 7 POLICY RECOMMENDATIONS

This section provides an overview of the policy recommendations, developed as a result of policy research and based on the findings of the project.

### 7.1 Introduction to key challenges

As part of the process of developing policy recommendations, challenges associated with the retrofit of buildings under multiple ownership were explored in more depth. Key issues identified through case study experience, stakeholder feedback, and policy analysis can be summarised as:

- **Financial barriers**, including funding schemes, financial incentives and difficulties with individuals contributing to the costs of improvements
- **Information provision**, the format, targeting, provision and delivery of information in order to initiate decisions to retrofit
- **Demand side issues**, including difficulties specific to multi-occupancy buildings where various and numerous building residents and stakeholders need to be engaged
- **Supply chain issues**, such as finding and working with multiple installers on technically complex retrofit projects
- **Legal and regulatory barriers**, such as decision making with multiple stakeholders, limitations of EPCs, requirements for minimum standards and planning regulations.

### 7.2 Overview of policy recommendations

In response to these issues, a set of policy recommendations were developed, including calls for:

- Improvements to EPC methodology and applicability
- Changes to the format and content of EPC reports
- Improvements to public funding schemes
- Expansion of financial support initiatives
- Introduction of more stringent minimum standards
- Improved information provision on low carbon retrofit
- Support for, and upskilling of the workforce, including accreditation schemes
- Implementation of maintenance plans and improved management structures in multi occupancy buildings

#### EU wide recommendations

Specifically, 18 EU-wide recommendations were developed:

1. Develop and maintain a publicly available database of all EPCs
2. Improve the quality of energy saving calculations presented in the EPC
3. Improve communication of recommended measures on EPCs
4. Improve overall clarity and explanation of content of EPCs
5. Improve comparability of EPCs between different member states



- |   |             |
|---|-------------|
| 6. Ensure there are whole building EPCs in all member states (with minimum standards linking to communal areas)                         | (92 plus) A |
| 7. Improve the availability, design and management of public funding schemes  | (81-91) B   |
| 8. Expand the level and type of financial support initiatives   | (69-80) C   |
| 9. Develop the role of EPCs in financial support initiatives for energy efficiency improvements   | (55-68) D   |
| 10. Introduce minimum requirements at the point of renovation   | (39-54) E   |
| 11. Introduce minimum requirements at the point of sale and/or lease  | (21-38) F   |
| 12. Improve the provision of information on low carbon retrofit   | (1-20) G    |
| 13. Expand local energy advice services and demonstration projects  |             |
| 14. Implement accreditation schemes for installers and EPC assessors  |             |
| 15. Upskill the workforce, with a focus on developing local networks and improving ambition and quality of retrofit projects            |             |
| 16. Improve integration between low carbon retrofit and maintenance and renovation work   |             |
| 17. Require maintenance plans and funds for multi occupancy buildings   |             |
| 18. Require management arrangements for multi occupancy buildings which include communication structures and decision making processes. |             |

### National recommendations

In addition, national policy recommendations were also developed, based on local and national policy analysis. The EU-wide recommendations apply in all countries, but specific additional recommendations were developed for individual partner countries. Although all the barriers are cross-cutting, the local and national context varies quite significantly and different issues were seen as priorities in different countries and regions. These can be seen in the individual [national recommendations reports](#) on the LEAF website.

## 7.3 Good practice examples

The LEAF project also flagged up some examples of best practice across Europe where policy and practice enables, promotes or supports energy efficiency retrofit in multi-occupancy apartment blocks. These include both national and regional strategies and schemes which could be replicated elsewhere. Here are eight of the examples which were identified:

1. Requirement to do energy efficiency work at the same time as maintenance work is carried out. This policy is being introduced in France from 2017.
2. Minimum standards for energy performance (currently in place in Scotland for social landlords).
3. Rental Price Points System. In the Netherlands, rent setting is based on a 'home points system', in which various features including energy efficiency improvements,

add points, meaning that higher rent can be charged and over the long term the cost of making improvements can be recouped by building owners.

4. Maintenance funds ring-fenced for energy efficiency improvements. Currently, this only exists in very few situations but is a way of ensuring funding for energy efficiency improvements is available when it's needed.
5. Local trade support programmes to upskill and support the supply chain and local installer networks (e.g. B&NES retrofit programme, UK).
6. Targeted funding for those most in need (e.g. Scottish area based programmes for home energy efficiency improvements).
7. Demonstration homes to stimulate renovation through demonstration projects and using the principle of social norming. The UK Green Open Homes programme is a good example and has proven impact in stimulating retrofit.
8. Funding for improvements over and above minimum requirements to improve ambition of retrofit projects (for example schemes currently in place in Germany).

## FURTHER INFORMATION

All of the Policy Recommendation reports (for national and EU versions) can be downloaded from the [policy recommendations page](#) on the LEAF website.

