SUstainable solutions for affordable REtroFIT of domestic buildings

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Publishable summary

The objective of this deliverable is to outline the methodology and strategy used during SUREFIT project's findings. This methodology provides a comprehensive and systematic approach to planning and retrofitting domestic buildings.

The domestic building retrofit journey is the process of improving the energy efficiency and sustainability of a residential home through energy conservation measures. It is a multi-stage and comprehensive process that starts with an initial assessment and ends with project completion.

The SURe³FIT Approach:

This five-phase approach guides homeowners through the entire retrofitting process:

1. Assessment and Planning: Evaluating the current energy performance and identifying potential areas for improvement.
2. Decision-Making: Selecting the most suitable retrofitting solutions based on technical feasibility and economic considerations.
3. Implementation: Developing a detailed plan, acquiring necessary permits, and executing the chosen retrofitting measures.
4. Use: Learning to operate the installed measures and following a maintenance plan for optimal performance.
5. Verification: Evaluating the effectiveness of the implemented retrofitting measures.

The benefits:

- Energy Cost Savings
- Enhanced Comfort
- Increased Property Value
- Environmental Sustainability

Introduction

The residential building sector is a significant contributor to global energy consumption. Retrofitting existing homes with energy-saving technologies presents a substantial opportunity to improve energy efficiency and achieve environmental sustainability goals. This document outlines a comprehensive methodology for planning and executing residential home retrofitting projects.

Developed within the framework of the H2020 SURe^{3}FIT project, this methodology empowers homeowners to make informed decisions and successfully implement retrofitting measures. The document details a five-phase approach, guiding homeowners through:

1. Assessment and Planning: Evaluating the current energy performance and identifying potential areas for improvement.
2. Decision-Making: Selecting the most suitable retrofitting solutions based on technical feasibility and economic considerations.
3. Implementation: Developing a detailed plan, acquiring necessary permits, and executing the chosen retrofitting measures.
4. Use: Learning to operate the installed measures and following a maintenance plan for optimal performance.
5. Verification: Evaluating the effectiveness of the implemented retrofitting measures.

By following these steps, homeowners can undertake successful retrofitting projects, enhance the energy efficiency of their homes, and contribute to a more sustainable future.

Figure 1 - SUREFIT PROJECT

1 Importance of domestic buildings retrofitting

1.1 Context

Buildings account around 40% of the European Union's energy consumption and 36% of its greenhouse gas emissions. Most of the citizens' energy consumption, 80%, is dedicated to heating, cooling, and domestic hot water [1].

In addition, at present around 35% of buildings in the European Union are over 50 years old and almost 75% of the building stock is inefficient. However, only 1% is renovated each year [2].

EU's Energy Performance of Buildings directive sets the goal for Europe to achieve a zero-emission, fully decarbonised building stock by 2050. This requires the development and application of technological solutions, and renewable, more efficient, and less polluting energy systems for our homes to decrease emissions, save energy, tackle energy poverty, facilitate renovation, improve quality of life, and generate jobs and growth. The EPBD recast, officially published on May 8th of 2024, reinforces the need for strong national building renovation plans and provisions to decarbonise heating and cooling. This movement will be supported by improved Energy Performance Certificates and the uptake of building renovation passports.

As 85% to 95% of the EU's buildings are expected to still be standing in 2050, retrofitting residential buildings is consequently at the forefront of these efforts.

1.2 Methodology purpose and structure

The primary objective of this methodology is to provide a comprehensive and systematic approach to planning and retrofitting residential buildings. It aims to assist building owners, municipalities, and stakeholders in identifying and prioritizing retrofit measures that not only enhance energy efficiency and reduce greenhouse gas emissions but also ensure financial viability and occupant comfort. By integrating advanced optimization techniques and decision-making frameworks, this methodology enables stakeholders to make informed choices that balance cost-effectiveness with sustainability goals. The goal is to facilitate the transition towards nearly zero-energy buildings (nZEBs), aligning with the EU's stringent energy performance targets and contributing to a sustainable and resilient built environment. Through a detailed assessment of existing conditions, evaluation of retrofit options, and strategic planning, this methodology empowers stakeholders to implement effective retrofit solutions that achieve long-term energy savings and improve the overall quality of residential buildings.

In other words, it aims at covering the whole retrofit journey of the homeowners aiming to renovate their home. Among other stages, it is essential that homeowners and technicians:

- have access to all the necessary information to facilitate the assessment and planning.
- are aware of the cost-effective retrofitting strategies and possible technical retrofitting measures.
- feel confident in the decision-making process.
- are aware of the entire implementation strategy.
- are familiarized with the maintenance, and the verification of their building's retrofit process towards zero emissions.

This Methodology for planning and retrofitting of residential buildings is a step-by-step approach developed specifically for this purpose. It also includes a best practice manual for the installation and operation of the innovative technologies developed within the SUREFIT Project. These technologies reduce heat losses through the building envelope and energy consumption by heating, cooling, ventilation, and lighting, while increasing the share of renewable energy in buildings.

