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Residential Retrofits at district scale

Business Models under Public Private Partnerships

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The Catalonia Institute for Energy Research (IREC) began its activities in January 2009. Its mission is to become a centre of excellence and an international benchmark organization in the energy sector, through research, technology development and innovation. The main research subject of the Thermal Energy and Building Performance Research Group, leaded by Dr. Jaume Salom is the integrated and systemic approach for Zero Energy Buildings and Communities with special focus in the Mediterranean and other warm weather regions. This research group is the one from IREC participating in the present report.

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01 Executive summary

European countries must thoroughly modernize their building stock. The EU directives envision raising the refurbishment rate to around 3%, representing an estimated 110 million buildings across the EU.[1] However, several barriers exist that keep actual retrofitting rates far below envisioned ones, especially in southern countries. Retrofitting at the district level has been found to be an effective way to overcome the obstacles that prevent the retrofitting rate from rising above its current rate of 0.2% - 1.0%. In all analysed experiences – including the recent project "Renovem els barris" deployed in the municipality of Santa Coloma de Gramenet (Barcelona) – the Public Sector leads the project and end-users are able to take advantage of a greater percentage of grants and soft loans.

This study proposes three business models that function as Public Private Partnerships with the goal of implementing large-scale residential retrofitting. Each model is designed to clearly define the business process, financial fluxes, and each of the different stakeholders and their required skills, with the overarching goal of establishing a robust and easily replicable system that increases residential retrofitting rates across Europe.

The three proposed business models are based on the idea of establishing a Public Private Partnership between the city council and several private actors, including financial entities, while also implementing a participative strategy that involves end-users (i.e. district residents) in the project. The intervention action should follow four sequential phases: the project initiation phase, the end-user aggregation phase, the procurement phase and the execution phase. The financial support phase will be carried out in tandem with the other parts of the process. For the model to be successful, it must include the following key factors:

1 Directorate General for Internal Policies Policy Department A: Economic and Scientific Policy Boosting Building Renovation: What potential and value for Europe?, http://www.europarl.europa.eu/RegData/etudes/STUD/2016/587326/IPOL_STU%282016%29587326_EN.pdf

Stakeholder Expertise and Project Processes

- Clearly define process and timeline.
- Involve public sector (i.e. city municipalities) in leadership role.
- Engage residents in large-scale retrofitting actions beyond technical projects via a socio-technical participative process.
- Adjust actions to be deployed and municipal-level budgetary resources that need to be activated.

Financial and Economic Roles and Fluxes

- Establish centralised and competent system for managing of economic fluxes, including contracting third parties, gathering administrative information from end-users and managing retrofitting grants and/or subsidies.
- Reduce risk of default through a combined action of resident engagement, mechanisms (supported by the city council) and economic model adjustments.
- Determine the cost and establish agreements with financial entities for loans and/or length of payment periods.
- Design subsidies for vulnerable end-users through a city revolving fund.
- Ensure length of payment period and monthly payment amount complies with end-users' financial means.
- Include private partners' operational costs, in addition to technical advisory and project execution costs.
- Engage at least 150 households large-scale retrofitting action.
- Supra-municipality public bodies should provide retrofitting grants equalling at least 15% of the project cost.
- The reference investment should ideally equal no more than 7 000 €/dwelling, which is enough to apply the cost-optimal solutions for energy efficient retrofitting of buildings

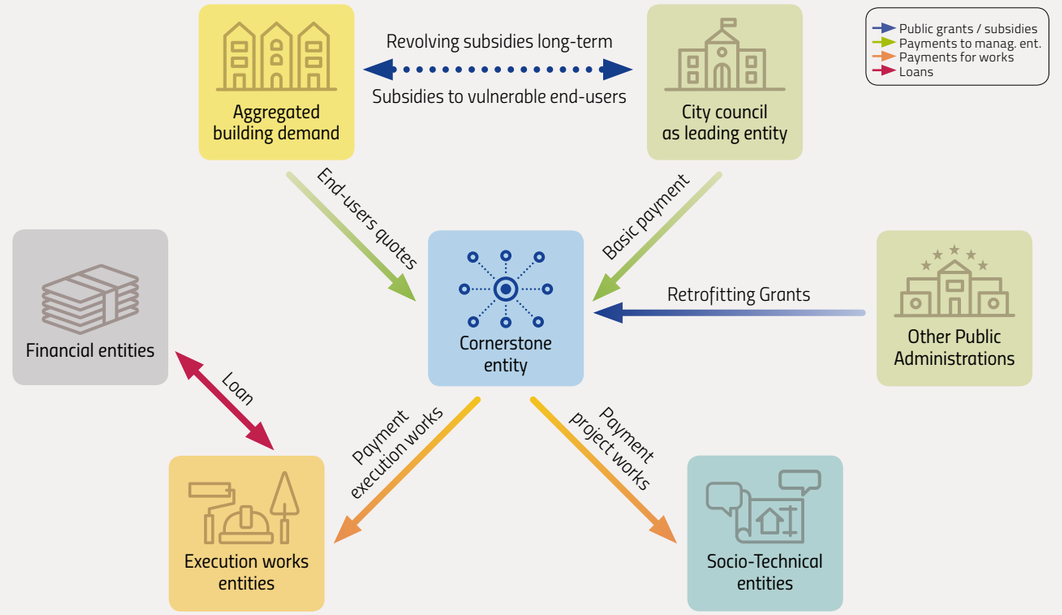
The first model *(Scheme 1)* is defined as "**PPP Management Model with a Single Public Tender**". The PPP model is based on a public tender that selects a company to manage the project, namely the Cornerstone. With the support of the city council, this company will be responsible for managing the process after the pre-initial planning phase, including aggregating end-user demand, implementing the technical project, supervising the construction works and managing grants, subsidies and end-user payments. This company will internalise some tasks necessary to complete the project and subcontract others when necessary.

This model will alleviate some of the burden off the city council budget; however, it is projected that a basic fee will be paid to the Cornerstone – at an amount defined within the public tender framework – to cover at least the fixed operational costs in the first steps of the project (until the demand aggregation and project phases are complete). The tender should take the role of local public entities into account when defining the framework. According to an interview with key stakeholders, there are already actors that exist in the market that are qualified to assume the Cornerstone project manager role; although, they must naturally adjust their daily tasks to comply with the requirements of the proposed model.

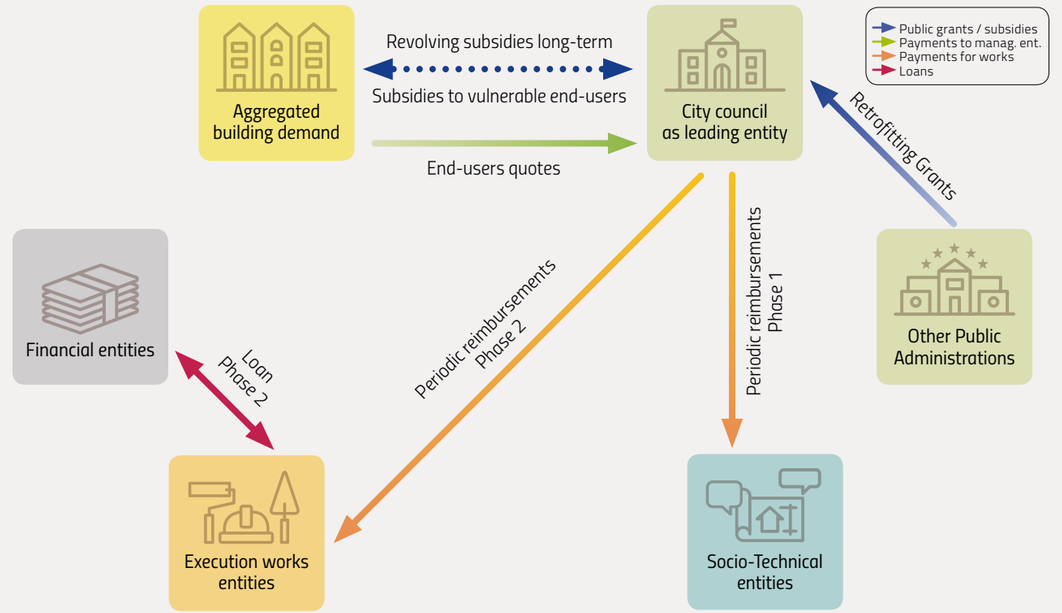
The second and third models *(Schemes 2 and 3)* are variants of a model defined as **"PPP Model with Two-Phase Public Tender Including Financial Contribution".** They build off the project processes that successfully guided previous retrofitting cases. This PPP model is characterized by strong municipal leadership that takes on the responsibility for grant and subsidy management. This model is based on a two-phase public tender process. Under the first phase, the city selects a socio-technical company that will deploy demand aggregation and will encourage residents to participate in the retrofitting project, and also realize the technical projects for the buildings in the area. The second public tender subcontracts a company to execute construction works.

Under the first variant of the model, the construction company will charge the city council based on the knowledge that end-user payments will support a significant portion of the project cost. This will alleviate some of the burden off the city treasury, enabling the city to activate multiple large-scale operations simultaneously.

Scheme 1. Monetary and Financial Fluxes for the ***Cornerstone PPP Model.***



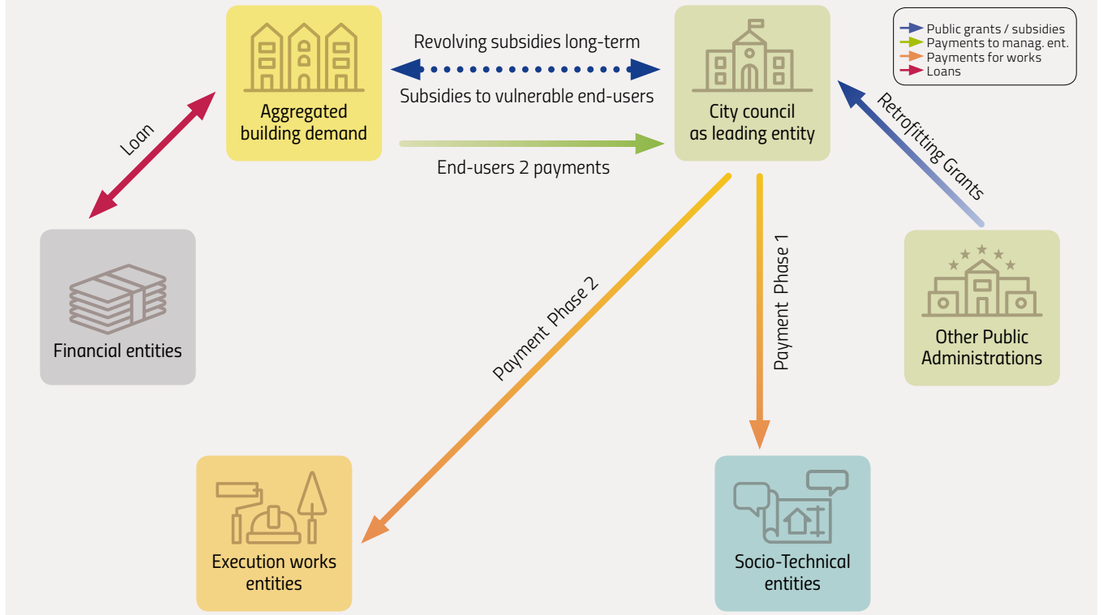
Scheme 2. Monetary and Financial Fluxes for the ***Two Public Tenders PPP Model*** (Variation 1).



The second variant involves a financial entity that is introduced to the process under an agreement between the end-users, under city council supervision. Under this agreement, the financial entity will deliver soft loans directly to end-users. This process may also be implemented through a kind of tender in order to ensure optimal conditions for all involved stakeholders.

This PPP model involves three different private actors. The first actor is a specialised technical company that is able to incorporate a participative strategy when deploying the socio-technical tasks for the first part of the process. The second is a construction company that finances construction works for the city council through a services contract. The construction company will operate alongside a financial company that will support the financial aspect of the operation. The third is a financial entity that offers soft loans to end-users; the terms of this transaction between financial entity and end-users are defined within an agreement under the city council's supervision. Such transactions would occur in case of large-scale operations that have minimized the risk of defaulting.

Scheme 3. Monetary and Financial Fluxes for the ***Two Public Tender PPP Model*** (Variation 2).



These types of private entities already exist in the market; however, they must slightly adapt their roles to comply with the proposed PPP structures and processes.

The economic model was designed based on the conditions of a typical business case, as defined by the following parameters: A single retrofitting intervention that delivers cost-optimal energy efficiency solutions to 350 households at once, for a total cost of €2.7 million. Household owners will pay average monthly payments equaling €88, paid over 5-year period. Large-scale retrofitting plans result in 12.3% less investment than their individual-level counterparts. Although the analysis is based on a test case in Catalonia, the model is designed to be replicable and can be easily adapted to other regions throughout Europe.

Each of the three models envisions new roles for existing private partners, presenting an opportunity for companies to participate in large-scale retrofitting actions. According to the results of a brief analysis, the potential market in the building retrofit sector is quite substantial. There exists a €60

billion market for retrofitting projects across Europe by 2020, and €260 billion in Spain alone by 2050. Indeed, the annual revenue for large-scale retrofitting operations equals an estimated €1.697 million.

Retrofitting actions has the potential to significantly benefit society, not just by improving living conditions and saving energy, but also by increasing property value, promoting the circular economy, creating or maintaining jobs in the building sector, and realizing savings for the health care system (due to healthier indoor living conditions).

While this report already defines the main aspects of proposed business models based on the results of previous success cases, the configuration details cannot be solidified until the models are implemented in real-life scenarios – pinning down the optimal details based on real project data could make all the difference realize future success. The first PPP model must focus on identifying a qualified company to take on the Cornerstone entity role and manage the project. The second and third models must focus on finding key actors that are able to slightly adjust their pre-defined roles in order to comply with the requirements of the proposed models. Both models most place great emphasis on the details (mostly related to the public tender) and on monitoring financial costs and flows, in addition to analysing co-benefits for end-users and other involved stakeholders, including energy savings, health improvements, economic revitalisation and overall district-level property revaluation.

Future steps must focus on implementing pilot programs using these three proposed models. Through the support of Innoenergy and local public authorities, these models are expected to be disseminated through select market stakeholders and engage supramunicipal public entities, while also considering public fund opportunities.

02 Introduction

It is well established that all European countries require a thorough modernization of their building stock; for this reason, Article 4 of the Energy Efficiency Directive (EED[2]), requires Member States *"to create a long-term strategy beyond 2020 for mobilising investment in the renovation of residential and commercial buildings with a view to improving the energy performance of the building stock"*. The ideal rate envisioned for the renovation of the building stock is around 3%, which represents an estimated number of more than 110 million buildings in need of renovation in the EU[3]. However, several barriers exist that keep actual retrofitting rates far below envisioned ones. The publication by the Buildings Performance Institute Europe (BPIE)[4] estimates the refurbishment rate hovers at an average of 1% across Europe; in Catalonia the energy renovation rate drops to just 0.2% of residences per year[5], representing a very low fraction of overall building stock.

The present study develops in-depth Public Private Partnership (PPP) models to implement building retrofitting on a large scale, such as retrofitting projects that expanse entire neighbourhoods or dozens of different buildings. The model mostly applies to urban areas consisting of multifamily buildings (condominiums) whereby a project involving dozens of buildings affects hundreds of residences; however, the model can also be extended to include detached or semi-detached houses. It should be mentioned that the aim of this analysis is to introduce new potential PPP models by defining the main stakeholders' skills and roles, project processes, and financial plans. From there, the real-world implementation of this model will require a certain degree of adaptation according to the specific characteristics of each case and the individual conditions of targeted neighbourhoods.

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2 https://ec.europa.eu/energy/en/topics/energy-efficiency/energy-efficiency-directive

3 Directorate General for Internal Policies Policy Department A: Economic and Scientific Policy Boosting Building Renovation: What potential and value for Europe?, http://www.europarl.europa.eu/RegData/etudes/STUD/2016/587326/IPOL_STU%282016%29587326_EN.pdf

4 M. Economidou, B. Atanasiu, C. Despret, J. Maio, I. Nolte, O. Rapf, Europe's Buildings Under the Microscope. A country-by-country review of the energy performance of buildings, Buildings Performance Institute Europe (BPIE), 2011

5 E. Cubí, J. Ortiz, J. Salom, Potential impact evaluation: an ex ante evaluation of the Mediterranean buildings energy efficiency strategy, International Journal of Sustainable Energy, (2013) 1-17.

This research largely stems from the experience of the 4-year-long project "Renovem els barris" led by the municipality of Santa Coloma de Gramenet[6] in collaboration with the neighbourhood association. The project sought to initiate a successful Public Private Partnership model as a means of accelerating building stock renovation, including energy efficiency measures. In consequence, Santa Coloma de Gramanet's Department of Urbanism and Housing – alongside COOP57, a cooperative dedicated to providing financial services – have both actively participated in the working sessions of this project.

The report is broken into several parts. First, it explores past experiences in large scale retrofitting projects, as well as financial models pertaining to energy efficiency projects in residential areas (Chapter 3); afterwards, it describes the main elements, phases, and key issues for large-scale retrofitting processes (Chapter 4). Chapter 5 offers a summary of different types of PPP models, while Chapter 6 elaborates on which characteristics of the PPP models could be potentially implemented in the near future, focusing on describing each part of the process and the main stakeholders involved. This includes presenting an economic analysis of the proposed business models from the perspective of all stakeholders involved. This section establishes the functions and operational conditions of new market actors as fundamental to the overall process, as they will potentially be responsible for deploying the business model; the section also explains how existing market actors should adapt. Chapter 6 also includes a sensitivity analysis of the defined economic model to test its robustness under different scenarios. The reference case that defines the economic model considers vulnerable socio-economic conditions in order to test more complex scenarios. The study methodology includes exchanging intermediate results with professionals who are familiar with and experienced in the topic, including candidates for the newly required roles under the proposed PPP models. Chapter 7 presents the conditions for business model replication as well as a brief estimate of the total addressable market across Europe. Finally, some indirect factors that may interact with building stock retrofitting are highlighted in Chapter 8.

6 Santa Coloma de Gramenet is inhabited by 119.067 persons and it is a city located in the metropolitan area of Barcelona.

03 Review of recently implemented district-level retrofit projects

This chapter seeks to establish a frame of reference by considering an analysis of previous projects, as well as sector-specific studies. The goal is not to conduct a deep analysis of each of these cases, but to offer an overview of the problem and its main characteristics.

District-level retrofit project reference cases

Many community- and district-scale retrofitting projects have been implemented in recent years, the large majority of which were either private or public initiatives and would not have been considered PPP initiatives. Nevertheless, they are useful to reference in order to offer background information of the problem in question. The following sheets provide basic information for experiences located mainly in the Spanish geography.

Trinitat In-Nova

Urban Renovation Plan

Barcelona

General Data

Emplacement. Trinitat Nova Neighbourhood in Barcelona.

Affectation. Approximately 7,000 residents and 0.6 km^2 surface extension, with a high concentration of immigrant and Romani populations.

Building typology. Low quality, multifamily houses constructed during the 1950s and 60s in order to quickly respond to large-scale immigration.

Objectives. To solve structural problems by thoroughly retrofitting the buildings via an educational and inclusive process.

Period. 1997 - present

Economic and Financial Aspects

Budget. €63,050,000 (2005 - 2009)

Main stakeholders. Regional governments – Generalitat de Catalunya (60%), Barcelona City Council (25%) and residents (15% - depending on their financial means).

Other financial funds. ECO-City European project and European Regional Development Funds (ERDF) for a singular building.

Legal Aspects

Legal process. The neighbourhood association initially detected structural problems in the building and asked for an integral action through the preparation of a community development plan. Later, it became the Metropolitan General Plan and a Special Plan of Internal Reform (PERI) was launched.

Efi-District

Project of Chantrea

Pamplona

General Data

Emplacement. Chantrea Neighbourhood in Pamplona.

Affectation. Approximately 6,335 residents.

Building typology. Multifamily houses of varying quality built between the 1950s and 1970s; Central heating systems are managed via cooperatives.

Objectives. To thoroughly regenerate the neighbourhood to improve the residents' quality of life and put a truly energy efficient and renewable model into practice.

Period. 2014 - 2016

Economic and Financial Aspects

Budget. €10,972,372

Main stakeholders. European Commission (Mobilising Local Energy Investments-Project Development Assistance-MLEI_PDA), the Regional Government (Gobierno de Navarra), the Pamplona City Council and local residents.

Other financial funds. Agreement with a private bank to ensure the community has access to the funds.

Legal Aspects

Legal process. The regional government aims to certify the zone as Preferential Retrofit Area in order to allow for higher public grants. The local government centralizes all the administrative processes related to the DHC and public space improvement.

Poblado Dirigido de Caño Roto

Renovation Plan

Madrid

General Data

Emplacement. Poblado Dirigido de Caño Roto in Madrid.

