THE COLEOPTER APPROACH

SUCCESS FACTORS FOR AN INNOVATIVE APPROACH TO ENERGY EFFICIENCY IN PUBLIC BUILDINGS

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COLEOPTER PROJECT

The COLEOPTER (*COncertation LocalE pour l'Optimisation des Politiques Territoriales pour l'Energie Rurale*) project develops an integrated approach to the energy efficiency of public buildings that links technical, social and economic challenges. COLEOPTER addresses two energy efficiency challenges in buildings: difficulties for rural municipalities to act and carry out work despite the positive local impact (i.e., energy savings and local employment) and a lack of awareness of building challenges, which leads to irrational use of energy-water and low renovation rates.

The COLEOPTER approach has three components:

1. Territorial dialogue with local actors to co-construct work plans of public buildings.
2. Use of Building Information Modelling (BIM) as a collaborative tool to support the dialogue.
3. Consideration of water efficiency issues along with energy challenges to better consider usage.

The approach was tested on four public buildings, three to be renovated (in Póvoa do Lanhoso, Portugal; Cartagena, Spain; and Creuse, France) and one new building (in Creuse, France). It is also being replicated in Escaldes-Engordany (Andorra) to validate its transferability.

The main contributions of the project, namely the COLEOPTER approach and the work conducted on the test sites, will benefit municipalities, citizens and small and medium-sized enterprises (SMEs), leading to better planning of energy efficiency policies and increased public and private renovation rates.

The COLEOPTER project (SOE3/P3/F0951) is financed by the Interreg Sudoe Programme that supports regional development in Southern Europe by financing transnational projects through the European Regional Development Fund. The Programme promotes transnational cooperation to solve common problems in Southern Europe, such as low investment in research and development, weak competitiveness among small and medium-sized enterprises, and exposure to climate change and environmental risks.

Project leader	Céline Seince – contact@rurener.eu
Axis 3	Low-carbon economy
Objective 4C1	Improving energy efficiency policies and the use of renewable energy sources in public buildings and housing through the implementation of networks and joint experimentation
Total eligible cost	1 454 944.07 €
ERDF Grant	1 091 208.06 €
Duration	36 months (01/10/2019–30/09/2022)

Partners

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Agência para a Energía (ADENE)
Asociación Empresarial Centro Tecnológico de la Energía y del Medio Ambiente de la Región de Murcia (CETENMA)
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Ayuntamiento de Cartagena
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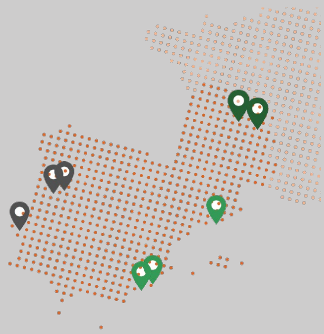

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1. INTRODUCTION

The COLEOPTER project examines four case studies in the following Sudoe eligible regions: two in Nouvelle-Aquitaine (France), one in Norte (Portugal) and one in Murcia (Spain). The methodology is also being replicated in Escaldes-Engordany (Andorra) to validate its transferability.

Figure 1 shows the locations of the buildings to be renovated in Póvoa do Lanhoso (Norte, Portugal), Tallante (Murcia, Spain), Chénérailles (Nouvelle-Aquitaine, France) and the new building in Chambon-sur-Voueize (Nouvelle-Aquitaine, France), as well as the building in Escaldes-Engordany (Andorra).