The methodology is divided into the five essential phases of building retrofit: assessment, decision, implementation, use and verification.

To implement this methodology, all the necessary calculations and simulations can be performed with the help of the SUREFIT developed tool. The referenced databases are also presented in the tool as well as in this document.

2 The residential building retrofit journey

2.1 Understanding the concept of the residential building retrofit and its main phases

The residential building retrofit journey is the process of improving the energy efficiency and sustainability of a residential home through retrofitting measures. It is a multi-stage and comprehensive process that starts with an initial assessment and ends with project completion.

The **first stage** in the retrofit journey is the initial assessment, which includes a detailed evaluation of the home's energy performance and sustainability. This assessment may involve energy audits, building inspections, and analysis of energy bills and other relevant data. This stage aim is to identify areas of inefficiency and opportunities for improvement. Along with the assessment comes project planning. Once the objectives for retrofitting are defined, and in line with energy efficiency and sustainability targets, the retrofitting measures are identified and designed to address the areas of inefficiency identified. The planning may involve selecting technical retrofitting measures concerning: i) insulation and building envelope (e.g. windows); ii) HVAC systems; iii) renewable energy integration; iv) water heating and usage, and the possible combinations between them.

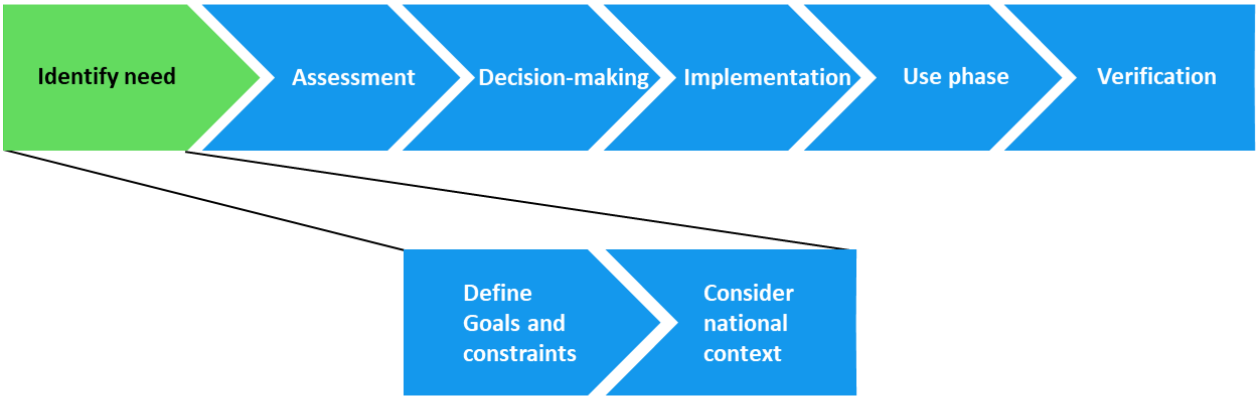
The **second** phase is decision-making. The aim of this stage is to develop a comprehensive plan that maximizes energy efficiency and sustainability while minimizing costs. In other words, it aims at providing a systematic approach for homeowners to make informed decisions, prioritizing actions, and allocating resources efficiently.

The **third stage** is the implementation phase, where retrofitting measures are implemented. This may comprise obtaining necessary permits, but mostly it involves construction and installation of technologies, e.g., the installation of insulation, window replacement, heating systems updates, and other retrofitting measures identified in the planning step. The aim of this stage is to ensure that the retrofitting measures are effectively and efficiently implemented.

The **fourth stage** is the use phase, in which the user of the retrofitted home learns how to operate of the measures installed as well as how to follow and apply the maintenance plan.

The **final stage** is the verification phase, which assesses the effectiveness of the retrofitting measures. This may include conducting energy audits, analysing energy bills, and other relevant data (similarly to what may be performed in the assessment phase, but now in a post-retrofit scenario). The aim of this stage is to determine the energy efficiency and sustainability gains made possible by the retrofitting measures, as well as to identify any areas for further improvement.

The retrofit journey is a complex process that requires careful planning, design, and implementation. It is important to collaborate with experienced professionals who can guide homeowners through each stage of the process and ensure that retrofitting measures are implemented effectively and efficiently. Following the retrofit journey allows homeowners to improve the energy efficiency and sustainability of their homes, reducing energy bills, and contributing to a more sustainable future.



2.2 Defining targets, budget, and timeframe

The preliminary step to define targets, budget, and timeframes is to identify the specific retrofitting criteria and objectives. This may include improving energy efficiency, reducing carbon emissions, or enhancing indoor air quality. It is important to set specific, measurable, achievable, and relevant targets to ensure that the retrofitting project is effective and aligned with the homeowner's goals.

