Risk reduction for Building Energy Efficiency investments

The EEnvest Evaluation Methodology for EE Investments including multiple-benefits

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Abstract

The EEnvest innovative Methodology developed in this document represents a multi-dimensional approach to analyze energy efficiency investments that includes energy and non-energy related benefits and consequently enhance the attractiveness of investments in the sector. The main objective of this document consists of providing investors with an evidence-based set of qualitative and quantitative KPIs to ease the assessment of multi-benefits in Deep Energy Renovation projects and therefore facilitate the investment decision-making process. Such approach responds to the investment market need for a standardized evaluation method assessing risks in building energy efficient renovation projects.

This document elaborates the EEnvest Methodology in a step-by-step way. Firstly, it maps investors profiles, their perspectives and relevant trends in the current financial market. Then it displays multiple-benefits KPIs for investors, based on the results of internal and consortium-level discussions, extensive desk research, interviews, events & webinars participation. A special focus is placed on the increasing importance of environmentally sustainable economic activities and sustainable finance framework in the UN Sustainable Development Goals and EU Taxonomy Regulation. Thereafter is presented in detail the Multi Criteria Decision Analysis (MCDA) tool as a standardized method to benchmark investment alternatives built upon the assessment of three dimensions: (i) Technical Risk Assessment, (ii) Financial Performance Assessment and the (iii) Multi benefits assessment. The expected project investment performance and impact assessment on an ex-ante basis further strengthen the investors' project evaluation and minimize the investment's risks.

EEnvest Methodology validation is conceived through several phases of the EEnvest project. The method was submitted to the Advisory Board for endorsement, it will also be applied in two demo-cases of energy renovation projects in Italy and Spain, and it has been designed to be a replicable tool for different asset types and across European countries.

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List of abbreviations and acronyms

EE	Energy Efficiency
DER	Deep Energy Retrofit
SDG	Sustainable Development Goals
ESG	Environmental, social, and governance criteria
MCDA	Multi Criteria Decision Analysis
CSR	Corporate Social Responsibility
PE	Primary Energy consumption
TSC	Technical Screening Criteria
MB	Multi-benefits
GHG	Greenhouse Gases
GWP	Global-Warming Potential

1 Introduction

For building renovation operations, the risk insight is an important driver of most energy efficiency related investments. However, the investors and building owners' understanding of the associated risks to renovation can be limited.

In fact, as of today most of the investment decisions in deep energy retrofits (DER) are solely based on empirical methods which depend on company specific characteristics and single project features. As a result, this single-case approach hinders the market uptake for deep energy retrofits across Europe.

It is thus clear that the investment market lacks a reliable knowledge-based evaluation method to better understand the risks that are deeply embedded in energy efficiency investments. This market failure can be coped with the design, development and roll-out of a structured methodology that analyzes DER investment opportunities from a technical, financial and multiple-benefits angle. In addition, the methodology should provide building owners and external investors the expected full performance and impact assessment of the project on an ex-ante basis.

The EEnvest Project is strategically positioned to close the knowledge and financial gap in the building renovation value chain, providing economic and impact indicators to investors and building owners with the objective of de-risking energy efficiency investments. In fact, the EEnvest Project aims to connect investors, who are looking for investment opportunities with building owners, who are seeking financing, through a user-friendly web-based platform.

In a nutshell, the EEnvest Project will develop a methodology (i.e. the EEnvest Methodology) which de-risks energy efficiency investments and provides jargon-free KPIs to interested parties. These outputs are meant to be exploited both as independent tools as well as presented as a whole in the EEnvest Platform, where investors will be able to benchmark Deep Energy Retrofits (henceforth DER) investment opportunities.

Under this context, this report main objective is to provide investors with an evidence-based and investor-friendly method to evaluate the impact of both energy and non-energy related benefits on the investment case of energy efficiency renovation projects.

To fulfil this objective, the report is divided in 5 main sections. The first section (i.e., Second Chapter) exposes the strategy and activities carried out to deliver this report. The second section of the report presents the multiple-benefits KPIs for investors. Then, the third part builds upon the multiple-benefits for investors and showcases the full picture of the multiple-benefits for both building owners and investors. The fourth section exhibits the Multi-Criteria Decision Analysis method as the most suitable procedure to benchmark DER investment opportunities. Then, the fifth component integrates all the prior sections and presents the EEnvest Methodology with a systematic and step-by-step approach.

2 Approach

In the light of producing a methodology that is exhaustive and reliable enough to mitigate investment risks and boost investors' confidence, a thorough and step by step methodology was followed to produce this report.

The first step consisted of monitoring and reviewing the latest trends on multiple benefits, ESG criteria and impact investing criteria in the real estate market. Whilst performing this activity, interviews with relevant investors have shown that the Sustainable Development Goals gained traction and relevance among investors. Interview details and questionnaire results are described in Annex 4.

