ARV
CLIMATE POSITIVE CIRCULAR COMMUNITIES

D9.5 DESIGN BUILDING-LINKED FINANCING INSTRUMENTS

WP9 BUSINESS MODELS, FINANCIAL INSTRUMENTS, POLICY AND EXPLOITATION

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[1] *ARV is a Norwegian word meaning "heritage" or "legacy". It reflects the emphasis on circularity, a key aspect in reaching the project's main goal of boosting the building renovation rate in Europe.*

		Amengual Llofriu, Jaume Salom		
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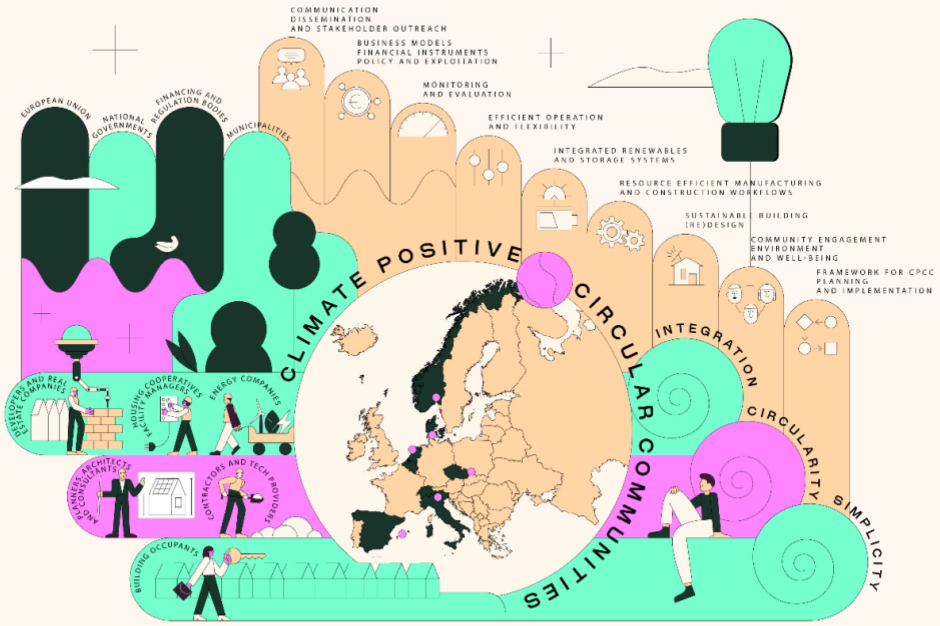
ABOUT THE ARV PROJECT

The vision of the ARV project is to contribute to speedy and wide scale implementation of Climate Positive Circular Communities (CPCC) where people can thrive and prosper for generations to come. The overall aim is to demonstrate and validate attractive, resilient, and affordable solutions for CPCC that will significantly speed up the deep energy renovations and the deployment of energy and climate measures in the construction and energy industries. To achieve this, the ARV project will employ a novel concept relying on a combination of 3 conceptual pillars, 6 demonstration projects, and 9 thematic focus areas.

The 3 conceptual pillars are integration, circularity, and simplicity. **Integration** in ARV means the coupling of people, buildings, and energy systems, through multi-stakeholder co-creation and use of innovative digital tools. **Circularity** in ARV means a systematic way of addressing circular economy through integrated use of Life Cycle Assessment, digital logbooks, and material banks. **Simplicity** in ARV means to make the solutions easy to understand and use for all stakeholders, from manufacturers to end-users.

The 6 demonstration projects are urban regeneration projects in 6 locations around Europe. They have been carefully selected to represent the different European climates and contexts, and due to their high ambitions in environmental, social, and economic sustainability. Renovation of social housing and public buildings are specifically focused. Together, they will demonstrate more than 50 innovations in more than 150,000 m^2 of buildings.

The 9 thematic focus areas are 1) Effective planning and implementation of CPCCs, 2) Enhancing citizen engagement, environment, and well-being, 3) Sustainable building re(design) 4) Resource efficient manufacturing and construction workflows, 5) Smart integration of renewables and storage systems, 6) Effective management of energy and flexibility, 7) Continuous monitoring and evaluation, 8) New business models and financial mechanisms, policy instruments and exploitation, and 9) Effective communication, dissemination, and stakeholder outreach.



The ARV project is an Innovation Action that has received funding under the Green Deal Call LC-GD-4-1-2020 - Building and renovating in an energy and resource efficient way. The project started in January 2022 and has a project period of 4 years, until December 2025. The project is coordinated by the Norwegian University of Science and Technology and involves 35 partners from 8 different European Countries.

EXECUTIVE SUMMARY

The deliverable D9.5 is a proof of concept (POC) that assesses whether the capital needed for energy renovations can be lowered by producing retrofitting carbon credits purchased by buyers through the voluntary carbon markets (VCM). The POC is contextualised in the ARV project demonstration case in the districts Nou Llevant and La Soledad in Palma de Mallorca, Spain.

The retrofitted buildings are located in the part of the city where the average annual salary per household is within the poorest 10% poorest in the Autonomous Community, which presents significant challenges to financing and implementing energy retrofits. Therefore, alternative financing solutions and sources for retrofitting are needed.

The global carbon markets are either compliance programs (capped and regulated, applicable for certain industries and geographies) or voluntary (for uncapped economies and sectors). Residential energy efficiency forms part of the voluntary carbon market (VCM). For offsets to be certified and sold in the voluntary carbon markets, the emission reduction generating projects must comply with existing or new methologies approved by VCM standards bodies.

An Excel based tool was developed to assess the standards alignment of large-scale retrofitting projects with existing methodologies as well as their financial feasibility. The approach for assessing standard alignment consisted of laying out the relevant methodology's requirement as static fields and qualitatively comparing alignment and data availability from the Palma pilot's perspective. Assessing financial feasibility was done by on one hand selecting the most feasible renovation scenarios from IREC's modelling for the neighbourhood's building typology and extrapolating that to all buildings that can potentially be renovated in the area. This was complemented with various carbon credit pricing scenarios based on market data and estimations of project development costs. The outcome is a dynamic assessment of the investment–return contribution by a selected and modifiable set of parameters.

As the preset inputs based on Palma pilot data in the Excel tool indicate, the pilot is well aligned with the methodological requirements. Most uncertainties, future points of clarification, and additional data gathering work relate to the baseline calculations and the emissions reduction measurement approach. As for financial feasibility, only district scale retrofitting and significantly higher than current average carbon price in the VCM allows the project to reach profitability. Alternatively, especially operational project development costs would have to be significantly lowered for the project to be financially feasible. For the time being, some operational costs are unavoidable, as they relate to administation or auditing and are mandated by the standardization body.

The approach taken was validated through feedback interviews with two carbon credit project developers, a carbon consultancy / project development support and a non-profit carbon market research organisation. The interviews helped shape the proof of concept, and provided valuable feedback for the tool development as well as reflections on future developments and implementation potential.

All prices in the POC are shown in USD, since the VCM is international and generally presented in USD. The exchange rate at the time of writing was approximately 0.9517 (USD to EUR) according to the European Central Bank.

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1. INTRODUCTION

The energy and building sectors are vital to Europe's environment and energy policy success since buildings are responsible for 40% of total EU energy use and 36% of greenhouse gas emissions[2]. In addition, the recent energy crisis highlighted the need for immediate and coordinated market and policy actions to reduce the EU's energy dependence on foreign resources. Lastly, energy poverty in Europe is on the rise. In 2023, over 10% of EU citizens were in a situation of energy poverty[3], which negatively affects quality of life and health and wellbeing. In this context, improving the energy performance of the EU's building stock is an absolute priority.

The main problem with providing more sustainable, low-carbon real estate is that most of the building stock is already in existence. Most of the existing buildings were built long before green or low-carbon solutions became available and are often not sufficiently energy-efficient. Therefore, massive potential for energy savings lies in renovating the existing building stock.

The current rate of deep retrofits is stagnating, and this slow progress threatens the EU's climate ambitions, and accelerating retrofits is essential for reducing energy consumption and cutting emissions from buildings. The Building Performance institute of Europe (BPIE) estimates that emissions from the building sector should decrease by 60% by 2030 compared to 2015, which means that the deep energy renovation rate should reach 3% per year as soon as possible before 2030 and be maintained up to 2050[4]. This involves several possible interventions, from improving thermal isolation to installing solar panels and water-saving technologies. According to their calculations, there is no room for renovations that deliver less than 40% of savings and that all renovation scenarios should consider deep renovations to be the majority.

Energy efficiency investments face unique hurdles, such as high up-front costs, long pay-back periods, and small-scale individual investments, and the biggest barrier to retrofitting remains the cost of the intervention itself. All this contributes to the investment gap needed to reach the climate goals set in the Paris Agreement. Though public subsidies and support provided by EU governments have created an early economic stimulus toward energy retrofitting projects, public money alone is not enough. For energy efficiency alone, the estimated annual investment need to retrofit EU's building stock by 2030 is €275bn[5]. Unlocking necessary private finance requires, among many other things, new financing solutions and value capture models. Carbon credits from retrofitting residential real estate might be one of these.