The next step is to determine the budget available for the project. The objective is to identify the funds available for the retrofitting project and to prioritize retrofitting measures based on their cost-effectiveness. When setting the budget, it is important to consider the long-term economic benefits of retrofitting measures, as these measures can lead to significant energy savings in the long run.

Finally, it is essential to establish a timeline for the retrofitting project, which involves setting specific milestones and deadlines for each stage of the project, from initial assessment through project completion.

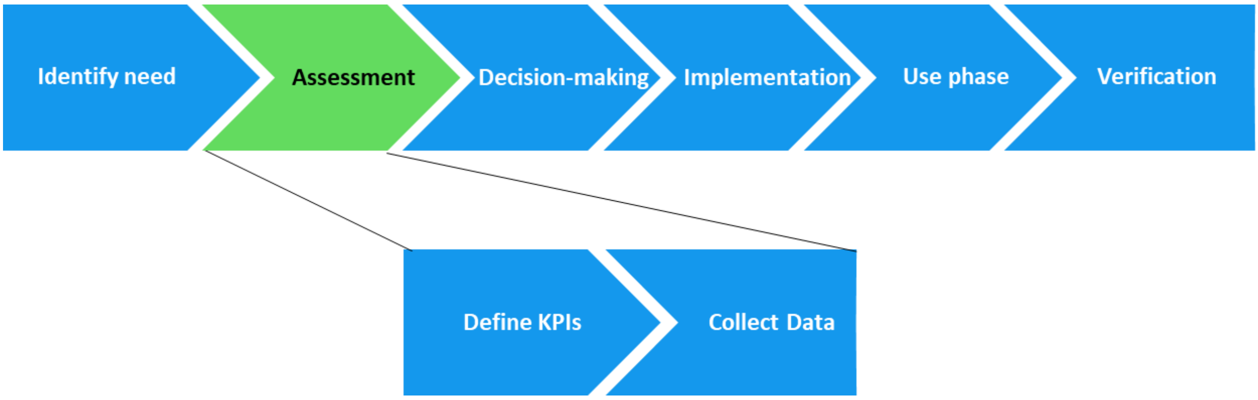
2.3 Adaptation to national contexts

One of the challenges of retrofitting the European residential building stock is the need to adapt to national or regional contexts. Each country in Europe has its own climate, building stock and regulations, all of which can affect the planning and implementation of a retrofitting project. For example, a retrofitting project in a cold climate country may require a different approach than one in a warm climate country.

To successfully adapt to each country's context, retrofitting projects need to consider many factors, including local building regulations, climatic conditions, and cultural and social considerations. This may require collaboration between stakeholders such as architects, engineers, policy makers and residents to ensure that the retrofitting project is tailored to the specific needs of the local context.

In addition, retrofitting projects must also consider the financial and technical feasibility of different measures, which may require a detailed analysis of the building's energy performance and assessment of available funding and technical sources.

3 Phase 1 – Assessment



Conducting an initial energy assessment is the first essential step to start retrofitting a building. Based on collected data this assessment will provide measurable results to evaluate the energy performance and status of the present building and then enable energy saving measures to be identified and estimated.

The energy audit is a tool that allows us to know and characterise energy consumption - where, how much and when - and the energy efficiency of the equipment.

Data collection, surveys and inspections will be conducted to help identify potential for energy savings improvements. The data collected will be essential to study and simulate savings, reductions, and possible energy saving measures. Once the audit has been carried out, the barrier of the information gap will have been overcome.

The environmental audit report presents all the relevant information collected during the environmental audit and shall also contain the analysis of the building's current situation (baseline), the identification of anomalies/wastes and it must propose measures considered more convenient to prevent or reduce energy waste.

3.1 Define the energy performance indicator(s)

The retrofitting process of upgrading and renovating existing homes aims to improve their energy efficiency and sustainability. Key Performance Indicators (KPIs) are important metrics used to track and measure the success of such retrofitting projects. Some common KPIs used in the context of residential home retrofitting that can be used to analyse the obtained results are:

- Energy consumption: This KPI measures the amount of energy consumed by the building before and after retrofitting. One of the goals of retrofitting is to reduce energy consumption, so this KPI can help track the success of the project.
- Energy savings: This KPI measures the amount of energy saved because of retrofitting. This can be expressed as a percentage of the original energy consumption or as amount saved on energy bills.
- Carbon footprint: This KPI measures the amount of greenhouse gas emissions generated by the building before and after retrofitting. One of the goals of retrofitting is usually reducing the building's carbon footprint, so this KPI can help track progress towards that goal.

- Indoor air quality: This KPI measures the quality of the air inside the building. Retrofitting can improve indoor air quality by reducing the number of pollutants and allergens present in the air.
- Occupant comfort: This KPI measures how comfortable the occupants of the building are before and after retrofitting. Retrofitting can improve occupant comfort by improving insulation, reducing drafts, and increasing natural light. This KPI is of high importance as the European Green Deal highlights the issue of fuel poverty by identifying it as an issue to be addressed as part of a 'renovation wave'.
- Return on investment (ROI): This KPI measures the financial benefits of retrofitting. As one of the goals of retrofitting is to reduce energy costs, so this KPI can help determine if the investment was worth it by comparing investment to savings obtained.