In fact, the investors' responses highlighted a distinct consideration for environmental benefit as primary non-financial focus in the investment decision-making process. The progressive definition of the EU Taxonomy represents a powerful incentive for investors towards activities that comply with ESG criteria. Non-compliance could lead to an increase in investment cost in the long term, which results in the most undesirable investment risk, according to the interviews' results.

Secondly, a deep dive into the several types of investors took place. This distinction goes beyond the difference between an investment fund and an asset manager; it was rather oriented towards the still-emerging boom of sustainable finance or green investments as mentioned in the previous paragraph. The underlying rationale of this approach was to identify and understand how these new investor types are allocating capital and to establish impact metrics that could be of interest to investors.
The next step of this approach consisted of selecting a set of specific KPIs that could be investor-friendly and, at the same time, able to expose the full impact of DER investment opportunities. Since DER investments are typically not attractive from a purely financial standpoint, due to technical complexity and financial risks associated, it was extremely relevant to design a set of reliable KPIs that would attract investors while exposing any sort of environmental, societal, and economical impact of the investment opportunity at hand.

Based on an intensive desk research and stakeholders' engagement, it was concluded that there are building owners (or project promoters) that seek financiers to execute DER whereas investors are looking for greener impact metrics for financial, competitive, strategic and perception reasons[1]. On top of this, policy instruments and regulations are pushing the market towards this direction with high level initiatives such as the Renovation Wave and the EU Taxonomy. This rationale is in fact the guiding backbone of this report and it is better presented in Figure 1.

[1] Venkataramani, S., Gartner (2021) Retrieved from https://www.gartner.com/smarterwithgartner/the-esg-imperative-7-factors-for-finance-leaders-to-consider

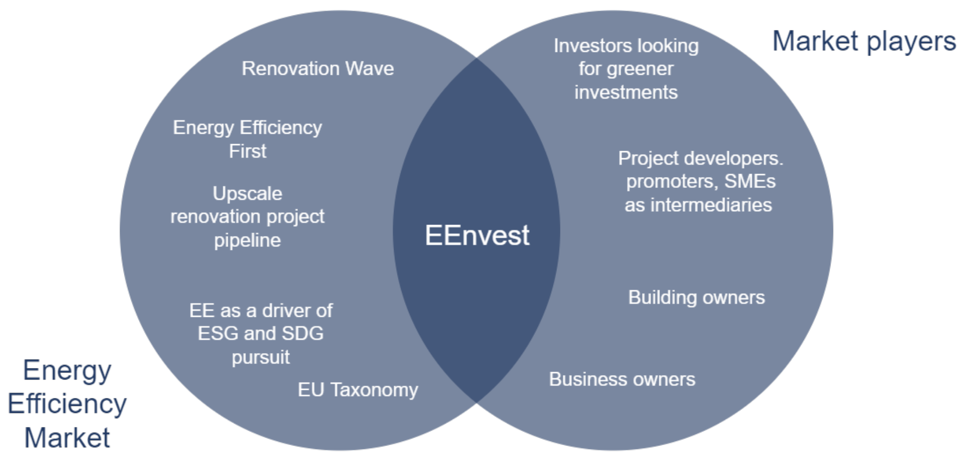

Figure 1: Venn Diagram on the EE Market Dynamics and positioning of the EEnvest Project

Then, internal discussions took place in the light of differentiating between the KPIs that are most relevant for investors and project promoters, a dedicated working session with the Advisory Board was enacted with the objective of sharpening the selection of KPIs that are of interest to investors. The first effort on this line refers to a technical workshop that took place during 2021. The *"Future of Multiple-Benefit for Investors: Accelerating Energy Renovations Investments" workshop* had the objective of discussing with the most representative actors of the market (scientific, policy-making and financial institutions) how multiple benefits could upgrade DER investment opportunities and furthermore, how multiple benefits are nowadays incorporated in the investment decision-making process of investors, whilst of course disseminating the EEnvest Project with external stakeholders. The workshop counted on the participation of GNE Finance's representatives, as well as from BNP Paribas Fortis and the European Commission's Joint Research Center (JRC). The recording of the event is available online[2] and the promotional leaflet can be found in Annex 1. Further discussion with top market actors took place during 2021, such as a technical discussion on financial modeling where GNE Finance representatives participated in a Plenary Meeting with the Energy Efficiency Financial Institutions Group (EEFIG) during February 2021, the agenda of the meeting is shared in Annex 2.