Affectation. About 1,606 dwellings, of which 1,004 are part of multifamily houses (70); the remainder are single-family houses.

Building typology. Multifamily and single-family houses constructed during the 1950s using low quality materials; severe structural problems were detected in the 1990s.

Objectives. To thoroughly regenerate the neighbourhood to improve the residents' quality of life and put a truly energy efficient and renewable model into practice.

Period. 1994 – 2004. All multifamily houses and the 58% of single-family houses were retrofitted.

Economic and Financial Aspects

Budget. €31,000,000

Main stakeholders. Spanish Ministry of Public Works (30%), the Regional Government of Madrid (20%) and residential areas. The Madrid City Council funded the urban development project.

Other financial funds. Agreement with a private bank in order to ensure the community has access to the funds.

Legal Aspects

Legal process. The regional government aims to certify the zone as a Preferential Retrofit Area to allow for larger public grants and create optimal conditions for private funds. The end-users (owners, tenants and usufructuaries) and public authorities participate as specific entities of retrofitting management in order to control the entire process and manage public grants.

Eco-City

Urban Renovation Plan

Tudela

General Data

Emplacement. Lourdes neighbourhood, Tudela.

Affectation. Approximately 760 dwellings.

Building typology. Multifamily houses constructed between the 1950s until the 1970s using low quality materials; many self-constructed projects.

Objectives. To thoroughly regenerate the neighbourhood to mitigate greenhouse gas emissions by reducing the energy demands and implementing renewable energy sources. Sustainable regeneration of the existing DH system.

Period. 2010 – 2012; 146 dwellings were retrofitted.

Economic and Financial Aspects

Budget. €6,760,000

Main stakeholders. Eco-City Project on EU CONCERTO framework, Regional Government (45%), Local City Council and owners. The public funds represented approximately 60% of the total costs.

Other financial funds. Agreement with a private bank to fund the required budget in full, including public grants.

Legal Aspects

Legal process. A public entity was responsible for all the management procedures, including the participative process, the public tenders, and the finance aspects. A specific meeting space was established in order to facilitate cooperation between end-users and technicians.

Ekostaden Augustenborg

Urban Renovation Plan

Malmö

General Data

Emplacement. Augustenborg neighbourhood, Sweden.

Affectation. Approximately 1,600 dwellings.

Building typology. Multifamily and single-family houses constructed during the 1950s of which the majority are public entities.

Objectives. To thoroughly regenerate the community to mitigate greenhouse gas emissions and to improve social conditions for the end-users.

Period. 1998 – 2005

Economic and Financial Aspects

Budget. €28,000,000

Main stakeholders. Malmö City Council (34%) and Municipal Housing and Land Company of Malmö (50%).

Other financial funds. LIFE Program (3%) and Local Initiative Program Grant (13%).

Multi-Neighbourhood

Retrofit Action

Zaragoza

General Data

Emplacement. Various communities throughout Zaragoza.

Affectation. Several buildings grouped in four areas of the cities including eight communities.

Building typology. Multifamily houses that were rapidly constructed between the 1940s and 1960s using poor quality materials.

Objectives. To retrofit public buildings as a demo project that serves as an example for future projects.

Period. 2004 – present

Economic and Financial Aspects

Budget. No universal budget has been established, but varies according to each building's needs.

Main stakeholders. Zaragoza City Council (25%), General Council of Aragón (25%), Spanish Ministry of Housing (25%) and residential areas (25%). The cost distribution varies depending on each building.

Other financial funds. No other financial funds are available at this moment.

Legal Aspects

Legal process. The regional government aims to certify the zone as a Preferential Retrofit Area to allow for larger public grants. Each of the public entities involved signed an agreement in order to establish a specific framework to manage legal issues and public funds. A designated meeting space was established in order to facilitate cooperation between end-users and technicians. Also, a social program was accorded to promote the reduction of the unemployment taxes by offering some of the retrofit projects to local stakeholders.

La Ribera Neighbourhood

Retrofitting Plan

Montcada i Reixach

General Data

Emplacement. La Ribera neighbourhoods in Montcada i Reixach.

Affectation. 41 multifamily houses with approximately 2,000 inhabitants.

Building typology. Multifamily buildings constructed from the 1960s to the 1970s, the majority of which are social housing projects and are in poor condition due to lack of maintenance.

Objectives. To improve the buildings' energy consumption efficiency and to educate the inhabitants about the benefits of maintenance projects.

Period. 2008 – 2012

Economic and Financial Aspects

Budget. No universal budget has been established, but varies according to each building's needs.

Main stakeholders. Public entities (74%) and residential areas (26%).

Other financial funds. Agreement with a private bank in order to ensure the funds access of the communities at optimal conditions. Commitment by public entities to be responsible for payments in case communities are unable of making payments by themselves.

Legal Aspects

Legal process. Action undertaken to improve regional residential laws. Technical and social processes completed by public entities in order to attain the goals and educate inhabitants.

Los Angeles City

Retrofitting Plan

Madrid

General Data

Emplacement. Villaverde district in Madrid.

Affectation. 486 multifamily buildings with approximately 7,990 inhabitants.

Building typology. Multifamily houses constructed from the 1950s to the 1960s, construction is of low quality; mostly occupied by immigrants and the elderly.

Objectives. To improve building accessibility, energy efficiency and homogeneity.

Period. 2005 – present

Economic and Financial Aspects

Budget. €68,500,000 (€51,900,000 for building retrofit actions).

Main stakeholders. Public Housing Entity of Madrid, Madrid City Council, Madrid Regional Government, Ministry of Public Works (50%) and neighbourhoods.

Other financial funds. Inspire European project.

Legal Aspects

Legal process. The regional government aims to certify the zone as a Preferential Retrofit Area to allow for larger public grants. Due to the financial crisis, fund proceedings were paused in 2012.

CITyFiED

Urban Renovation Plan

Valladolid

General Data

Emplacement. Torrelago district in Laguna de Duero, Valladolid.

Affectation. 1,490 dwellings.

Building typology. Multifamily houses constructed from the 1950s to the 1970s.

Objectives. To develop a focused retrofit methodology that could be implemented in other cities and reduce energy bills by 50% in 2019 thorough implementation of a DH system.

Period. 2014 – 2019

Economic and Financial Aspects

Budget. €16,000,000

Main stakeholders. EC 7th Framework Program (50) and local PPP partnerships.

Other financial funds. Each community will receive 15% of total energy savings (expected to reach 50%); the remainder will be used to pay back the project cost (20 year period).

Legal Aspects

Legal process. Signed agreement between owners and private companies investing in retrofitting actions and managing the DH system. The agreement was approved with less than 33% of the vote.

Soto de Leizkaru

Urban Renovation Plan

Pamplona

General Data

Emplacement. Soto de Leizkaru district, Pamplona.

Affectation. 96 dwellings.

Building typology. Multifamily houses constructed from the 50s to the 60s; poor quality construction.

Objectives. Improve overall building quality and accessibility, including energy consumption reduction.

Period. In progress.

Economic and Financial Aspects

Budget. €3,600,000

Main stakeholders. Regional Government and Pamplona City Council (until 40% of the costs for façade retrofitting) and neighbourhoods.

Other financial funds. The Pamplona City Council will implement and specific funding plan for those inhabitants under poverty conditions (10 years period).

Legal Aspects

Legal process. After a technical process, the local government and the owners signed an agreement for the creating of a public fund mechanism.

Renovem els barris

Urban Renovation Plan

ACR-Pirineus

Santa Coloma de Gramenet

General Data

Emplacement. ACR Pirineus, El Fondo district, Santa Coloma de Gramenet, Barcelona.

Affectation. 32 buildings, 386 dwellings.

Building typology. Multifamily houses constructed in the 1950s and 60s; low quality construction.

Objectives. Retrofit main components, including façades, roof and electrical distribution, and façade insulation (ETICS); improve living conditions within the buildings; help residents afford payments.

Period. 2013 - 2017

Economic and Financial Aspects

Budget. €2,100,000

Main stakeholders. The Santa Coloma de Gramenet City Council and neighbourhood associations.

Other financial funds. Public sector-supported building retrofitting grants (30%) managed by the AMB (Barcelona Metropolitan Authority).

Legal Aspects

Legal process. The city council legally defined the "Conservation and Retrofitting Zone". As part of a collaborative and social process involving local residents, the city council is responsible for contracting and funding the retrofitting project based on a revolving fund scheme. The city council also defined regulations for project payments based on three models: two payment modes, regular payments made over a five-year period, and grants that include a registry inscription plan.

Review of key factors contributing to successful large-scale retrofit actions

We can draw from the experiences introduced in the chapter and other references from the literature to determine several key factors that lead large-scale retrofit projects to success. While the specific details of each project are also relevant to their success, it is also pertinent to define and review the common factors between successful projects.

Management. Competent management is vitally important, especially considering the extended timeframe and the large number of stakeholders and interested parties involved. Overall, three factors for successful management have been determined:

- Participative Protocol Management. Active resident participation is critical to successful achieving the goals originally defined. The degree of participation may differ depending on each project's background and the overall management model; however, successful projects are often characterized by end-user participation (participative architecture).
- One-Stop Shop Method. Due to the complexity and the large number of administrative issues to be solved in such processes, the implementation of one-stop shop is crucial for success.
- Co-Management Entities. Depending on the level of involvement of public entities (specifically for cases declared Preferential Retrofit Area or with equivalent legal status), a fluent co-management process is quite relevant, usually under a legally binding agreement and with clear rules defined from the beginning. These entities usually manage the main decisions and, often, the grants, subsidies and the technical tenders.

Economics. The economic aspect is perhaps the most important factor considered. This aspect has been widely examined for all involved stakeholders, with two main factors for success determined:

- Grants and Subsidies Provisions. The availability and smart management of existing or specifically featured grants or subsidies provisions are essential to the success of a given case.

While it is not always necessary or convenient for the entirety of the required budget to be funded by third parties, the existence and smart management of grants and subsidies is a fundamental factor for success.

- Overall Budget and Financial Conditions. Special attention should be paid to the overall budget and the financial conditions in order to ensure the viability of the global operation. At one hand, it should be ensured and demonstrated to the neighbourhoods that the overall budget is quite reduced compared to the market condition Easy-to-use financial mechanisms should manage the budget, ensuring minimal to no initial spills and, typically, long payment periods. In regards to the final point, the payment period must adhere to a time frame acceptable to both end-users and financial institutions (typically 5 to 10 years).

Project Execution

- Local Market Involvement. Although not a specifically required, the involvement of local stakeholders often helps to build the trust with end-users. Promoting the participation of local entities or facilitating entities responsible for project execution in hiring local workers has often contributed to project success.
- Construction Works Quality and Schedule. Besides a limited budget, a shortened project schedule is another key goal. However, this should be achieved without sacrificing project quality in order to gain the confidence of the residential end-users. A small budget with favourable terms should not become synonymous with low-quality solutions. It needs to be widely demonstrated that high-quality solutions can be delivered under a short timeframe and on a reduced budget.
- Pilot Demonstrations. In some cases, a pilot demonstration phase on a small-scale, such as on a small set of buildings or an individual level, could help ensure end-user confidence.
- As mentioned earlier, each project's success also depends on specific details only relevant to that project. This being said, the commonalities between successful projects should also be considered when planning business models for large-scale retrofit projects.

Review of financial mechanisms and business models for large-scale retrofit actions

Infinitesolutions project (www.energy-cities.eu/infitesolutions) has developed business models for renovating residential building energy infrastructure through soft loans and third-party investment plans. The business models have been tested and implemented in several cities/regions across Europe. Because homeowners and market actors perceive city and regional governments to be trustworthy and legitimate coordinators of housing retrofit programmes, the business models is designed to enable cooperation with local financing institutions, investors, and technical project managers. Most business model options promote soft loans as financial instruments proven to be relevant and attractive for nearly all household types. Soft loans lend money to homeowners at a lower interest rate than standard market conditions, enabling homeowners to borrow money in order to carry out renovation work that increases the energy efficiency of their homes. Soft loans include other advantages, such as a longer term to maturity, a longer grace period and lower administrative and insurance costs.

The following table briefly summarizes each business models options and indicates where they have been implemented.

Table 2. Business model options for various reference case studies

Option 1	Option 2	Option 3	Option 4
Description. Partner banks provide soft loans Banks are willing to cooperate and are ready to offer attractive soft loans to homeowners The city or its partners provide technical assistance to homeowners.	**Description.** Partner banks provide soft loans and the city subsidises the interest rates, pay for the banks' operational costs and guarantee funding The city has a budget to pay the bank to make the loans more attractive for homeowners. The city uses this budget to subsidise the interest rate, fund the partner bank's operational costs (e.g. costs related to establishing a new financial product and other standard procedures) and/ or set up a guarantee fund to cover payment defaults The city or its partners provide technical assistance to homeowners.	**Description.** Cities /regions set up a revolving fund that disburses soft loans and pays a fund manager The city has strong political support The city has the budget to set up a revolving fund that will disburse soft loans. The city has the budget to pay a commercial bank or a fund manager to manage the loans. The city has the staff to set up a fund structure & standard procedures (e.g. Fund Management Board) The city or its partners provide technical assistance to homeowners, check their creditworthiness, and approve projects	**Description.** Third-party Investment & Energy Supply Contracting Third-Party Investment is a scheme whereby the investment in the building is not made by a homeowner but by a third party investor. Thus the homeowner does not take on a debt but pays a service fee to the investor. The investor can be a public, private, a mixed public-private company or a cooperative. It can guarantee energy savings, thus taking on all the risk if they are not achieved.
Case Studies Frederikshavn Bordeaux Metropole Parma	**Case Studies** Brussels capital Regionw	**Case Studies** Riga Delft	**Case Studies** Stuttgart

The case of Brussels Green Loan

The case of Brussels Green Loan is further analysed. Some summary conclusions about the procedure can be extracted.

A financial cooperative "Credal" is in charge to provide the soft-loans (interest rates 0-1% and maturity 1.5-10 years (up to 25.000 €). The cooperative responded to a call for an expression of interest launched by the region.

The region provides to the cooperative

- An administrative fee (€300,000 per year) to cover operational costs
- Interest rate subsidies (up to 3.5%)
- An allocated €12,000 per year as a guarantee fund (discontinued in 2016, as only one defaulting incident occurred since 2008)

The region handles

- Development of the scheme
- Communication and promotion
- Partner banks and stakeholders relations
- Following up on the scheme

The region also pays for the operational costs of the Energy House (€1,8 M in 2016), which mainly covers technical assistance expenditures, ascertaining beneficiaries' financial situation and verifying the project quote and feasibility proposed by specialists.

Between 2008 and 2016, only 857 loans equalling over €8 M were distributed. For the region, the cost per loan is €2,221 (a factor of 4.8), which represents a large portion of the regional budget.

Time consuming for the bank advisors (16.5 hours for Crédal on average).

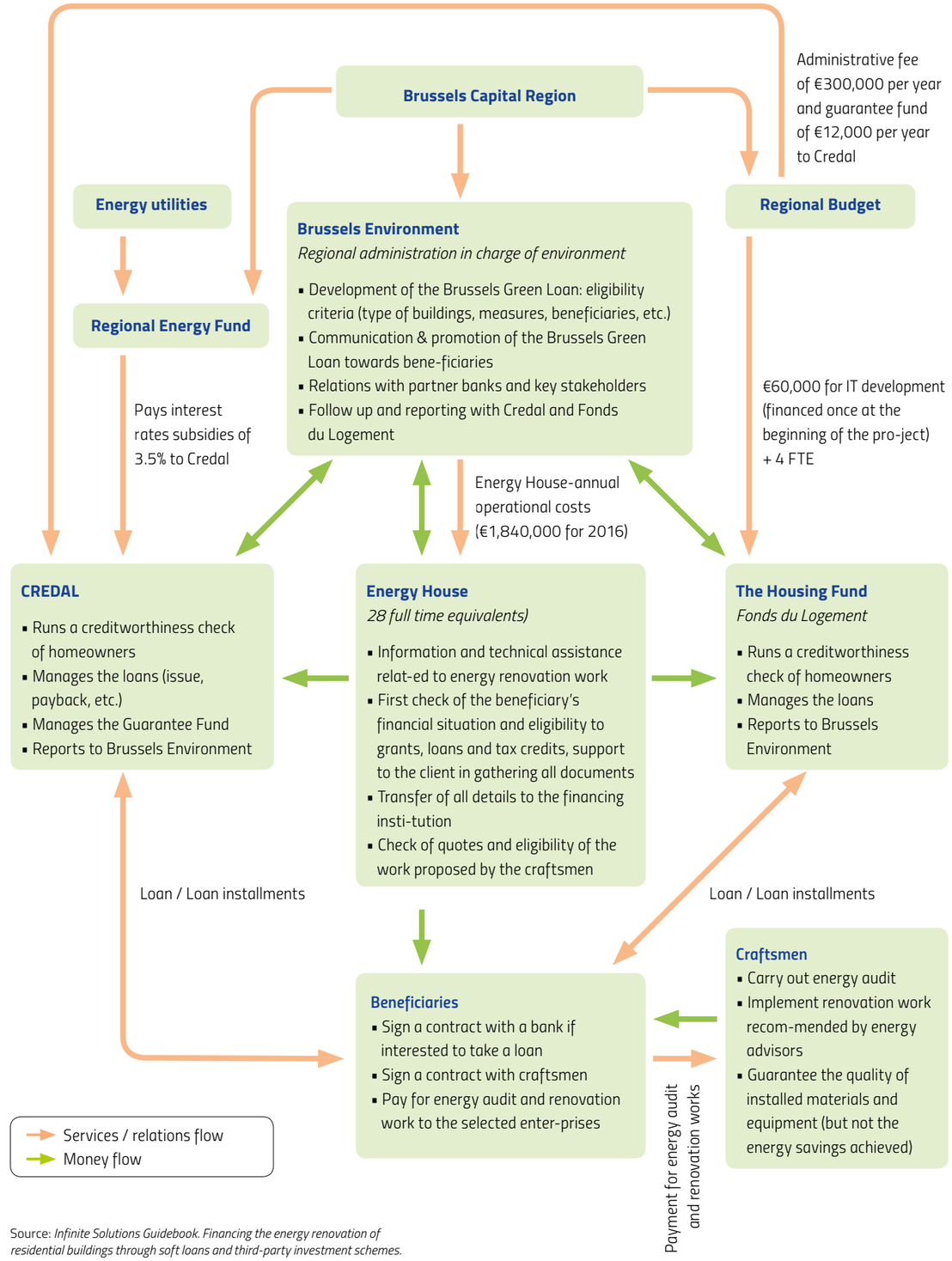
The region assumes the risk.

Homeowners are responsible for finding appropriate specialists.

The involvement of many different actors can slow down the process.

The condominium renovation rate is too low.

Scheme 4. Brussels Green Loan. Business Model Description.



Source: *Infinite Solutions Guidebook. Financing the energy renovation of residential buildings through soft loans and third-party investment schemes.*
http://www.energy-cities.eu/IMG/pdf/guidebook_softloans_web.pdf

After analysing a case whereby a revolving fund was established in Delft, some key points can be highlighted:

- Created a municipal revolving fund (a limited amount of €0.7 M).
- Managed funds via a municipality-owned bank; operational costs equal 0.9% of the loan until the maturity date.
- The municipality assumes the risk.
- Only 35 loans equalling €400,000 have been given since it was established in 2006 (very little compared to other cases).
- Private organizations give technical advice, acting as local Energy Advice Centres through 4-year signed agreements with the municipality.

04 Structure of a retrofit process at community and district-scale

With the goal of proposing a stable and coherent PPP model, the problem framework and main determinants and delimiters must be first established. This chapter seeks to dissect the general problem according to different points of view, according to different actors, temporaries, or topics.

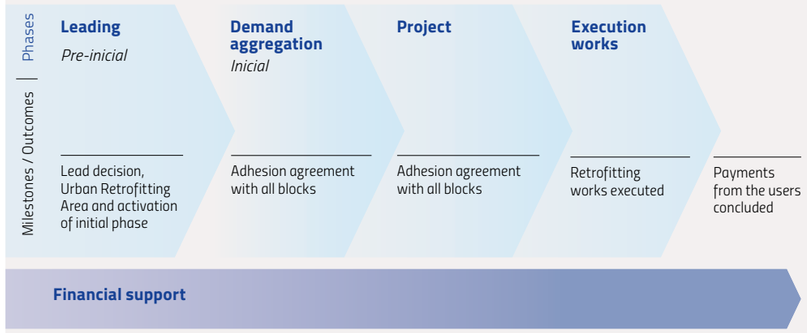
Processes summary chart

Independently of the different business models, the process of retrofitting at neighbourhood scale can be structured in different parts or phases, which are:

- Leading (or pre-initial) phase
- Demand aggregation (or Initial phase)
- Project phase
- Execution phase
- Financial support phase

The following scheme shows graphically the main phases of the project, as well of the main milestone to be achieved at the end of each of the parts of the process. It should be advised that this section describes the process once the business model is set up (established) at some extent.