3.2 Collect relevant data of the building and relevant systems and their operation

Analysing the energy performance of a residential building is a crucial step in the process of retrofitting a home to improve its energy efficiency. By understanding its energy characteristics, homeowners can identify opportunities to make changes that can result in energy savings, improved user comfort, and reduced environmental impact. This process will also allow for the monitoring of the results after retrofitting, enabling the calculation of the benefits obtained.

To analyse the energy performance of a building effectively, data gathering is essential. The specific parameters to collect depend on the indicators established in the prior step, and it can encompass various methods, including on-site measurements or document consultations. A critical parameter typically involved in this process is the assessment of energy consumption and/or demand, which can be done by reviewing utility bills, conducting energy audits, or using energy monitoring systems. The review of utility bills is a major step to define a yearly baseline that considers seasonal variances. The data from these bills should span at least an entire civil year and should be representative of the occupation and use that the building will have after retrofitting.

A detailed energy audit can provide more in-depth information about energy consumption. A professional energy auditor can conduct a comprehensive assessment of the home's energy use, including thermal imaging and blower door tests. Regulations regarding energy audits can vary between different regions and countries in Europe, but the Energy Performance of Buildings Directive (EPBD) establishes a framework that serves as a base to be adapted by each EU member state.

The EPBD also regulates the issuance of Energy Performance Certificates (EPCs), which is a document that details the building's energy characteristics and must include recommendations for improving its energy performance. EPCs are mandatory when a building is constructed, sold, or rented out, although these requirements may differ from one EU member state to another.

4 Phase 2 – Decision-making

SURe³FIT

Operational Tool

4.1 Tool to support the decision-making process

Deciding on specific cost-effective measures is a critical step in the energy renovation process. The objective of this chapter is to identify the energy retrofitting decision-making tool being developed in the context of this project, which is based on energy estimation models and cost-optimal approach for dwellings. According to the selected KPIs, the operational tool should make use of data collected during phase 01 - assessment and planning. Furthermore, the approach should be aligned with the objectives defined in the *Identifying needs step*, and with the three pillars of sustainability: economic, social, and environmental (Figure 2).

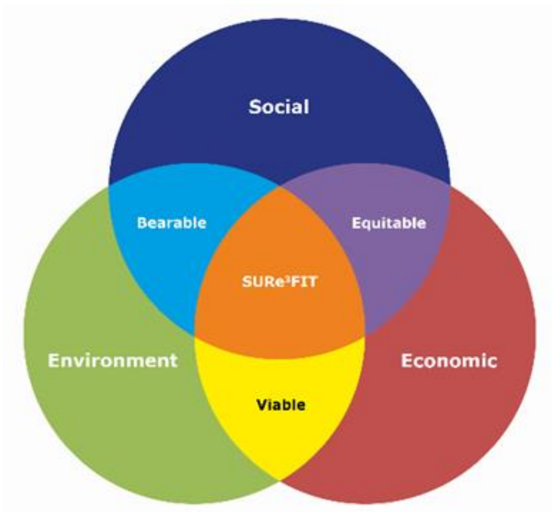


Figure 2 - e³ - Energy Efficiency in the Built Environment

It is important to emphasize that the solutions identified for comparison at this stage must be technically feasible to implement in the building in analysis, considering factors such as available internal space and regulatory limitations for façades, among others. More information will be highlighted in deliverable 7.2.

4.2 SURe³FIT tool

The SURe³FIT tool encompasses six different modules, as presented in Figure 3.

The administrative routine, hidden from users, manages the continuous update of parameters needed by the calculation engine (**PU module**). The Assessment of Technologies (**AT module**) offers standalone functionality. Users can directly input energy demands to assess the most suitable technologies for installation, including HVAC and DHW systems. This can be a great advantage, as selecting such systems is typically a complex process, considering different energy sources and potentially addressing multiple energy needs (domestic hot water, heating, cooling, ventilation and lighting).

The other modules are user-oriented and allow for:

- Building characterization data entry (**ID module**): geometry, construction details, and location information.
- Calculation of the building's current thermal performance (**EPS module**), based on the EPBD adaptation.
- Input of additional data, including technical systems data, economic factors, and environmental data, to simulate (**SM module**) the impact of individual and combined energy conservation measures (ECMs). Examples of ECMs include envelope solutions, energy systems, and equipment using renewable energy sources (RES).
- Analysis of the improvement measures' impact on building energy performance, accessible through the Output Data module (**OD module**).