Many companies are stepping up their efforts to mitigate their carbon-intensive activities and set science-based emission reduction goals, net zero targets, and decarbonisation pledges. The global carbon markets (generated and traded under a compliance program in capped markets[6] as well as in voluntary markets[7] in uncapped economies and sectors) are likely to provide a growing and steady capital flow towards both organic (e.g. tree planting) and inorganic (e.g. engineering technologies such as direct air capture) carbon offsetting projects. As a result, financial institutions are increasingly

[2] https://knowledge4policy.ec.europa.eu/publication/communication-com2020562-stepping-europe%E2%80%99s-2030-climate-ambition-investing-climate_en#:~:text=17%20September%202020-,Communication%20COM%2F2020%2F562%3A%20Stepping%20up%20Europe's%202030%20climate,the%20benefit%20of%20our%20people&text=With%20the%202030%20Climate%20Target,below%201990%20levels%20by%202030

[3] https://energy.ec.europa.eu/topics/markets-and-consumers/energy-consumers-and-prosumers/energy-poverty_en

[4] BPIE, 2021. https://www.bpie.eu/wp-content/uploads/2021/11/BPIE_Deep-Renovation-Briefing_Final.pdf

[5] EEA, 2023. https://icapcarbonaction.com/en/publications/emissions-trading-worldwide-icap-status-report-2020

[6] https://icapcarbonaction.com/en/publications/emissions-trading-worldwide-icap-status-report-2020

[7] https://www.ecosystemmarketplace.com/publications/state-of-the-voluntary-carbon-markets-2021/

applying carbon pricing scenarios in their disclosure of climate-related risks and opportunities in various sectors, from banking to insurance underwriting and asset management.

A carbon offset can be described as "a contract between two parties under which one party voluntarily agrees to reduce emissions (or increase carbon sequestration) in exchange for payment from the other party"[8]. A carbon offset program offers flexibility in emissions reduction measures and allows entities to take the most cost-effective path to achieve the GHG requirements or voluntary pledges.

In the case of "deep renovations", offset projects would work, for example, by reducing the consumption of electricity and natural gas in residential and/or commercial buildings, which will lead to a reduction in carbon emissions from power generation. This reduction will then be counted as a carbon offset (where one offset stands for one ton of carbon dioxide equivalent emission reduction).

Energy positive buildings and newly established climate circular neighbourhoods have the potential to tap into the voluntary carbon market as an additional instrument to raise capital to make the "renovation wave"[9] scalable. This is particularly acute in communities and areas with high rates of energy poverty or households living with low or irregular incomes. Such households often have less savings and disposable income to finance deep retrofits, and their customer profiles might be less appealing for commercial renovation loan or mortgage issuers.

Therefore, carbon trading programs could encourage building owners with lower retrofit costs to further reduce their emissions, generating credits that can be purchased by corporations. Hence, carbon offsets could improve the business case for green buildings, providing additional cash flow beyond water and energy savings, subsidies and tax incentives. These could be high-quality carbon credits due to the good additionality of credits (the emission reduction would not happen if the credits were not sold, and therefore the project to reduce emissions would not occur).

Carbon offsetting has faced significant and high-profile controversies due to concerns about the effectiveness and transparency of carbon credits and carbon credit projects (for instance an investigation reported by the Guardian in 2023, where 90% of rainforest carbon offsets by Verra, the biggest certifier, were analysed to be worthless[10]). This has highlighted the urgent need for high-quality credits that are verifiable and represent real emission reductions.

If all above is true, why aren't building retrofit carbon projects mainstream already?

One significant barrier has been the difficulty in obtaining accurate data to measure and verify energy and emission savings. However, the boom of IoT (Internet of Things) and the increased use of smart meters and the growing availability of energy consumption data are now key drivers enabling better measurement and management of energy efficiency projects.

Another challenge is the fragmented nature of the building landscape, with individual projects, such as single-family homes or apartment buildings, offering limited carbon credit potential. However, emerging opportunities for aggregation—enabled by improved data, digital tools and technologies—are beginning to unlock the potential for a sufficient project scope.

This proof of concept (POC) is contextualised in the ARV project demonstration case in the districts Nou Llevant and La Soledad in Palma de Mallorca, Spain. The city is carrying out a pilot of large-scale retrofitting of multi-family buildings by means of a novel Public Private Partnership mechanism. Various

[8] https://nicholasinstitute.duke.edu/mitigationbeyondcap/offsetseries5
[9] https://ec.europa.eu/commission/presscorner/detail/en/ip_20_1835
[10] https://www.theguardian.com/environment/2023/jan/18/revealed-forest-carbon-offsets-biggest-provider-worthless-verra-aoe

tools and data driven approaches have been developed within the project to plan, design, and analyse large-scale retrofitting actions and assess their impact at a district level. This provides an opportune foundation for this proof of concept.

2. OBJECTIVES AND SUCCESS CRITERIA

The POC assesses whether the capital needed for energy renovations can be lowered by producing retrofitting carbon credits purchased by buyers through the voluntary carbon markets (VCM). This could act as a substitute or complement to more traditional capital, such as renovation loans or additional borrowing on existing mortgages.

It is developed in the context of the ARV project, which aims at creating climate positive circular communities in Europe and increasing the building renovation rate in the continent. One of the project's Spanish pilot sites is the Llevant Innovation District in Palma de Mallorca, and the proof of concept is based on the characteristics and data available of the Spanish demonstration case.

The pilot neighbourhood is about 90 hectares with approximately 9000 inhabitants in a mixed-used development area of residential, tertiary, and educational buildings either newly constructed or in need of retrofitting interventions. The pilot site and the retrofitted buildings are located in the part of the city where the average annual salary per household is 30.419 € and 10.337 € per person[11] (data from 2022), making the neighbourhood residents the 10% poorest in the Autonomous Community.

Low-income levels present significant challenges to implementing energy retrofits for several reasons. First, many residents lack the economic capacity to cover upfront costs required before starting renovations, such as building permits or project development fees. Second, banks security filters mismatch with the payback capacity of the community of owners. Third, some owners are reluctant to get a mortgage together with their neighbors through the community of owners' entity.

As part of the energy retrofitting initiative in the neighborhood, the Palma City Council team engaged with various financial institutions and banks to better understand the available financing products for energy retrofits. All institutions do a meticulous study of the economic health status of the community of owners by analyzing their bank statements. They analyze economic balances and cases of community fee default. Most banks admitted that if more than 10% of the neighborhood's residents were in arrears on their community fees, they would refuse to provide financing. Unfortunately, this monthly fee default is common in the neighborhood, posing a significant obstacle to the success of the energy retrofitting process.

Success criteria

The proof of concept is assessed through the following criteria:

1) Financial feasibility: The market value of carbon credits to be generated should be higher than the costs that occur from their generation. This would indicate that carbon credits can bridge the implementation financing gap to fund deep retrofits in the residential sector.

2) Standard alignment and technical feasibility: The standard alignment and technical feasibility of carbon credits for retrofit projects is assessed by comparing the methodology requirements of standard-setting organisations and the data available in the ARV project's demonstration sites.

[11] https://www.ine.es/dyngs/INEbase/es/operacion.htm?c=Estadistica_C&cid=1254736177088&menu=ultiDatos&idp=1254735976608

3. LIFE CYCLE AND STAKEHOLDERS OF A CARBON CREDIT PROJECT

The starting point to this proof of concept was to generate an understanding of the carbon credit project phases and main stakeholders.

PROJECT LIFE CYCLE

The first step was to develop an understanding of what a carbon credit project would look like in the context of building renovation. The following figure 1 maps these project development, implementation, and monitoring steps.