Scheme 5. Phases and milestones of the retrofitting at neighbourhood-scale.



Source: Authors

The main activities / actions to be deployed in each of the phases of the project are:

Leading Phase *(pre-initial phase)*

This phase aims to activate the retrofitting process to become a fixed part of the city. Municipalities with strong political support should lead the initiative. The main activities are:

- Lead decision-making to initiate the rehabilitation process
- Activate informal contacts with representatives of the building blocks and/or residential actors
- Elaborate preliminary diagnoses
- Declare Urban Rehabilitation Area (URA) and its boundaries

Demand Aggregation Phase *(initial phase)*

This phase aims to start the participative management process and make the initial assessment in order to obtain the adhesion agreement of each of the building blocks which want to participate within the process. The activities which are described here are indicative and may vary depending of the company /actor executing the tasks

- Promotion and dissemination of the benefits due to energy retrofitting
- Activating demand / mediation works
- Identification of buildings subject to intervention
- Gathering information from Proprietary
- Registration and municipal census
- Interview with occupant proprietaries
- Informative meeting with all buildings presidents
- Activating demand / Technical pre-assessment work
- Building inspections by architects managers with community mediators
- Pre-diagnosis brief
- Drafting estimated budget of construction works
- Gathering economic data to value economic capacity of owners to afford retrofitting works
- Declaring acting entity of the rehabilitation plan
- Adhesion agreement of the building blocks

Project Phase

The phase aims to obtain residential agreement concerning the execution details of the building project. The activities go beyond the technical work while maintaining the participative dialogue with the building blocks initiated in the previous phase.

- Project of rehabilitation works
- Technical inspection report for each block
- Energy efficiency building certificate for each block
- Rehabilitation project for each block
- Cost of work for each block
- Residents participate in defining urbanscape
- Obtain agreement for the building blocks to execute project

Execution Phase

This phase aims to execute the construction works. The main activities are:

- Procure and select a construction company
- Execute the retrofitting project
- Deliver legal and as-built project documentation

Financial Support Phase

This time-transversal phase starts with the demand aggregation phase, when end-user information is collected, and finishes when end-user payments are recovered. Activities include:

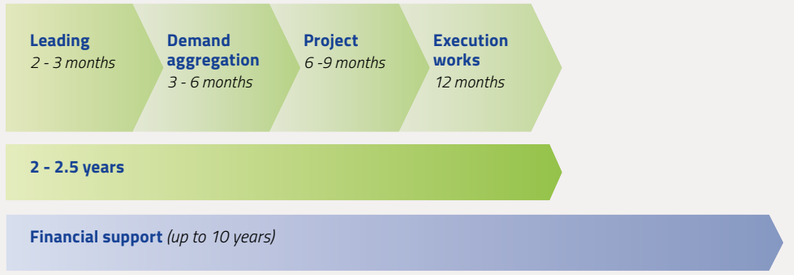
- Activating and detailing financing mechanism
- Managing retrofitting Grants to PPAA, including final justification
- Managing other specific subsidies related to retrofitting works. i.e., specific subsidies for vulnerable owners
- Fixed payment modalities
- Obtaining urban quotas and establishing follow up mechanisms
- Administrating payments to external companies and funding entities, if any.

Process Timeline

The following figure schematically represents the process timeline, depicting the indicative time for each of the phases. The timeline is based on the process of implementing a new project within a municipality that is already equipped with minimal mechanisms and support; it does not factor in how the process would run in a city that is hosting such a project for the first time. Cities without existing mechanisms and support may need to overcome some preliminary implementation barriers, which may prolong the initial phases of the project.

The entire length of the process – including from the pre-initial phase until project execution is complete – typically lasts 2-2.5 years. The financial support phase continues until end-users make the final payment. The financial support phase lasts as long as the payment periods, which can last between 5 and 10 years. This does not take into account the time it takes for the municipality to recover a revolving fund for vulnerable users by means of rehabilitation grants, which inscribes the debt in the Property Registry.

Scheme 6. Phases and indicative timeline of community-level retrofitting projects.



Source: Authors

Main key issues and constraints

A set of key issues and constraints has been determined based on the case study review explored in Chapter 3 and following several brainstorming sessions held with external collaborators, including Santa Coloma de Gramanet City Council (a public body) and Coop57 (a financial institution). Each of these issues and constraints have been grouped according to the topic they address. It is relevant to define and characterize these issues both as a means of defining possible PPP models and also to analyse the model's strengths, weaknesses, opportunities and threats.

Social Challenges and Constraints

The social pillar is the first of three pillars determined. Social aspects are always important when undertaking building retrofit projects; however, in the case of large-scale projects – such as residential- or district-level projects – social aspects are critical to successful project completion. Social challenges and constraints are the issues that directly involve the end-users.

Specifically, and in order of perceived relevance:

Confidence felt by the end-user. Of the successful reference cases analysed, the degree of trust end-users feel towards involved stakeholders is critical to project success. Coupled with this idea, public bodies are often perceived to be credible partners; even so it doesn't mind that an intensive social work should be done to consolidate this aspect. Furthermore, implementing participative methodology while defining the technical conditions of the project correlates with more actively engaged users.
Legally binding agreements with end-users. While this cannot be strictly considered a barrier, legal terms could become a conditioning factor when several buildings housing hundreds or thousands of people are affected. This aspect mainly affects different management steps, specifically those directly related to decision actions, subsidy management or fee payments. Considering national regulations and administrative requirements, it is not evident whether individual management can be overcome (i.e. for subsidy management which is typically nominal), but the end-user association should be reinforced as far as possible, at least at building level.
Tax declaration penalty for some end-users. Within the current Spanish legislation framework, received subsidies are considered as part of end-users' incomes. As such, they should be declared on annual income tax forms. In some cases, due to the stretches system, that means that the end-user will "pay for subsidies". This is not a specific characteristic of these large-scale actions but, due to their nature, most end-users were unaware of this fact before the process had already been initiated. Accordingly, this constraint should be addressed before project initiation in order to maintain end-user confidence and detect potential economic problems early on.

Financial and economic challenges and constraints

Financial and economic issues construct the second pillar to be considered when defining a PPP model, as they are instrumental in ensuring end-user engagement and also warrantying financial institution operations. Risk management is a major point of focus.

Specifically, and in no particular order:

VAT value depending on the actor who asks for grant. The Spanish legislation applies a special reduced VAT (10%) for retrofitting actions. However, this only applies to the beneficiary end-user. In other cases, the common VAT value (21%) is applied. This rule is a well-known barrier for ESCO companies and will likely undergo modifications in the future; nevertheless it currently remains a relevant factor. In special cases, public entities could claim status as an end-user and thusly request an exception, thereby maintaining this advantage despite not being the final beneficiaries.
Grant direct assignee accounts for cash flow. Centralizing subsidy management for large-scale processes simplifies the management tasks and assures the feasibility of the overall process. Nevertheless, most subsidies are estimated on a nominal cash-flow basis, hampering operation management and third party cash flow. Again, if public bodies demonstrate they are responsible for project execution, they could be eligible for exceptions.

Financial timeline considers all stakeholders. As has been introduced in the reference chapter, most successful cases include lengthy payment periods. However, long payment periods are rarely implemented, except in cases in which the financial institution is an ESCO Company linked to the exploitation of a DHC system, or something similar. For the remainder of cases, longer periods result in higher financial risks. The typical period lasts from 4 to 6 years. Lengthening the time period to a 7 to 8-year period, up to a 10-year period is an easy method for engaging end-users; however, at the same time, some measures to minimize financial risks should be taken.
Expected benefits for investment funds/companies. In most cases, the expected benefits received by investment funds, banks or other financial institutions involved are equivalent to those obtained from common market loans operations. In the case of social funds, these benefits could be adjusted according to the requirements of a given situation. In any case, benefits are always linked to financial risks (based on end-users and the project timeline) and the overall management costs.
Minimum operation scale to reach aggregated savings. In some specific cases, the operation scale allows the request for specific grants, subsidies and conditions, significantly reducing investment costs. Nevertheless, when project replicability is taken into account, material price adjustments and project execution are the most important factors. It is not clear how relevant this factor is in context of the overall operation (final costs savings or end-user fees), but it is certainly worth consideration. A cursory analysis is given in Chapter 6.

Business Model Challenges and Constraints

The final set of challenges and constraints relates to the business models. While the issues mentioned in the previous sections do relate to the business model, the issues mentioned in this section will be used to shape the models.

Specifically:

Risk management considering the involved actors. Any successful model determines risk and establishes specific mechanisms to manage risk. This is especially relevant in projects that involve hundreds or thousands of end-users and are implemented in degraded or low-income areas. In order to minimize financial risks as far as market conditions allow, end-user typologies and subsidy mechanisms must be precisely classified.
Alleviation of the public responsibility and contributions in order to guarantee their involvement. Public bodies have given significant effort to improve large-scale retrofitting projects; however, the actual retrofit rate is still far behind the rate proposed at European level. For public bodies, the large investment of labour and financial resources required to carry out renovation projects remains the main constraint. Any alternative model should maintain the benefit of keeping public bodies involved, while also reducing their labour and financial burden on public bodies.
Local economy involvement involving local companies. Although not a requirement, local company participation carries many benefits including strengthening end-user confidence and boosting the local economy. In most cases, the legal framework regarding free competition would need to be considered and focused actions would need to be implemented in order to encourage local companies' involvement.

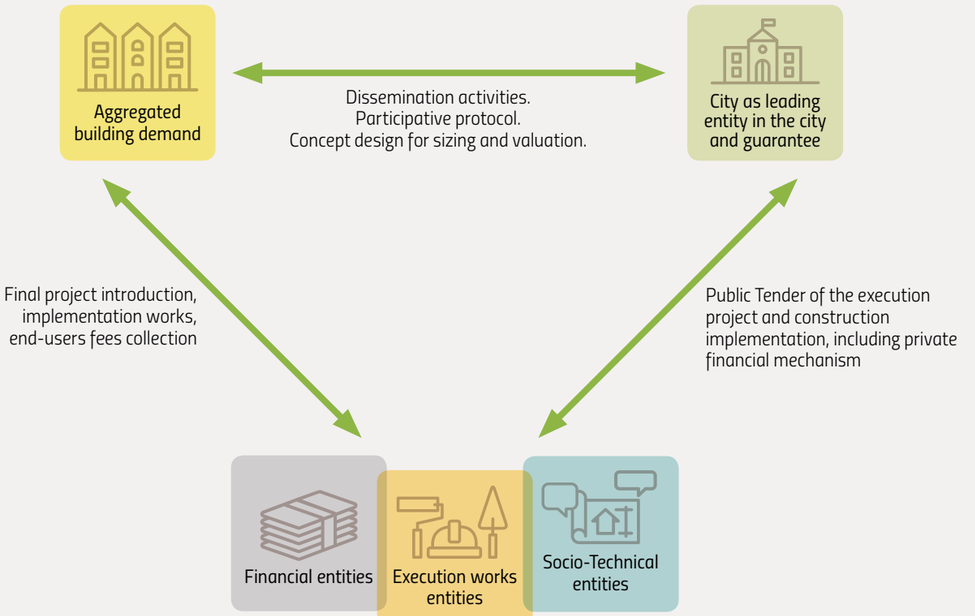
05 Oriented PPP models

This section introduces five business models for large-scale retrofitting process based on the reference case review. All models are accompanied by a graphic representation and a brief description. External consultants reviewed and discussed each of these models, giving extra consideration to the key issues and constraints for project implementation; three of the original models were discarded based on these discussions, while the remainder became the foundation for the proposed PPP models, as is further explained in the final subchapter.

Model 1. Global public tender including financial contribution

This model begins with a preliminary public evaluation and initial project concept, in addition to a public tender that covers project phases from design to implementation and financial mechanisms. Schematically, the model could be represented as:

Scheme 7. Global Public Tender Including ***Financial Contribution Model.***



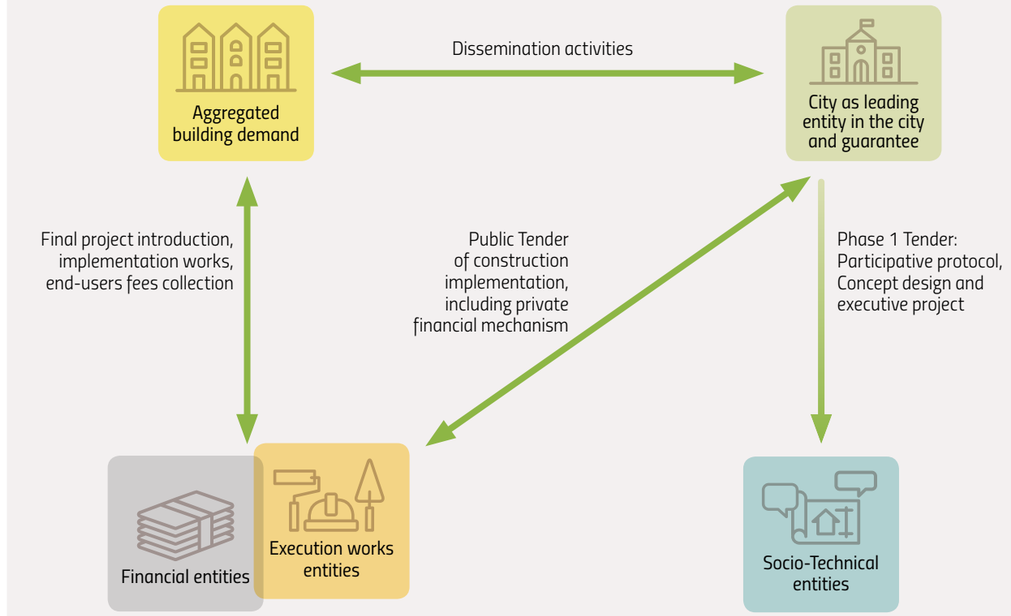
Under this model, the city council is responsible for all activities related to the launch of project initiation and demand aggregation, in addition to covering tasks related to project and execution works. This scheme demonstrates that winning tenders must be of a certain financial calibre and must be able to finance the works throughout the duration of a typical fee collection period (5 to 8 years). Fee collection is also the responsibility of the winning tender.

Model 2. Two-phase public tender including financial contribution

The first step includes defining and implementing the demand aggregation and project phases, and the second phase focuses on executing construction works, with consideration given to the financial mechanisms. Schematically, the model could be represented as in Scheme 8.

The main difference between Models 1 and 2 is that under Model 2 the initial tender winner is responsible for initial tasks (defining and implementing demand aggregation and project phases). Accordingly, city council expenditures are expected to be alleviated. Furthermore, the initial tender the retrofit project in detail, allowing for a more streamlined second tender. As is true under Model 1, the second tender includes a financial mechanism that guarantees the construction company is able to support long-term payments and collect end-user fees.

Scheme 8. ***Two=Phases Public Tender*** Including Financial Contribution Model.

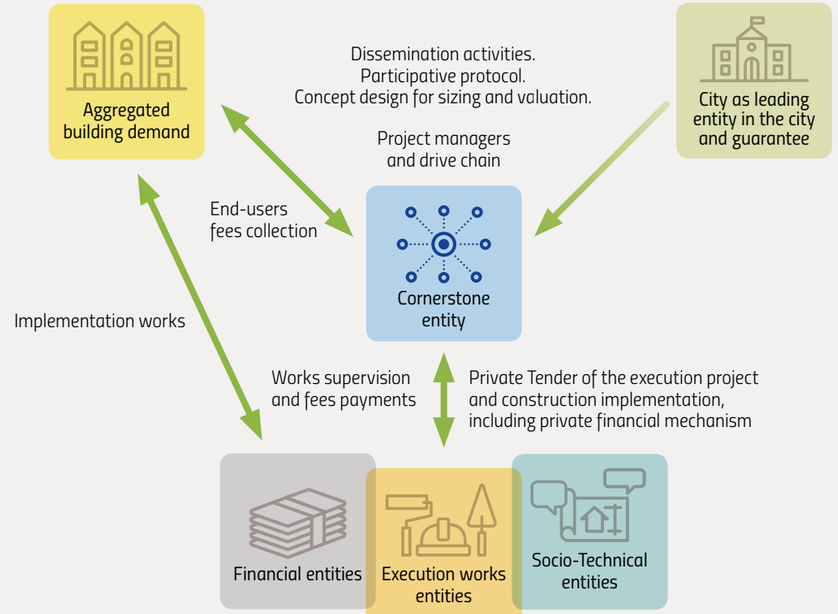


Model 3. Cornerstone PPP entity

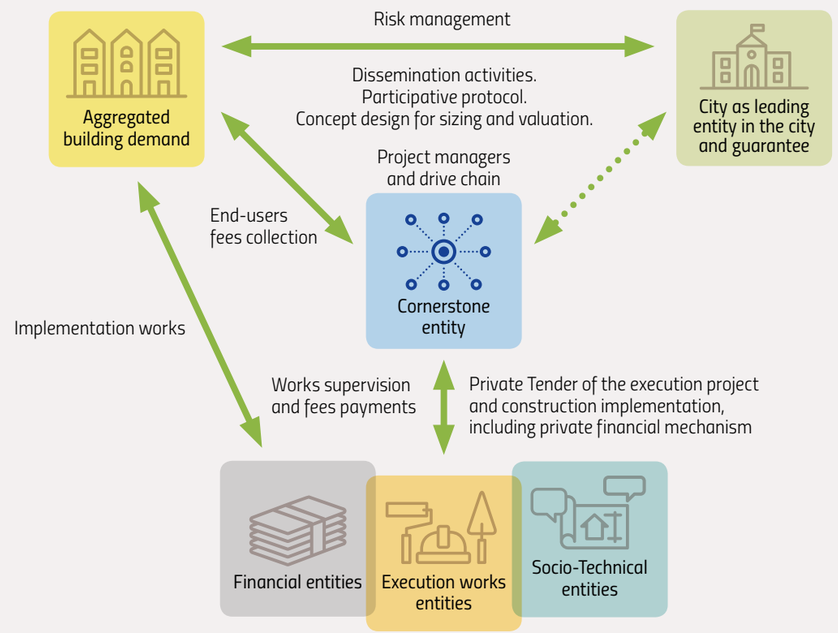
A business model involving a private company with public participation, whereby end-users are able to participate in retrofitting activities via an implementable funding scheme. This model also ensures projects can be reproduced in other neighbourhoods or districts. Schematically, the model could be represented as in Scheme 9.

This model does not include a public tender, but instead creates a flexible mechanism to allow for the existence of a public-private entity (also called a "Cornerstone"). This entity is responsible for all phase activities, from initial planning phases until construction work execution and fee collection. Under the city council's support and supervision, the Cornerstone directly manages all stakeholders, including end-user engagement and fee collection, and is also responsible for subcontracting specialists to define and implement the project and construction works. Subcontracting would also include the financial mechanisms that ensure the ability to manage long-period payments.

Scheme 9. ***Cornerstone PPP entity Model.***



Scheme 10. ***PPP management Model.***



Model 4. PPP Management model

A business model involving a private company that is responsible for defining and managing retrofitting tasks under an implementable funding scheme introduced by third parties. Risk management is shared with public entities. Schematically, the model could be represented as in Scheme 10.

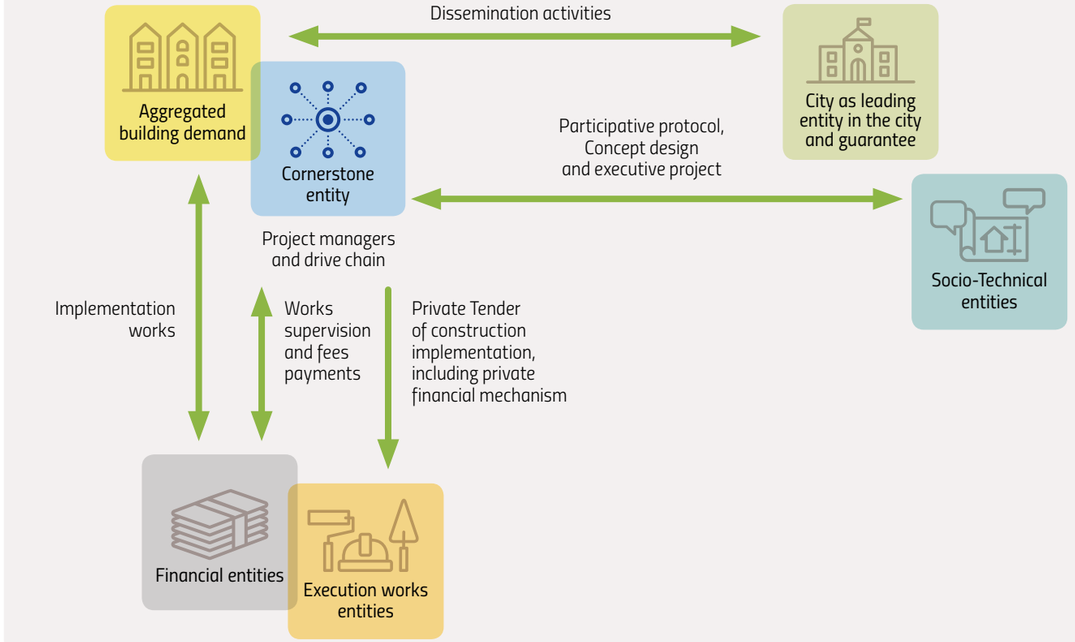
The main difference between Models 3 and 4, is that under Model 4 the Cornerstone is a 100% private company, acting independently. It receives support from the city council regarding risk management through defining, implementing and managing required subsidies.