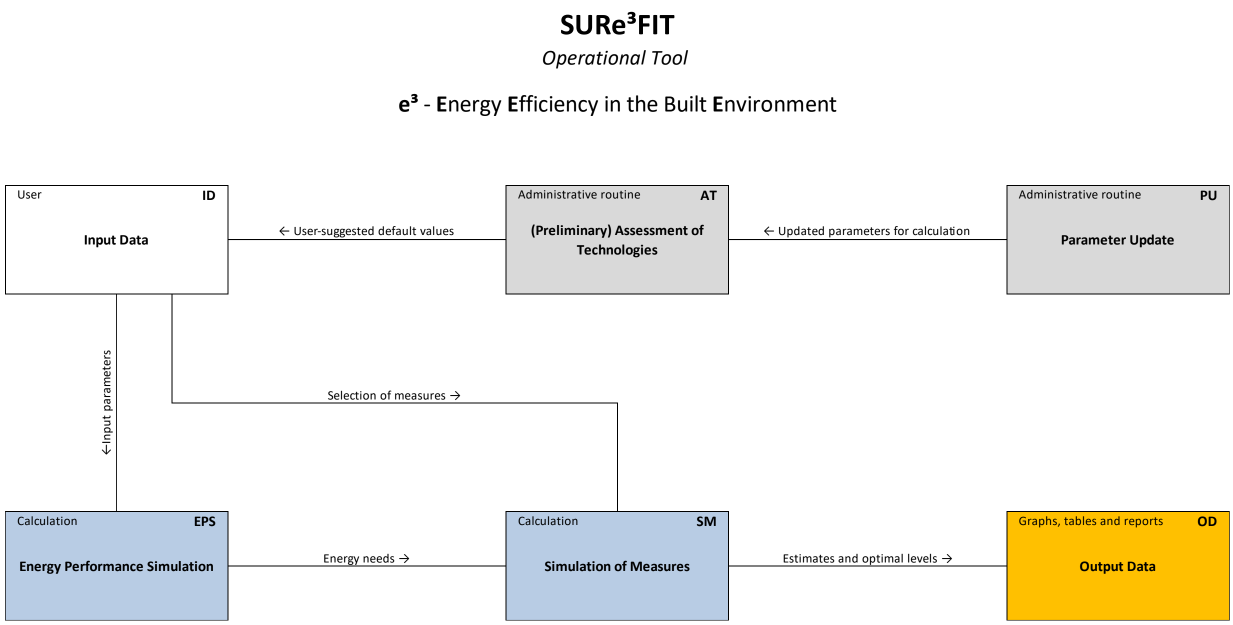
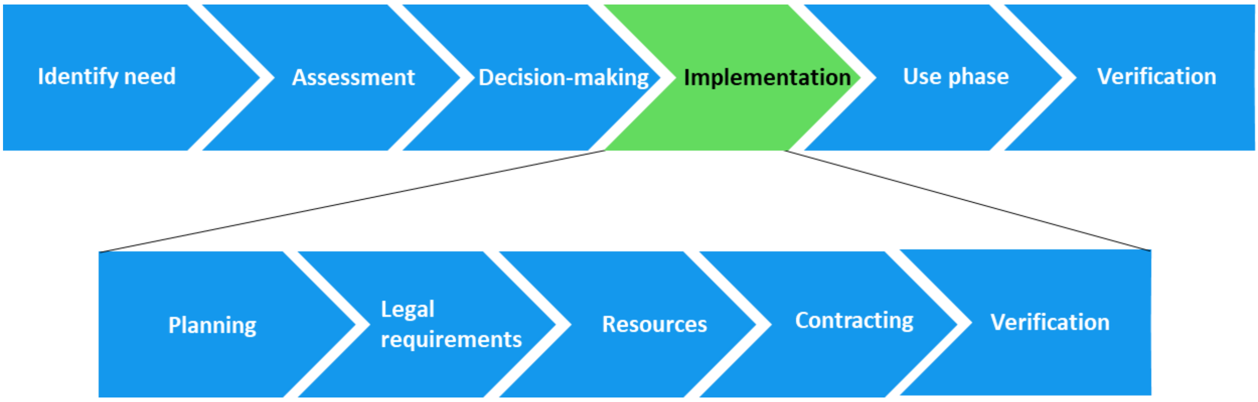


Figure 3 - SURe³FIT tool structure

Based in previous scientific studies [3-5], the SURe³FIT tool proposes several improvements to the cost-optimality methodology, established by the Delegated Regulation 244/2012 and EN 15459, in order to support the decision-making process for energy renovation projects and select retrofitting measures. It includes a comparison, with graphical results of the relation between the environmental and economic impacts of the business-as-usual (BAU) scenario and the ECMs simulated, adopting a life cycle perspective. More information and details are provided in D7.3.

5 Phase 3 – Implementation



5.1 Planning the implementation

While this step typically occurs in Phase 3, its preliminary discussion took place in Phase 1 for a more comprehensive initial plan. Planning the implementation of works is a crucial step in the process of residential home retrofitting. It involves developing a detailed plan for the installation of innovative technologies and upgrades to improve the energy efficiency and sustainability of the home.