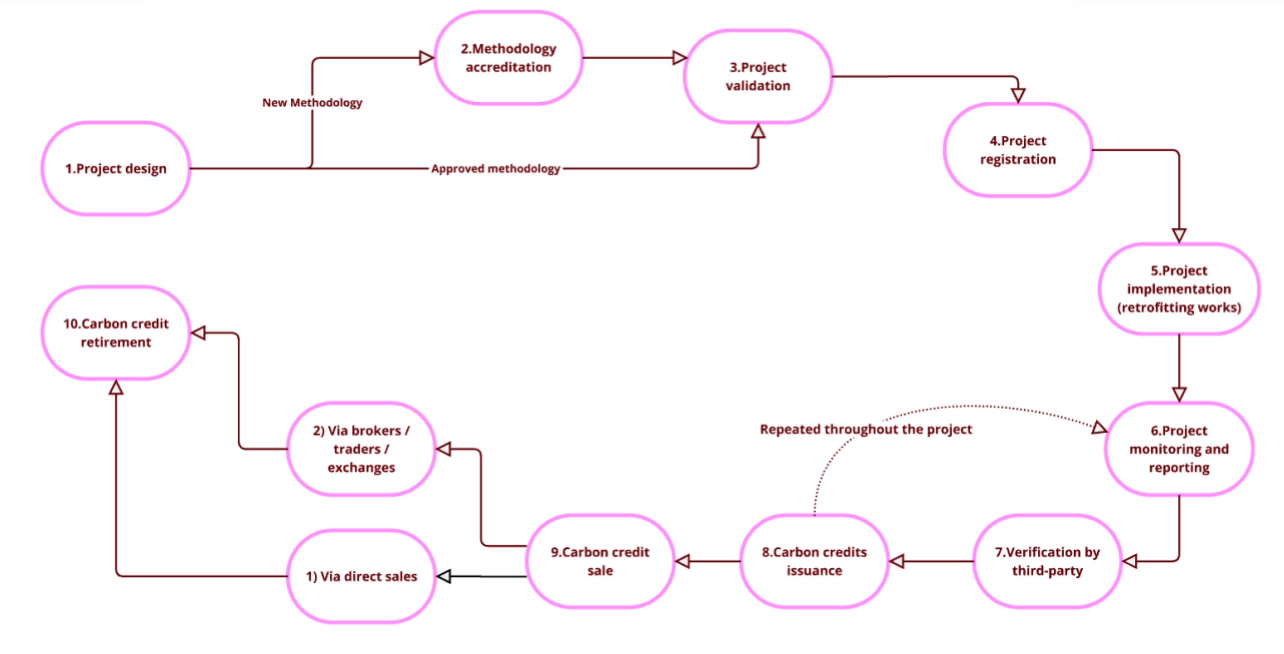

Figure 1. *Life cycle of a carbon credit project (Source: GDFA)*

Stages 1-7 correspond to assessing standard alignment and technical feasibility. Stages 8-10 are where the financial feasibility of the carbon credit project is evaluated.

This exercise was followed by detailing the various actions that would have to be taken /completed at each stage to develop a successful project.

MAPPING OUT KEY STAKEHOLDERS

From the list of actions, the following responsible key stakeholders were identified:

***Table 1.** Main stakeholders of a carbon credit project*

Stakeholders	Roles
Project developer	Leads, implements and manages the carbon credit projects and necessary administrative and registration procedures. Carbon credit seller.
Building / homeowners	Own the renovated buildings / apartments, often financing the renovation. In the case of multi-family building renovation, convene and make a coordinated renovation decision for the building.
Standardisation bodies	Provide quality assurance for carbon credits in the voluntary carbon markets, create methodologies, guidelines, and criteria to ensure consistent and credible measurement, verification, additionality, and accounting for carbon offset projects with which projects must comply to be certified.
Verification and validation bodies / third party auditors	Independent evaluators of carbon offset projects. Assess, validate, and verify the legitimacy of projects, ensuring compliance with established standards and providing impartial evaluations of emission reduction or removal claims.
Project funders/investors	If the project is not completed funded by the developers or building / homeowner, these stakeholders provide external funding for project design and implementation.
Brokers	Act as intermediaries between sellers and buyers, connect both parties to facilitate the sale of carbon credits.
Carbon credit buyers	End customers who purchase generated carbon credits, either directly or via brokers, traders or carbon exchanges or trading platforms.

APPLICABLE METHODOLOGIES

Various standardisation bodies have been established to provide quality assurance for carbon credits in the voluntary carbon markets. The biggest 4 markets and registries are Climate Action Reserve, American Carbon Registry, Verra (Verified Carbon Standard or VCS), and Gold Standard. These four registries generate almost all the world's voluntary market offsets[12].

The **table 2** below shows the results of a review of available project methodologies applicable to energy efficiency improvements in buildings through retrofitting.

As seen in table 2, the VM0008 is the only globally available methodology for generating carbon credits from energy efficiency and retrofitting projects from residential real estate. This methodology was selected as the basis for this POC.

As of this writing, only eight projects globally generate or aim to generate carbon credits from building renovations, with six located in the US and two in the UK[13]. None have been registered or implemented within the EU. The two UK-based projects focus on single-family or individual dwellings, whereas the Spanish proof of concept (POC) aims to assess the feasibility of applying this approach to a multi-family

[12] https://gspp.berkeley.edu/research-and-impact/centers/cepp/projects/berkeley-carbon-trading-project/offsets-database

[13] https://registry.verra.org/app/search/VCS (registered under methodology VM0008)

building context. Among the US projects, only one actively involves retrofitting actions, while the others centre on smart thermostats or remain inactive. This makes the Spanish POC a uniquely valuable contribution to advancing carbon credit methodologies in both the EU and Spanish contexts.

Table 2. *Available project methodologies applicable to energy efficiency improvements by retrofitting in buildings.*

Methodology	Standardisation body	Sectoral scope	Geographic scope
VM0008 Weatherization of Single Family and Multi-Family Buildings, v1.1[14]	VCS	Energy demand	Global
VM0025 Campus Clean Energy and Energy Efficiency, v1.0[15]	VCS	Energy (renewable/non-renewable), energy demand	USA

[14] https://verra.org/methodologies/vm0008-weatherization-of-single-family-and-multi-family-buildings-v1-1/
[15] https://verra.org/methodologies/vm0025-campus-clean-energy-and-energy-efficiency-v1-0/

4. TOOL DEVELOPMENT

The tool was developed in collaboration with the City of Palma, IREC, and GDFA.

CLIMATE POSITIVE CIRCULAR COMMUNITIES

ARV

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 101036723

Developed by:

Ajuntament de Palma IREC Green Digital Finance Alliance

Introduction

This tool helps assess whether the capital needed for energy renovations can be lowered by producing retrofitting carbon credits purchased by buyers through the voluntary carbon markets (VCM).

It is developed within the ARV project, which aims at creating climate positive circular communities and increasing the building renovation rate in Europe.

The theoretical assessment is based on the characteristics and data available from one of the project's demo cases is in Palma de Mallorca, Spain, where a large-scale retrofitting action of private dwellingsis piloted by means of a novel Public Private Partnership mechanism.

The tool assesses feasibility in releation to the only one globally available methodology for generating carbon credits from energy efficiency and retrofitting projects from residential real estate:
Verified Carbon Standard (VCS) methodology VM0008v1.1.

Instructions

The tool consists of 5 tabs where different aspects of the retrofitting carbon credit feasibility can be assessed.

Tab Demo data sheet: relevant background information for pilot

Tab Investment-Return Contribution: assessment of financial feasibility of the project

Tab Applicability conditions: qualitative assessment of project alignment with general methodology requirements

Tab Baseline and additionality: qualitative assessment of most suitable approach to measuring emissions baseline and assessing additionality

Tab Emission reduction approaches: qualitative assessment of selecting the most suitable approach to calculate the emissions reductions from the project

Legend

Computed field

Modifiable input (change values or add your own input)

Figure 2. *Screenshot of Excel based tool*

The first step was to collect relevant data from the ARV project regarding the Palma pilot into an accessible project one pager, that was used as the starting point for the POC. The "pilot data sheet" contains this key information, including the project overview , existing building performance, implemented renovation measures, estimated energy and emission savings, and other environmental and social benefits. The goal of this exercise was to condense data and modelling from various project deliverables and analyses into a format that could be used to communicate with a potential external project developer.

Large scale retrofitting in Palma de Mallorca, Spain

Pilot project data sheet

1. Project overview

Project title: Caracas 1: Large scale retrofitting of a multifamily building
Location: Street Caracas 1, Nou Llevant neighbourhood, Palma (Mallorca), Spain
Type of building: Residential
Year of construction: 1977
Number of apartments: 16
Floor area to be retrofitted: 1 235 m_2
Project start date: Estimated January 2025
Completion date: Estimated 12 months after starting date
Objective: To enhance energy efficiency, reduce operational costs and improve indoor comfort by improving the thermal envelope of the building and improving the energy efficiency of the heating and ventilation systems.