Model 5. Cornerstone end-user entity

A business model involving an end-user private company that defines and manages retrofitting tasks. Third parties are responsible for introducing the funding scheme. Public participation is not a necessary element of this business model. Schematically, the model could be represented as in Scheme 11.

Model 5 differs from Model 4 in that Model 5 requires an end-user company to take the place of a Cornerstone entity. Consequentially, Model 5 cannot take on cases in other regions or be reproduced in other zones.

Scheme 11. ***Cornerstone end-users entity Model.***



Selected PPP base models for success

Based on the aforementioned base models and a multi-part discussion involving several external consultants, two base models have been selected.

As any option must be fine-tuned in order to achieve the overarching goal, the final base models have been chosen by a process of elimination, whereby the least feasible models are discarded. The justification for discarding or modifying these models are introduced in the following table.

Taking into account the aforementioned considerations, the final proposed PPP models are Model 2: "Two-Phase Public Tender Including Financial Contribution" and Model 4: "PPP Management Model". The following chapter will elaborate on each of these models, and offer suggestions for overcoming each of their limitations.

Table 3. Justification for eliminating proposed models

Main model affected	Justification for elimination
Model 1. Global Public Tender Including Financial Contribution	While this model was introduced in order to reduce the burden on public entities, specifically labour and financial expenditures, it also carries with it some major issues, for which no easy or reasonable solutions were found. In particular: It is unreasonable to establish a reliable and fine-tuned global tender without first having an understanding of the socio-economic conditions of end-users and on the technical problems to be solved. This lack of knowledge would hinder the financial structure, specifically related to subsidy management. This would create significant risk for investment funds. This risk would increase final costs, which end-users would be forced to pay. Gaining citizen's trust is difficult under a global tender model, resulting in a top-down process with limited chance for public participation in decision making Although this model is established as a public tender, public entity control is likely to be quite limited. Hence, final results could differ from the original goals.
Model 3. Cornerstone PPP entity	The National Spanish Legislation does not see significant advantages between a company with limited public participation and a private company, even though this model was established by giving consideration to the core PPP structure. That is, if public participation is under 50%, the PPP company would be considered a private company, which limits manoeuvrability. If public participation surpasses 50%, the PPP company would be considered a public entity; however, it is likely to be difficult to be considered a completely public company, as would be still partly privately owned. Hence, if the PPP company is considered a private entity, this model would not significantly differ from the "PPP Management Model" (Model 4). If it is considered a public entity, the tasks would not differ from the public tender model, neither in terms of labour or financial costs. Regardless, there is little reason go into further detail to develop this model.
Model 5. Cornerstone end-users entity	Model 5 is a more conventional building retrofit model that has been implemented on several occasions. However, this model is more suited to new constructions rather than retrofitting projects. Despite this, it is still worth exploring as a point of reference. The main open issues that hamper implementation for large-scale retrofitting projects are: Difficulty of creating a cornerstone entity directly introduced and managed by end-users. There are only a few examples of this occurring (see Chapter 3, Trinitat InNova). This type of model often occurs when a neighbourhood is quite degraded, and only after a long process. Public subsidy management is extremely complex, considering that that Cornerstone entity is both the judged and interested party. Cornerstone entities exhibit low transparency, which could result in large financial risk with higher investment costs and established fees for third parties. Low level of reproducibility, even if future retrofitting projects are undertaken in the same district or city.

06 Proposed PPP models for building retrofits at community –and district– scale

This chapter describes the proposed and selected PPP models in extensive detail, defining involved actors, their roles, and relevant processes. Thereafter, the chapter will establish key factors and quantify benefits from each stakeholder's point of view (end-users, local public entities and Cornerstones). Finally, it will present the results of a sensitivity analysis, which examined possible factors that could influence the business model's feasibility from an economic point of view.

Main stakeholders' descriptions and roles

It is necessary to first clearly establish each participant stakeholder and their characteristics in order to effectively define the introduced model.

End-users according to various typologies

Different user typologies were established according to the interaction between stakeholders during the Santa Coloma Project and are created by taking a financial point of view. These typologies are identified in order to better assess different scenarios and apply the most suitable solutions based on end-user types.

User Type	Characteristics
User Type 1. Mode 50/50	End-users pay 50% of the project costs upfront and the final 50% after construction is complete. Grants deduct any costs that can be covered by end-users. This mode is applicable for companies that own the different entities (whereby entities refers to dwellings and premises (shops, restaurants, etc.) within in a building).
User Type 2. Mode 60 Payments	End-users pay 100% of the costs in 60 monthly payments (5 years), where the first payment is made at the beginning of the project. Grants deduct any costs that can be covered by end-users. Monthly payments should range from €60 – 120/residence for an average household in Catalonia. In reference ACR-Pirineus[7], this option was limited to physical persons. Hence, banks and companies must go for "Users Type 1 – Mode 50/50".
Users Type 3. Mode 96 Payments	End-users 100% of the costs in 96 monthly payments (8 years), where the first payment is made at the beginning of the project. In special cases, this period could be expanded to 10 years (120 payments). This type of user is applicable under a situation that requires users to pay a large overall sum for retrofitting projects (i.e. premises and dwellings in low-rise buildings) • In the case of premises, % of share is big compared with dwellings and most of them are closed without activity. So owners have the biggest quotes in the building and didn't have related incomes with the premise to afford payments. • The per-square-meter cost of retrofitting a low-rise building is higher than other types of buildings. As such, the degree of intervention in low-rise buildings is minimized in order to keep project costs within a reasonable sum. Increasing the length of the payment plan is one way to keep payments low and ensure energy efficiency measures are affordable. Grant is deducted of the costs to be covered by these users.

7 See section 3

User Type	Characteristics
User Type 4. Mode Inscription	A third party covers the corresponding payment for end-users The third entity lends money to the owner, who accumulates the debt in favour of the entity. The debt is rgistered in the Public Propierty Register. It is assumed that the debt will be cancelled in the long term (i.e. when the dwelling is sold, inherited, etc.) Previously, this mode has applied restrictions, such as: • Must be a person who physically owns property and lives in the area • Annual income should be less than 2.35 times the basic family income of the region[8] In the reference case of ACR Pirineus, approximately 14% of the owner-occupants selected this mode. Grant is deducted of the costs to be covered by these end-users
Users Type 5. Mode not available	Owner cannot be reached. The following cases are relevant for this type of user: • Person is unaware of the process or notification • Person unwilling to participate in the process and does not communicate • Party in question is an entity (i.e. company) that is bankrupt Grant is not deducted of the costs to be covered by these end-users (as end-users could not beidentified or reached) In some cases, this type of user can be converted to another type of user at some point throughout the duration of the project In some cases, the owner has an irregular situation and would not like to be identified or even receive a grant An unfavourable assumption is that this type of user will default
Users Type 6. Mode defaulter	Belongs to sub-group of Type 2 and 3 Users (Mode 60 / 96 payments). Refers to a user that becomes a defaulter because they cannot afford the planned payments In rare cases, this type of user can be a subgroup of Type 1 Users. However, for the sake of simplicity this study does not consider this type of user. Also, non-physical people are prevented from choosing Type 2 or 3 User (e.g. premises belonging to a single society)

Public bodies and their legal and administrative framework

Although public bodies are typically involved in large-scale retrofitting projects, the majority of them are only partially engaged, often playing a role in the subsidy plan or, occasionally, by allowing the legal framework to adapt to local conditions (in the following plans, this role is introduced as "Other PPAA"). This being the case, the relevant public stakeholder is generally the local administration, specifically, the city council and its staff.

Ultimately, the city council is the entity responsible for its inhabitants' living conditions, which encompasses building conditions. Nevertheless, three main aspects should be taken into account:

8 In the case of Catalonia and for the ACR-Pirineus project, 2.35 times the basic income €25,0000 for a single-person household and €27,700 for a 4-person household

- In the majority of large-scale retrofitting cases, the buildings to be refurbished are privately owned. While some city councils have disposed of property development in the past, most of them instead devote their energies to new public constructions or public building retrofitting.
- National governments are responsible for most legal framework surrounding the building sector, while local authorities are considered, at most, key stakeholders.
- Most existing grants and subsidies are established at European, national or regional level, while local authorities merely act as intermediaries.

City councils that aim to actively improve the building sector on a large scale must take into account certain opportunities and limitations that are presented as a result of the aforementioned framework. Mainly:

Management skills

End-user and citizen confidence. As mentioned earlier, citizen and end-user confidence is likely the parameter most relevant to the success of such operations. Involving large numbers of end-users and presenting socio-economic opportunities greatly contributes to complex management scenarios. Public bodies are the most appropriate entity to deal with the casuistries.

Regulation Implementers. Local authorities are responsible for transferring national and regional resources to the local condition, giving them the power to boost interventions by adapting regulations to local needs and ensure the process continues to move forward.

Economic and financial constraints

Adjusted authority budgets. Partly due to the recent global crisis that continues to influence several latitudes, local authority budgets are limited. In consequence, managing contract specialists to handle requested management or technical developments stresses local budgets, thereby limiting their ability to be involved in projects.

Limited indebtedness. Also due to the recent global crisis, national laws regulate and limit city council debt, including an annual zero indebtedness duty, clearly restricting local authorities' financing capabilities.

Treasury conditioning. Considering local authorities' role as intermediaries, technical and construction works could be considered services in order to avoid financial constraints. Nevertheless, natural cash flow limits should still be taken into account and that services have a 4-year period of limitation. (Note: A new regulation has recently been enacted that allows for 8-year periods of limitation; however, regional governments have the final say in whether they wish to adopt this regulation).

Project capacity

Staff limitations. The staff of mid- to –large-sized cities can be limited and may not have the resources to manage several different projects simultaneously, even if protocols and processes are clear.

City size. Small towns and cities receive the majority of their services from a supra-municipality authority that is shared with other cities. This being considered, if a business model were to be reproduced in small towns or cities it would likely need to be adapted in way that allows for inter-town or supra-municipality cooperation.

Intermediation limits

Applied VAT. Although a 21% VAT is usually applied to services, the Ministry of Finance is reducing this percentage to just 10% in order to incentivize building renovation. However, only an owner-level applicant is eligible for this reduction, restricting third parties (e.g. ESCO companies, public authorities). City councils could request an exemption from this rule by adopting the legal status of "Executor City Council".

Nominal subsidies. Due to transparency laws, subsidies and grants should always be nominal. However, this reduces the opportunity of establishing a subsidy purse that is used only when necessary with no pre-defined recipients. The aforementioned Type 5 Users (defaulters) are most likely to be affected by this.

Cornerstone – General management

A Cornerstone entity is introduced in some of the proposed PPP models. Companies that already exist in the current building market could be candidates to play a Conerstone role (i.e. property managers or project managers); however, the role should be adapted on a case-by-case basis. The Cornerstone will be responsible for:

- Receiving information and considerations concerning the overall process and adapting to the specific case, specifically regarding the Aggregate Planning phase.
- Leading social activities linked to end-user management.
- Subcontracting the project definition and development to third parties.
- Subcontracting the construction works execution to third parties, including the requested financial mechanism to adapt the payments to end-users' typology distribution.
- Managing the public grants for the end-users.

As explained above, there already exist entities that are able to implement the aforementioned activities, and these entities are likely able to learn how to implement new and specific activities, mostly those related to social skills recommendations (which are both relevant to the initial stages of the process and also interesting for the remainder of the process) and to financial mechanism adaption and management.

Socio-technical entities

Socio-technical entities' participation is required under the proposed PPP models. Two kinds of companies would participate:

Citizen-Facing Companies

These companies would act as the face of the entire Cornerstone as city council and engage directly with end-users, at least in the first stages of the process and, potentially, until the completion of construction works (depending on the case-specific rules). Responsibilities include:

Disseminate information to end-users that introduces and promotes the large-scale retrofitting actions. These activities should be coordinated and should be able to be shared with the municipality.

End-user classification, according to different end-user typologies established.

Introduce architects and technicians that meet the end-users' requirements while also facilitating communication between end-users and public authorities.

Social Architecture Companies

Responsible for technical design of construction works. Based on the experiences of previous cases, it is recommended that members have relevant social skills that can be reflected in the final processes and construction works. Responsibilities include:

Preliminary design, which should be used to focus the overall project and pre-size the requested budget.

Executive design, which should be the basis for the construction works and should for sizing according to the requested budget.

Direction for project execution.

Construction works entities

The construction works company implements the daily operation of construction works. However, the financial capacity could play an important role that could cause actual scenarios to differ from proposed models. As will be explained in the next chapters, proposed PPP models require that the construction works company has a strong financial capacity in order to carry out the cash flows. The actual value of a company's financial capacity depends on the variants of each proposed PPP model, as explained below.

Financial entities framework

In the proposed models, the financial entities (i.e. banks, investment funds, or social funds) lead the requested budget, consider the distribution of end-user typologies, and manage payments, either directly through the end-users or indirectly through the construction works company, depending on the variants of the proposed PPP model. The two main considerations would be:

Risk assessment

Although financial entities are familiar with the risk assessment process, it should be taken into account

that the proposed models allow risk to be partially shared. The end-user classification completed by other stakeholders and subsidies should be considered as part of the risk assessment process.

Interest rate
The interest rate could be a determinant of the overall success of the overall operation (see sensitivity analysis below). The interest rate is contingent on the risk assessment and, due to the aforementioned considerations, it is expected the interest rate value can be adjusted.

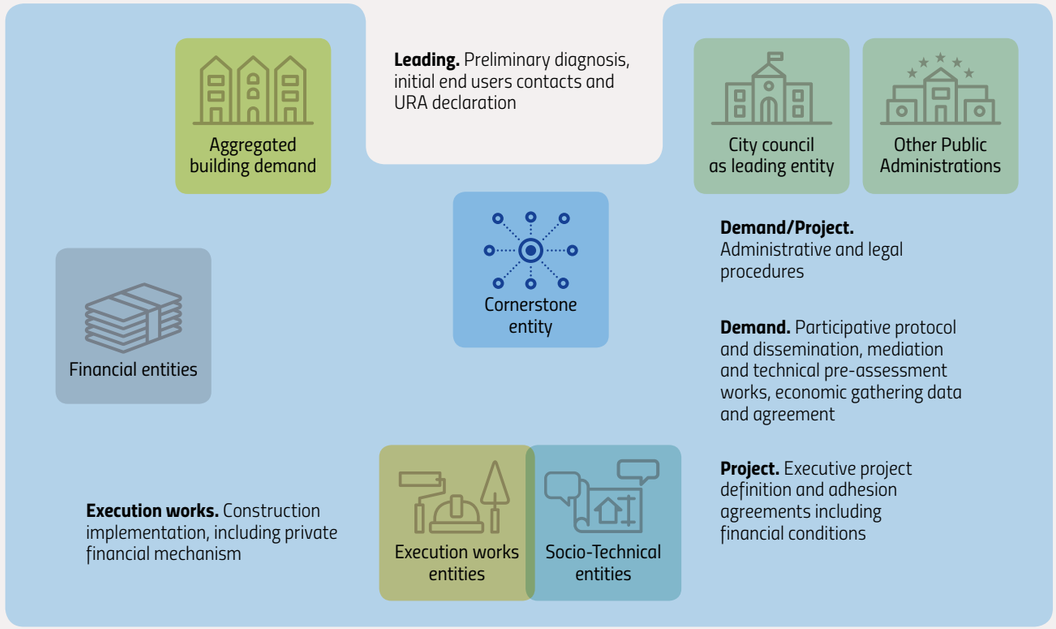
Business model process description

This chapter introduces the two different public tender-based process structures underlying the proposed PPP models. The description focuses on public tenders and their fluxes, while next section explains each of the financial mechanisms in depth, depending on model variants. In each case, the city council should lead the initial phase, as defining the project includes legal and administrative processes – and the public authorities play a key role in gaining the confidence of different stakeholders, especially building owners.

Process for the proposed PPP cornerstone model

The proposed PPP Cornerstone Model Process introduced in Scheme 12 considers each stakeholder involved in the process and its main expected activities.

Scheme 12. Description of the Processes Regarding the ***PPP Cornerstone Model.***



After the city council designs and implements the initial planning phase, a public tender is launched to select a company able to cooperate jointly with the city council during the aggregate planning phase, represent public authorities in front of third parties, and manage each step from project development to implementation, including defining financial mechanisms and managing public funds. It is relevant to emphasize that the city council will conduct initial planning activities (i.e. preliminary diagnosis, end-user initial contracts and URA declaration), while the Cornerstone entity will define and implement a large portion of the demand aggregation phase (i.e. they will manage the phase until the end-users and the Cornerstone sign an agreement, under the supervision of the City Council). Thereafter, the Cornerstone entity would be completely in charge of the remainder of the process. The process will be monitored by the city council. The process includes signing an agreement between end-users and subcontracted companies (technical, social (if necessary), and construction) and implementing and managing the financial plan.

The introduced tender is expected to only pay the Cornerstone fixed costs required to begin the process and limit company risks. The remainder of Cornerstone benefits will be integrated into the end-users' fee definition. As mentioned previously, while the Cornerstone could potentially subcontract social activities, it seems more optimal to internalize these activities. Technical development (i.e. project definition), construction works and financial operations will be subcontracted to third parties. Following sections in the chapter provide a more detailed explanation regarding monetary and financial flows.

Process for the Proposed Two Public Tender PPP model

Schemes 13 and 14 outline the second proposed model, the two-step tender model.

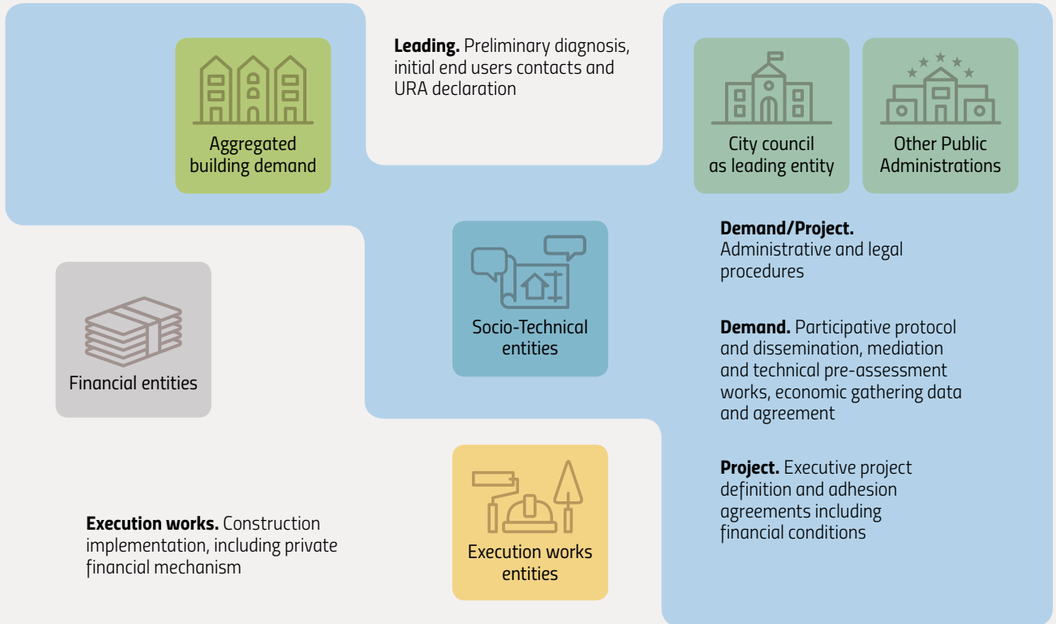
Similar to the PPP Cornerstone Model, under the Two Public Tender Model the city council introduces and executes the initial planning phase (including preliminary diagnosis, end-user initial contracts, and URA declaration). The entity that is awarded the first public tender will cooperate with the city council during the aggregate planning phase. Specifically, for the first public tender, the awarded entity (operating jointly with the city council) will be responsible for managing the agreement between the city council and end-users in order to officially engage them. Thereafter, the entity would be responsible for managing the technical and end-user intermediation by introducing architects and technicians that meet end-user requirements. Besides this, the entity is also responsible for facilitating communication between end-users and public authorities and for obtaining end-user approval for the project design, which would be used to focus the project and estimate the budget. As the second tender is being implemented, the first tender would be responsible for the direction of the construction works. The first tender requires the requested fees for each of the introduced activities before it can request a budget. The first tender may have an intermediate milestone preventing them from developing the technical project in case not enough end-users were engaged in the process.