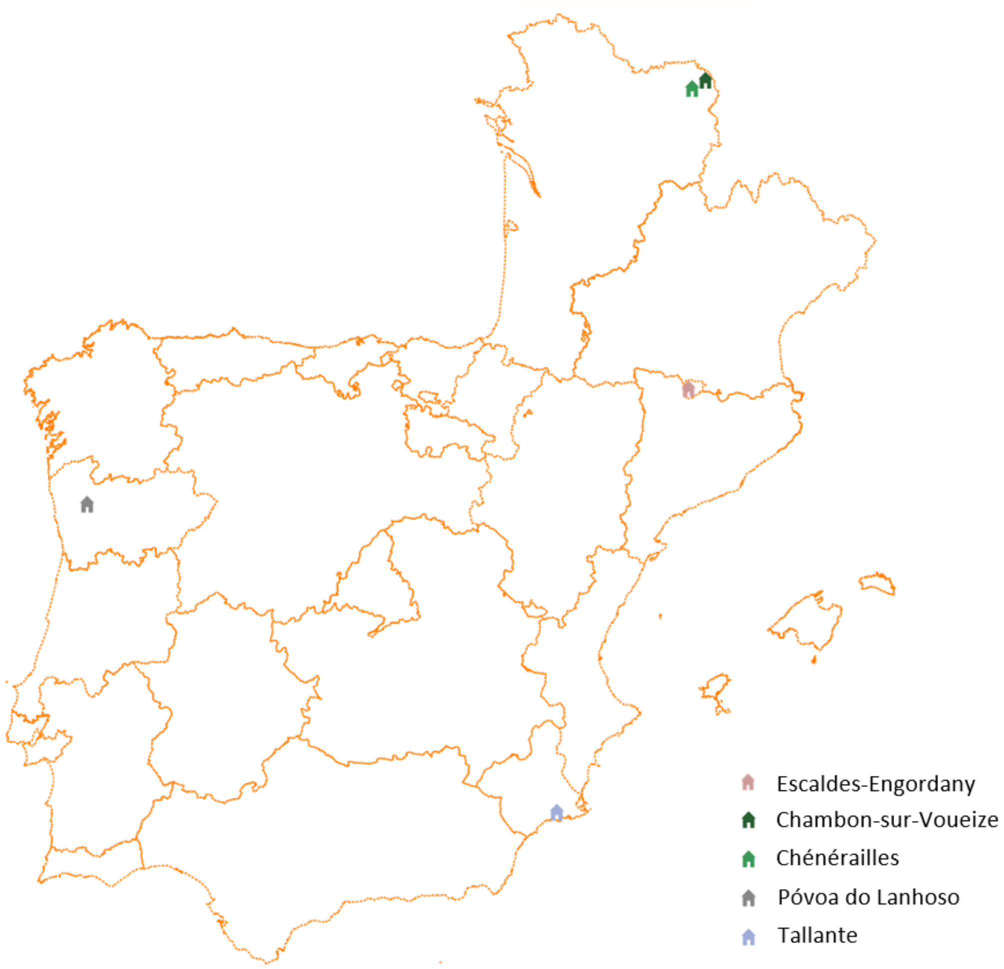

Figure 1. Locations of the case studies in the COLEOPTER project

Based on the experiences in the five territories, this report sets out the COLEOPTER approach, its tools and recommendations to transfer the methodology to other territories. After the introduction, the report is divided into three main sections. Section 2 starts with a summary of the COLEOPTER approach and provides useful links to the implementation documents and materials for each major building block in the approach. Section 3 presents the identified success factors and barriers based on the case studies, while Section 4 summarises the main conclusions in relation to the transferability of the methodology. Finally, the section on references lists the main publications on the implementation of the approach.

2. THE COLEOPTER APPROACH

COLEOPTER is an integrated approach to the energy efficiency of public buildings that links technical, social and economic challenges. The approach addresses the difficulties facing rural municipalities to act and carry out energy efficiency renovations despite the positive local impact, as well as the lack of awareness of building challenges, which leads to an irrational use of energy-water and low renovation rates.

The COLEOPTER approach was designed and tested between 2018 and 2022 in four rural territories: Chambon-sur-Voueize and Chénérailles in France, Póvoa do Lanhoso in Portugal and Tallante in Spain. At the end of 2021, the methodology also started to be replicated in Escaldes-Engordany, a small city in the Principality of Andorra.

The implementation of the approach is made up of three major building blocks:

a) Implementation of an energy-water audit
b) Use of BIM as a collaborative tool
c) Conduct of a territorial dialogue

Although the three building blocks are presented separately in the report that follows, it is important to emphasise that they are closely linked and their implementation is generally applied non-chronologically. Below are the three subsections that summarise the major building blocks of the approach in order to facilitate its transferability to other territories.

2.1 IMPLEMENTATION OF AN ENERGY-WATER AUDIT

Energy and water auditing is a way to assess where a building consumes the two resources in order to reduce their consumption efficiently wherever possible. Auditing is an important instrument for building owners and managers to identify how water and energy are used in different processes, determine their impact on the costs of running a building, and pursue any measures and investments that are required to improve the efficiency of energy and water usage.

As Table 1 shows, the methodology for energy and water auditing **(Poças et al., 2020)** that was defined during the COLEOPTER project consists of six steps.

ENERGY-WATER AUDITS	
1. Definitions	2. Information
- Definition of objectives and client validation - Task definition - Resource definition - Audit plan	- Preliminary information analysis - Identification of water usage equipment - Identification of energy conversion equipment - On-site inspection
3. Fieldwork – Data collection	4. Analysis
- Checklist for data collection - Identification of parameters to be monitored - List of auditing equipment - Fieldwork	- Inventory of collected information - Consumption calculation - Identification of water & energy savings
5. Proposals	6. Plan
- Improvement measures - Technical economic study - Report	- Action plan definition - Action plan monitoring

Table 1. Overview of audit steps **(Poças et al., 2020)**

In addition to the main methodological document, a summary with the indispensable steps for energy and water auditing appears in a very simplified form in **ADENE (2021)**.

The performance of energy-water audits requires looking at auditing from a new perspective, which is why **ADENE (2020)** developed a training module to help local technicians in their adoption of the methodology. The training materials describe the equipment required to do an audit and how to use it, as well as the measures and calculations that will be of use during the implementation of an audit. It is a rather technical document that will be highly useful for local technicians or any auditing body. Figure 2 shows some of the instruments used in the energy-water audit conducted as part of the Portuguese case study in Póvoa do Lanhoso.

Figure 2. Energy-water audit performed in Póvoa do Lanhoso (Portugal)

The energy and water audit is generally the starting point of the COLEOPTER approach. It gives an overview of a building and its water/energy efficiency potential. It is also a technical resource for the territorial dialogue (described in Section 2.3), because it promotes both an understanding of the water and energy issues in a pilot building among a wide range of stakeholders and the identification of any technical solutions for the building's refurbishment or renovation.

Some examples of the audits conducted during the project can be found on the COLEOPTER website.[1]

[1] For examples of conducted audit reports, see https://coleopter.eu/initial-audit-reports/

2.2 USE OF BIM AS A COLLABORATIVE TOOL

Building Information Modelling (BIM) is a collaborative working methodology for the creation and management of a construction project. Its objective is to centralise all project information in a digital information model created by all project agents. BIM is the evolution of traditional design systems based on plans, as it incorporates geometric (3D), time (4D), cost (5D), environmental (6D) and maintenance (7D) information.

In the COLEOPTER approach, the BIM model is a fundamental tool that can be used as a collaborative tool to support the dialogue described in Section 2.3. The implementation and use of the BIM model in the COLEOPTER approach are set out below.

2.2.1 Implementation of the BIM model

The implementation of the BIM model starts with the collection of any available information about the building in question. This includes architectural data such as the building layout but also information on the current (electrical, mechanical and hydraulic) installations.

The **architectural survey** combines the use of point cloud data obtained with 3D laser scanning and site visits to the building to compile information. In some cases, when a detailed building layout is included in the construction project, the 3D model can be implemented without the scanning process. The laser scanning process used in the Spanish and Portuguese case studies is depicted in Figure 3.