2. Existing building performance

Current energy rating: F for NREC and E for carbon emissions
Primary energy sources: Gas and electricity
Energy consumption (kWh / m2 year): 198,3 kWh/m2
Annual kgCO2 emissions / m2 year: 48,7 with software electricity transfer coefficients – 37,4 with updated electricity transfer coefficients
Key issues identified:
- Lack of façade and roof insulation
- Single-glazed windows
- Building in high need of reparations

3. Implemented renovation measures

- Improving insulation
- Window replacement
- Heat pump for domestic hot water

4. Estimated energy & emissions savings

Estimated energy savings of non-renewable energy consumption (NREC): [%or kWh/year of NREC]

Non-renewable primary energy consumption savings (NREC)	*Caracas 1*
Percentage of savings (%)	69,6%
Global savings (kWh/year)	170.568 kWh/year

Estimated emissions reductions: [CO_2e/year]

Carbon emissions savings per staircase	*Caracas 1*
Percentage of emission savings (%)	**63,6 %**
Global carbon emission savings due to electricity consumption according to EPC	6.585 Kg CO2/year
Global carbon emission savings due to gas consumption according to EPC	31.697 Kg CO2/year
Global carbon emission savings (Kg CO2/year) - according to EPC	38.282 Kg CO2/year
Global carbon emission savings (Kg CO2/year) - with updated electricity coefficients	34.650 Kg CO2/year

5. Other environmental or social benefits

- Energy affordability
- Thermal Comfort
- Acoustic Comfort

Figure 3. *Screenshot of the pilot data sheet*

In the next step, the model to assess financial feasibility was developed. This included estimations of carbon credit project development costs (initial and recurring operational costs) as well as 6 different building archetype or renovation targets determined by the City of Palma and based on modelling by IREC (described in detail in D4.3) and various carbon credit pricing scenarios based on market data. The outcome is a dynamic assessment of the investment – return contribution by a selected and modifiable set of parameters. Figure 4 shows an example of that calculation for a district scale reftofitting action. In that scenario, only the high carbon price reaches profitability between years 2 and 3.

Figure 4. *Tool screenshot of a result of one Investment-Return Contribution calculation*

A carbon credit project must meet and follow various applicability conditions, procedures, parameters and data collection monitoring requirements described by the methodology in order to be certified by the standardisation body and to generate verified carbon credits. The approach for assessing standard alignment and technical feasibility of carbon credits for retrofit projects was developed by comparing the methodology requirements of standard-setting organisations and the data and measuring infrastructure available in the ARV project's demonstration sites. This consisted of three steps:

1. Applicability conditions: qualitative assessment of project alignment with general methodology requirements
2. Baseline and additionality: qualitative assessment of most suitable approach to measuring emissions baseline and assessing additionality
3. Emission reduction approaches: qualitative assessment of selecting the most suitable approach to calculate the emissions reductions from the project, including pilot data availability

There are some general applicability conditions for the methodology VM0008 in a residential building retrofitting project. These conditions and the project pilot alignment can be assessed qualitatively in the following tables.

The project must fit at least one of the following categories.

Category	*Description*	*Pilot applicability*
Category A	All energy retrofit: A combination of energy efficiency measures directed at the Building Envelope (i.e. air infiltration, insulation), improving the efficiency of the central heating and/or cooling system and reducing energy consumption of Appliances (i.e. replacement of refrigerators, air conditioning units, lamps, showerheads).	Yes
Category B	Efficiency enhancement of the Building Envelope and central heating and/or cooling system only.	Yes
Category C	Replacement of Appliances currently in service.	No
Category D	Replacement of a mobile home currently occupied.	No

Figure 5. *Tool screenshot of assessing standards alignment*

Why Excel based tool?

An Excel based tool was developed for the POC assessment. It allows users dynamically to select, change and manipulate relevant project parameters such as floor area to be retrofitted, emissions reduction ambition as well as project development costs and carbon credit prices and revenue potential. The interplay of these project parameters ultimately enables the assessment of whether the capital needed for energy renovations can be lowered by producing retrofitting carbon credits purchased by buyers through the voluntary carbon markets, and under which conditions.

Beyond the ARV demonstration site in Palma de Mallorca, it is available for potential project developers or cities to help assess carbon credit revenue potential and project feasibility in their particular contexts.

5. KEY STAKEHOLDER PERSPECTIVES AND FUTURE REFLECTIONS

The proof of concept approach was validated through several 1-1 online interviews and feedback conversations with some of the key stakeholders described in Chapter 3 to maximise its relevance and boost potential applicability and uptake in the real-world context. Two carbon credit project developers, a carbon consultancy / project development support and a non-profit carbon market research organisation were interviewed during the second half of 2024. Initial interviews helped shape the proof of concept, and subsequent follow up conversations provided valuable feedback for the tool development as well as reflections on future developments and implementation potential.

CARBON CREDIT PROJECT DEVELOPMENT BARRIERS AND ENABLERS

The limited adoption of energy efficiency or retrofit carbon credit projects can be attributed to several key barriers.

Firstly, the collection of data necessary for measuring and verifying energy savings has been fragmented and challenging, which has hindered scalability.

Secondly, showing additionality is significant challenge. Energy efficiency projects and projects aligned with the Verified Carbon Standard (VCS) methodology VM0008v1.1 are not included in the "positive list" which would mean emission savings from a project would automatically be considered additional (such is the case, for instance, of a clean cooking stove project).

Thirdly, perception plays a significant role in the uptake and success of carbon projects. The carbon market has been affected by turbulence and reputational damage from revelations of low-quality credits[16], reducing trust in the market. Energy efficiency credits originating from retrofitting actions are generally considered high quality due to being permanent and emission avoiding in nature, whereas some other project types such as nature-based projects, have a harder time demonstrating permanence as carbon sinks are less predictable or permanent. Projects with visible social or environmental co-benefits, such as (energy) poverty reduction benefits are more appealing to buyers, whereas high-quality but less marketable projects, like landfill gas capture, struggle to attract interest due to limited image benefits for purchasers.

The increasing penetration of smart meters and Internet of Things (IoT) devices—key for data collection and a prerequisite for accessibility—is emerging as a key enabler. Spain has almost a 100% smart meter coverage[17] thus is well positioned hardware roll-out-wise. The electricity consumption data collected by these meters can be downloaded primarily through two web-based platforms: E-distribucion and Datadis. Access to this data is restricted and can only be viewed and downloaded by the contract holder. The access rights can be transferred to a third party through a formal agreement, but each agreement must be signed individually by the respective contract owner. As a result, obtaining bulk electricity consumption data for all households in a building or block would require securing these individual agreements. Significant number of households have been monitored for energy consumption, and good statistics with Datadis data are already available. This could be a sufficient pipeline for a pilot, but a large-scale retrofitting program in the neighbourhood or city would require a more robust and

[16] https://www.nature.com/articles/s41467-024-51151-w
[17] https://www.cnmc.es/prensa/cnmc-contadores-integrados-20201021

potentially (partially) automated data pipeline. However, access to consumption data of fossil fuels and /or biomass is not as automated as the access to electricity data.

In contrast, one interviewed project developer in the UK uses a data sample covering 4 million dwellings, nearly 20% of all UK dwellings to carry out performance benchmarking test for additionality[18]. This data is published by the Department for Business, Energy and Industrial Strategy (BEIS) as part of the National Energy Efficiency Data Framework (NEED)[19].

With regards to additionality, especially in the context of low-income households or people living in energy poverty, the investment barrier and cost of retrofitting is considered the biggest roadblock or challenge. In some methodologies, investment or implementation financing gap is sufficient to prove that a project generates additional emission savings. The analysed VCS methodology VM0008, however, requires using performance benchmarking for demonstrating additionality. In that case, for emissions savings to be considered additional, each apartment involved must achieve a certain level of savings that is above a set benchmark. This benchmark is calculated as a level of savings that is very unlikely to happen naturally without the carbon credit project and funding. Using another approach, such as an investment analysis or a barrier analysis might more accurately reflect the reality and the significant hindering impact of the investment barrier on retrofitting actions. At the same time, for some residents, the overall energy consumption after retrofitting might not decrease but rather remain the same while providing improved comfort and quality of life. This could indicate a goal conflict between addressing energy poverty and reducing emissions. This is not necessarily a problem, however it may mean that this initiative can claim less to contribute to emissions reductions.

On the other hand, projects with visible social or environmental co-benefits, such as poverty reduction or biodiversity benefits are more appealing to buyers, whereas high-quality but less marketable projects, like landfill gas capture, struggle to attract interest due to limited image benefits for purchasers. In the context of the Palma pilot, and according to the neighbourhood residents' behaviour observed during monitoring campaigns, many are not able to maintain sufficient heating or cooling conditions due to the cost of energy and to the lack of energy efficiency of their homes. Therefore, energy retrofitting could significantly improve the quality of life and health conditions of these residents, providing additional social benefits beyond emission reductions.

MARKET DYNAMICS AND BUYER PERCEPTION

National and corporate net zero commitments were perceived as key drivers of the market and buyer demand in the voluntary carbon market. This is particularly true in retrofitting or energy efficiency projects that are not regulatorily mandated but instead supported by participants in the voluntary carbon market. The absence of regulatory pressure means that value perceived by these buyers, particularly value that can be communicated externally in corporate ESG reports to improve corporate image and reputation remains critical for market uptake.