After the definition of multiple benefits KPIs for investors in Chapter 3.2 of this report, the following step of the methodology consisted of selecting the most suitable way to benchmark different DER investment alternatives by using all the set of KPIs. This stage of the procedure emerged as a natural task, given the market need for reliable methods and tools to (i) assess DER investment opportunities and subsequently (ii) benchmark DER projects. A special taskforce was formed to achieve such an objective. Specifically, strong desk research, technical discussions, testing, and several iterations took place. As result of these efforts the Multi-Criteria Decision Analysis (henceforth MCDA) tool emerged as the most appropriate method to compare different DER projects.

Then, the next step of the approach consisted in integrating and explaining all different parts of the EEnvest Methodology and its outcomes presented as a report. In brief, the EEnvest Methodology is the combination of the technical risk assessment, financial performance assessment, multiple benefits assessment, the EEnvest Reporting tool and the MCDA

[2] https://www.youtube.com/watch?v=WbY2TND5oFk.

benchmarking tool. The EEnvest Methodology is designed considering needs related to integration and implementation into a web platform accessible for investors, building owners and project promoters. All relevant project partners contributed during development of the reporting tool, which template form is presented in a summarized and concise way in.

3 An investors' perspective to multiple benefits

The renovation of buildings has become a topic of vital importance for the achievement of the targets set by the European Union for 2030-2050 as buildings in the EU are responsible for 40% energy consumption and 36% greenhouse gas emissions (European Comission, 2020). As the renovation of buildings is becoming a key point for driving decarbonization, understanding the impact of these projects is of fundamental importance. The multiple benefits approach seeks to unfold the full impact of DER projects resulting in stronger and reinforced investment opportunities for investors looking to deploy capital in these endeavors.

Multiple benefits consist of benefits embedded into a project that go beyond the monetary value (i.e., pure financial parameters) and they accrue to three impact dimensions: environmental, economic, and social. These impact dimensions can be perceived from two angles: the impact that the DER project brings to building occupants (i.e., inside the building) and the benefits that occur outside the building. A brief example on how multiple benefits impact building occupants (i.e., employees) in a commercial building would be a reduction in employees' absenteeism rate or higher productivity levels as results of better indoor air quality, thermal comfort, visual comfort and acoustic comfort. It may be concluded that employees perform better after the indoor conditions get improved. For the second case, benefits occurring beyond the building would be the CO2 equivalent emission reduction deducted from the percentage of energy savings as well as the numbers of jobs created as results of the investment. The same impact dimensions apply to DER projects related to other asset types, such as residential buildings, in line with the requirement about replicability.

This section of the report deals with those multiple benefits that occur beyond the building itself, which are relevant for the investors. The rationale of this relies on that multiple-benefits for investors are incorporated in the investment decision-making process and therefore may guide the investors towards one project or another, as per project's performance on these multiple-benefits. Therefore, in this type of project an investor is defined as any person or organization which have the capacity of financing a DER project with the expectation of achieving a profit. The investor does not hold any equity or have specific relation with the owner of the building asset. The counterpart of this perspective refers to the building owner (or project promoter) who holds equity and owns the asset. For the sake of this report, investor and financier are used as synonyms.

Under this frame, the paradigm of investors (or investors dilemma) comes into play. Historically, investors worldwide were allocating capital and deploying investments in those investment opportunities with the highest return of capital. In other words, the parameters and metrics that guided investors' decision-making process were purely financial and did not consider other impact dimensions such as environmental and social impact. In today's world, where the whole society has a stronger sense of awareness of the harmful impact of some economic activities, such an approach is no longer valid and suitable for the needs of the market. Modern-day investors are updating and thus improving the way investments are valued with an increased focus on sustainable investments with social and environmental impact. This change is also being driven by regulatory changes and legal compliance requirements, like the introduction of the EU Taxonomy. In fact, companies are now being forced to comply with environmental, social and governance (henceforth ESG) and corporate social responsibility (hereafter CSR) standards, that are driving new competitiveness in the financial strategies which has fostered green and sustainable investments from many private investors.

The results of this context are straightforward: investors are looking for greener investment opportunities with clear, reliable and reportable impact metrics that can be used for in-company corporate decisions as well as external branding towards the market, shareholders and relevant stakeholders.

In the light of selecting relevant impact metrics for investors three work streams were defined and performed. The first one refers to an investor mapping with the objective of understanding the investors' point of view and investment objectives. The second workstream relates to selecting and proposing specific multiple-benefits KPIs relevant for investors. Along this process, the third workstream refers to a deep dive into the sectioned KPIs, in the form of dedicated discussions to narrow down the definition and implication of such KPIs. The guiding rationale of this last workstream was to propose a set of metrics that are not only relevant for investors, but also reliable in the sense of computation methodologies, and potentially replicable to other types of assets. The result of the methodology developed in this report gets validated both by addressing the EEnvest Advisory Board, whose feedback will be included in the Annex 5, and by the application of the methodology instruments in the Work Package 6, as concrete proof-of-concept for the proposed investment evaluation approach.