Following the outcomes of the first public tender, the city council will launch the second public tender, which focuses on the construction works and includes the financial mechanisms. After first tender implementation and the end-users and city council reach an agreement, the total budget amount will also be known and financial conditions, including requested subsidies, can be clearly established. All this information and generated frameworks would act as pillars for the second public tender.

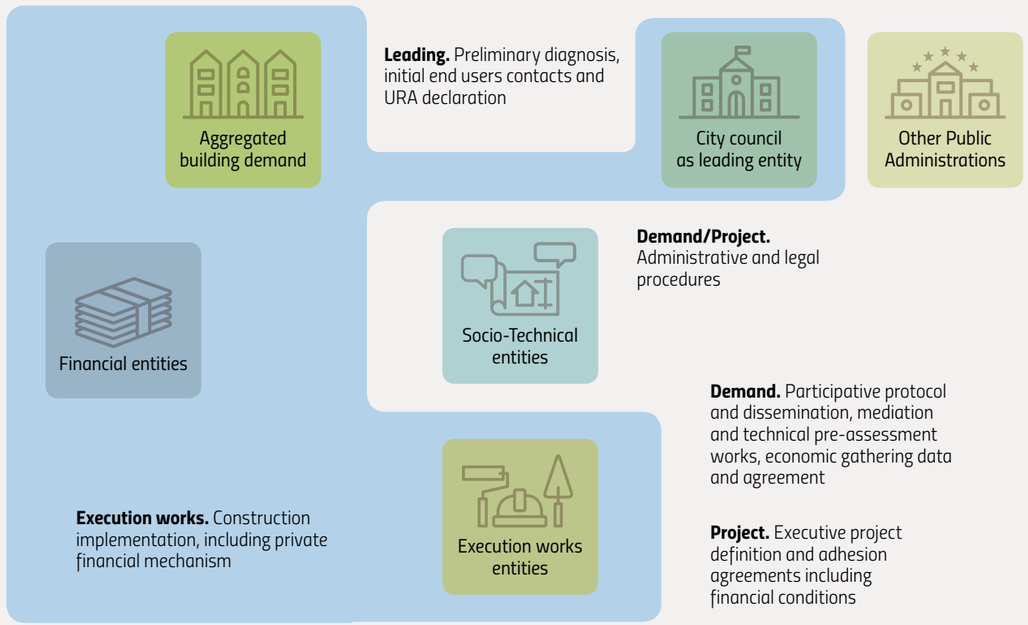
The construction works companies will agree to offer conventional services and deductions, but may require extra financial capacities in order to respond to specific requirements, depending on model variants. This is summarized in the company's ability to directly or indirectly bear the overall intervention cost throughout the course of the established time periods, which can range from 12 months (period of construction works) to 5-8 years, depending on the agreed payment period. For any of the model variants, specific financial conditions are defined according to the case and would be part of the entities' proposal improvements.

This phase ends after the building retrofitting is complete, and will be finalized following the end of the construction works period until the end of the reimbursement period, depending on recovering management models, as introduced in model variants.

Scheme 13. ***First Tender Process*** Under the Two Public Tender Model.



Scheme 14. ***Second Tender Process*** under the Two Public Tender Model.



Variants of the proposed PPP models regarding monetary and financial structure

Chapter 4 clarifies why the two proposed models – PPP Cornerstone and PPP Two Public Tender – are the most optimal. However, three very different variants are introduced regarding implementing and managing the financial mechanisms. Each variant offers a slightly modified scope of the introduced process and stakeholders' skills by considering characteristic fluxes. Neither socio-economic entities nor construction companies are optimally qualified for managing recoveries. Instead, financial entities, public authorities or property managers (as front officers of the global Cornerstone model) should be responsible for this task.

Monetary and financial fluxes for the PPP cornerstone model

As explained previously, the Cornerstone acts as the general manager that is able to manage the different required tasks, including the financial management *(Scheme 15)*.

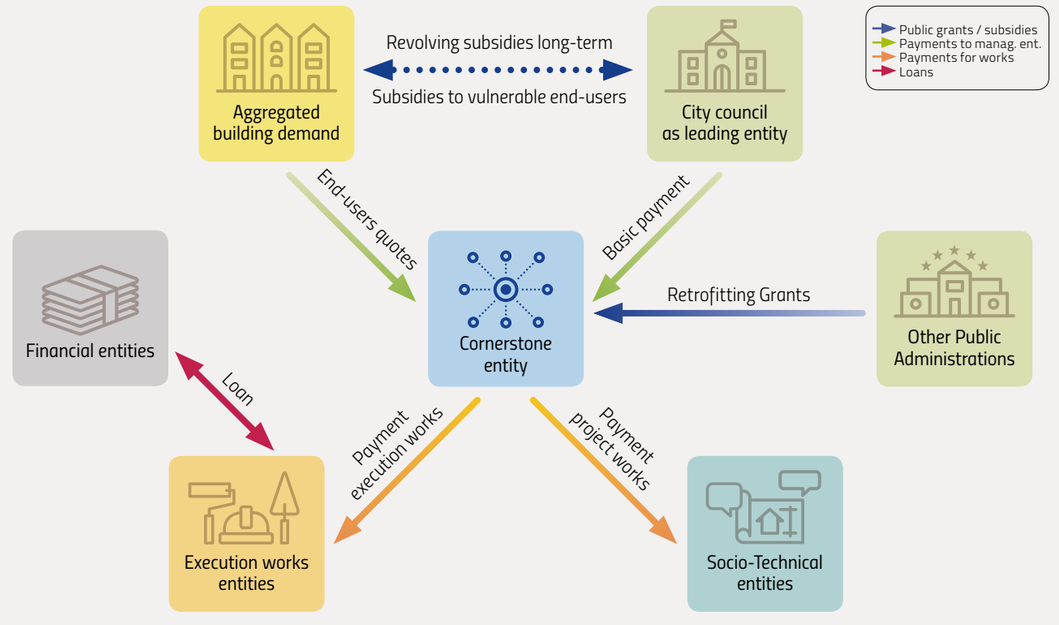
The main monetary and financial fluxes of this scheme are:

The required subsidies (as depicted in lilac in Scheme 15) are defined in detail during the preliminary stages, including the leading and demand aggregation phases. The city council would directly manage these subsidies, including taking responsibility for their administrative definition and managing the revolving fund (when applicable).

The Cornerstone entity will manage the public grants (as depicted in blue in Scheme 15) on an individual-scale or building-scale. As they are nominal based, the Cornerstone is responsible for requesting grants on behalf of the end-users and integrating them into the end-user payment structure.

The initial public tender award and end-user payments define the Cornerstone income (as depicted in green in Scheme 15). The first payment is considered a basic payment, and is enough to cover

Scheme 15. Monetary and Financial Fluxes for the ***Cornerstone PPP Model.***



fixed costs in order to reduce Cornerstone risks and encourage the Cornerstone to participate in the process. The city council will completely subsidize the award budget (without expected returns).

The Cornerstone's main expenses (as depicted in red in Scheme 15) are payments to third parties (or subcontracted entities) regarding project planning and construction work implementation.

These two tasks (project definition and construction works) could be subcontracted in one or two steps through private tenders thus ensuring high quality at a cost-effective price under ideal financial conditions. As such, the payment structure to the subcontracted entities would differ; however, in each case the construction works company would introduce the financial mechanism that allows for a payment period that aligns with end-user payment requirements (5-8 years). Subcontracted construction works companies would be able to support this scheme by itself or through an external loan sponsored by a financial body.

This model's main characteristics are:

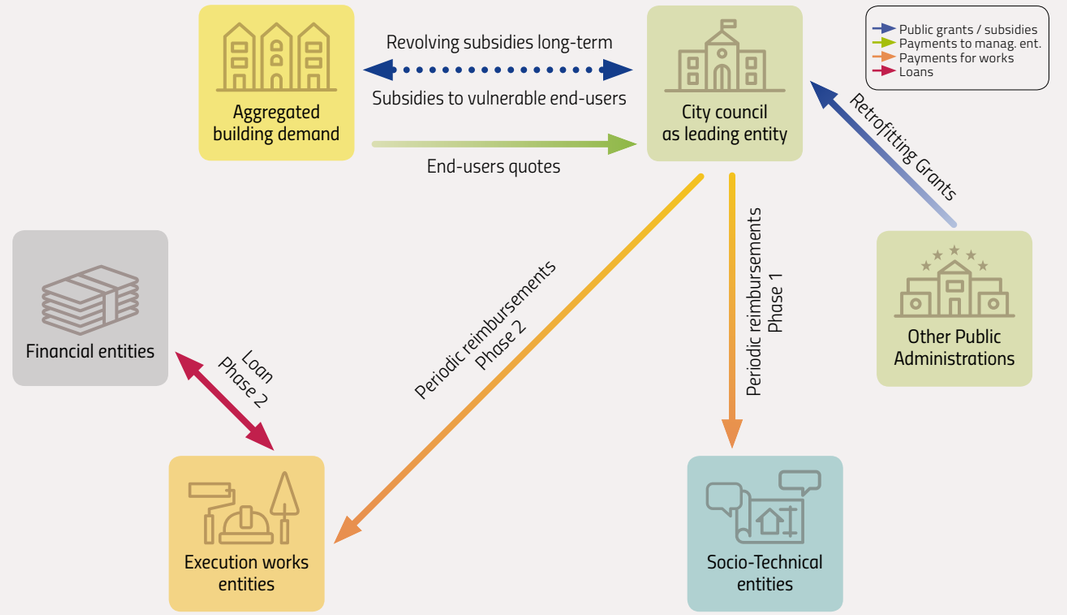
1. The Cornerstone assumes responsibilities for risk assessment and management as they independently define end-user distribution definitions and negotiate agreements with end-users. As such, as soon as subcontracted private entities (socio-technical and construction work companies) are engaged in the process, Type 4 end-users (inscription mode) have already been detected and the subsidy channels have already been introduced and approved.
2. The construction companies assume the remainder of the risk, either directly to themselves or through an external loan sponsored by a financial entity (the risk being the possibility that user types become Type 6 throughout the course of the project). To mitigate this risk, they will integrate it into the construction works budget that is offered to the Cornerstone. As such, all end-users will cover this risk through an increase on monthly payments. However, because of a user type are defined at the beginning of the projects – and subsidies and public funds also represent a large portion of the budget – the increase in monthly payments assumed by end-users is likely to be minimal.
3. Although Cornerstone entities must independently implement the overall process, the fact that the city council defines and manages initial planning and that the public tender would be awarded with estimated fixed costs makes for an attractive business model. Even entities that currently exist would be required to adapt their daily tasks to fit with those expected under this model.
4. Although the city council would be responsible for leading the initial phases, the overall process requires less resources than the current process. This is for three main reasons. First, the city would not be responsible for the project or construction works, thus saving labour resources. Second, the city council would not assume the overall risks; rather, the risks would be distributed through end-users. Finally, the city council would not be responsible for fee recovery, thus saving financial and labour resources. In addition, the city council would have the capacity to monitor the entire process. It should be mentioned that this model also requires the city council to establish a fluid communication and administrative mechanism between the other stakeholders, implementing a "one-stop shop" throughout the course of the process.
5. The end-users are expected to gain confidence both through the first phase of public implementation and engagement and when the public tender procedure is implemented. The final payments would be adjusted according to each case. Even though the end-users would indirectly assume part of the economic risk, the project would still result in attractive payments, due to subsidy and fund implementation, basic costs assumed by the city council, and the tender requirements established and monitored by local public actors

Monetary and financial fluxes for the two public tender PPP model (Variations 1 and 2)

Scheme 16 introduces a monetary and financial flux scheme for the Two Public Tender PPP Model. The main monetary and financial fluxes of this scheme variant are:

From the preliminary stages (leading planning and demand aggregation phases), therequired subsidies (depicted in lilac in Scheme 16) will be defined in detail, as is also true under the PPP

Scheme 16. Monetary and Financial Fluxes for the ***PPP Two Públic Tender Model*** (Variation 1).



Cornerstone Model. The city council will directly manage these subsidies, taking responsibility for its administrative definition and managing the revolving fund (when applicable).

This model differs from the PPP Cornerstone Model in that the city council manages payments, including grant managements and payments, end-user payments, and periodic reimbursements to the socio-technical entities that won first tender and the construction company that won the second tender. However, the city council does not assume all the risk, which will be distributed between end-users through the payments defined by the second tender winner. These payments take into account the risk of users defaulting on payments.

As is true under the current model, the city council directly manages grants (as depicted in blue in Scheme 16), which will be integrated into end-users' payments.

The city council will be responsible for collecting end-user payments and will periodically manage payments to each of the two winning tenders.

The first tender would manage daily operations, including typical payments for such tenders.

The second tender would support specific financial conditions, such as the 5- to 8-year reimbursement period. They will personally assume financial risk or will take out a loan from an external financial entity.

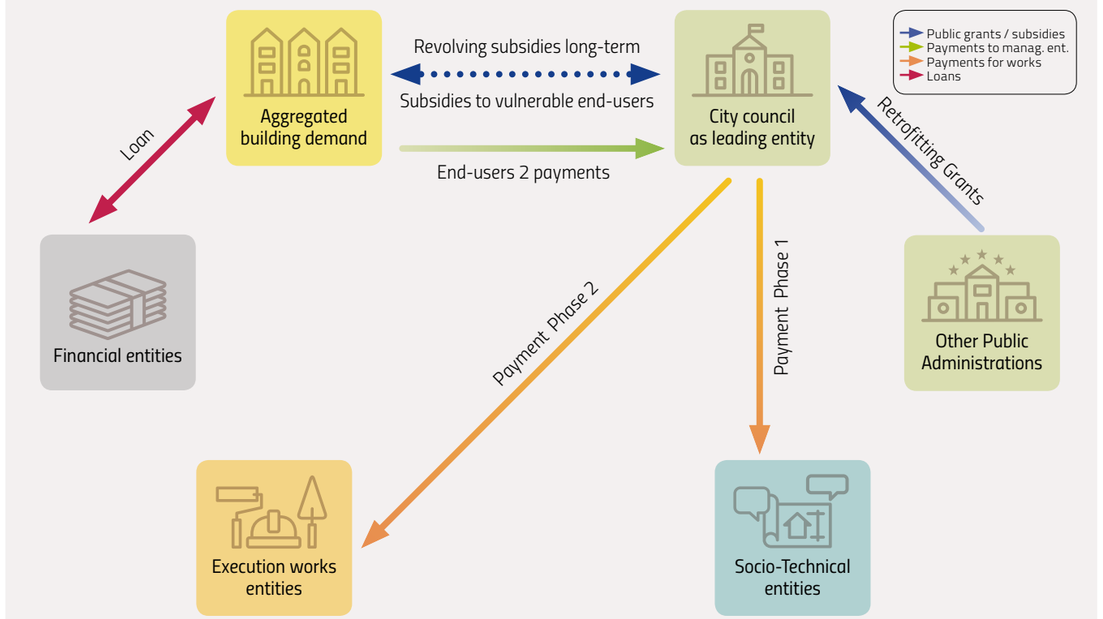
The main characteristics of this model are:

1. The city council assumes a large portion of responsibility for assessing and managing risk as they independently conduct an end-user distribution analysis and create the initial agreement with end-users. After the private entities (Cornerstone and Subcontracting entities) are engaged in the process, the initially defined Type 4 End-users (inscription mode) have already been detected and subsidy channels to them have already been introduced and approved. The city council would manage the risk, but would spread the risk to end-users by increasing final payments. To do this

it would be necessary to establish a mechanism that temporarily adjusts the final payments in real-time according to the number of defaulters, considering public entities receive no benefit as a result of this process.

2. The process whereby the first tender develops and establishes payments for social-technical entities would be similar to existing processes, which work under a competitive environment.
3. Although construction companies would also be responsible for supporting the operation financial, the required tasks would be very similar to their current daily tasks. This would benefit competitive conditions.
4. While the city council would be required to commit more resources than under the previous model, a portion of risk management and financial requirements would be spread to third parties (end-users and construction companies, respectively). As is also true of the previous model, the city council must establish a fluid communication and administrative mechanism between the other stakeholders, implementing a "one-stop shop" throughout the course of the process.
5. The end-users are expected to gain confidence as the process will be implemented by public entities, including payment management. As far as finances are concerned, the final payments would be adjusted on a case-by-case basis. Although end-users would indirectly assume part of the economic risks, the subsidy and fund implementation and tender requirements established and monitored by local public actors (because of the two step tender) would result in attractive payments.

Scheme 17. Monetary and financial fluxes for the ***PPP Two públic tenders Model*** (Variation 2).



A second monetary and financial fluxes scheme is introduced for the Two Public Tender PPP Model, as depicted in Scheme 17.

The main difference between the two variations, is that under Variation 2 end-users are responsible for financing the construction works through a direct loan via an external financial entity. As seen in Chapter 3, this procedure is commonly implemented for large-scale retrofitting actions. After the city council finishes the initial stages (leading and demand aggregation phases), this procedure would

require an agreement between the financial entity, the city council and the end-users, adjusting conditions on a case-by-case basis. This would mean:

The city council would still be responsible for overall payments, not as quotes but as timely payments (following usual payments methods for public works), considering that the end-users would have the required budget at once and, by that, would face the reimbursements as timely payments instead of quotes.

The financial entity assumes some of the risk (as they currently do), but to a limited degree as the city council manages the risk assessment and is responsible for facilitating access to subsidies and grants.

The construction company that is awarded the second tender would act as they currently do, without any special financial conditions.

In order to ensure building owners are able to obtain the most optimal financial conditions, the agreement between the financial entity and end-user should be implemented through a special tender.

The main characteristics to be underlined are:

1. Even though the city council manages the initial risk assessment, risk management is shared with financial entities. Although the scheme depicts a model whereby first tender costs are covered by the city council, it is possible the public stakeholder could assume this cost, both reducing final cost assumed by end-users and reducing city council labour hours, as they are not required to manage so many payments. Compared to Variation 1, Variation 2 does not require a non-public benefit mechanisms (although this results into a slightly higher cost to be assumed by end-users).
2. For socio-technical entities, the necessary developments and payments would be quite similar to existing processes, strengthening the competitive market environment.
3. Regarding the city council, they required resources would be quite similar to those currently used. However, a portion of risk management and financial requirements would be transferred to third parties (to financial entities and to end-users through contracted loan payments). Again, the city council must establish a fluid communication and administrative management process between stakeholders by implementing a "one-stop shop" throughout the course of the process.
4. End-users are expected to gain confidence because a public procedure oversees the entire process and the engagement terms of financial entities are defined under a public-private agreement. From a monetary point of view, final cost estimates are to be adjusted according to the case. Although end-users indirectly assume part of the economic risk, local public actors facilitate access to subsidies and funds and monitor tender requirements (because of the two-step tender process), resulting in attractive payments for the end-users.

Quantitative evaluation and sensitivity analysis

An economic model was created to perform a quantitative evaluation and analyse critical elements of this type of operation for the different stakeholder types. A sensitivity analysis is used to analyse the most critical parameters around a defined case base. This section presents the resulting main indicators based on the model, the reference case description, and sensitivity analysis results.

This economic model was built assuming that the "Cornerstone" entity manages the entire process from the initial phase until the end of the supporting financial phase. In order to stress the economic and financial conditions, the analysis was made assuming the worst socio-economic conditions. For this reason, economic benefits are eliminated as a factor in potential energy savings or property revaluation.

The end-user pays the Cornerstone to cover costs associated with construction works and technical projects, operational costs (including the company profits), and the financial costs, with three exceptions:

- The city council assumes a portion of operational works.
- The city council uses subsidies to compensate user Type 4 with an equivalent payment (mode inscription).
- A certain percentage of default payments are accounted for in the model. In consequence, the remaining users will pay an incrementally higher amount in order to cover the cost of default payments. In any case, the defaulter will be urged to pay their debt.

Business Model KPIs

The model calculates several KPIs[9] for different stakeholders in addition to intermediate results. The main indicators are:

For the end-user, the two main KPIs are:
Monthly payments: The total value of monthly payments that user type 2 should pay over 5 years. The amount should stay within the user's ability to pay. According to this study, €105 is the upper limit, or a maximum amount of €6300 per dwelling[10].
End-user Savings: The percentage of investment an end-user can save if they adhere to large-scale intervention, compared to the same type of retrofitting works[11] if done on single building-scale.