1. **Develop a timeline**: Develop a timeline for the retrofitting project, including the installation of innovative technologies and upgrades. This should include a start date, estimated completion date, and milestones along the way.
2. **Establish a budget**: Establish a budget for the retrofitting project, including the cost of new technologies and upgrades, installation, and any professional services needed such as contractors or energy auditors.
3. **Obtain permits**: Some retrofitting projects may require permits from local or state authorities. It is important to obtain any necessary permits before beginning work to avoid delays or fines.
4. **Hire professionals**: Depending on the complexity of the retrofitting project, it may be necessary to hire professionals such as contractors, electricians, or HVAC technicians to install innovative technologies and upgrades.

5.2 Obtain necessary legal requirements

During the retrofitting process, a key step is to ensure that all legal requirements are met before starting the retrofitting project. When obtaining legal requirements for the retrofitting project, some steps need to be taken into consideration:

- **Research local regulations**: Regulations regarding residential home retrofitting can vary widely between different regions and countries in Europe. It is essential to research local regulations and requirements before starting any retrofitting project.
- **Obtain necessary permits**: In many cases, homeowners will need to obtain permits from local authorities before beginning any retrofitting work. These permits may include

planning permission, building permits, or environmental permits, depending on the scope of the project.

- **Ensure compliance with energy efficiency standards**: Many European countries have energy efficiency standards that must be met by residential buildings. Before starting any retrofitting project, homeowners should ensure that their plans comply with these standards and that the planned upgrades will result in an energy efficiency that complies with legal requirements.
- **Hire a licensed contractor**: In many European countries, residential retrofitting work must be carried out by licensed contractors. Hiring a licensed contractor will ensure that the work is completed to the highest standards and in compliance with local regulations.
- **Keep detailed records**: Homeowners should keep detailed records of all work conducted during the retrofitting process, including permits obtained, contractor information, and any inspections conducted. These records will ensure compliance with local regulations if a prove is necessary in the future.

5.3 Resources for implementation

Residential home retrofitting can be an expensive undertaking. Fortunately, there are various financing and funding options available in Europe to help homeowners cover the cost of retrofitting:

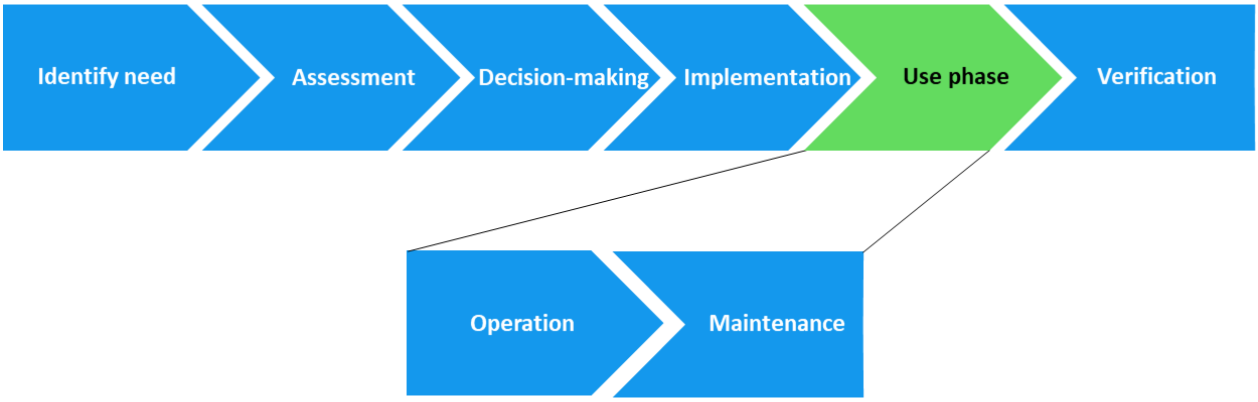
- **Green Loans**: Green loans are specifically designed to finance energy-efficient improvements to homes. These loans typically offer lower interest rates and longer repayment periods than traditional loans, making them an attractive option for homeowners looking to finance their retrofitting project.
- **Energy Efficiency Mortgages**: These allow homeowners to borrow more money than they would be able to with a traditional mortgage to finance energy-efficient upgrades to their homes. They are available from many European banks and typically offer lower interest rates than traditional mortgages.
- **Energy Performance Contracting**: Energy performance contracting is a financing model that allows homeowners to pay for retrofitting work overtime using the energy savings generated by the upgrades. This model is popular in many European countries and is often used in public buildings and large-scale retrofitting projects.
- **Government Grants**: Many European governments offer grants and subsidies to homeowners looking to retrofit their homes. These grants can cover a portion of the retrofitting costs and are typically awarded based on income and other eligibility criteria.