3.1 INVESTOR'S MAPPING

The starting point to identify the different types of investors is the platform users map that was developed in the Deliverable 3.2, where a general framework has been established defining the potential users of the platform in the investment sector. To further develop the investors' mapping, in this chapter an overview of the difference among impact investing, SDG investing, ESG and sustainable investing will be provided. During this process, special focus has been put on the investment decision-making drivers as they are in close relation to the most relevant metrics for investors.

The stakeholder mapping is the first and most important step to understand which types of investors are interested in DER projects. In fact, the objective of the Platform is matching at best the expectations of both the supply and demand side as it impacts the market penetration and usage rate. During the effort led by Project Partners, a map of stakeholders was created and is reported in Figure 2 below.

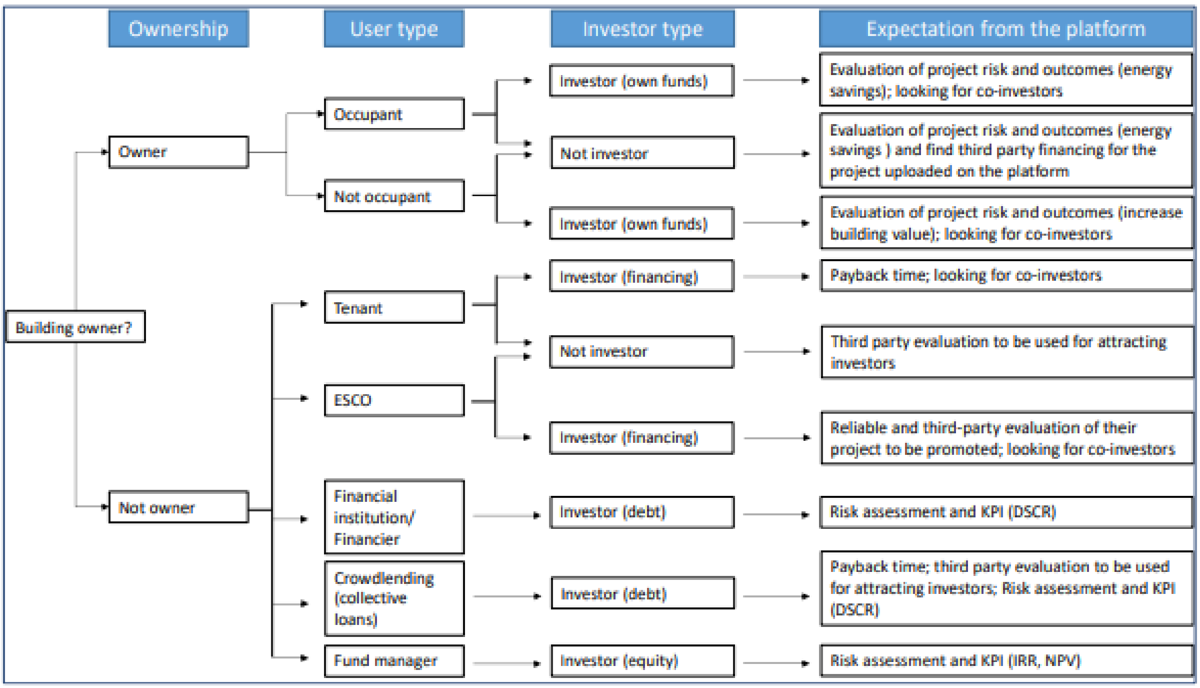

Figure 2: Source: Platform Users Map SINLOC, 2021

To identify the investor profile, the first aspect relies on grounding the ownership of the asset. The scope of this report is to define and address investors as not holding ownership on the building. These types of investors can finance the project by equity or debt, as shown in Figure 2. Each investor type has its specific investment objectives while analyzing the opportunity of an investment in a DER project. Types of potential investors and user categories and respective decision-making drivers are presented below:

- <u>Tenants:</u> This specific profile may be eager to renovate the building in the case the payback period of the investment falls within the time horizon of the contract that formalizes the relationship tenant-owner of the building occupancy. This may be the case for those tenants that are accounted for the utility bills. Another investment driver would be the impact that building occupants may experience (i.e., employees) especially if these benefits may boost employee's productivity and therefore increase the company's output. If the tenant is seeking co-investors or financiers in the form of debt, this external investor may be looking for corporate reporting metrics such as CO2 emission reduction, EU-Taxonomy Compliance Metrics or Numbers of Jobs Created as results of the investment.