For the city council, two main KPIs are proposed:
City operational costs: The operational cost assumed by the city, typically associated with tasks related to the project that the city council must perform.
Revolving funds: The investment amount granted to Type 4 Users (mode inscription) that will be recovered when the property is transferred to a new user

For the Cornerstone, the indicators are:
Cornerstone operational costs: The operational cost assumed by the Cornerstone, considering both direct and indirect costs assuming a flat overhead of 40%[12].
Cornerstone benefits: EBT (Earnings Before Taxes), expressed as a % of operational costs.
Financial costs: Estimated financial costs.
Financial needs: The loan capital necessary to cover operation costs. Based on the economic model's calculation of the operation-related cash flow.

9 KPI: Key Performance Indicator.

10 Based on an analysis of incomes and expenditures of average households in Catalonia, an average household can save 4% of their income every year (around €1,000/yr). If expenditures are analysed in further detail, an average household spends around €1,000/year on furniture and maintenance. As such, a €1,260/year investment seems reasonable for the average household in Catalonia. (More details can be found in: *Optimization of energy renovation of residential sector in catalonia based on comfort, energy and costs*; Joana Ortiz, Antoni Fonseca, Jaume Salom, Verdiana Russo, Nuria Garrido, Pau Fonseca, *Building Simulation 2015 Conference*).

11 For individual buildings, it is assumed that the covered costs are only the base costs associated with construction works and technical projects, without any reductions due to operating on a large scale. In a conservative estimate, no operational or financial costs are assumed.

12 Remember that the business model considers that the costs of the cornerstone (and the additional benefits) are covered by the end-users.

Description of the base case

A reference case has been created that fixes certain variables in the economic model. Using the Santa Coloma Gramenent project, among others, as a reference case, the base case aims to represent a conservative scenario to analyse the feasibility of the business model. The following table represent the fixed variables in the base case.

Table 4. Main Parameters and Variables considered in the Analysis.

Parameter / Variable	Value	Comments
Number of entities / dwellings	350	
Contract budget / entity	€5,800 /dw	The contract budget (PEC) is the average reference value (discluding VAT). The value remains within in the range of cost-optimal solutions for the analysed building typology.
% of premises	10%	It is assumed that are double size that the average dwelling but pay in 10 years instead of 5.
Scale reduction contract	15%	Estimated reduction of the contract with reference to PEC and considering scale factors and external competition. Also applied to technical project fees.
Scale reduction of PEC	20%	Estimated reduction of the PEC with reference to market price.
Technical project fees	13%	Percentage of the PEC.
% Public grant	35%	Percentage of retrofitting cost covered by public grants. The percentage is applied to the base that includes the construction costs, technical project works and cornerstone operational works. No VAT.
Operational costs - Fixed term	€75,000	The total amount of direct operational costs is the sum of the fix term and the variable term multiplied by the number of entities. For example, for the base case of 350 entities, the direct costs will be €209,750.
Operational costs - Variable term	€385/dw	
User type 1 - 50/50	10%	A higher percentage indicates less financial need.
User type 2 - 60 Payments	70%	
User type 3 - 120 Payments	10%	
User type 4 - Inscription	10%	A higher % will increment the amount of revolving funds for the city and reduce the risk to the cornerstone.
User type 5 - Not available	0%	
User type 6 - Defaulter	5%	The percentage of User Types 2 and 3 that will default.
Cornerstone overhead	40%	Total proportion of indirect costs based on an estimation of direct costs.
Loan - Interest rate	5%	Yearly interest rate for the long term loan.
Loan years	5 years	
VAT Construction works	10%	
VAT Technical projects	21%	
VAT Cornerstone works	21%	

Table 5. Operational cost breakdown (%).

Project phase	City	Cornerstone
Pre-initial phase	10	0
Initial phase	9	1
Project phase	6	14
Execution phase	3	12
Financial support phase	5	20
TOTAL	33	67

The total cost under the base case scenario equals €2,761 k, which is broken down in Table 6 (including public sector involvement and without including grants). Total operational costs represent slightly more than technical project works. The financial costs represent 8% of total costs (€216 k).

After including access to grants, the following table (Table 7) presents the total amount that end-users must cover, including private contribution to the Cornerstone via payments.

Table 6. Breakdown of the total project costs (VAT included) without grants.

Concept	Distribution (%)	Unitary cost (€/entity)	Total budget (€)
Execution works (VAT included)	69	4,930	1,898,050
Project works (VAT included)	10	705	271,421
Operational works cornerstone (VAT included)	11	795	306,080
Operational works public sector	3	180	69,218
Financial costs	8	563	216,824
TOTAL COSTS (VAT included)	**100**	**7,173**	**2,761,592**

Figure 1. Distribution of the Total Project Costs

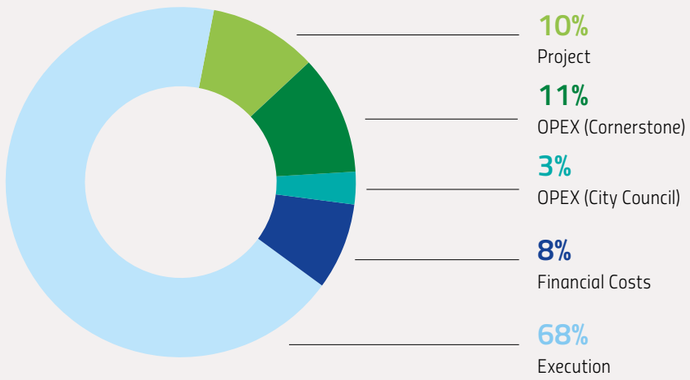


Table 7. Breakdown of expected costs to be covered by end-user private contribution (VAT included).

Concept	Distribution (%)	Unitary cost (€/entity)	Total budget (€)
Execution works (VAT included)	67	3,361	1,294,125
Project works (VAT included)	10	501	192,911
Operational works cornerstone	11	565	217,544
Financial costs	11	563	216,824
TOTAL COSTS (VAT included)	**100**	**4,991**	**1,921,404**

The final contribution by user type is shown in Table 8. Note that the final amount is slightly higher than the expected private contribution due to the assumption that defaulters will not have access to the grant. The city council will support Type 4 User contribution via a revolving fund created for vulnerable users. Table 9 presents operational costs both for the city and the Cornerstone, divided into different process phases.

Table 8. Breakdown of private contribution by end-users type.

End-users / Private Contribution	Users (%)	Contribution (€)
Users Type 1 Mode 50/50	10.0	185,113
Users Type 2 Mode 60 Payments	66.5	1,231,002
Users Type 3 Mode 120 Payments	9.5	351,715
Users Type 4 Inscription	10.0	185,113
Users Type 5 Not available	0.0	0
Users Type 6 Defaulter	4.0	0
TOTAL	**100.0**	**1,952,944**

Table 9. Breakdown of operational costs for the city and the cornerstone. Costs for the city are direct costs. Cots for the cornerstone are total costs, including benefit and VAT.

Phases of the process (€)	City	Cornerstone
	OPEX	**OPEX**
Leading phase	20,975	0
Demand aggregation phase	18,878	95,935
Project phase	12,585	63,957
Execution phase	6,293	54,820
Financial support phase	10,488	91,367
TOTAL	**69,218**	**306,080**

The following tables summarize the main KPIs for the reference case.

Table 10. End-users KPI for the base ase.

KPIs End-user	Value	Comment
Monthly payment	€88	
Total investment	€5,289	For the average household. Investment for premises are double.
End-user savings	12.3%	

Table 11. City council KPIs under the base case.

KPIs City council	Value (€)	Comment
City operational costs	69,218	Direct costs
Revolving funds size	185,113	

Table 12. Cornerstone KPIs under the base case.

KPIs Cornerstone	Value	Comment
Cornerstone operational costs	€196,746	Total costs, including overhead, but not benefit (VAT not included) (Direct costs = €140,553).
Cornerstone benefits	29%	EBT = €56,213
Financial cost	€216,824	
Financial need	€1,400,000	

Quantitative evaluation for different stakeholders

A sensitivity analysis to evaluate the effect of some key parameters in the model was performed. This chapter presents a summary regarding KPIs for each of the different stakeholders, analysing the following elements:

Breakdown of different user types

- User Type 2 vary from 60% (meaning 20% of users of type 4) to 80% (0% of users type 4)
- Number of defaulters between 0 and 10%.
- The proportion of User Type 3 (60 payments) and User Type 3 varies from 5% to 20% of total User Type 3 population.
- Effect of number of entities (50 to 500)
- Effect of cost reduction due to the scale factor (25% to 45%)
- Effect of level of investment (4500 €/dw to 12 000 €/dw)
- Effect of varying the fixed term (€60 k to €120 k) and variable term (€285/ent to €500/ent) of the direct operational costs
- Effect of construction works VAT (10% to 21%)
- Effect of loan interest rate (3% to 7%).

Figure 2. End-users quotes vs. Expected savings (per entity) compared to an individual retrofit action.

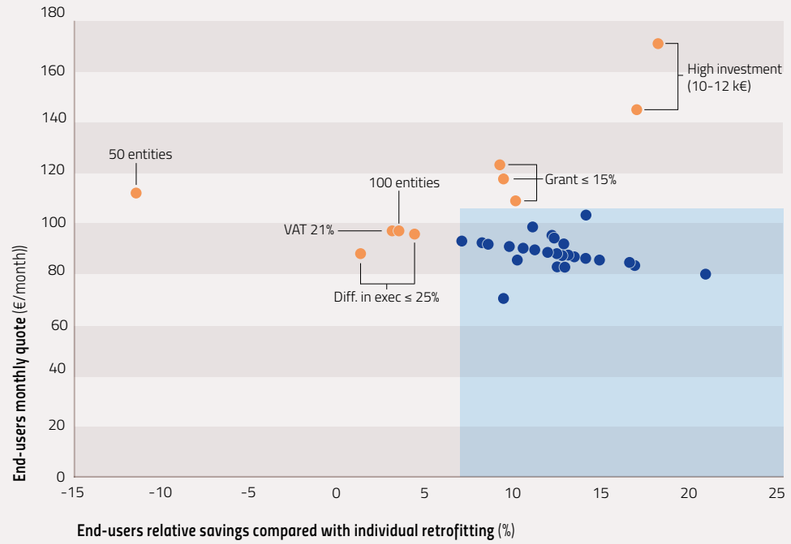


Figure 2 presents a case analysis that considers two KPIs from the perspective of end-users. For end-users to comply with a large-scale retrofitting project, the payments will need to be within their economic means (the upper limit is placed at €105/month) and the savings will need to be comparable with individual retrofitting actions. For the latter, it is expected that 7% savings is sufficient for end-users to comply with large-scale retrofitting actions. Figure 2 highlights the cases that meet the defined "acceptable KPIs" for the end-user.

Expected savings are low or even negative if:

- The number of entities is below 150
- The cost reduction for a large-scale project compared to an individual action is under 25%
- VAT applied to construction works is 21%. (For single-building retrofitting, the reference VAT applied to construction works is 10%)

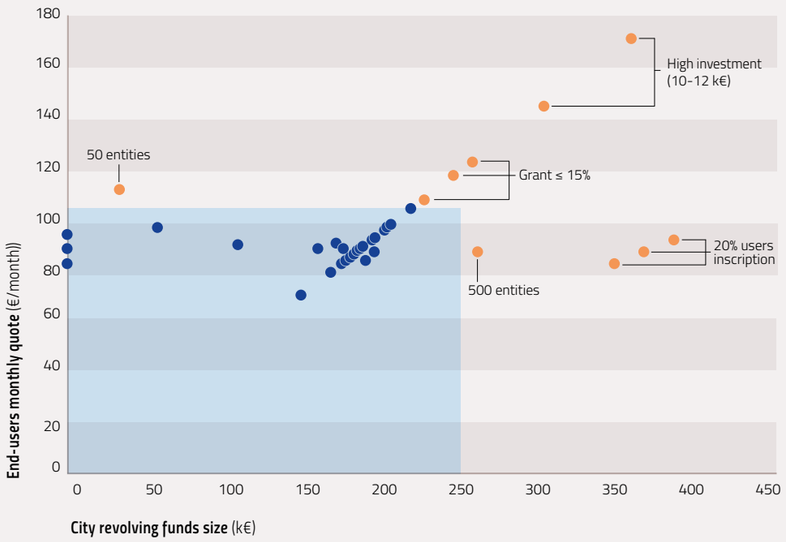
Payments are over the upper limit if:

- Retrofitting project grants are below 15%
- Investment level is high (€10k to €12k). To maintain a monthly payment below €105, the maximum level of investment per dwelling is €7,000.

For the case of high investment rates, one can allow to increase the number of years meaning that the resulting quotes will go below the limit of €105. In this case, one must consider the associated increment of financial costs due to the increase of years for the loan.

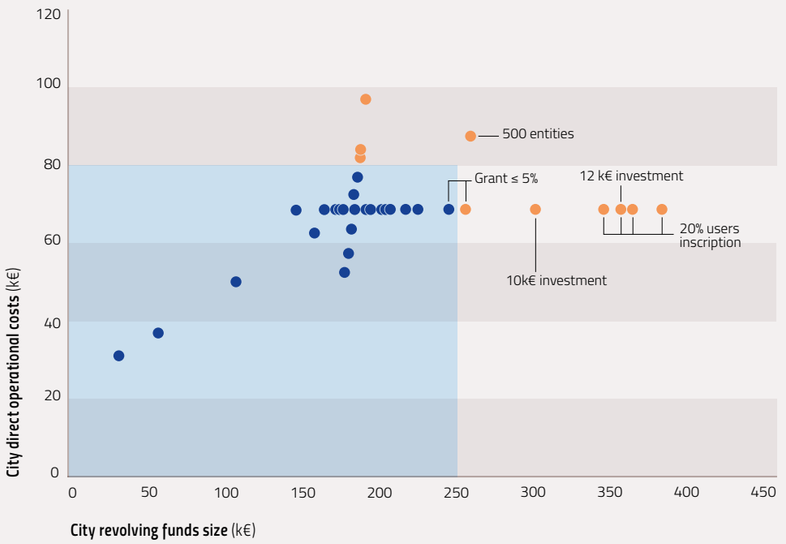
Figure 3 presents the case analysis considering two KPIs: one from the perspective of the end-users (monthly payments) and the other from the perspective of the city council (revolving fund size). The revolving fund size indicates the funds the city council expects to grant to vulnerable users. The owner will pay this amount to the Cornerstone, thereby minimizing risk of default. The city council will recover the funds after the owner transfers the dwelling to a third person. The financial capacity of the city council determines the acceptable limit of the revolving fund. The revolving fund will surpass €250k when investment is high, public grants equal less than 15% of total cost, or a significant number of entities (e.g. 500 dwellings) are involved in the operation. Another factor that could cause the revolving fund to increase (while maintaining end-user monthly payments within the acceptable

Figure 3. End-user payments vs. Overall revolving fund size.



range) would be if the proportion of Type 4 Users increases from 10% to 20%. If the number of grant-receiving vulnerable users increases, the city council is also limited in the number of parallel operations they are able to activate. The city council can adjust the €250k limit to a suitable amount.

Figure 4. Public (municipal) operational cost vs. Total revolving fund amount.



The proposed models also aim to alleviate public expenses, defined as reducing city council staff labour hours. Under the base case, direct costs to the city are estimated at around €69k. This number only changes when a high number of entities are involved in the operation; however, other variations in operational costs (up to €100k) don't significantly impact users' monthly payments. Figure 4 graphs the city operational costs versus revolving fund size.

Figure 5 presents a case analysis that considers two KPIs from the Cornerstone's perspective. For the Cornerstone, the first key element of a successful business model depends on whether the operational costs and earnings are sufficient to manage the operation. The second element is the level of financial need (and associated costs): the higher the financial need, the higher the risk (given no change in operational cost). Under the business model, interest rates and loan period remain the same (5% and 5 years, respectively). The following figure depicts an acceptable range of conditions for these KPIs, highlighting certain cases.

- Financial need is high if investment per dwelling is also high (€10 – 12 k). This might be acceptable if associated operational costs also increase. However, an increase in operational costs will also impact the end-users' final estimated payment, which is already high in this case. In contrast, a case with 500 entities creates conditions that are acceptable for the actors involved as associated costs and financial needs increase simultaneously.
- For large-scale operations with a small number of dwellings (50-100), operational costs are also low. As such, the project is less attractive to potential stakeholders and makes the model more risky.
- Cases with a high variable OPEX (€500/ent) are the most attractive for the Cornerstone, as they result in increased earnings. As seen in the previous analysis, incremental increasing in operating costs don't significantly impact KPIs for other stakeholders.

Figure 5. Cornerstone OPEX vs. Financial need.

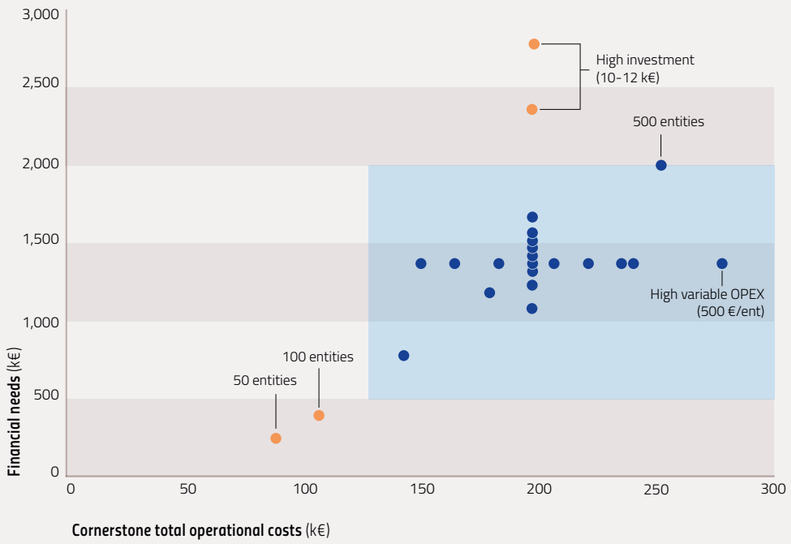


Figure 6. Cornerstone: Financial cost vs. Financial need.

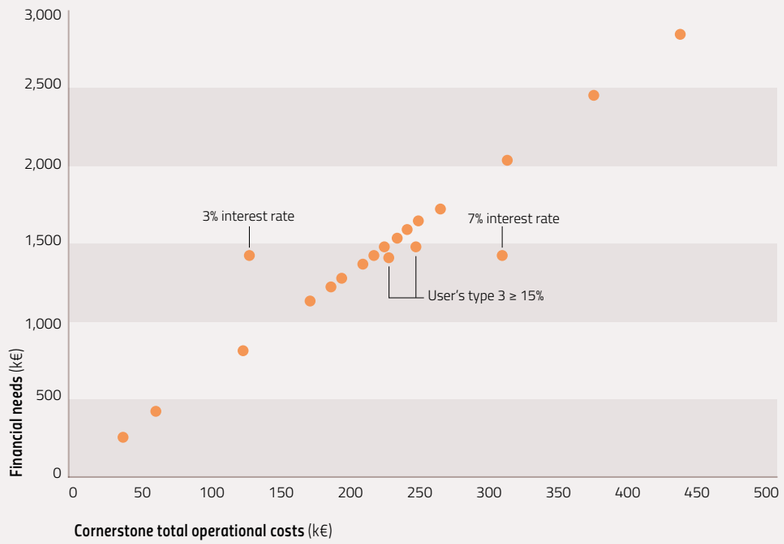


Figure 6 shows the relation between financial cost and financial need. The conditions are the same for the majority of the cases (5% interest rate and 5-year period). In cases with a higher than average proportion of Type 3 Users (15% and 20%, compared to 10% in the base case), financial costs are expected to increase slightly due to a longer loan period. However, it is worth nothing if the interest increases to 7% the financial costs and end-user payments will naturally increase, but only by a total of €4 (from €88 to €92).

The conclusions of the sensitivity analysis for the economic model demonstrate the model is robust enough to allow for different breakdowns between user types, variations in operational costs, variations in financial costs (i.e. interest rates), investment per dwelling (€7,000/dwelling) and number of entities (above 150). In those cases, robustness refers to whether final monthly end-user payments remain below €105 and savings offer incentive to undergo a large-scale retrofitting operation. The key factors are:

- Minimum number of entities per operation: 150
- Maximum amount of reference investment per dwelling: €7,000
- Minimum proportion of public grants 15%
- Minimum savings due to scale factor of 25%

However, large operations with a high number of entities (i.e. 500) or more vulnerable users that may require access to municipality grants increase both financial need and municipal resources in terms of operational cost and size of revolving fund. In such cases, the size of the operation can be a limiting factor.

07 Replicability and market analysis

After establishing the structure and conditions surrounding the operational and economic viability for the PPP model in the previous chapters, this chapter explores the feasibility of extrapolating the model to other geographic latitudes and labour and financial markets.