5.4 Contracting resources

One of the most important steps in retrofitting your home is getting quotes from contractors who specialize in this type of work. When getting quotes for residential home retrofitting, some steps are important:

- **Identify the scope of the project**: Before contacting contractors, it is essential to know exactly what you want to achieve with your retrofitting project. Are you looking to install new insulation, replace windows, upgrade your HVAC system, or do a combination of these things? Knowing the scope of your retrofitting project will help to communicate the needs clearly to contractors and ensure accurate quotes.
- **Research potential contractors**: Look for contractors who have experience in residential home retrofitting and who are licensed and insured. Check their online reviews and ratings from previous clients to get a sense of their reputation.
- **Request quotes from multiple contractors**: Request quotes from at least three contractors to compare prices and services. Be sure to provide each contractor with the same information about the scope of the project for the best comparisons.
- **Ask for references**: Before hiring a contractor, ask for references from previous clients. Contact these references and ask them about their experience collaborating with the contractor.
- **Review the quotes carefully**: When you receive quotes from contractors, review them carefully. Look for any hidden fees or charges and make sure that the quote includes all the work you need to be done. If you have any questions or concerns, ask the contractor to clarify.
- **Do not make your decision based solely on price**: While price is an essential factor to consider when choosing a contractor, it should not be the only factor. Consider the contractor's reputation, experience, and the quality of their work as well.

6 Phase 4 – Use phase



6.1 Learning to operate innovative technologies

As part of the process of home retrofitting, homeowners may need to learn how to operate innovative technologies installed during the retrofitting project. This requires reading and understanding the user manual for each technology.

User manuals: the guide to optimal performance

User manuals provide detailed instructions on how to use a particular technology, including safety guidelines, troubleshooting tips, and maintenance requirements. Reading the user manual and following the instructions carefully will help ensure that the technology operates as intended and provides maximum benefits in terms of energy efficiency and sustainability.

- Read the manual thoroughly: Before attempting to use an innovative technology, it is important to read the user manual thoroughly. This will help users understand how the technology works and the steps required to use it safely and effectively.
- Follow safety guidelines: The user manual will provide safety guidelines that must be followed to prevent injury or damage to the technology. Users must ensure they follow these guidelines carefully and take any necessary precautions before operating the technology.
- Practice using the technology: Once the user manual is read and the technology understood, it is important to practice using it. This will help users become familiar with the technology and ensure they can use it effectively.
- Keep the user manuals handy: It is important to keep the user manual for each technology handy for future reference. This will help with troubleshooting any issues that may arise and ensure that the technology is used correctly.

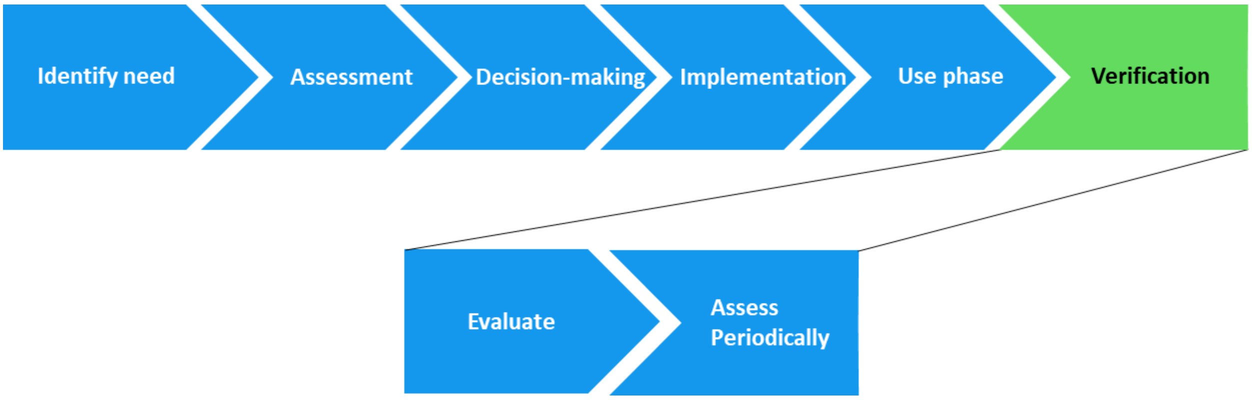
6.2 Maintenance of the retrofitted home

To keep the retrofitted home in good condition, it is essential to develop and apply a comprehensive maintenance plan. This plan should cover all aspects of the retrofitting:

- Identify retrofit components: Before creating a maintenance plan, it is essential to identify the components of the retrofitting.

- Understand maintenance requirements: Once identified, research and understand the specific maintenance requirements for each component. This may involve cleaning, inspections, or filter replacements depending on the technology (e.g. if insulation was installed, it is important to ensure that it is not damaged or displaced, as this can affect its performance; if energy-efficient windows were installed, regular cleaning is needed to ensure that they remain clear and efficient).
- Set up a maintenance schedule: Based on the individual maintenance requirements, a maintenance schedule should be established. This can monthly, quarterly, or annually.
- Allocate resources: Maintaining retrofitting components requires resources such as time, tools, and materials. These need to be allocated accordingly to ensure that the effectiveness of the maintenance plan.
- Monitor and evaluate: Once the maintenance plan is set up, it needs to be monitored and its effectiveness evaluated. This helps identify any issues or areas for improvement and make necessary adjustments to the plan.