Figure 3. Laser scanning process used in Tallante (Spain) and Póvoa do Lanhoso (Portugal)

In the case of **installations**, most of the information is collected during the implementation of the energy-water audit. It is important to integrate most of the information on the installations into the BIM model.

Autodesk Revit has been used as the **software** to implement all BIM models in the COLEOPTER project. Although there are other kinds of BIM software including open-source options, Revit has been considered the best choice in terms of the management, development and especially publication of the BIM models on a common collaborative platform.

In general terms, the **Level of Development** (LOD)[2] of the implemented model will be LOD300. Table 2 presents the specific LOD considered for the implementation of the BIM model in the COLEOPTER approach. For the COLEOPTER case studies, the final construction of the BIM models was subcontracted out to specialised companies.

[2] For more detail, go to https://bimforumstg.wpengine.com/wp-content/uploads/2022/02/LOD-Spec-2021-Part-I-FINAL-2021-12-28.pdf

ID	Part	LOD	Definition
Architecture	Party wall	300	Position, thickness, typology, finishes
	Front wall	300	Position, thickness, typology, finishes
	Soils	300	Position, thickness, typology, finishes
	False ceilings	300	Position, thickness, typology, finishes
	Doors	300	Position, dimensions, typologies, Ref, commercial information
	Windows	300	Position, dimensions, typologies, Ref, commercial information
	Stairs	200	Position, dimensions, finishes
	Furniture	300	Position, dimensions, typologies, Ref, commercial information
Electrical installations	Terminal elements	300	Position, typologies, circuit, commercial information
	Electrical distribution box	300	Positions, ID, circuit
	Equipment	200	Position, typologies, circuit, commercial information, ID
	Electrical panels	200	Positions, typologies, circuit, ID
	Circuits	100	ID
Mechanical installations	Terminal elements	300	Positions, typologies, circuit, ID
	Equipment	200	Position, typologies, circuit, commercial information, ID
	Valves	300	Positions, typologies, circuit, ID
	Lines	100	ID
	Pipelines	100	ID
Hydraulic installations	Drains	300	Positions, typologies, circuit, ID
	Traps	300	Positions, typologies, circuit, ID
	Gaskets	300	Positions, typologies, circuit, ID

Table 2. Technical specifications (LOD) of the BIM models in the COLEOPTER approach

Some examples of the BIMs implemented during the project can be found on the COLEOPTER website.[3]

2.2.2 Use of the BIM model

The implemented BIM model will be used mainly in the co-construction of renovation plans during the conduct of the territorial dialogue (see Section 2.3), but it will also be used in the technical work performed during the refurbishment or renovation phase. In addition, the model can be used to carry out energy simulations with other software tools in order to estimate the potential energy savings of any solutions identified during the dialogue.

In order to share a BIM model with dialogue participants, it is important to use or develop a collaborative platform. In the case of the COLEOPTER project, the BIM models implemented at each pilot site are accessible on a public collaborative platform.[4,5] In this way, participants in the territorial dialogue have access to detailed information on the building in question and can make suggestions and modifications to the project. In the COLEOPTER project, Autodesk Forge[6] was used as a basis for the BIM collaborative platform. The platform allows for the visualisation and exchange of design and engineering data linked to the models. The interactive tool was developed on the platform to visualise

[3] For BIM implementation reports, go to https://coleopter.eu/building-of-the-building-information-modelling-3d-models/

[4] For COLEOPTER's BIM collaborative platform, see https://www.cetenma.es/works/coleopter-2/

[5] For the BIM collaborative platform user guide, go to https://www.cetenma.es/wp-content/uploads/2020/01/E3.3.2_User-guide-BIM-platform.pdf

[6] For more information, visit https://forge.autodesk.com/

and manipulate the different models and link comments to the different construction elements. Once the tool was completed, it was embedded on the project's website.

The use of the collaborative platform serves a dual purpose. First, as mentioned above, it can be used to share detailed information about the building with any participants in the dialogue in a user-friendly way and give them an opportunity to suggest renovations. Similarly, it is a great tool to show the results of any solutions identified in the dialogue and foster discussion in the group meetings. On the other hand, the content of the BIM model can also be used in the development of the construction process, making it a useful tool in the definition phase of any refurbishment or renovation.

2.3 CONDUCT OF A TERRITORIAL DIALOGUE

The inclusion of the territorial dialogue process is probably the most innovative aspect of the COLEOPTER approach. Putting users, citizens and other local stakeholders at the heart of public energy efficiency projects is key to increasing their local impact.

Territorial dialogue is a form of dialogue that:

a) Aims at the co-construction of propositions in relation to a decision-making process
b) Integrates all concerned parties
c) Promotes listening and mutual understanding of each other's needs
d) Facilitates the dialogue of knowledge and puts the experts at the service of the dialogue
e) Requires the prior definition of a specific framework and process
f) Follows a simple, progressive and flexible approach that puts the process above any facilitation tools
g) Is moderated by a person capable of showing empathy and adopting a neutral position

This section summarises the general process for the conduct of a territorial dialogue. A more detailed explanation of the framework and main steps can be found at **RURENER & Dialter (2021)**. Additionally, specific capacity-building material on the conduct of a territorial dialogue in public building efficiency projects was developed for elected representatives as part of the COLEOPTER project **(Barret, 2020)**.

The implementation of a territorial dialogue is made up of three main steps (**preparation**, **conduct of the dialogue** and **monitoring or follow-up**), which are described in greater detail below.

2.3.1 The preparation of the dialogue

Preparation starts with the definition of the **roles of the participants** in the process.

The facilitation team, which should be defined from the very beginning, is usually made up of two people: one facilitator and one support person to take notes during the meetings and manage technical aspects.