- <u>Energy Service Companies (ESCOs):</u> Under an Energy Performance Contract Business Model (EPC Business Model) ESCOs may offer financing directly to building owners. In this case, the investment drivers for the ESCO goes in line of (i) offering an end-to-end service to the client (i.e., building owner), (ii) returns on the investment and associated risks, and (iii) CO2 emission reduction and other sort of related multiple benefits that may ease the access for financing the ESCO's operations themselves.

- <u>Financial institutions or financiers</u>: As debt investors, they pay special attention to the inherent risks of the project but most importantly, to the creditworthiness of the building owner. This is especially relevant as what these investors try to assess is the capacity of the building owner to repay the loan, of course with the set return of the investment. As previously explained, these investors are under the spotlight due to strong market pressure and regulations such as the EU Taxonomy. Hence, financial institutions do have the obligation to look to multiple benefits, such as CO2 Emission Reduction, as a source of tangible data that can be reported to external stakeholders and market regulators.

- Crowdlending: This financing method facilitates companies or building owners to finance their ventures through a large and diverse group of people without having to go directly to a retail bank. The terminology of this instrument refers to crowd = people and lending = lending money. In other words, a relevant number of people lend money in an exchange of financial return that is stipulated in the loan agreement[3]. For crowdlending it is also relevant to highlight the importance of non-financial profits, such as social impact, as key investment drivers in the sector.

  Under this frame the renovation project is financed by debt and thus the method to determine the return on the investment as well as the payback period may be linked to the creditworthiness of the building owner. Nevertheless, the impact dimension of the investment is particularly relevant for crowdlending mechanisms as it is a mean to motivate the critical mass of lenders (i.e., the crowd) to lend their money instead of investing in a long-term and low-risk investment. So, if articulated and measured properly, the crowd may prioritize lending their money for projects that have a measurable and positive impact, such as DER.

- Fund Managers: Managers of an investment fund investing in energy efficiency projects. The objective would be, on one hand, to activate new investments and, on the other hand, to support the achievement of environmental benefits. This investor would use the methodology to get support in calculating technical risks as they may lack the necessary resources (technical skills, time) to assess project risks and performance. As this user is investing in equity, they will expect to look at the risk assessment and financial KPIs (NPV; IRR). Similarly, to financial institutions, these funds are under scrutiny and thus are looking for specific multiple benefits that showcase the full impact of their capital allocation. However, differently from debt investors, they are exposed to risk of having stranded assets in their portfolio if they don't take into consideration the depth enough renovation of buildings.

Looking at this diversified scenario of investors profile and their specific interests for DER projects, it could be concluded that there is no standardization nor common agreement on the market in respect of which metrics may be reliable enough to be used to benchmark different investment opportunities. Likewise, there is no consensus in the financial world in respect of what is the best-in-class approach to account for environmental, social and economic impact or a direct link between one specific investment and its contribution to the social and environmental topics such as the SDGs.

[3] For further details on crowdlending and crowdlending platforms, we suggest reviewing Ecrowd! Mechanism in the following website: https://www.ecrowdinvest.com/en/what-is-crowdlending-or-debt-crowdfunding. Ecrowd! is a member of the EEnvest Consortium.

In fact, within the financial world there are different strategies to approach issues of social and environmental impact. At one extreme there are traditional finance models that focus solely on obtaining the best possible financial returns considering the risk of the investment, and at the other extreme is philanthropy whose sole objective is to achieve positive impacts without expecting any type of financial return. Alternatives then emerge in the middle that open the possibility for investors to approach impact issues from different perspectives.
To provide greater clarity on this spectrum of possible investment strategies, in November 2015 Bridges Fund Management, an impact investment fund located in London, developed the following "capital spectrum" showing the different approaches to investment issues in regards of social and environmental impact that investors have, which are not exclusive and are often used in parallel by investors according to their investment thesis:

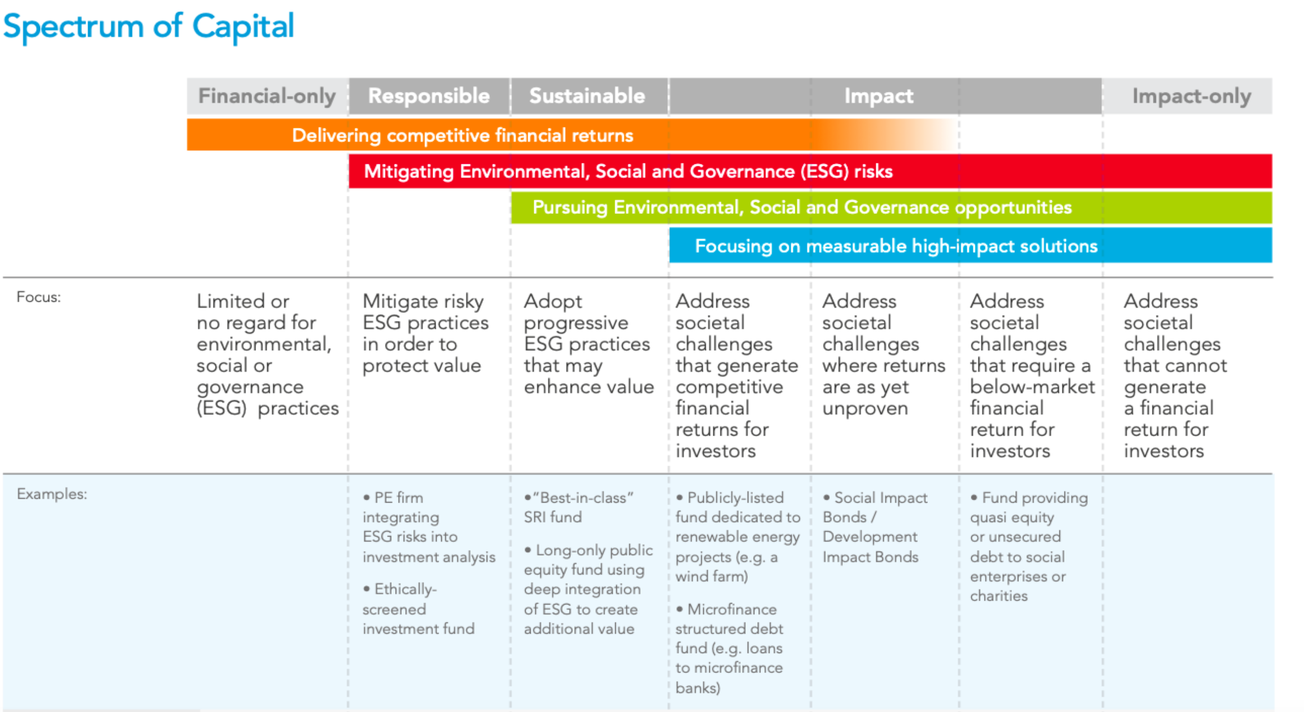

Figure 3: The Spectrum of capital provided by the Bridges Fund Management

From Figure 3 it is observable that within the "capital spectrum" the divisions between the different strategies are not exclusive or definitive and it may well happen that the same investor has different investment funds in his portfolio and that each of them aligns with a different strategy. For example, the Bridges Fund Management fund itself, when describing the "spectrum of capital", explains how they have different funds and in which thesis each one is located.

The first of the alternatives are the *Socially Responsible Investments (SRI)* that emerged in the 1960s as an alternative to align investments with individual values in such a way that those investment options that do not align with the values of the investor (e.g., tobacco, coal, copper, weapons, gambling) are not considered as a viable investment option (this is what is known as a *"screening out"* or "exclusionary screening" strategy). Years later, investors realized the importance of incorporating Environmental, Social and Governance (ESG) risks into their investment decisions. Corporate transparency in the business world is increasingly important and the strategy of discarding investment opportunities based on ESG risks is known as "negatively screen".

In developing the investment option "negatively screen", the first sustainable finance modality emerged which not only discards those options that are risky based on ESG criteria, but also focuses on finding those alternatives that will have better performance in terms of ESG (this strategy is known as "best-in-class"). Thus, these are investments that consider the ESG criteria not as an additional risk measurement parameter, but as a criterion that allows identifying the most sustainable investment options to the extent that they will have a greater social and / or environmental impact. In 2005, to promote responsible investments aligned with ESG factors, the United Nations created the Principles of Responsible Investment (PRI) to encourage investors to align their investment theses with them. Today more and more investors seek to include these principles in their strategies, so much so that Deutsche Bank predicts that by 2030 95% of portfolios will be governed by them[4].

Within the spectrum of sustainable finance there are also thematic investments which are those made in sectors with a defined social or environmental theme - renewable energy, climate change, deforestation, water management, health, emerging markets, etc. - still aiming for competitive market outcomes. It is then a type of investment strategy that is part of sustainable finance when it uses ESG criteria to determine on which specific social or environmental issue it will focus its investment focus, for example energy efficiency as a solution to climate change.

Impact investment arises as an additional investment strategy that is made with the specific intention of having a positive impact on a specific social or environmental problem. It is then an investment modality in which, not only do the traditional elements of investments converge - financial returns and risks - but also the desired and measurable impact is considered as a third fundamental element within the investment decision. In the range of impact investing, it is also possible to find investors who prioritize achieving financial returns in line with the market (return first) or those who prioritize impact, although this may imply sacrificing financial returns (impact first).

Leveraging on the return first and impact first concepts, it may be concluded that investors tend to find the perfect balance between return and impact, while a building owner that is also the tenant may be prioritizing impact over return. It is precisely here where multiple-benefits come to play a significant role.