7 Phase 5 – Verification



7.1 Evaluate the energy performance of the retrofitted building

Evaluating the energy performance after renovation is a major step in assessing the effectiveness of residential building retrofitting measures. The aim of retrofitting often includes the improvement of the building energy efficiency, the enhancement of its indoor conditions, and energy savings. Therefore, evaluating and comparing the pre-selected indicators in the post-retrofitting scenario is crucial in determining the success of the rehabilitation.

This analysis can be conducted, for example, by comparing the energy usage data from before and after retrofitting and calculating the percentage reduction in energy consumption. It is also useful to compare the energy consumption reduction achieved to the predicted energy savings estimated during the planning phase of the retrofitting project.

It is worth noting that some factors beyond retrofitting can affect energy consumption, such as changes in climate and occupant behaviour. Others can arise as a direct outcome of the energy renovation itself, due to the rebound effect. This phenomenon relates to the behavioural responses provoked by the retrofit measures, as energy efficiency improvements can affect the demand for resources and energy, e.g., increased energy usage due to the decreased cost of operation.

Nonetheless, it is important to emphasize that the building's interior conditions can vary significantly before and after renovation, e.g., indoor temperatures. As a result, relying solely on energy consumption comparisons may not always accurately reflect the true improvement in the dwelling's energy efficiency. So, an alternative approach for this indicator could involve comparing the before and after scenarios while maintaining consistent interior conditions, i.e., evaluating the energy demand to attend the minimum reglementary comfort standards.

In addition to evaluating the overall energy performance, it is also important to identify the specific retrofitting measures that contributed most to the improvement of the building's condition. This information can be used to optimize future retrofitting projects and improve their effectiveness.

7.2 Define periodic energy assessments

Periodic assessments after renovation are a crucial component of residential building retrofitting. This process involves conducting regular evaluations of the performance and condition of the building systems and components that were retrofitted during the renovation process.

These assessments are necessary to ensure that the retrofitting measures are functioning as intended and to identify any issues that may have arisen since the initial installation. This allows for any necessary adjustments or repairs to be made promptly, preventing potential safety hazards or inefficiencies.

Periodic assessments typically involve a thorough inspection of the building envelope, mechanical systems, and other key components such as windows and doors. They may also include performance testing of HVAC systems, air leakage, and insulation levels to evaluate their effectiveness.

The frequency of these assessments can vary depending on the complexity of the retrofitting measures, the age of the building, and the climate conditions in the region.

In addition to ensuring the safety and efficiency of the retrofitting measures, periodic assessments can also provide valuable information on the overall energy performance of the building. This data can help homeowners identify areas where further improvements can be made to reduce energy consumption and save money on utility bills.

Conclusions

Residential buildings are major energy consumers. Retrofitting them offers a significant opportunity to improve efficiency and sustainability. The SURe³FIT methodology empowers homeowners to plan and execute successful retrofitting projects.

Benefits:

- Energy Cost Savings: Retrofitting reduces energy consumption, leading to lower utility bills.
- Enhanced Comfort: Measures like insulation improve temperature regulation and air quality.
- Increased Property Value: Energy efficiency upgrades can attract buyers and increase market value.
- Environmental Sustainability: Reduced energy use translates to lower greenhouse gas emissions.

The SURe³FIT Approach:

This five-phase approach guides homeowners through the entire retrofitting process:

1. Assessment & Planning: A thorough evaluation of the home's current energy performance identifies areas for improvement. Project planning follows, selecting specific retrofitting measures.
2. Decision-Making: Homeowners prioritize actions and allocate resources efficiently to maximize energy savings and sustainability.
3. Implementation: This phase involves obtaining permits and installing the chosen retrofitting measures.
4. Use: Homeowners learn to operate and maintain the new systems for optimal performance.
5. Verification: The effectiveness of the implemented measures is assessed, comparing energy consumption before and after the project.

By following these steps, homeowners can ensure a successful project, leading to significant energy savings, improved comfort, increased property value, and a contribution to a sustainable future.

Future Considerations:

- Digital Tools: Integrating digital tools for data collection and analysis can provide real-time insights into energy consumption and retrofitting effectiveness.
- Technological Advancements: Continued development of advanced energy-efficient technologies can further enhance the effectiveness and cost-effectiveness of residential building retrofits.
- Expanding the Methodology: Exploring the potential for adapting the SURe³FIT approach to encompass a wider range of building types.

The SURe³FIT methodology empowers homeowners to manage residential building retrofits effectively. This structured approach helps homeowners make informed decisions, achieve energy savings, and contribute to a more sustainable future.

8 References

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