The stakeholders include all the people or groups that are impacted directly or indirectly by a project (i.e. the municipality, any building users, any neighbours of a building, the staff working in the building, local SMEs in the building sector, institutions related to the use of the building, etc.). A first identification of the stakeholder groups impacted by a project can be done by the municipality. Other groups may be mentioned during the preparatory interviews (see below) in the preparation phase, in which case they will be contacted afterwards.

The experts are people or entities that have been mandated by the municipality to conduct an expert study of the building (i.e. performing an audit or implementing a BIM model). Giving a report on a study conducted for the municipality is the role of an expert in the dialogue, while sharing views on a project and taking part in the co-construction phase pertain to the role of the stakeholders.

Elected representatives are key stakeholders in the process of territorial dialogue. Indeed, they are core stakeholders because they are the project's owners. The presence of elected officials in the dialogue (that is, in the preparatory and co-construction phases) is a gauge of their interest in hearing from others on the project and considering the outcomes of the dialogue in the final decision.

After the definition of roles, the **consensus-building process** is the first step in preparing for a dialogue. Before starting a dialogue process, an initial meeting must be organised with municipal staff and elected representatives involved in the relevant services. The goal of the meeting is to agree the local framework for the dialogue with the elected representatives based on a general framework that is applicable to any project using territorial dialogue:

- The objective of the dialogue

- The topics to be discussed
- The final products of the dialogue
- The participants in the dialogue and how they are related to municipal decision-making
- The calendar of the dialogue and project

The next step involves conducting **preparatory interviews**, which are key for the preparation of the dialogue. The interviews bring together the facilitator of the dialogue and the representatives of the previously identified stakeholder groups. They can be bilateral interviews or group interviews when there is a stakeholder group that does not have a representative. The preparatory interviews are meant to identify the needs of the different stakeholder groups in relation to the building that is to be renovated (or built), the groups' interest in taking part in the dialogue, and any potential barriers for the conduct of the dialogue. During the interviews, the facilitator will adopt a posture of active listening, which entails listening very attentively to what each interviewee says, reformulating any points that seem to be most important to the interviewee, and asking for validation. The interviews are unstructured and open-ended (the interviewer does not follow a list of questions) and they will last approximately one hour in length and should address the following three points:

- The vision and needs of the interviewee regarding the project
- The barriers that the interviewee foresees in the conduct of the dialogue
- The involvement that the interviewee is willing to have in the project

After the preparatory interviews, the framework of the dialogue can be adjusted, particularly the topics for discussion so that they fit the participants' interests and the calendar so that it matches participant availability. In addition, it is necessary to make a broader communication to the public to honour the transparency of the project. This is the last step in the preparation of the dialogue, which is known as **validation and information to the public**.

Both the quality and the success of the territorial dialogue process rely on the preparation. **Seince (2020)** provides a more in-depth explanation of the step.

2.3.2 The conduct of the dialogue

After the dialogue framework has been validated by the steering committee that oversees the territorial dialogue, the heart of the dialogue process can start. This consists of three group meetings that should be conducted over the subsequent three months. In order to encourage participant engagement, it is recommended neither to extend the meetings beyond three months nor for each meeting to exceed two hours in length.

The first meeting will identify the needs of all stakeholder groups (comfortability, respect for the renovation budget, reduced energy bills, respect for any regulations, etc.). During the first group meeting, an expert will present the results of the energy and water audit conducted on the building. This will help to enrich the shared vision that the first meeting seeks to build.

The second meeting will focus on finding solutions. The 3D BIM model, which is presented on the BIM platform, is used to support the identification of potential solutions that can respond to the previously stated needs. Having a 3D model of the building helps to visualise the renovation work that lies ahead. The BIM platform should be accessible between the second and third meetings so that participants can continue to add their input.

The third and final meeting will aim to identify the solutions that are most suited to the project (in terms of feasibility, budget, how well they meet needs, etc.). The BIM model will be used to present renovation scenarios. The third meeting will end with the selection of a final scenario and the creation of the final products: a list of recommendations and co-constructed workplans directly implemented on the BIM platform, together with any additional products expected to ensure the sustainable use of the building in the medium and longer term.

A more detailed explanation of the conduct of the dialogue and recommendations on how to run each meeting can be found in **RURENER & Dialter (2021)**.

After the third group meeting, the final products are presented to the steering committee for final validation. It is also important to inform the dialogue participants of the results of the steering committee's decision.

Figure 4 shows the second group meeting in the Spanish case study, which focused on identifying solutions to the building's needs, and the third group meeting in one of the French case studies, Chambon-sur-Voueize, which focused on selecting the most suitable solutions. In addition, the figure shows the different modalities employed in group meetings: online and on-site.

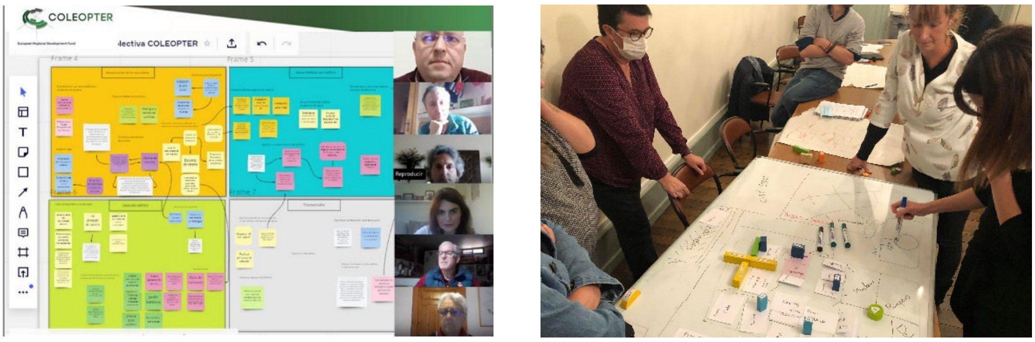

Figure 4. Territorial dialogue group meetings in Tallante (Spain) and Chambon-sur-Voueize (France)

As Figure 5 shows, it takes roughly six months to proceed from the initial internal consensus-building through the validation of the dialogue products. For this reason, if a dialogue process is desired, it has to be planned ahead to fit into the overall project calendar (i.e. any deadline to apply for funding, etc.).