Under this context, the consequent step is to define a specific set of metrics that will help investors find the link between their specific investment strategies and the embedded impact of DER projects. This is indeed the content of the following section.

3.2 MULTIPLE-BENEFITS KPIS FOR INVESTORS

This section showcases the multiple-benefits KPIs for investors. The content is presented in a result basis, meaning that the following paragraphs illustrate the results of hosting several internal discussions as well as consortium-level discussions, exhaustive desk research, events & webinar participation as well as input from experts.

[4] (Flow, 2020)

3.2.1 Predicted Energy Savings

The Predicted Energy Savings is aligned with the environmental category of KPIs. The indicator states the difference between the Primary Energy consumption (hereafter PE) of a building before the renovation (considered the baseline, as this is an ex-ante evaluation) and the estimated Primary Energy after the renovation project has been carried out. PE savings encompasses the reduction of energy used for space heating, cooling, and air ventilation due to improvements in the high energy performance of the building envelope (thermal insulation, new windows, etc.) and thermal plants substitution of existing heating and cooling system with high energy performance ones), use on site Renewable Energy Sources (as solar energy by thermal and solar panels), use natural ventilation, abatement on electricity usage by efficient lighting, better use of natural illumination and by increasing the lifetime of materials used in the renovation among others renovation strategies. Primary Energy will be computed in kWh/m²y.

To classify the Predicted Energy Savings within an energy renovation context, a benchmark must be set in accordance with valid literature. The chosen qualitative metrics for this KPI is the one in line with the EU Building Stock Observatory published by the European Commission in the final report "Comprehensive Study of building energy renovation activities and the uptake of nearly zero-energy buildings in the EU"[2]. The literature provides a well-established benchmark based on the achieved goals and updated targets of the European Union and provides solid numbers to compare renovation achievements throughout the economic block. Renovations with up to 3% annually achieved primary energy savings are considered "Below Threshold", followed by "Light renovations" with annual PE savings ranging from 3% to 30%, then "Medium renovations" scoring between 30% and 60% savings, and lastly the so called "Deep Renovations" with annual PE savings reaching higher than 60% (European Commission, 2019). In this case the indicator is a percentage of primary energy savings, primary energy savings compared to the baseline scenario (consumption before the renovation project).

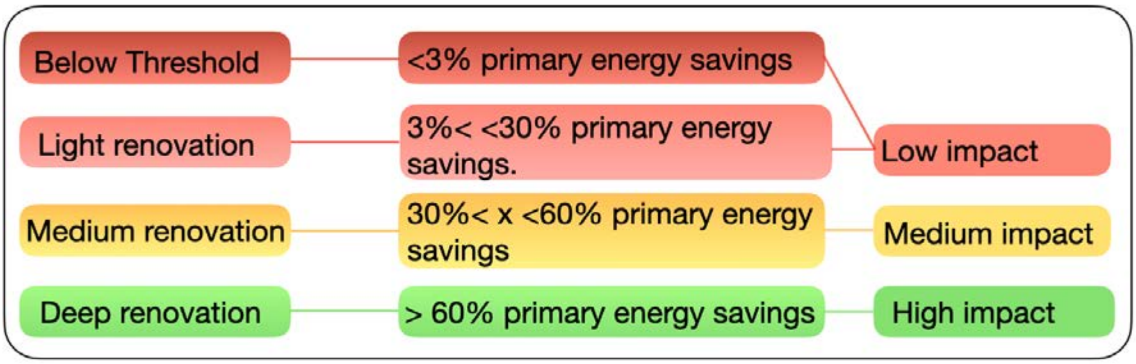

Figure 4: Four-category and three-value scale for assessing the impacts on Predicted Primary Energy Savings.

To further classify the renovation projects, a simple three-value scale has been applied to facilitate the decision-making process for investors. The categories decided upon are "Low impact", "Medium Impact" and "High Impact" and will be applied to all quantitative KPIs available.

To translate the threshold percentages into absolute metrics kWh/m^{2}y, then the categorization can be described as following. Renovations in non-residential sector achieving PE savings between 1 kWh/m2y and 50 kWh/m2y fall under *light* renovations and together with *below threshold* they account for the low impact investment category. Renovations achieving between 50 kWh/m2y and 116 kWh/m2y are classified as having *medium* impact and those exceeding 116 kWh/m2y will lead to *high impact* investments.
It is also useful to mention residential buildings for replicability purposes. Renovations in the residential sector achieving PE savings between 1 kWh/m2y and 19 kWh/m2y fall under *light* renovations and together with *below threshold* they account for the *low impact* investment category. Furthermore, renovations achieving between 19 kWh/m2y and 64 kWh/m2y are classified as having *medium impact* and those exceeding 64 kWh/m2y will lead to *high impact* investments.