## 8 CONCLUSIONS

This report has provided an overview of the LEAF project: why the project was carried out, the methodology, the results achieved and the key findings.

The aim of the project was to demonstrate that significant savings could be achieved in multi-occupancy apartment blocks (e.g. 30% savings on CO<sub>2</sub> emissions). This has been demonstrated by a small number of case study buildings where large savings have been achieved; however it was not achieved by most.

Results from the case study buildings highlight that whilst such savings are technically possible, a range of barriers prevent many buildings from doing so, particularly in a three year timescale. A whole range of barriers were encountered relating to:

- A lack of finance
- Lack of interest or motivation from owners or other key stakeholders
- Lack of regulation to require energy efficiency improvement
- Difficulty in selecting appropriate measures
- Difficulties in engaging and communicating with owners, and with the decision-making process

Whilst the contexts and therefore exact problems varied between partner countries, often the problems encountered were very similar.

Yet the project also encountered successes in terms of supportive policy and good practice. Such examples include:

- National policies requiring minimum energy efficiency standards or the requirement to improve energy efficiency at the same time as maintenance
- Examples of management structures such as housing co-operatives which enable residents to discuss issues frequently and therefore progress projects
- The impartial support and advice provided by LEAF partners was often pivotal in enabling projects to be progressed
- Effective funding schemes

The LEAF toolkits were developed to enable more retrofits to take place. The engagement



toolkit provides a guidance document to help interested stakeholders navigate their way through these complex projects. The technical toolkit provides useful information on EPCs, recommended measures in EPCs, possible savings from communal parts of buildings and advice on resident behaviour. Feedback from potential users has highlighted the value of both of these resources.

*Figure 14: Case study in Hungary*

Of particular importance to this project is whether EPCs can drive retrofits. This project has shown that EPCs alone cannot drive retrofits but they can provide indicative information on measures to support decision-making. However retrofits need a whole host of other support and policies in place before retrofit will be driven forward. There are also many limitations of EPCs; for example, that they are not user-friendly. The policy recommendations on EPC improvements, developed for the EU as part of this project, would help ensure these improvements occur. For example, this includes improving the quality of EPC calculations, how recommended measures are communicated and ensuring whole building EPCs are available. Better and more accurate EPCs are likely to lead to them having more credibility amongst building residents and stakeholders, hence the potential for them to be used more widely.

Interest in the LEAF project has been very high, which shows both the importance of this issue and the multitude of stakeholders involved in multi-occupancy apartment blocks. Retrofitting apartment blocks will continue to be challenging since by their nature these properties will always have more challenges and barriers than single dwellings. However, by sharing lessons across partner countries, the LEAF project has shown that significant savings can be achieved from retrofitting these buildings. It has also highlighted how practice and policy must develop to ensure that retrofit of these buildings can occur on a larger scale, and that carbon, energy and fuel poverty goals are achieved.



*Figure 15: Typical apartment block in Edinburgh*

Finally, the project also highlighted the need for further research in this area, particularly in quantifying the multi occupancy housing sector in each EU country, and exploring policy implications related to:

- Access to, and use of data on multi occupancy housing and energy efficiency
- Motivations and engagement for carrying out retrofit
- Funding and finance for retrofit projects
- Regulatory and property factors affecting retrofit options.

## 9 FURTHER INFORMATION

Further information about the LEAF project can be found on the project website:

LEAF website including the final report	<a href="http://lowenergyapartments.eu">lowenergyapartments.eu</a>
Background reports	<a href="http://lowenergyapartments.eu/about-leaf/background/">lowenergyapartments.eu/about-leaf/background/</a>
The technical toolkit	<a href="http://lowenergyapartments.eu/the-leaf-toolkit/the-toolkit/">lowenergyapartments.eu/the-leaf-toolkit/the-toolkit/</a>
The engagement toolkit	<a href="http://lowenergyapartments.eu/the-leaf-toolkit/engagement-toolkit/">lowenergyapartments.eu/the-leaf-toolkit/engagement-toolkit/</a>
Case study reports	<a href="http://lowenergyapartments.eu/case-studies/">lowenergyapartments.eu/case-studies/</a>
Results and evaluation report	<a href="http://lowenergyapartments.eu/project-findings/results-and-evaluation/">lowenergyapartments.eu/project-findings/results-and-evaluation/</a>
Policy recommendations	<a href="http://lowenergyapartments.eu/project-findings/policy-recommendations/">lowenergyapartments.eu/project-findings/policy-recommendations/</a>

## Funders

### Main funder:



Co-funded by the Intelligent Energy Europe  
Programme of the European Union

The sole responsibility for the content of this publication lies with the authors. It does not necessarily reflect the opinion of the European Union. Neither the EASME nor the European Commission are responsible for any use that may be made of the information contained therein.

### Co-funders:



This report was written by the LEAF project partners. The report lead was Changeworks.

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