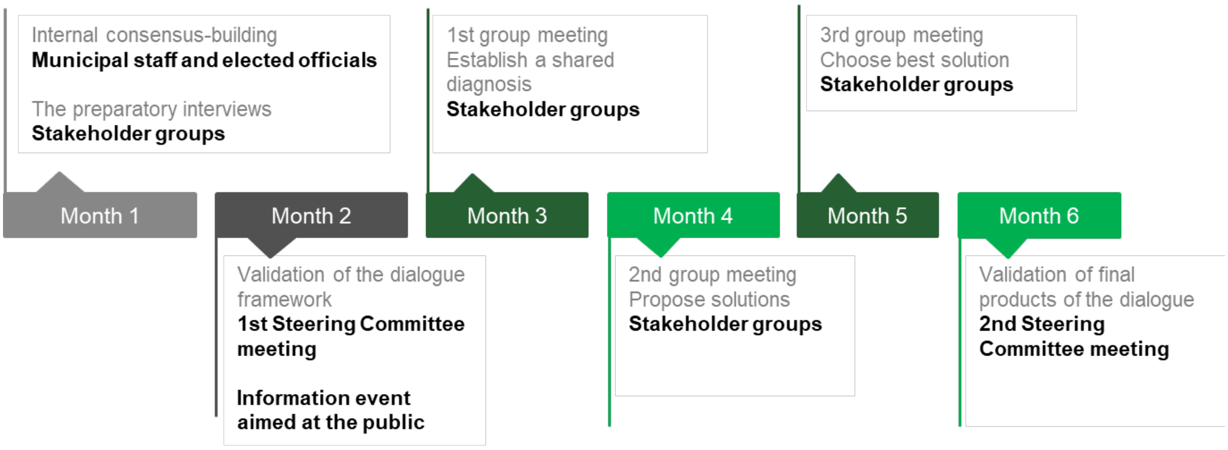

Figure 5. Estimated calendar for the preparation (in grey) and conduct (in green) of the dialogue

2.3.3 The monitoring or follow-up

Keeping up the engagement of people who take part in the dialogue process is important so that they do not feel left out or "used". In the case of a building renovation or construction, many unexpected events can occur in the renovation/construction phase.

Monitoring can take different forms but it is ideal to organise one or two monitoring meetings with any dialogue participants who are interested in the follow-up. The meetings can be held during key steps in the renovation/construction work, such as at the beginning of work after a company has been selected or if the need arises to change an initial plan because of some structural barrier. The meetings also provide a good opportunity to talk with participants about the uses of the building in question and collect ideas on how to invite users to engage in a more rational use of energy and water. Indeed, beyond the technical aspects of a building’s efficiency, how users are going to evolve in the building will have a significant impact on consumption.

Finally, hosting an event with the public can furnish an opportunity to thank everyone who is taking part in the dialogue process and make the project more visible. It is important both to raise awareness about efficiency challenges and to invite the public to participate even more in local projects. This sets a positive tone for any future projects that involve aspects of participation.

3. SUCCESS FACTORS AND BARRIERS

While the previous section set out the major building blocks of the COLEOPTER approach, the current section focuses on the success factors and barriers encountered during implementation at the four pilot sites. First, however, Section 3.1 briefly summarises the main characteristics and results of the COLEOPTER pilot.

3.1 COMPARISON OF THE PILOT SITES

The main characteristics and results of the COLEOPTER approach implemented at the four pilot sites appear in Table 3. The information is grouped into the three major building blocks, together with some general aspects. As can be observed, the four case studies are all located in urban areas, but they are very different in terms of use: two involve abandoned buildings and one is yet to be built. **Borges et al. (2020)** present a comparative analysis of the local contexts of the four case studies.

Concerning energy-water audits, the table highlights the proposed savings measures. It has not been considered appropriate to present any other content from the audits since the collected data are quite similar in all case studies that follow the methodology designed in the framework of the COLEOPTER project. While the savings measures do vary slightly depending on the building and place where they are intended to be implemented, what they all have in common is that the measures are related to the improvement or substitution of the building's architectural aspects or its systems and equipment, such as the replacement of the current lighting with LEDs.

With respect to BIM models and platforms, some of the most important aspects to consider are the cost of their implementation, the time needed to carry them out and the baseline data used to generate them. It is worth noting that the models are expensive, which can pose a major barrier to the implementation of the COLEOPTER approach.

Finally, regarding territorial dialogue, one important aspect to consider in Table 3 is participation. In comparison to what happened when stakeholder groups were identified at an early stage, participation in other case studies has been rather weak albeit fairly constant throughout the group meetings. Other aspects to consider are the total duration of the territorial dialogue and the length of group meetings. If the meetings are stretched over a greater span of time or they last longer, they could lead to a lack of motivation and involvement among the stakeholder groups. Finally, the solutions proposed as a consequence of the dialogue are also presented in the comparative table. In contrast to the solutions proposed in the audits, these solutions are more focused on the building uses and participant needs identified during the dialogue.