According to 2023 data, carbon credits generated from household energy efficiency projects were priced at $3,65 per ton[20], although this data mostly includes energy efficiency of industrial processes, residential and commercial heating and lighting, and fuel switching projects. Residential retrofitting projects using the Verified Carbon Standard (VCS) methodology VM0008 assessed in this deliverable were mostly excluded due to its limited uptake. In contrast, the interviews with UK based project

[18] https://registry.verra.org/app/projectDetail/VCS/4534
[19] https://www.gov.uk/government/collections/national-energy-efficiency-data-need-framework
[20] https://hub.ecosystemmarketplace.com/categories

developers state that retrofitting carbon credits (following methodology VM0008) are estimated to sell at a significant premium, signaling buyer perception of high quality. These credits are sold locally / nationally, and local buyers value local development benefits. Social value in particular is considered a big value add.

To that extent, ARV project goals extend to social inclusion and increasing the quality of life of citizens and boosting sustainable economic development, among others. The project carries out an analysis of these multiple benefits, as well as aims to test an approach where the project success is measured through financial and economic as well as ESG criteria (environmental, social, and governance), to leverage (further) investments. These insights have the potential to demonstrate the social value of retrofitting actions, therefore boosting the credits' perceived value and price.

INNOVATIVE FINANCING AND AGGREGATION MODELS

The ability for local project aggregation is important for the success of retrofitting carbon credit initiatives, such as the Palma pilot project. Working directly with individual households can be challenging and inefficient, given the administrative complexity and the relatively small emissions reductions from individual households. Large multi-family buildings or a district level renovation increase the overall scale of emission reductions and improve feasibility, however a strong ecosystem of local partners and a project aggregator would be needed for successful project development.

To that extent, the city of Palma has already established a public-private-partnership for a retrofitting management entity, a private company that offers support services for retrofitting customers. This enables the public administration to better support the acceleration of energy retrofitting in specific areas. Aggregation at this level and collaboration with such a player could streamline project management and monitoring, making retrofitting initiatives more attractive to developers and buyers.

The development of a coalition of national buyers is a potentially high impact approach to ensure guaranteed offtake for retrofitting carbon credits instead of credit sales through global and carbon credit agnostic traders or exchanges and with no guaranteed buyers. Such a coalition could include companies committed to addressing energy poverty and supporting local community rehabilitation while fulfilling their ESG goals. A compelling narrative is critical to attract these buyers, with particular emphasis on the social and environmental co-benefits of retrofitting projects. Stakeholders also pointed out that the first project in such an initiative often commands a price premium, underscoring the importance of timely action in designing innovative, high-impact projects rather than generic efforts without secured buyer commitments. Therefore, initiatives to ensure a high carbon price for these carbon credits are a key mechanism to make the financing contribution attractive and enable overcoming the cumbersome dealing and resistance or inactivity of individual private households.

The Balearic Islands government created a corporate carbon footprint registry in 2022, requiring local large and medium sized companies to calculate and verify their emissions as well as provide the plans to reduce their emissions to meet the climate change mitigation objectives in the territory[21]. Engaging companies from such a registry could be a good starting point for sourcing interested candidates for a national buyer coalition of local retrofitting carbon credits.

Alternatively, banks could explore the potential of using carbon credits as collateral for energy efficiency financing through renovation loans or mortgages. Various initiatives and commitments are underway to enable banks and financial institutions to measure the emissions linked to their financing activities

[21] https://www.caib.es/sites/canviclimatic2/ca/preguntes_freqaents_sobre_el_decret_faqs/#comsaber

("financed emissions") with the goal to reduce their emission intensity and decarbonise their portfolios[22,23]. By reducing the emissions from residential real estate that commercial mortgages are financing, banks could directly reduce their financed emissions from their mortgage portfolios.

Lastly, establishing a type of revolving or evergreen fund could provide a financing mechanism for retrofitting projects over time. The fund, based on a "pay-forward" approach, could provide upfront financing for the first series of buildings, covering costs related to energy efficiency improvements. Once the retrofits are completed, the project generates carbon credits from the resulting emissions reductions. The revenue generated is reinvested into the fund to finance retrofitting across other similar buildings in the project portfolio. Over time, this mechanism could reduce reliance on external financing, creating a self-sustaining model that supports long-term retrofitting efforts. It also addresses household cash flow challenges, which are particularly prominent in low-income households. Challenges of governance and necessary scale still remain significant. For the latter, the POC tool developed can help find the breakeven point considering m^2 renovated, emissions reductions vs. CO_2 price and project development cost, and to determine project size and scope needed to make a profit.

FUTURE DIRECTIONS FOR RETROFITTING CARBON CREDITS

This POC was developed in the context of existing standards bodies and methodologies and assessed against their protocols and requirements. The field, however, is in constant development, not the least after the agreement at COP29 about global carbon markets (Article 6[24]), which, while not directly regulating the VCM, might have an impact on the standards requirements and future projects on the ground. National voluntary carbon markets are also emerging as an alternative to current established standardisation bodies in the VCM (in development already for instance in Portugal[25]). Therefore, the perspectives presented and explored in this chapter take a forward-looking approach for advancing the field.

Green fintech can play an important role in that space, and indeed is already providing various services from monitoring, reporting, and verifying carbon emissions to carbon credit trading and transactions. The integration of digital measurement, reporting, and verification (dMRV) platforms presents a significant opportunity to reduce the costs associated with monitoring and verification and improve trust and transparency in carbon credit projects. Currently, these costs represent the largest cost item for a carbon credit project and often must be carried out by third party auditors at a significant price to meet the standard body's requirements. By automating workflows and incorporating dMRV tools into new methodologies, operational costs could be substantially reduced, enhancing the economic feasibility of carbon credit projects.

Nonetheless, successful uptake requires a high carbon price and sufficient data access on a household level, a challenge briefly described at the start of this chapter. Furthermore, standards bodies often work with their vetted verification and validation bodies / third party auditors, collecting annual fees from their participation. Opening that part of the process to a digital platform participation might mean slight reduction in standard bodies' revenue, however an alternative accreditation and associated fees for such platforms could easily be envisioned.

22 https://carbonaccountingfinancials.com/
23 https://www.gfanzero.com/
24 https://www.carbonbrief.org/cop29-key-outcomes-agreed-at-the-un-climate-talks-in-baku/
25 https://mvcarbono.pt/

An innovative proposal to automate emissions reduction calculations involves the use of "security coefficients" linked to the Certified Energy Efficiency (CEE)[26] approach to evaluate energy performance and carbon savings. This is a well-established methodology, and mandatory both before and after energy retrofitting in Spain. Since the infrastructure and procedures to calculate carbon savings after a retrofitting intervention are already available, there is no need to develop new methods. A downside of this procedure, however, is that the models rely on several assumptions and hypotheses, including factors like user behaviour, and therefore might not be completely accurate, affecting the measured carbon savings To address this, conservative reduction coefficients could be applied to the carbon emissions reported by CEE, ensuring that the carbon savings ultimately accounted for are more likely to reflect real reductions with a high degree of certainty. Although introducing such coefficients might reduce potential revenue in some cases, it could simplify carbon credit calculations and the credit quality as well as increase feasibility by standardising and streamlining methodologies. This could provide a robust foundation for automating emissions reductions assessments in future carbon market frameworks.

[26] Eider Iribar, Isabel Sellens, Laura Angulo, Juan M Hidalgo, Jose M Sala. 2021. Nonconformities, Deviation and Improvements in the Quality Control of Energy Performance Certificates in the Basque Country.
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APPENDIX A – GLOSSARY OF TERMS

***Table A.1** Abbreviations used in the report.*

Abbreviation	Description	References
CEE	Energy efficiency certificates (CEE)	
CPCC	Climate Positive Circular Communities.	See ARV Deliverable D2.1 for a detailed definition of CPCC
dMRV	Digital Measurement, Reporting and Verification	
ESG	Environmental, social, and governance criteria	
VCM	Voluntary Carbon Market	
VCS	Verra Carbon Standard	