Considerations for the geographical replicability

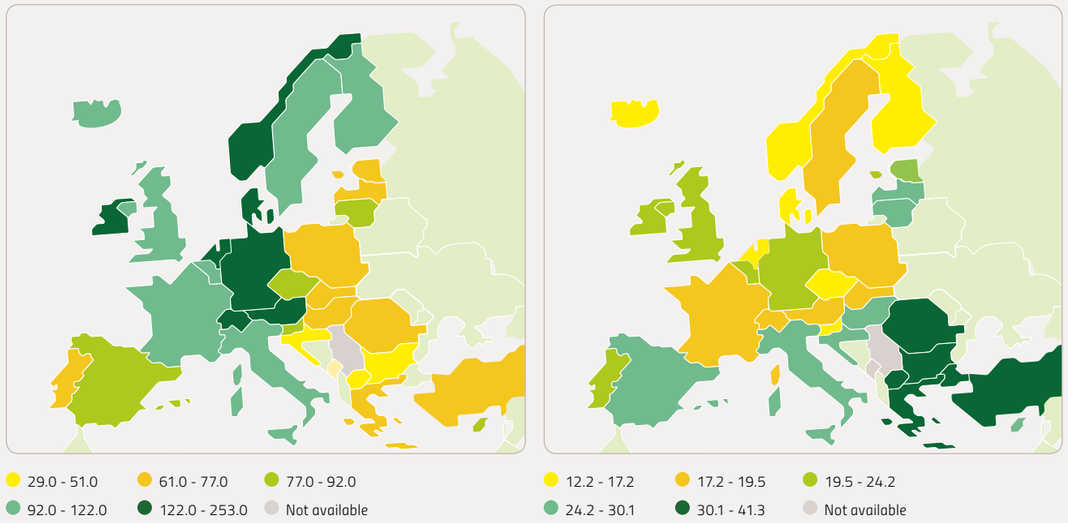
Considering the scope of the present analysis, the idea of this chapter is to point the main key factors of the model that could change from the analysed latitude to other European one's and, thus jeopardize its operational and/or financial viability.

In order to introduce these considerations, it is relevant to define the main frameworks for this latitude analysis and compare it to other countries from the European countries. These considerations transcend the fact that all the European countries requires a deep modernization of the building stock and, because of that, the Energy Efficiency Directive (EED[13]), in the Article 4, requires Member States *"to establish a long-term strategy beyond 2020 for mobilising investment in the renovation of residential and commercial buildings with a view to improving the energy performance of the building stock".*

13 https://ec.europa.eu/energy/en/topics/energy-efficiency/energy-efficiency-directive

Figure 7. GPD per capita in PPS 2017 (EU28 = 100) (left) and Percentage of people at risk of poverty or social exclusion (right).

Source: ©EuroGeographics



Minimum value: 29.0 Maximum value: 253.0

Exeptions: CY, LU, SE, LT, HR, SK, IS, UK, IT, RS, FR, CH, MK, DE, IE (2016) TR (2015)

Minimum value: 12.2 Maximum value: 41.3

At one hand, the global socio-economic conditions for Spain could be roughly represented by the GPD per capita and the risk of poverty or social exclusion. By evaluating these indicators, it could be said that Spain is emplaced in the middle-lower part of the table of the European Union countries.

However, the financial instruments available for the Spanish market in the building refurbishment sector are mainly based on subsidies, most of which originate from the European Union[14]. Hence, more advanced measurement mechanisms are still non-existent for this market.

Accordingly, the Spanish market represents, at the very lest, an average building stock modernization scenario for the EU condition. That is, conditions are neither the most nor the least optimal. The most important factors that may affect model replicability is national legislation concerning the building and financial sectors[15].

We can point to the challenges and constraints defined in Chapter 4 as the main factors to be considered when determining model replicability. Specifically;

Social considerations

- End-users' legal status may differ starkly across countries depending on many different factors, including land legacy. Generally, for countries that facilitate end-user partnerships, this model would be more easily implemented.
- Tax declaration for received subsidies. The Spanish market could be considered a sub-optimal situation, as subsidies must be declared as income, thereby reducing the benefit for the end-user. Countries with better financial regulations will be able to implement the model more easily

Financial and economic considerations

- VAT value depends on the actor requesting the grant. The Spanish legislation complicates the mechanisms for including third parties in the process (i.e. ESCO companies). While other European countries don't offer reduced VAT values for retrofitting actions, this is a limiting factor for building refurbishment in general, not to the proposed PPP model specifically.
- For the reference market, the grants direct assignment, (nominal definition), are, again, the worst scenario to be found. More open legacies allowing for communal grants, would ease the proposed model implementation.
- Other financial and economic challenges (e.g. financial timelines, expected benefits and minimum operations scale) are comparable between European countries, and are unlikely to impede model replicability.

14 *Diagnóstico de la rehabilitación en las comunidades autónomas*. Green Building Council spain (GBCe) 2016

15 See *Entranze* Project. http://www.entranze.eu/pub/pub-policies

Business model considerations for replicability:

From the business mentioned one's, it is considered that the risk assessment and management is the main consideration for the replicability of the model. Nevertheless, and from this point of view, it is not considered, that the Spanish market significantly differs from other European countries markets'.

Other considerations

Two other factors could be relevant in determining model replicability, not as limiting factors, but as facilitating factors:

- Extreme climate conditions may result in higher energy savings as a result of building retrofitting, creating more favourable financial situations or encouraging ESCO companies to be more involved.
- Specific financial mechanisms that do not exist in Spanish markets (e.g. dedicated credit lines, subordinated loans, covered bonds, leasing models, etc.[16])could ease model implementation in other regions.

Brief market analysis at regional, national and european level

Approximately 35% of buildings in the EU are over 50 years old.[17]: The majority of existing structures were constructed without prioritizing sustainability. Retrofitting these buildings could be unfeasible for users trying to control costs and maximize profitability. It is estimated that over the last 5 years, Housing Europe members have refurbished over 1.8 million dwellings, investing approximately 33 billion Euros[18].

Recent economic studies indicate that the EU energy renovation sector was worth approximately €109 billion in 2015, employing 882,900 people[19]. Renovation represents 57% of the total construction segment, and households account for 65% of the total renovation market.[20] Annual investment in energy renovation will need to increase from €12 billion in 2014 (~€30 per capita) to €60 billion (~€150 per capita) in order to achieve the EU objective of 20% energy efficiency improvement by 2020[21]. Considering the average age of buildings in the EU (35% of buildings are over 50 years old [22-23]) and the slow construction rate for new buildings, the renovation potential of buildings in the EU is enormous. According to one estimate that surveyed 210 million buildings across the EU, more than 110 million buildings could be in need of renovation[24]. Some studies have estimated that by deeply renovating existing buildings and constructing new buildings that are nearly zero energy, energy used for heating can be reduced by 80% by 2050[25]. Deep renovation of 3% of the building stock (25 million m^2) could generate approximately 100 TWh of energy savings per year by 2020.

16 Energy Efficiency Fionancial Institutions Group. Energy Efficiency – the first fuel for the EU Economy. European Union, 2015. See http://www.eefig.com/index.php/the-eefig-report. The report is also available in French, German, Italian, Polish and Spanish, see https://ec.europa.eu/energy/en/news/new-report-boosting-finance-energy-efficiency-investments-buildings-industry-and-smes.

17 https://ec.europa.eu/energy/en/topics/energy-efficiency/buildings

18 http://www.housingeurope.eu/file/468/download

19 The weighting coefficients used are 15% to assess the energy efficiency component of the renovation market is and 8.1 jobs per million invested, based on the US study by ACEEE, 2008. The size of the US energy efficiency market: generating a more complete picture.

20 Saheb, Y., 2016. Energy Transition of the EU Building Stock. Unleashing the 4th Industrial Revolution in Europe.

21 CA EPBD, 2016. Implementing the Energy Performance of Buildings Directive (EPBD).

22 http://cordis.europa.eu/result/rcn/186598_en.html.

23 https://ec.europa.eu/energy/en/topics/energy-efficiency/buildings.

24 Directorate General for Internal Policies Policy Department A: Economic and Scientific Policy Boosting Building Renovation: What potential and value for Europe?, http://www.europarl.europa.eu/RegData/etudes/STUD/2016/587326/IPOL_STU%282016%29587326_EN.pdf

25 Ecofys, 2015. The role of energy efficient buildings in the EUs future power system.

If around 20% of the building stock were deeply renovated by 2030, it would save 750 TWh/y. The size of the EU building renovation market may increase by half of today's levels if a 40% energy savings target were adopted for 2030. Meeting this target would require renovation rates to increase to almost 3% (from 1%). Consequently, the 2030 renovation market would be worth about €122 billion, creating nearly 988,200 additional jobs in the sector. This impressive growth is set to occur in spite of obstacles due to rising energy prices. While electricity prices have not risen quite as dramatically as gas, many European countries face the daunting task of fulfilling commitments to shut down all nuclear power generation facilities by 2022. At the same time, coal-consuming and carbon dioxide-emitting power stations are reaching the end of their lives, and an increasing threat of power outages looms ahead. This reality, combined with increasingly aggressive environmental targets at national and EU level, means that Europe continues to invest in energy efficiency, even though it has been on the brink of recession for nearly five years. Increasing demand for building services and improved comfort levels, combined with a growing population that spends more time indoors, assures energy demand will continue to exhibit an upward trend. For this reason, efficiency efficiency in buildings today is a prime objective for energy policy at regional, national and international levels.[26]

In Spain, there are nearly 25 million dwellings responsible for 17% of final energy consumption and 25% of CO2 emissions. While building stock was built relatively recently, 53% of housing was built before the adoption of the first energy efficiency normative.

According to the National Statistics Institute (INE)[27], almost one third (~30%) of existing buildings are 50 or more years old (i.e. were built before 1961). Of the remaining buildings, only 15% have been built in the last decade, and 55% were between 10 and 50 years ago.

However, due to the decline in new housing construction, it is expected that by 2050 buildings built between 2015 and 2050 will be only represent 10% of existing housing in Spain[28].

Moreover, the potential for housing refurbishment is not only driven by the aging of buildings, but also, and more importantly, by the lack of energy efficient buildings, even among new buildings. The newest version of the Technical Building Code will be launched in 2018[29] and, although it was updated in 2017, the previous version had last been updated in 2006.[30] As such, many buildings less than 15 years old were not built according with energy efficiency measures. Thus, almost 84% of existent buildings have E, F or G energy ratings, compared to just 4.25% of buildings with A, B or C ratings[31].

According to various authors [32-33], the building refurbishment sector in Spain expects to act on about 10 million buildings by 2050 with more than €260 billion invested, from which €173 billion are expected to be invested in energy retrofitting. On average, more than 150 thousand jobs could be created.

In the context of Catalonia, the renovation of public buildings is experiencing a gradual rise after plummeting from 2007 to 2011 due to the economic crisis in the EU[34]. This increase is expected to

26 Luis Pérez-Lombard , José Ortiz , Christine Pout "A review on buildings energy consumption information" 2007

27 INE (2011). Censo de Población y Viviendas 2011 (in Spanish). Spain: Instituto Nacional de Estadística. Retrieved from

28 ANERR (2015). El Potencial de la Rehabilitación de Edificios y Estado Actual del Sector (in Spanish). Spain: ANERR association. Retrieved from https://www.fenercom.com

29 Escoda, S. (2017). Update of the Technical Building Code CTE 2018 (in Spanish). Spain: Salvador Escoda, S.A. Retrieved from http://www.elblogdelinstalador.com/actualizacion-del-nuevo-codigo-tecnico-de-la-edificacion-cte-2018/

30 Housing Ministry (2006). Royal Decree 314/2006, of March 17, which approves the Technical Building Code (in Spanish). Spain: Boletín Oficial del Estado (BOE). Retrieved from https://www.boe.es/buscar/doc.php?id=BOE-A-2006-5515

31 Diversification and Savings (IDAE), Ministry of Transport and Infrastructure (Mfom) (2015). Estado de la Certificación Energética de los Edificios. Datos CCAA (3° Informe) (in Spanish). Spain: Ministry of Industry, Energy and Tourism. Retrieved from http://www.minetad.gob.es/energia/desarrollo/EficienciaEnergetica/CertificacionEnergetica/Documentos/Documents/Informe-seguimiento-certificacion-energetica-V2.pdf

32 Tirado Herrero., S. López Fernández, J.L., Martín García, P. (2012). >Pobreza energética en España, Potencial de generación de empleo directo de la pobreza derivado de la rehabilitación energética de viviendas. Madrid, Spain: Asociación de Ciencias Ambientales. Retrieved from

33 Cuchí, A., Sweatman, P. (2014). GTR 2014 Report: Strategy for Buildings Renovation. Keys to transform Spain's Buildings Sector. Spain: Green Building Council España (GBCE). Retrieved from http://www.gbce.es/en/pagina/gtr-2014

34 Secretary of Housing and Urban Improvement (2017). Report on the housing sector in Catalonia. Year 2016. Barcelona, Spain: Department of Governance, Public Administrations and Housing; Generalitat de Catalunya. Retrieved from http://habitatge.gencat.cat/web/.content/home/dades/estadistiques/03_Informe_sobre_el_sector_de_l_habitatge_a_Catalunya/informe_sobre_el_sector_de_lhabitatge_a_catalunya/docs/informe_sector_2016.pdf

continue in the years to come. Several introduced studies 3536 claim that between 17 and 18 full-time jobs (per year) can be created for each 2.01 million euros invested, of which almost two thirds would be qualified or highly qualified jobs.

The number of potential activated operations per year has been estimated (see Table 13) based on the total building stock that could be retrofitted and a conservative estimate of number of the annual rate of retrofitting (between 1.5 and 2% of dwellings/year) and market penetration of the proposed business model (10%). This amounts to potential activated operations equalling an annual amount of 1.697 million euros at EU level.

Table 13. Market penetration estaimte of the proposed Business Models. Number of large-scale retrofitting operations activated per year.

	EU	ESP	CAT
Potential Building Stock to Retrofit (dwellings)	110,000,000	10,000,000	1,500,000
Retrofitting Yearly Rate (%)	2.0	1.5	1.5
Retrofitted Dwellings per Year	2,200,000	150,000	22,500
Total Market Rate (%)	10.0	10.0	10.0
Large-Scale Market Penetration (dwellings/year)	220,000	15,000	2,250
# operations / year (average = 350 dwellings)	629	43	6

08 Other indirect factors

This chapter highligts the co-benefits that retrofitting at large scale can bring to end-users and other involved stakeholders, including energy savings, health improvements, economic revitalisation and overall district-level property revaluation.

Building Retrofit Co-Benefits

Municipality —or region— supported retrofitting plans at a district/urban level aim to encourage rehabilitation. Energy savings is a major benefit of highly degraded building stock. Beyond potential energy savings, additional benefits of large-scale retrofitting actions include:

- Upgrading most damaged/old residential buildings in the city
- Supporting the owners in fulfilling maintenance duties
- Improving the living and comfort conditions of households
- Improving the urban landscape of the municipality and citizens' quality of life
- Increasing end-user awareness, encouraging owners to take voluntary low-cost actions that generate additional savings
- Recovering property value
- Improving air quality due to lower energy consumption (assuming energy demand is supplied using fossil fuels)

In this sense, it is necessary to evaluate the economic impact from a broader perspective, including all externalities of energy renovation. Although some data are available, it is difficult to economically quantify the impact of these measures. More data, research, and specific studies are needed.

It is worth noting, however, that energy renovation interventions in buildings are positively correlation with household value appreciation. Energy renovation measures slow down building deterioration rate, thus increasing household value by up to 25%[35].

The link between homes and health has been well established by the scientific community, with results illustrating that housing conditions has one of the most decisive influences on population health. However, the role of energy retrofitting in improving the health of building occupants has yet to be thoroughly and comprehensively documented. Normally the benefits of energy retrofitting are calculated only in terms of energy savings and economics; as such, energy retrofitting has not seemed of great importance for many homeowners. A recent study from IREC[36] estimated how energy efficiency improvements in vulnerable dwellings could impact the health of building occupants and measured potential economic savings for the healthcare system. The study found that if 1.5 million of the vulnerable households between the 1960s and 80s in Spain were able to improve their energy efficiency, it could be possible to:

- Reduce the number of occupants with bad or very bad self-predicted health by 100,000
- Reduce the number of occupants diagnosed with cardiovascular disease by about 120,000
- Reduce the total number of EWD[37] (650 deaths for those under 65; 6,700 deaths for those older than 65).
- Generate up to €588 million in annual savings to the healthcare system by preventing 15% of diseases, generating a social benefit of €373 per retrofitted household.

Circular economy in the building sector

Despite the fact that energy retrofitting projects result in clear benefits on both the individual and the societal level, 'energy retrofitting' is not a business in and of itself, which presents a significant barrier from large-scale individual actions and severely hampers the fulfilment of retrofitting objectives. There are many different factors contributing to this phenomenon. First, energy retrofitting projects require a high level of investment, which are considered liabilities on balance sheets. Second, energy savings are relatively poor, especially for residential buildings. Third, any energy that is used to implement retrofitting projects slightly counteracts the positive benefit an energy-efficient building stock, reducing the net amount of estimated energy savings (this phenomenon is known as the rebound effect). Finally, energy poverty throughout Europe prevents end-users from undertaking any portion of required investments.

As such, while the projected energy savings can be used to partially fund an energy retrofit, the end-user (or owner) are only able to undertake this investment if it results in an increase in property value. For the case of residential buildings – the largest energy consumers in the building sector – energy consumption is more correlated to individual needs and behaviours compared to other sectors. This both makes it difficult to define a consumption baseline and also discourages ESCOs from guaranteeing energy savings. Furthermore, especially in the case of social housing or residential buildings with dwellings that are rented to tenants, it is unrealistic to request end-users to invest in a retrofitting project, either directly or through a PPP action. In such a case, end-users neither benefit from the increase in property value nor from energy savings (very minimal); as such, the (public) owner would be responsible for expending all effort related to the project.

Given the aforementioned context, proposed solutions must not only be price-adjustable and significantly reduce energy consumption, but must be implemented through newly defined business that provoke a paradigm shift. In the end, conventional models are too expensive, both in

35 Tinsa Research. Rehabilitación, aumento del valor y mejora de la eficiencia energética. 2014

36 J. Ortiz and J. Salom. Impact of the energy retrofit of households in the residential health in Spain, 14th International Conference ono Urban Health, 26-29 September 2017, Coimbra, Portugal

37 EWD – Excess Winter Deaths

terms of monetary investment and also the prolonged length of the life cycle. This limits the scale by which remediation efforts can mitigate the effects of climate change. Although the circular economy concept has been in circulation for several years, it is beginning to be introduced into the residential sector through focused research projects[38] or new public methodologies[39].

The key actors in incorporating circular economy concepts into the building sector will be the funders, occupants and owners; however, architects and designers, engineers, suppliers, contractors, facility managers and end-of-life material recycling/disposal companies will also play a key role in implementing robust circular solutions[40].

Therefore, circular economy business models (CEBM) for technical cycles are based on the idea that instead of selling conventional products, it is possible to offer products as a service. This new business model allows customers to pay to use a certain asset, rather than paying to acquire it, while the service providers hold ownership of the asset throughout its lifetime. This type of business models facilitates product management throughout its life cycle, including design, maintenance, reuse, remanufacture and recycling. The CEBM for the building construction sector can be classified into 5 main families according to their position in the building construction sector value chain: i) Circular Inputs: using materials in line with Cradle to Cradle Certified™ Products Program, ii) Product-Service-Systems: adopting a leasing or renting scheme to commercialize the product or asset, iii) Lifetime Extension: Extend product lifetime through maintenance and upgrading, iv) Sharing Platforms: for products or assets with low utilization rates, charging for product use rather than product purchase could serve as an alternate solution to increasing revenues and v) Value Recovery: reusing materials or parts at the end of life cycle allows for a whole new set of business possibilities.

These five CEBMs address the business opportunities that could be found along the building construction sector value chain. The current linear value chain, with all actors misaligned and working independently, has lots of value losses along it. However, the CEBM provides several alternatives to capture value at different points along this value chain, as recently introduced by relevant market actors[41].

These considerations could work in tandem with large-scale retrofitting actions, as introduced in the analysis presented in this report. Furthermore, because the global budget for large-scale projects is much higher than its conventional small-scale counterpart, large-scale projects could benefit from the introduction of CEBM, at least partially. The specific conditions and expected benefits would be included as part of another focused analysis.

Access to public investment funds and financial programs

There are currently several financial instruments, mechanisms and schemes to support implementation for energy efficiency actions in buildings; considering European-level and national regulations, this means retrofitting buildings in general. The solution framework should encourage energy efficiency retrofits by helping to overcome one of the main barriers: financing. Some financial solutions are more universal and therefore available nearly everywhere, while others are country specific.