	Tallante *Spain*	Póvoa de Lanhoso *Portugal*	Chénérailles *France*	Chambon-sur-Voueize *France*
General aspects				
Use of the building	NA	Sports pavilion	Day care	Day care
In use?	No	Yes	No	No
Year of construction	1980	1986	1948	Not yet built
Constructed area	270 m^2	1750 m^2	142 m^2	NA
Climate	Dry Mediterranean	Mediterranean with Atlantic influence	Atlantic	Atlantic
Energy-water audit				
Conducted?	Yes	Yes	Yes	No
Proposed measures	- Modernisation of the lighting system to LED - Replacement of windows - Installation of solar thermal energy (associated with the use of shelter) - Installation of photovoltaic solar or solar thermal energy - Installation of aerators at water consumption points	- Insulation of hot water pipes - Boiler replacement - PV system installation - Replacement of window frames - Incorporation of a centralised technical management system - Lighting system replacement - Installation of timers in faucets, urinals and showers - Dual-flush systems in toilets - Installation of aerators at water use points	- Installation of efficient equipment (dual-flush system for toilets, water-flow reduction devices, low-consumption domestic equipment, motion-sensitive lighting, LED) - Insulation of the attic floors - Double-flow ventilation system - Double-glazed windows/doors - Insulation of external walls - Floor insulation - High-performance gas boiler	Not included because the building is not yet built
BIM model and platform				
Completed?	Yes	Yes	No	No
Platform cost	€15,000			
Cost (approximate)	€5,000	€20,000	-	-
Architectural survey	3D laser scanning	3D laser scanning	-	-
Time to implement	6 months	2 months	-	-
Territorial dialogue				
Participation *Identified groups* *Prel. interviews* *1st meeting* *2nd meeting* *3rd meeting*	 23 9 19 21 18	 8 6 15 13 3/17 *(the 3rd meeting has been spread over two meetings)*	 9 9 8-9 NA NA	 9 9 8-9 7 7
TD duration	Prel. Interviews: 1 month TD: 4 months	16 months	Prel. Interviews: 1 month TD: Aborted after 1st meeting	Prel. Interviews: 1 month TD: 8 months
Meeting duration	10 hours over 3 meetings (3-3.5 hours per meeting)	2 hours per meeting	2 hours per meeting	2 hours per meeting
Proposed solutions	- Use the building as a place for the conservation, transmission and dissemination of the cultural values and environmental resources of the area - Space for workshops/ training programmes for environmental education and convergence - Space for activities to reactivate cultural traditions and customs - Space for leisure activities (i.e. summer schools, camping area, etc.) and programmes aimed at young people - Space to train personnel in the area (dynamisation, rural development, rural tourism, etc.)	- Increase the area of translucent roof panels - Efficient hot water system - Improved heating in the locker rooms - Insulate the locker rooms' envelope - Replace the window frames in the locker rooms - New doors in the locker rooms - Locker room walls and floor repairs	Only one group meeting has been held so far. The main topic for the first meeting was to identify how to reorganise the space of the current building to welcome kids.	As the building is going to be new, the territorial dialogue focused not only on the spatial organisation of the building to optimise its use and consumption but also on how people will access and navigate the building (e.g. food delivery, drop-off for parents, access for people with disabilities, space to park bikes and such). Special attention was paid to sun exposure in the different seasons. Finally, as the building will host kids, the equipment inside the building was also discussed (e.g. height of light switches, toilets, etc).

Table 3. Comparative table of the main aspects and results of the COLEOPTER approach implementation in the 4 pilot sites

3.2 IDENTIFIED SUCCESS FACTORS AND BARRIERS AT THE PILOT SITES

This section presents the main success factors and barriers identified during the application of the COLEOPTER approach at the pilot sites. For a better overview, they have been divided into four categories. The first category covers the success factors and barriers related to general aspects of the COLEOPTER implementation, while the other three address the success factors and barriers related to each of the three major building blocks of the approach.

Table 4 shows the success factors and barriers related to the general aspects encountered during the application of the COLEOPTER approach at the pilot sites.

GENERAL ASPECTS	
SUCCESS FACTORS	**Transversal agents** Even when the COLEOPTER approach is divided into three major building blocks as described, having a person involved in all stages helps to speed up processes and provide solutions immediately instead of having to contact the technicians in charge of other parts of the process.
	Political support Undoubtedly, one of the key success factors in the implementation of the COLEOPTER approach in the pilot buildings has been the active involvement of the municipalities. This gives confidence to the participants and makes them feel that they really will be listened to and their ideas carried out.
	Approach versatility An indispensable aspect in the application of any methodology is its adaptability to different scenarios. As Table 3 shows, the pilot cases are very different in many respects, such as the type of building, the year of construction, whether they involve an existing or a newly constructed building, whether they involve buildings in use or abandoned ones, and whether the methodology has been successfully applied. For example, in a non-existent building, a prior energy-water audit makes no sense, but it should be carried out later to evaluate the energy performance of the building once the COLEOPTER approach has been applied.
MAIN BARRIERS	**Resource-intensive** The COLEOPTER approach requires greater resources in terms of time, economic and human resources than traditional approaches. Although the required resources will be discussed in more detail in the corresponding section, one of the biggest barriers was the need for multidisciplinary teams because each of the three building blocks of the approach requires very different technical knowledge and skills. In view of this, workshops and training were carried out by the expert partners prior to the implementation of the COLEOPTER approach in the case studies in order to ensure that all the territories had sufficient knowledge for them to be successful. In addition, during the implementation of the COLEOPTER approach, the expert partners gave support as needed. To overcome the resource-intensive nature of the approach, the COLEOPTER website provides a toolbox and methods to support implementation in other territories.

Table 4. Success factors and barriers encountered during the implementation of the COLEOPTER approach

Table 5 presents the success factors and barriers found during the implementation of the energy-water audits in the pilot sites.