APPENDIX B – SUMMARY OF EXCEL BASED TOOL

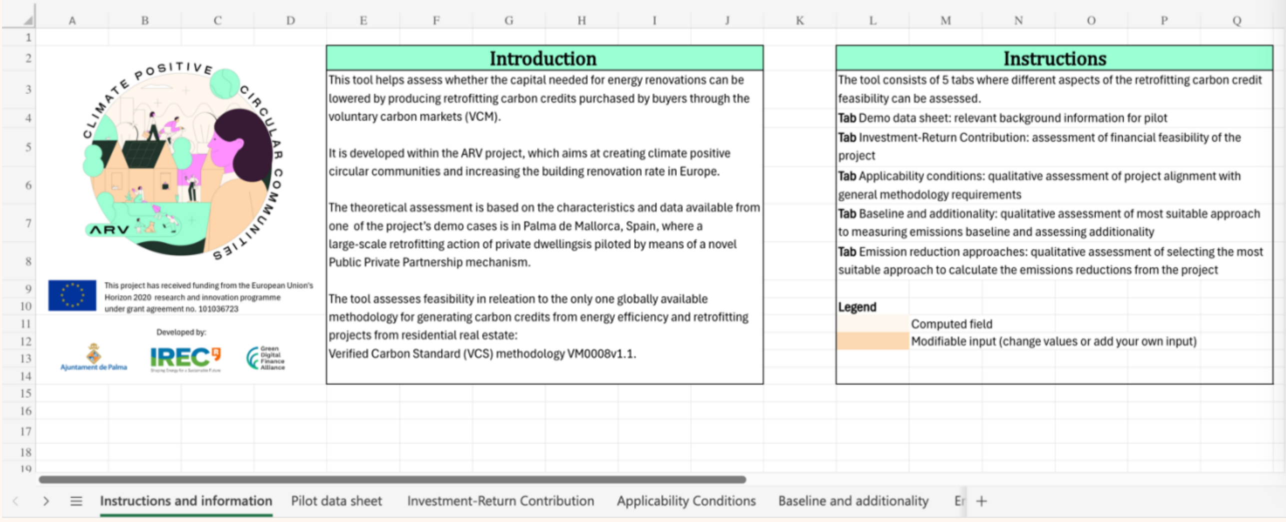

__Figure 6.__ Screenshot of tool introduction and instructiones of use

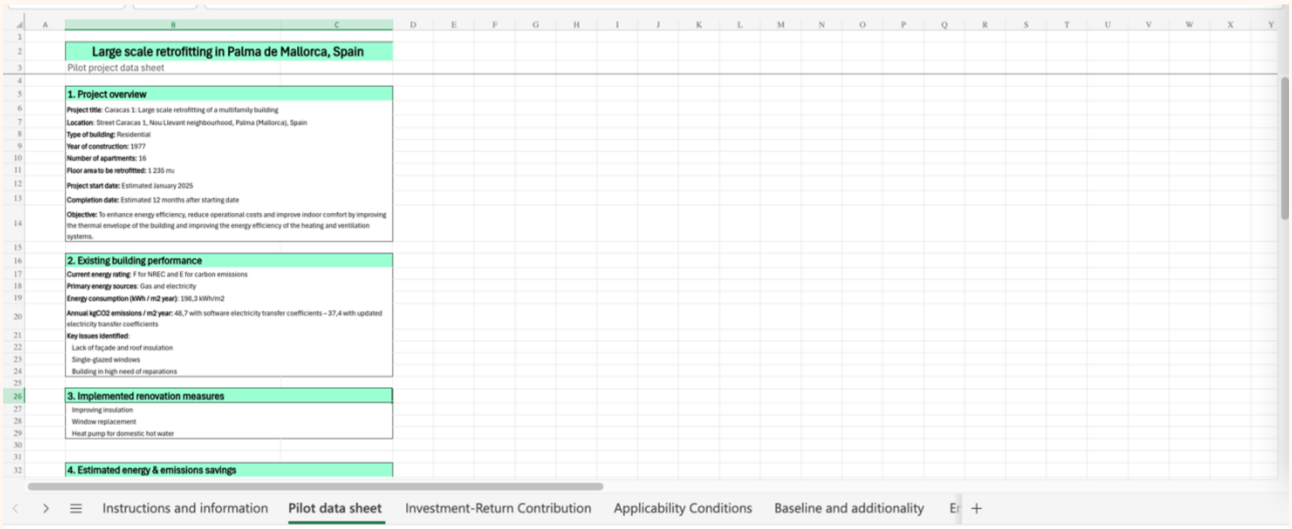

__Figure 7.__ Pilot data sheet containing key information about the pilot's use case in an accessible format

Carbon credit project development cost estimate

Planning and preparation costs

ACTIVITY	One-time	Annual	Cost type
Feasibility assessment	$50,000		Consultancy (optional)
Project design document (PDD)	$50,000		Consultancy (optional)
Account opening fee	$750		Administrative
Pipeline listing fee	$1,500		Administrative
Project validation fee	$20,000		Third party / Auditor cost
Registration review fee	$3,750		Administrative
Total	$126,000	$0	
Phase total	$126,000		

Operational costs

	One-time	Annual	
Monitoring report		$15,000	Consultancy (optional)
Monitoring report verification		$21,500	Third party / Auditor cost
Verification fee		$5,000	Administrative
Account maintenance fee		$750	Administrative
Total	$0	$591,500	
Phase total	$591,500		
Project total	$717,500		

Assumptions

Project developer's staff and overhead costs (i.e. project management costs) have been exclu

The cost of initial data collection and ongoing monitoring are usually borne by the project dev

Project implementation costs (i.e. renovation costs) have been excluded.

Cost breakdown data from retrofit carbon credit projects is not available. Costs shown here a

Carbon credit issuance levy not included (calculated under Carbon price scenarios)

Estimated time from feasibility assessment to first credit issuance: 18-24 months

Crediting period: 14 years

Sources

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https://climatefocus.com/publications/cost-benefit-model-clean-cooking-carbon-markets/

Emission reduction scenarios

Renovation target	Number of apartments renovated	m2 renovated	Estimated emission reduct per m2 (tCO2e/year)	Emissions reductions p target (tCO2e/year)
Caracas 1 (official EPC)	16	1,235	0.031	38
Caracas 1 (updated electricity coefficients)	16	1,235	0.028	35
High priority buildings archetype 1	413	17,753	0.028	497
Medium priority buildings archetype 2	708	19,404	0.028	543
Low priority buildings archetype 3	557	30,904	0.028	865
District (all above)	1,678	70,531	0.028	1,975

Assumptions

A 63,6 % reduction in emissions as a result of deep retrofit (please refer to "Pilot data sheet" f

District (all above) renovation target includes the following targets: High priority buildings arch

Sources

Demo data sheet

ARV Deliverable D4.3

Year	Caracas 1 (official EPC)	Caracas 1 (updated electricity coefficients)	High priority buildings	Medium priority buildings	Low priority buildings	District (all above)
1	38	35	497	543	865	1,906
2	38	35	497	543	865	1,906
3	38	35	497	543	865	1,906
4	38	35	497	543	865	1,906
5	38	35	497	543	865	1,906
6	38	35	497	543	865	1,906
7	38	35	497	543	865	1,906
8	38	35	497	543	865	1,906
9	38	35	497	543	865	1,906
10	38	35	497	543	865	1,906
11	38	35	497	543	865	1,906
12	38	35	497	543	865	1,906
13	38	35	497	543	865	1,906
14	38	35	497	543	865	1,906
Total project lifetime	**536**	**484**	**6,959**	**7,607**	**12,114**	**26,680**

tCO2e avoided per renovation target

Carbon prices

Price scenario	Carbon price	Unit	Reference
Low	$3.65	*$ per tonne*	VCM average Energy Efficiency projects 2023
Medium	$6.55	*$ per tonne*	VCM average all project type 2023
High	$60.00	*$ per tonne*	EU Compliance Program EU ETS, price as of April 1, 2024
Issuance fee	$0.23	*$ per tonne*	Verra Program Fee Schedule Oct 2024
Annual price increment	3	%	

Assumptions

Sources

https://hub.ecosystemmarketplace.com

https://openknowledge.worldbank.org/server/api/core/bitstreams/253e6cdd-9631-4db2-8cc

District (all above)	Low	Medium	High
Year 1	$6,754	$12,481	$118,038
2	$6,957	$12,856	$121,579
3	$7,165	$13,241	$125,227
4	$7,380	$13,639	$128,984
5	$7,602	$14,048	$132,853
6	$7,830	$14,469	$136,839
7	$8,065	$14,903	$140,944
8	$8,307	$15,350	$145,172
9	$8,556	$15,811	$149,527
10	$8,813	$16,285	$154,013
11	$9,077	$16,774	$158,634
12	$9,349	$17,277	$163,393
13	$9,630	$17,795	$168,294
14	$9,919	$18,329	$173,343
Total project lifetime	**$115,402.3**	**$213,258.1**	**$2,016,840.9**

Instructions and information | Pilot data sheet | **Investment-Return Contribution** | Applicability Conditions | Baseline and additionality | Er

Figure 8. *Screenshots of tool's financial feasibility feature for a selected scenario. Altogether six different scenarios can be modelled by inserting parameters in orange cells or selecting pre-set values from a drop-down menu*