The table below (Figure 8), taken from the comprehensive EEFIG report[42], provides an overview of available financial instruments, which are applicable for residential segments (excluding the first column 'commercial'). The financial mechanisms available to support energy-efficiency

38 See http://www.plug-n-harvest.eu or https://projects.leitat.org/houseful/

39 Level(s). http://ec.europa.eu/environment/eussd/buildings.htm

40 Carra, G., Magdani, N. (2016). Circular Business Models for the Built Environment. United Kingdom: Arup and BAM. Retrieved from https://www.arup.com/publications/research/section/circular-business-models-for-the-built-environment

41 Arup and BAM. Retrieved from https://www.arup.com/publications/research/section/circular-business-models-for-the-built-environment

42 Energy Efficiency Fionancial Institutions Group. Energy Efficiency – the first fuel for the EU Economy. European Union, 2015. See http://www.eefig.com/index.php/the-eefig-report. The report is also available in French, German, Italian, Polish and Spanish, see https://ec.europa.eu/energy/en/news/new-report-boosting-finance-energy-efficiency-investments-buildings-industry-and-smes

Figure 8. Overview of Financial instruments for energy efficiency investments in buildings. Score of 3 is mature, 1 marginally useful, while 0 is not applicable.

Mature financial instruments	Commercial	Public	Public rental	Private rental	Owner occupied
Dedicated credit lines	3	2	3	3	3
Energy performance contracting (undertaken by private sector)	3	3	3	1	1
Risk-sharing facilities	2	1	2	2	2
Direct and equity investments in real estate and infrastructure funds	2	1	1	2	0
Subordinated Loan	1	1	1	1	1
Covered Bonds	1	1	1	0	0
Leasing	0	1	0	0	0

Emerging financial instruments	Commercial	Public	Public rental	Private rental	Owner occupied
On-bill repayment	2	1	2	3	3
On-tax finance (PACE)	2	1	1	2	3
Energy efficiency investment funds	3	2	2	1	1
Energy services agreement	3	3	2	1	1
Public ESCOS for deep renovation of housing	0	0	3	2	2
Factoring fund for energy performance contracts	2	2	1	1	0
Public ESCOS for deep renovation of public buildings	0	3	3	0	0
Green bonds	2	1	0	0	0
Citizens financing	0	0	0	1	2

investments depend on the type of owners and whether the owner lives in or rents out the unit. However, there exist many commonalities between cases and, therefore, classification of instruments is possible.

EEFIG identified a total of 17 financial instruments with different levels of maturity and readiness. The most mature are:

1. **Dedicated Credit Lines:** Ad-hoc financial lending instruments for energy efficiency, at times backed by public financial institutions. Sometimes the lending institutions already define the specific sector/target and provide simplified standardised procedure to access the credit (e.g., eligible material). Examples are KfK, Kredex.
2. **Energy Performance Contracting (EPC):** A contractual arrangement between a host beneficiary and the energy efficiency performance measurement provider, verified and monitored during the whole term of the contract. It is one of the main instruments used by Energy Service Companies (ESCOs). The EPC provides guaranteed savings, know-how and turnkey contracts.

3. **Risk-Sharing Facilities:** Reduce the risks for banks and equity investors by covering part of the risk of payment default. They have the advantage of removing some of the uncertainty and risks; therefore, favouring the deployment of greater private instruments.
4. **Direct investment in Real Estate and Infrastructure Funds:** Not a financing instrument per se but a realisation that if real estate managers value buildings with improved energy performance, there could be a market for self-financed actions on the assurance that investors and buyers would be willing to recognise the investment sum.
   Subordinated loans, covered bonds and leasing: Subordinated loans sit between a direct credit line and grant; they are junior ranked compared to other senior debt. They are commonly used instruments in general, but are rarely used to finance energy efficiency in buildings. Covered bonds are corporate bonds backed by a pool of assets and are used as collateral to secure the cash for the bond. They could be used to refinance other investments; leasing, finally, is how a host obtains the use of machinery or highly efficient equipment. Ownership stays in the hand of the leaser, while the business retains the actual right to use the equipment.

Other emerging instruments include

5. **On-Bill Repayment and Tax Finance (PACE):** A mechanism for repaying energy efficiency investments whereby payments are recovered through the existing payment collection infrastructure, such as through utility bills or tax returns. PACE financing programs are gaining popularity in the United States. Under this program, a loan is given to a building owner, but the loan is attached to the property and reimbursed through local taxes, thereby improving occupants' creditworthiness. If the building is being rented, the tenant pays the tax and benefits from the savings. A change in tenant has no impact on the repayment. Financing can be either public or private.
6. **Energy Efficiency Investment Funds and Energy Service Agreements (ESCOs):** Energy Efficiency Investment Funds are dedicated to investing only in energy efficiency projects that seek a return based on achieved savings. Some of these Socially Responsible Investment (SRI) funds have partnered with governments. Energy Service Agreements (ESA) are a contract between a third-party investor and an asset owner to deliver energy savings as a service; it is an evolution of the traditional shared-savings model provided via EPC, with a structure that more closely resembles Power Purchase Agreements (PPA). The investor provides funds for realize energy efficiency opportunities and operate the necessary energy equipment for the asset owner, who in exchange agrees to pay historical utility bills to the investor.
7. **Public ESCOs for Deep Renovation:** A special purpose company that manages energy efficiency investment and delivers guaranteed savings to a host and acts as a publicly funded counterpart to an EPC. These ESCOs aggregate credit lines and other incentives.
8. **Green Bonds and Citizen Financing:** Financial instruments that finance projects and activities promoting climate and environmental sustainability outcomes. These bonds can by issued by corporations or by banks.

At the European level, the European Investment Bank (EIB) has a series of instruments that target sustainability. However, they are generally intended as city-wide initiatives rather than isolated projects, with budgets often falling between the range of €25 to 50 M. However, after a city has applied for an received a loan, it can then distribute the loan to finance individual projects.

9. EIB also acts via the European Fund for Strategic Investments (EFSI) and the associated investment platform that essentially pools public and private financing for investment in a portfolio of projects with a given thematic and/or geographic focus.
10. The European Commission and the EIB have created the European Investment Advisory Hub (EIAH [43]) that serves as a single access point to a wide range of services and assistance. This includes the Joint Assistance to Support Projects in European Regions (JASPER[44])

43 http://eiah.eib.org/
44 http://www.eib.org/products/advising/jaspers/index.htm

11. (ELENA[45]) program specifically targets energy efficiency. ELENA provides technical support to local and regional authorities to prepare, implement and finance investments that enhance energy efficiency.
12. The European Regional Development Fund (ERDF) aims to strengthen economic and socialcohesion within the European Union by correcting imbalances between its regions. The different pillars included are often related to Low-Carbon Economy and Resource Efficiency The European Local Energy Assistance.

The following presents a series of initiatives that aim to better match supply with demand. These are mainly intended as a meeting point to provide building owners seeking finances with relevant information, while giving investors the tool to confidently assess and evaluate an investment opportunity. Among others we cite:

13. Energy Efficient Mortgage Initiative (EEMAP[46]) aims to design and delivery of an energy efficient mortgage that intends to incentivise and channel private capital into energy efficiency investments.
14. Sustainable Energy Investment (SEI) Forum[47] aims to work with national stakeholders in order to boost large-scale investment and financing for sustainable energy. SEI Forums build on the works of EEFIG by organizing a series of events across the EU that showcase best practices.
15. Sustainable Energy Asset Evaluation and Optimisation (SEAF[48]) enables investment in small- to medium-sized projects in Sustainable Energy Assets (SEA) such as Demand Response, Energy Efficiency and Distributed Renewable Generation through a holistic online platform, eQuad[49], designed to function across Europe
16. Investor Confidence Project (ICP[50]) defines a clear road map to support reliable Investor Ready Energy Efficiency via established protocols that provide confidence to the investors.
17. EnergieSprong[51] is an initiative that promotes the whole house refurbishment with funding support. The initiative aggregates mass demand for high quality retrofits (and new built houses) in a market and creates the right financing and regulatory conditions in parallel. Solution providers can go into a quick and transformative innovation process to deliver against this new standard.

The aforementioned mechanisms exist at European level, some of them directly applied and most of them transferred to national and/or regional governments (i.e. the PAREER-CRECE mechanism in Spain, or the ELENA funds in Catalonia). Some European countries have launched specific financial mechanisms to be approved country by country, some of which exhibit significant overlap between mandatory building refurbishment action plans[52].

45 http://www.eib.org/products/advising/elena/index.htm
46 http://energyefficientmortgages.eu/
47 https://ec.europa.eu/energy/en/financing-energy-efficiency/sustainable-energy-investment-forums
48 https://www.seaf-h2020.eu/
49 https://www.eu.jouleassets.com/about-equad/
50 http://www.eeperformance.org/
51 http://energiesprong.eu/
52 See Article 4 of the Building Energy Efficiency Directive - https://ec.europa.eu/energy/en/topics/energy-efficiency/energy-efficiency-directive

09 Conclusions and following steps

The study has analysed different business models for large-scale retrofitting of residential building stock in urban areas, including energy efficiency measures. In addition to improving general living conditions, large-scale retrofitting actions could deliver many other benefits, such as increasing property value, promoting the circular economy, creating or maintaining jobs in the building sector, and realizing savings in the health care system. Previous experiences demonstrate that retrofitting at district level is an effective method for overcoming barriers to the retrofitting process and accelerating the retrofitting rate from the current 0.2% at regional level, up to CE-expected 3%. Based on past experiences – particularly the “Renovem els barris” project deployed in the city of Santa Coloma de Gramenet – this report proposes three different business models ideated as Public Private Partnerships, with the objective of developing models that could be replicable at European level.

The proposed models are based on the idea of establishing a Public Private Partnership lead by the city council and several private actors, including financial entities. Furthermore, the models include involvement of end-users (i.e. residents of a district) through a participative strategy. The study describes the steps that process should follow with four sequential phases: the initial planning phase, the end-user aggregation phase, the project phase and the execution phase. A financial supporting phase runs in parallel with the rest of the tasks. The key factors for success identified were:

Stakeholders Skills and Processes

- Clear definition of process and steps
- Implication and leadership of the public sector, represented mainly by the city municipality
- Socio-technical participative process to engage the residents in a large-scale retrofitting action, beyond the technical projects
- Adjustment of the city budget based on the actions to be deployed and resources to be activated resources.

Financial and Economic Roles and Fluxes

- Establish centralised and competent system for managing of economic fluxes, including contracting third entities, gathering administrative information from end-users and managing retrofitting grants and/or subsidies
- Reduce default risk through a combined action of resident engagement, supporting mechanisms from the city council and economic model adjustments
- Consider financial costs; establish agreements with financial entities or constructors for loans and/or payment period adjustment
- Design subsidies for vulnerable end-users through a municipal revolving fund
- Ensure monthly payments and payment periods comply with end-users' economic capacity
- Include private partner operation costs (not just costs derived from technical projects and construction works)
- Engage at least 150 households in large-scale retrofitting actions
- Issue retrofitting grants from supra-municipality public bodies equalling at least 15% of total project cost

Ideally, the reference investment should equal 7,000 €/dwelling, at the most, allowing for a cost-optimal solution for energy efficiency retrofitting projects in buildings. After considering the aforementioned factors, three potential business models emerged as the most promising. Each of these models envisions new roles for private existing partners, presenting an opportunity for companies to adopt these roles and participate in large-scale retrofitting actions. According to the results of a brief analysis, the potential market in the building retrofit sector is quite sizeable, with potential investments equalling €60 billion by 2020 at the European level, and €260 billion by 2050 just in Spain alone. The estimated market for the proposed business models could activate large-scale retrofitting operations for approximately for the proposed business models could activate large-scale retrofitting operations for approximately €1,697 million per year.

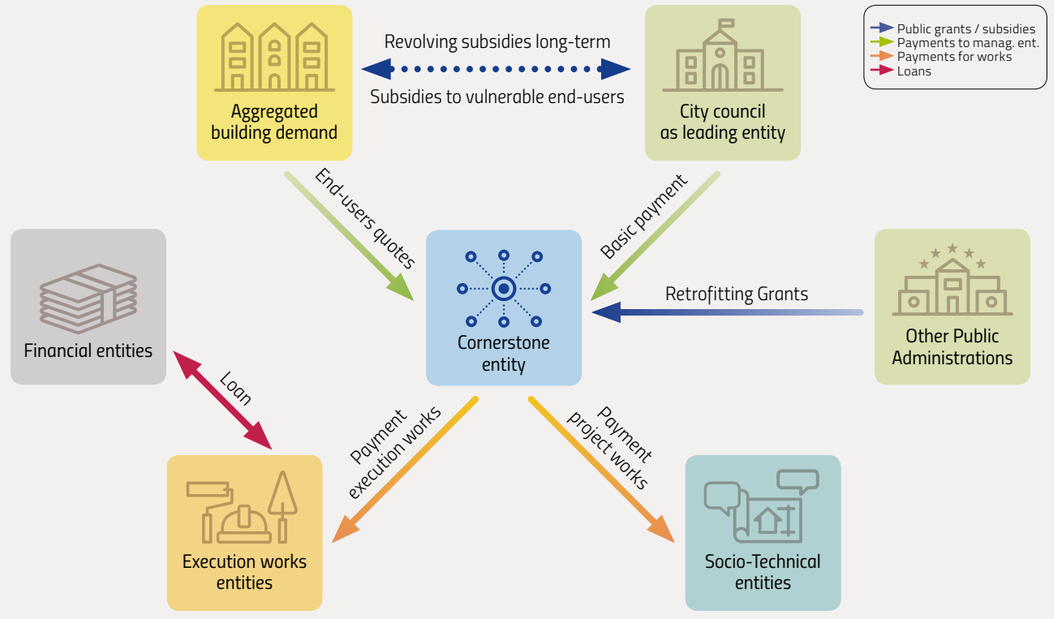
The first model proposed is a more disruptive one. The PPP model initiates public tender to select a company—in this case, the Cornerstone—to manage the project. The company will be responsible for supporting the city council in managing all steps of the process following the pre-initial planning phase, which includes aggregating end-user demand, performing technical projects, supervising construction works, and managing grants and subsidies in addition to end-user payments. This company will internalise some parts of the activities and subcontract others when necessary *(Scheme 18)*.

The first PPP model would alleviate burden on the city council budget. However, it is projected that a basic fee will be paid to the Cornerstone – defined within the framework of the public tender – that covers at least the fixed operational costs in the initial stages of the project (until the demand aggregation and project phases are complete). When defining the public tender, the more detached role of local public entities needs to be taken into account. According to interviews with stakeholders, the Cornerstone project manager role can be assumed by actors that already exist in the market by adapting their activities to include property management.

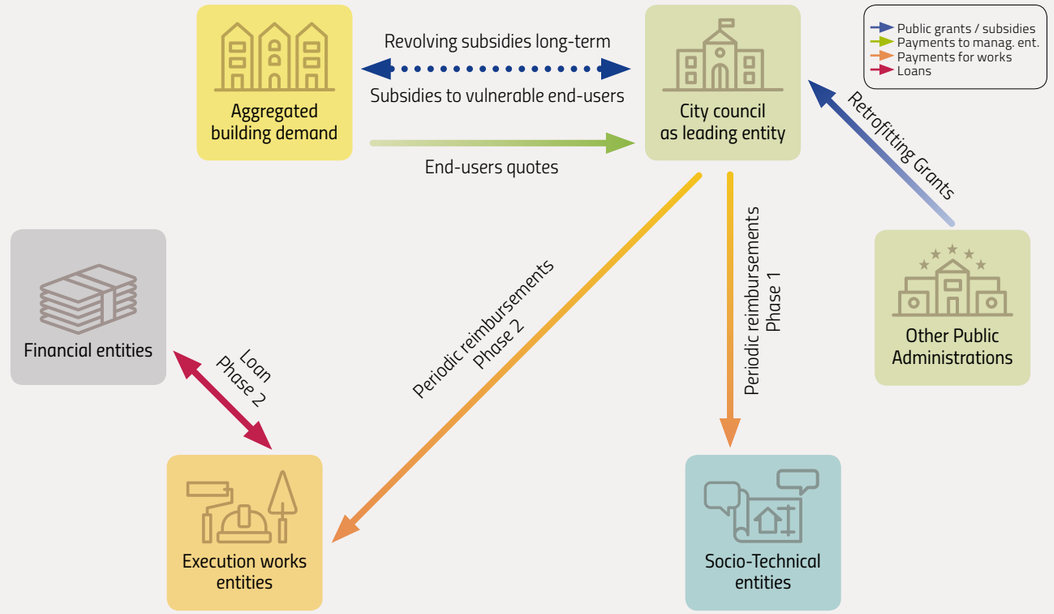
The second and third proposed models *(Schemes 19 and 20)* built off the model that guided the successful "Renovem els barris" project in the ACR-Pirineus section of the municipality of Santa Coloma de Gramenet, in addition to other reference cases introduced in the previous chapter. The PPP model is characterized by strong city leadership, assuming grant and subsidy management. The model is based on two public tender processes. Under the first process, the city selects a socio-technical company that both leads demand aggregation and encourages resident participation, in addition to realizing technical projects for each of the buildings in the area. The second public tender subcontracts the construction works. Two different model variants have also been considered. Under the first variant, the construction company charge for financial costs, but will cover a significant chunk of these costs with end-user payments. This will alleviate the city treasury and allow the city to activate multiple large-scale operations simultaneously.

The second variant introduces a financial entity into the work process through an agreement with the city council. Through this agreement, the financial entity provides soft loans directly to end-users. This model requires the involvement of three private actors. The first actor is a specialized

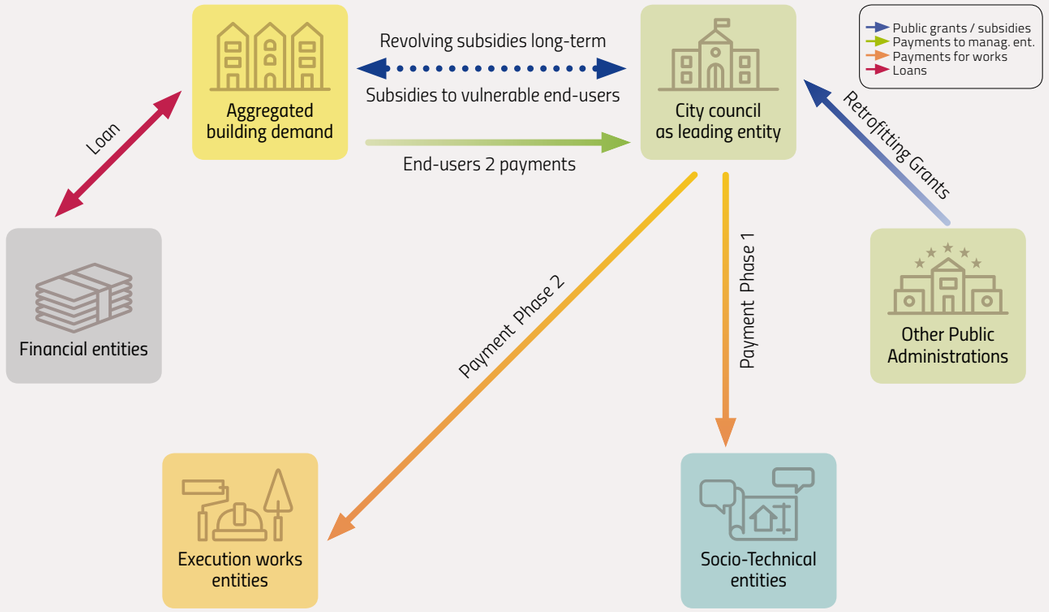
Scheme 18. Monetary and financial fluxes for the ***PPP Cornerstone Model.***



Scheme 19. Monetary and Financial Fluxes for the ***Two Public Tenders PPP Model*** (Variation 1).



Scheme 20. Monetary and Financial Fluxes for the ***Two Public Tender PPP Model*** (Variation 2).



technical company, with social and communication skills, that is able to implement a participative strategy for the first part of the process. The second is a construction company that can finance construction works for the city council through a services contract. The construction company will operate alongside a financial company that can over the financial portion of the operation. The third is a financial entity that offers soft loans to end-users within the framework of an agreement reached with the city council; this will take place for large-scale operations where risks of defaulting have been minimized. The three actors introduced above – socio-technical companies, construction companies, and financial entities – already exist in the market, and would only need to slightly adjust their role in order to comply with the proposed PPP structure and process.

The proposed business models have already been analysed through the lens of past experiences. Going forward, the models should be tested in pilot programs in one or more cities across Europe. This analysis proposes stakeholders' roles and skills, the main processes and the financial fluxes; however, the models must be implemented in the real world in order to fix the required and most relevant details, hence improving likelihood for future success. For the first model, a key aspect is identifying a company that can act as the Cornerstone project manager in order to test the business model. For the second and third models, it is important to find key actors that are able and willing to slightly adjust their pre-defined roles to comply with the proposed business model requirements. Both models must place great emphasis on the details (mostly related to public tenders) and on monitoring financial costs and flows, in addition to analysing co-benefits for end-users and other involved stakeholders.

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