IMPLEMENTATION OF AN ENERGY-WATER AUDIT	
SUCCESS FACTORS	**Building snapshot** Energy-water audits are the best way to take a snapshot of the current state of resource usage in a building. They provide essential information on a building's architectural elements (facades, roof, windows, etc.), as well as the main features of any installed technical systems and equipment (heating, cooling and ventilation systems, lighting, electrical and water appliances, etc.). They also help to identify abnormalities and estimate savings, and they provide a basis for establishing improvement measures.
	Commonly known

	Energy audits are very common and well-known practices to assess the energy efficiency of buildings.
	Integration of the water dimension The integration of water into the audit process is an important aspect. Water is not usually considered in energy audits, but the integration of this dimension is important in the resource consumption of buildings, given the growing tension in the use of water resources.
MAIN BARRIERS	**Too comprehensive and not always understandable** One of the barriers of energy audit reports is that they contain technical information about a building that is not always understandable to anyone who is not familiar with them. It is therefore important to convey this information in a simple way so that everyone can understand. In addition, the methodology was designed for buildings of all types, so that some information may not be applicable to a specific type. That is why the auditor must select the relevant information depending on the type of building under scrutiny (i.e. gym, swimming pool, day care, etc.).
	Avoids non-measurable factors In energy-water audits, it is difficult to capture aspects that are not measurable, such as user behaviour. It should not be forgotten that user behaviour plays a significant role in reducing energy consumption.
	SME mobilisation One aspect to highlight with regard to the barriers encountered during energy-water audits is the difficulty faced in mobilising local SMEs. Indeed, local SMEs have the greatest technical knowledge about the buildings in a region and would be a very important resource.
	Involve auditors in the COLEOPTER approach One thing that would considerably improve the COLEOPTER approach is to gain the involvement of technicians in charge of carrying out any energy-water audit. Indeed, their knowledge and their work on the energy-water audit would be of great help during the territorial dialogue meetings, providing technical information to the users of a building and thus helping in the decision-making process. It is important to note that their involvement would have to be defined so that they do not take up all of the time during group meetings but do share technical input as needed.
	Assign the audit results to the BIM model One of the barriers encountered during the implementation of the COLEOPTER methodology in the pilot buildings is that the BIM model of a building is not consistent with the information obtained through the energy audit. Indeed, it is very helpful to have the energy audit before the BIM model is built in order to supplement a great deal of information about a building that can be obtained at a glance during the inspections made by BIM technicians.

Table 5. Success factors and barriers encountered during the implementation of the energy-water audit

Table 6 shows the success factors and barriers faced during the use of BIM as a collaborative tool in the pilot sites.

USE OF BIM AS A COLLABORATIVE TOOL	
SUCCESS FACTORS	**Digital twin** BIM is a useful tool that allows for the creation of a 3D replica of a building (i.e. a digital twin), which can be used to test different solutions to problems in order to select the most suitable solutions in each case study. The 3D models helped the dialogue groups to see themselves in the buildings to be renovated/built and supported the co-construction process as all propositions could be discussed on the basis of the building's live 3D models.
	Centralised remarks BIM has made it possible to centralise the comments and contributions of all actors in a single place that is available for consultation by all participants.
	Multifunctional tool Although the use of BIM models was at first regarded as a visual tool solely to show any changes to be discussed during the participatory process and as a communication tool between the participants and the facilitators, the tool has much greater potential (i.e. energy simulations and the creation of plans for refurbishment or renovation projects, to name but two examples).
	Utility beyond the COLEOPTER approach Despite its cost (see barriers), a BIM model has a utility beyond its use in the development of the COLEOPTER methodology. Indeed, more and more public administrations require BIM managers when they carry out

	construction projects. This type of tool brings together a great deal of information about buildings, whether already built or yet to be built, which can be useful in future refurbishment or improvement projects and in relation to management aspects. Therefore, the costs associated with BIM should be seen as an investment to improve the information that the public administration has about its own buildings.
	Bringing the BIM methodology closer to the public administrations The development of the COLEOPTER project has helped to bring BIM tools closer to technicians in rural municipalities where the tools are not compulsory, unlike in major urban municipalities.
MAIN BARRIERS	**High cost** One of the main barriers to the use of BIM models is their cost, especially for small municipalities in rural areas. Indeed, in all of the case studies, the preparation of a BIM model has been subcontracted to specialised companies, resulting in one of the largest expenses in the implementation of the approach. In addition to the cost of subcontracting, other expenses related to the use of the model later on must also be taken into account, including the purchase of licences for the BIM software required, investing in more powerful computers for working properly with this type of data, and training for the end-users.
	Lack of technical skills One of the main barriers to the use of a BIM model is the lack of technical knowledge that is required to use it. In the COLEOPTER project, BIM models have been commissioned from an external company and then added to the collaborative platform to enable the addition of comments. It was found during the project that the participants did not dare to use it. Therefore, it is important to have someone on the facilitation team who has a minimum of BIM skills to use the tool. Wherever this is not the case, it is important to train one or more members who can explain how to use the collaborative platform. Additionally, the development of a user guide[7] is a good practice to complement the training.
	Updating the public administrations Most municipalities are outdated in the use of BIM in construction projects and often have neither the technical capacity nor the means to use it. Thanks to the COLEOPTER methodology, only a minimal updating of the public administrations is required, introducing 3D models to carry out the building design and move forward to generate the project documentation based on the models.
	Dependence on external experts The lack of BIM knowledge also leads to a heavy reliance on expert agents to apply the changes that arise during the territorial dialogue in relation to the original state of the model. This also implies an additional cost and can affect the project development calendar and deadlines.
	Limitations for minor improvements One of the main functions of a BIM model is to assist in the co-construction process by applying the solutions proposed during the dialogue sessions to the model. When assessing measures that entail corrective actions that are graphically difficult to capture in a BIM model (i.e. insulation of pipes and exterior walls, changes linked to the management of the building and its equipment, etc.), the effectiveness of the model in supporting the territorial dialogue is reduced since changes of this sort are not visible in the model.