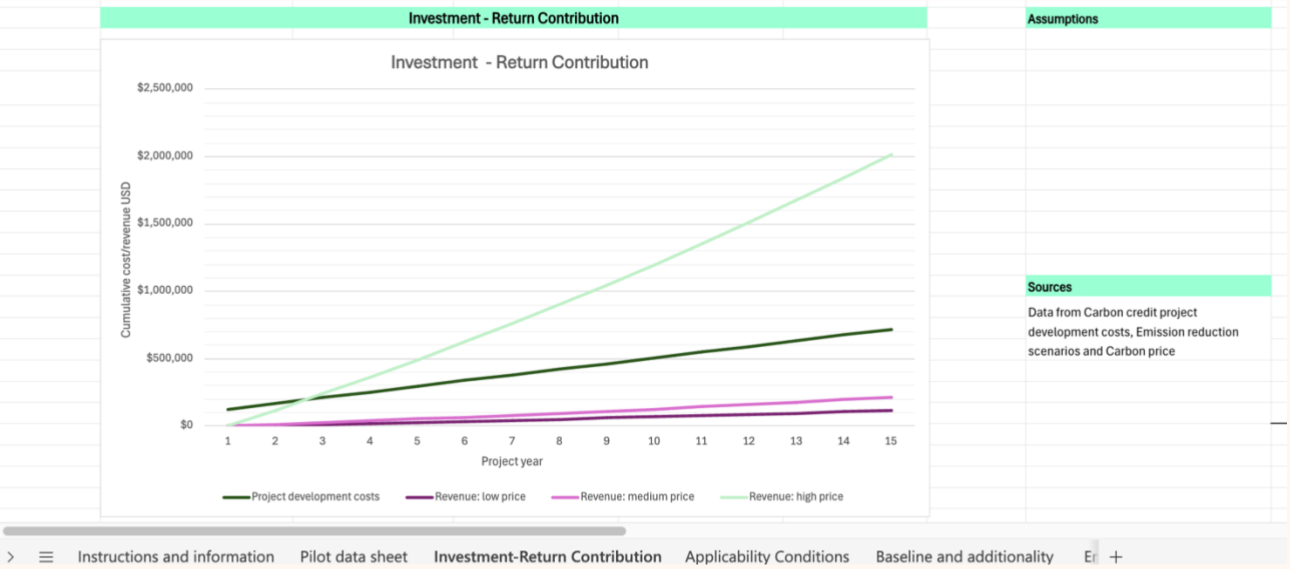


Figure 9. *Screenshot of investment – Return contribution calculation and cost-revenue breakeven point for a selected scenario*

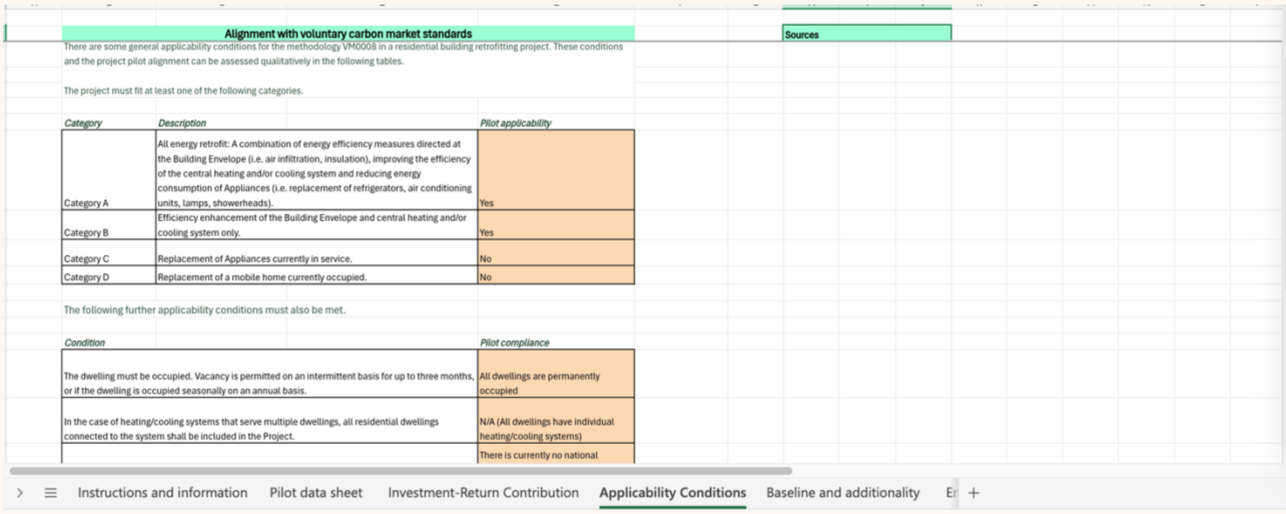


Figure 10. *Screenshot of assessing carbon credit project's methodological alignment*

Choosing suitable baseline scenario

Baseline scenario refers to the present conditions before the project's start. Which category is applied determines the choice of methods for demonstrating additionality and calculatin emission reduction approaches.

Baseline scenario	*Definition*	*Pilot applicability*
Category A	Fossil fuel and electricity consumed to satisfy the heat and cooling load and the Appliance plug load prior to Project implementation.	Yes
Category B	Fossil fuel consumed to satisfy the heat and cooling load prior to Project implementation. Electricity shall only be included when it is a heating or cooling source within the dwelling. Appliances and their corresponding electricity consumption shall not be included.	Yes
Category C	Replacement of Appliances: the baseline scenario consists of electricity consumed by the Appliances to be replaced prior to Project implementation.	No
Category D	Replacement of a mobile home: the baseline scenario consists of fossil fuel and electricity consumed to satisfy the heat and cooling load and the Appliance plug load of the mobile home to be replaced prior to Project implementation.	No

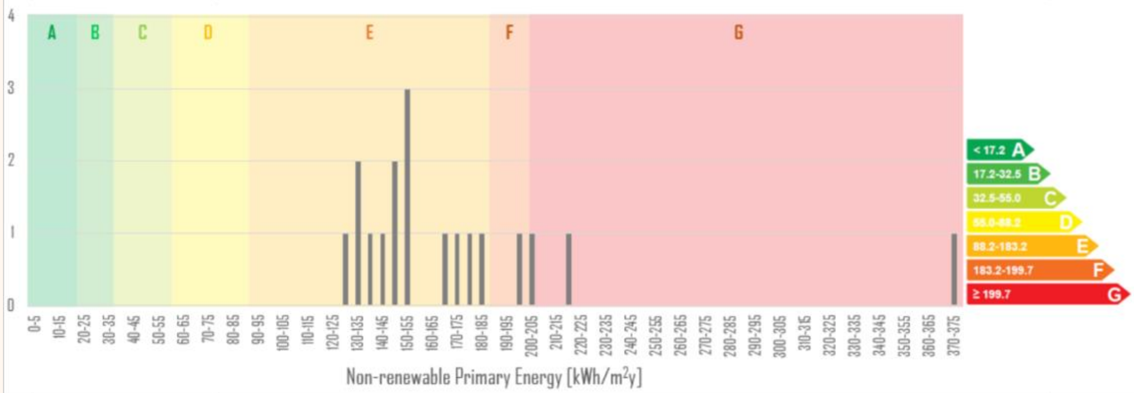
\> ≡ Instructions and information | Pilot data sheet | Investment-Return Contribution | Applicability Conditions | **Baseline and additionality** | Er +

Assessing additionality

Sources

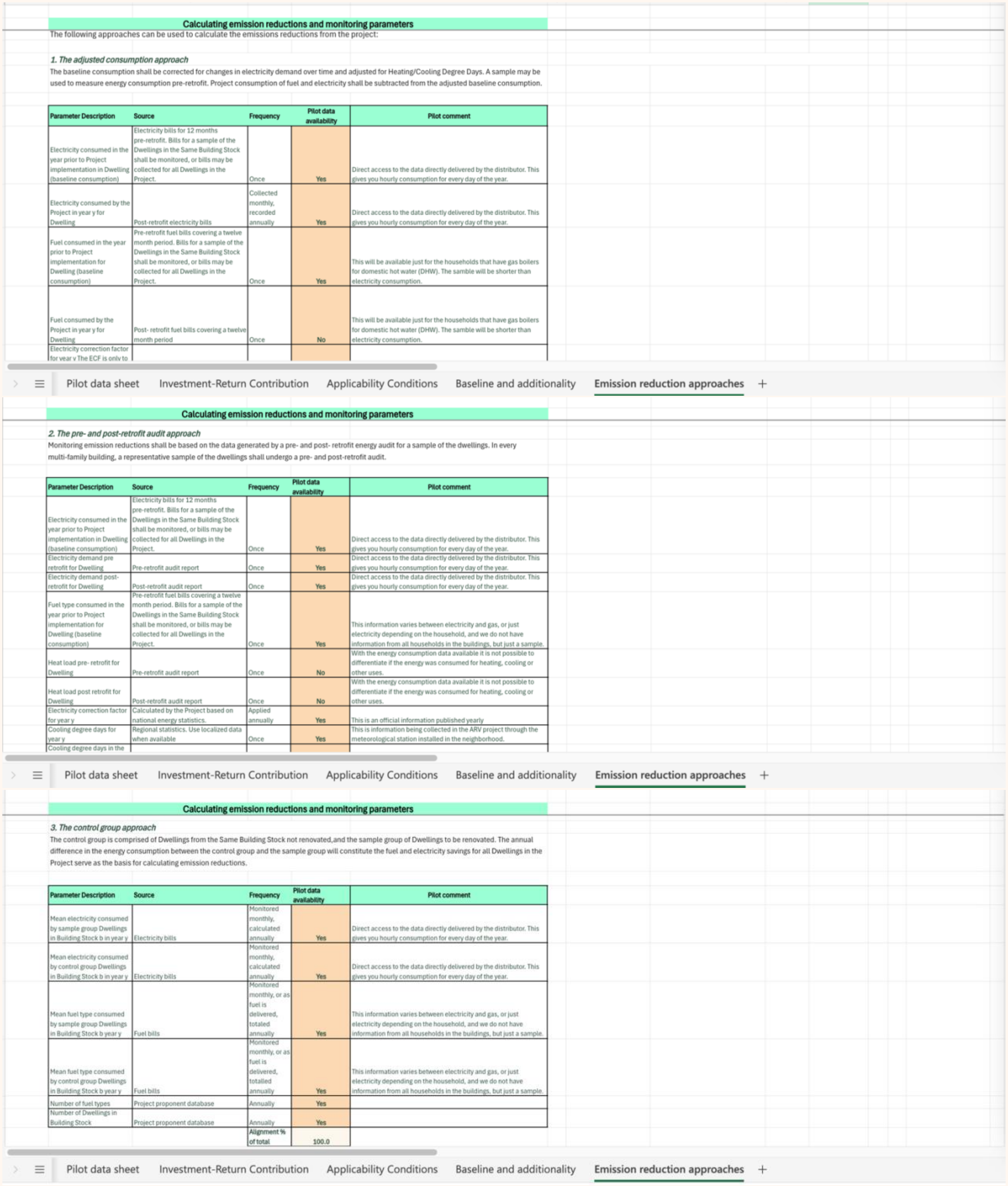
IEE (Informe d'avaulació d'Edificis) registers, City of Palma