Table 6. Success factors and barriers encountered during the use of BIM as a collaborative tool

Table 7 shows the success factors and barriers faced during the conduct of the territorial dialogue in the pilot sites.

TERRITORIAL DIALOGUE	
SUCCESS FACTORS	**User-based decision-making** The inclusion of the users of a building in the territorial dialogue make it possible to find out exactly which aspects of the building need to be improved, as well as to solve very specific problems that an external agent would not be able to detect on a simple visit or considering only the technical efficiency aspects.
	Focus groups with participants who have different knowledge

[7] For an example of a BIM collaborative platform user guide that was implemented during the COLEOPTER project, see https://www.cetenma.es/wp-content/uploads/2020/01/E3.3.2_User-guide-BIM-platform.pdf

	It is important to have people with different professional backgrounds at the meetings, because this allows problems to be approached from different points of view and enables the participants to reach a common solution that is not imposed.
	Ongoing feedback Another success factor is to be in constant contact with the different stakeholder groups. Send them the schedule of the meetings, as well as the minutes once the meetings are over, so that everyone is aware of what has been said even if they have not been able to attend some of the meetings and so that they feel free to give feedback whenever they want and remain involved.
	Personal contact A good practice to improve participation in the territorial dialogue has been to contact each stakeholder group personally. While there are other effective communication channels nowadays, having contacted each stakeholder group by phone to arrange the date and time of the different meetings and address any possible doubts has made people feel more comfortable and motivated to participate in the territorial dialogue. This is especially relevant for some age groups.
	Increase mutual understanding Putting people with different backgrounds, jobs, building uses and responsibilities around the same table enables participants to better understand what is at stake in a building’s renovation. Rather than complaining about the way a renovation has been conducted, it gives all participants a better understanding of the budget limits, usage habits and needs, and infrastructure barriers. Considering all of these aspects side by side makes for a legitimate project.
MAIN BARRIERS	**Low levels of motivation and participation** It has been found that the mobilisation and participation of the agents concerned is very difficult to achieve. In fact, as Table 3 shows, participation in the different group meetings is lower than the number of stakeholder groups identified. It is necessary to create dynamics that enable participants to engage in the process. It is important to highlight that participation was a little lower than expected during the four pilot cases, but that most participants did make it through the group meetings once they got into the process. It was also found that associations and organisations receiving public funding felt obliged to participate in the process, leading to a lack of motivation and reduced participation in the dialogue sessions. All stakeholders must participate on a voluntary basis for a territorial dialogue to be successful.
	Clear and transparent communication It is essential that the person who meets the different stakeholder groups has all the information. If not, it can cause mistrust and make people not want to participate. For example, in one of the case studies, neither the budget nor the schedule for the building improvements was available. As a result, people felt that what they were doing was not going to be carried out, so they lost interest in continued participation. It is important that nothing is hidden and that everything is made very clear from the beginning, even any uncertainties.
	Lengthy process As discussed in the first section, the territorial dialogue is spread over a period of approximately six months, which can lead to a loss of motivation on the part of stakeholders. To prevent this, efforts should be made to reduce the time between meetings. Depending on the building to consider, a less involved version of territorial dialogue could be developed, in particular when the use of the building is not going to change and there are no existing tensions around the building (for instance, between user groups or between users and the municipality).
	Long and excessive meetings With respect to the investment needed to mobilise stakeholders and encourage meetings, the management structure of the dialogue must be as simple as possible. In the operationalised model, there were too many "steering committees". On its own, mobilisation is a very complicated task in participatory initiatives. However, if we add the fact that there are many meetings and, in some cases, very long meetings, participants can become even more demotivated. Moreover, during the implementation of the territorial dialogue in the pilot cases, it was found that there are participants who sit on several committees, which implies more meetings and therefore more time.

	The meeting process should be simplified so that it is not an impediment.
	Need for a facilitation team Facilitating a dialogue process requires adopting a neutral position that can be difficult for municipality staff and require some capacity building in advance. This is an investment for the municipality, not only in terms of time as noted earlier, but also to train a couple of employees or hire an external facilitator.

Table 7. Success factors and barriers encountered during the implementation of the territorial dialogue

4. CONCLUSIONS

The COLEOPTER approach that is presented in this report can change how municipalities, populations and experts look at efficiency projects in public buildings. The approach seeks not to completely overhaul current practices in the refurbishment or renovation of public buildings but rather to improve each step by fostering a more integrated approach.

Each major building block of the approach, presented in Section 2, is based on an existing practice or tool. The most innovative aspect in the context of public refurbishment projects is the conduct of a territorial dialogue. This relies on existing participatory practices, such as public consultations, which are quite common even though rarely used in the case of public building refurbishment and renovation projects. Developing a specific methodology to ensure participation and co-construction is what the COLEOPTER approach brings to the usual participatory practices.

The three major building blocks of the COLEOPTER approach are closely linked and their implementation is generally applied non-chronologically. The flexibility of each building block is one the main strengths of the approach. COLEOPTER shows that there is no tool, approach or methodology that can simply be replicated as a “magic” solution in any particular territory. However, the toolbox and the methodology provided by the COLEOPTER approach are designed so that they can be adapted to each territory’s specific needs and characteristics.

Beyond being flexible, a second added value of the COLEOPTER approach is that it provides a framework to give equal consideration to technical inputs, behavioural inputs, user needs and political constraints.

Finally, public buildings are also a great tool to raise awareness about efficiency challenges and the need to make a more rational use of resources. By engaging stakeholders of all ages and social backgrounds, the COLEOPTER approach contributes to spreading the word.

This report synthesises the most important documents needed to transfer the COLEOPTER approach to other territories (see References section). In addition, the project website[1] hosts the detailed methodologies, templates and other tools that are used in the COLEOPTER approach.

[1] https://coleopter.eu/

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