Methodology requirement	A performance method must be used to demonstrate additionality for baseline scenarios A and B. The dwelling must meet or exceed the performance benchmark as calculated for the Same Building Stock. The performance benchmark is a value above average performance that represents a percent savings in energy consumption that dwellings are not likely to reach with 90% certainty in the absence of the project. A representative sample of the same building stock should be used for that purpose.
Pilot comment	Based on the pilot data availability assessed in "Emission reduction approaches", a performance benchmark of the same building stock has been calculated. The figure below shows the non-renewable energy consumption and corresponding Energy Certificate (EC) of the same building stock. This is based on a representative sample of 58% of the buildings in the area. This can be considered an indirect indicator that the energy labels of renovation targets (post-retrofit) is significantly lower than the current building stock, which don't undergo deep retrofitting under a BAU scenario. **Note:** The reliability of the Energy Certificate (EC) value varies depending on the context (energy retrofit, a regular building inspection (IEE), or a property transaction (buying/selling)). In general, ECs for IEEs and transactions (buying/selling) are significantly less reliable than those for energy retrofits, which are conducted with more care and attention to detail. The source data contains ECs from IEEs, which are known to have lower reliability. Therefore, the values presented are indicative only and a performance benchmark analysis should be carried out in subsequent project development steps.



Non-renewable energy consumption and corresponding EPC labels of renovation targets (Multifamily building described as Archetype 1 in D4.3)

***Figure 11.** Tool feature to assess suitable baseline scenario and determining additionality*



Calculating emission reductions and monitoring parameters

The following approaches can be used to calculate the emissions reductions from the project:

1. The adjusted consumption approach

The baseline consumption shall be corrected for changes in electricity demand over time and adjusted for Heating/Cooling Degree Days. A sample may be used to measure energy consumption pre-retrofit. Project consumption of fuel and electricity shall be subtracted from the adjusted baseline consumption.

Parameter Description	Source	Frequency	Pilot data availability	Pilot comment
Electricity consumed in the year prior to Project implementation in Dwelling (baseline consumption)	Electricity bills for 12 months pre-retrofit. Bills for a sample of the Dwellings in the Same Building Stock shall be monitored, or bills may be collected for all Dwellings in the Project.	Once	Yes	Direct access to the data directly delivered by the distributor. This gives you hourly consumption for every day of the year.
Electricity consumed by the Project in year y for Dwelling	Post-retrofit electricity bills	Collected monthly, recorded annually	Yes	Direct access to the data directly delivered by the distributor. This gives you hourly consumption for every day of the year.
Fuel consumed in the year prior to Project implementation for Dwelling (baseline consumption)	Pre-retrofit fuel bills covering a twelve month period. Bills for a sample of the Dwellings in the Same Building Stock shall be monitored, or bills may be collected for all Dwellings in the Project.	Once	Yes	This will be available just for the households that have gas boilers for domestic hot water (DHW). The samble will be shorter than electricity consumption.
Fuel consumed by the Project in year y for Dwelling	Post- retrofit fuel bills covering a twelve month period	Once	No	This will be available just for the households that have gas boilers for domestic hot water (DHW). The samble will be shorter than electricity consumption.
Electricity correction factor for year y The ECF is only to				

Pilot data sheet | Investment-Return Contribution | Applicability Conditions | Baseline and additionality | Emission reduction approaches | +

Calculating emission reductions and monitoring parameters

2. The pre- and post-retrofit audit approach

Monitoring emission reductions shall be based on the data generated by a pre- and post- retrofit energy audit for a sample of the dwellings. In every multi-family building, a representative sample of the dwellings shall undergo a pre- and post-retrofit audit.

Parameter Description	Source	Frequency	Pilot data availability	Pilot comment
Electricity consumed in the year prior to Project implementation in Dwelling (baseline consumption)	Electricity bills for 12 months pre-retrofit. Bills for a sample of the Dwellings in the Same Building Stock shall be monitored, or bills may be collected for all Dwellings in the Project.	Once	Yes	Direct access to the data directly delivered by the distributor. This gives you hourly consumption for every day of the year.
Electricity demand pre retrofit for Dwelling	Pre-retrofit audit report	Once	Yes	Direct access to the data directly delivered by the distributor. This gives you hourly consumption for every day of the year.
Electricity demand post-retrofit for Dwelling	Post-retrofit audit report	Once	Yes	Direct access to the data directly delivered by the distributor. This gives you hourly consumption for every day of the year.
Fuel type consumed in the year prior to Project implementation for Dwelling (baseline consumption)	Pre-retrofit fuel bills covering a twelve month period. Bills for a sample of the Dwellings in the Same Building Stock shall be monitored, or bills may be collected for all Dwellings in the Project.	Once	Yes	This information varies between electricity and gas, or just electricity depending on the household, and we do not have information from all households in the buildings, but just a sample.
Heat load pre- retrofit for Dwelling	Pre-retrofit audit report	Once	No	With the energy consumption data available it is not possible to differentiate if the energy was consumed for heating, cooling or other uses.
Heat load post retrofit for Dwelling	Post-retrofit audit report	Once	No	With the energy consumption data available it is not possible to differentiate if the energy was consumed for heating, cooling or other uses.
Electricity correction factor for year y	Calculated by the Project based on national energy statistics.	Applied annually	Yes	This is an official information published yearly
Cooling degree days for year y	Regional statistics. Use localized data when available	Once	Yes	This is information being collected in the ARV project through the meteorological station installed in the neighborhood.
Cooling degree days in the				

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Calculating emission reductions and monitoring parameters

3. The control group approach

The control group is comprised of Dwellings from the Same Building Stock not renovated,and the sample group of Dwellings to be renovated. The annual difference in the energy consumption between the control group and the sample group will constitute the fuel and electricity savings for all Dwellings in the Project serve as the basis for calculating emission reductions.

Parameter Description	Source	Frequency	Pilot data availability	Pilot comment
Mean electricity consumed by sample group Dwellings in Building Stock b in year y	Electricity bills	Monitored monthly, calculated annually	Yes	Direct access to the data directly delivered by the distributor. This gives you hourly consumption for every day of the year.
Mean electricity consumed by control group Dwellings in Building Stock b in year y	Electricity bills	Monitored monthly, calculated annually	Yes	Direct access to the data directly delivered by the distributor. This gives you hourly consumption for every day of the year.
Mean fuel type consumed by sample group Dwellings in Building Stock b year y	Fuel bills	Monitored monthly, or as fuel is delivered, totaled annually	Yes	This information varies between electricity and gas, or just electricity depending on the household, and we do not have information from all households in the buildings, but just a sample.
Mean fuel type consumed by control group Dwellings in Building Stock b year y	Fuel bills	Monitored monthly, or as fuel is delivered, totalled annually	Yes	This information varies between electricity and gas, or just electricity depending on the household, and we do not have information from all households in the buildings, but just a sample.
Number of fuel types	Project proponent database	Annually	Yes	
Number of Dwellings in Building Stock	Project proponent database	Annually	Yes	
		Alignment % of total	100.0	

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Figure 12. *Tool feature to assess the most suitable approach to measuring project generated emission reductions. Final score for each approach is presented at the bottom as a percentage.*

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