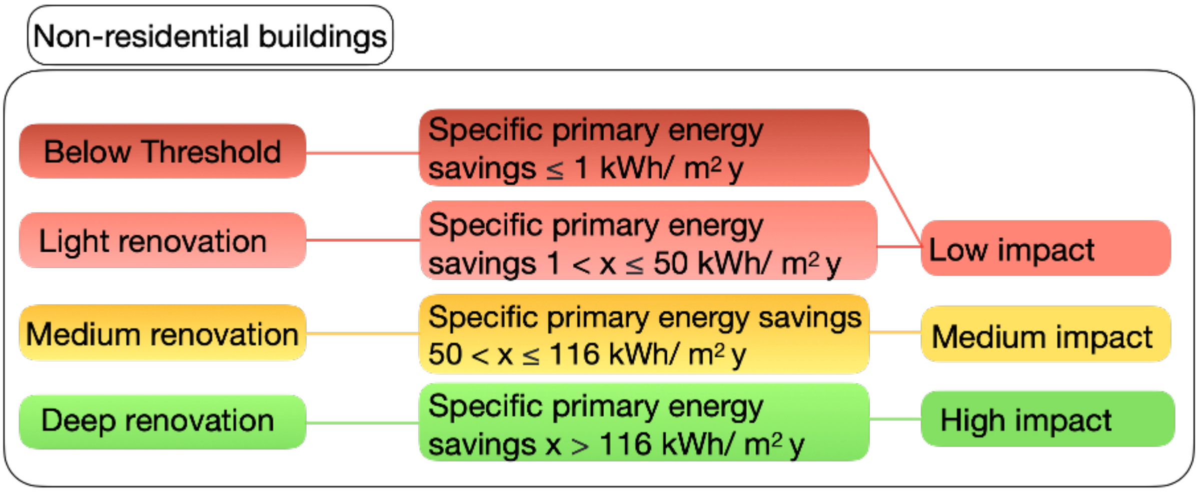

Figure 5: Four-category and three-value scale for assessing the impacts of Predicted Energy savings computed in kWh/m2y

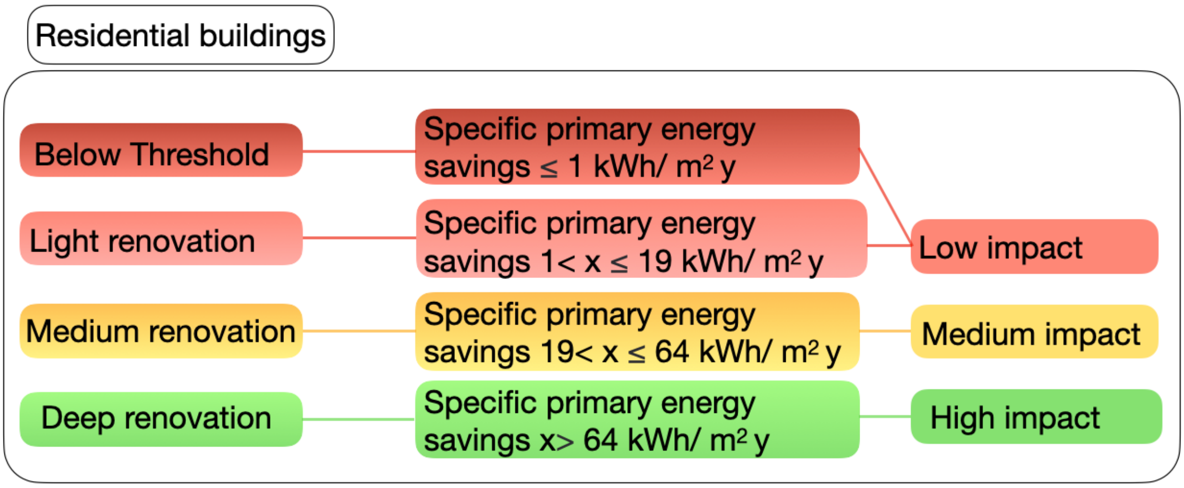

Figure 6: Four-category and three-value scale for assessing the impacts of Predicted Energy savings computed in kWh/m2y

3.2.2 CO_2 Equivalent Emission Reduction

The CO_2 equivalent emission indicator (abbreviated as CO_2-eq) is a metric that quantifies the effect of emissions of various greenhouse gases (GHG) on the global warming. Based on their specific global-warming potential (GWP), the amount of each greenhouse gases emitted is converted to its equivalent amount of carbon dioxide which would result in the same effect on global warming.

With the aim to evaluate the benefit associated to DER, the CO_2-eq emission *reduction* indicator is defined as the reduction in CO_2-eq emissions due to energy consumption by building operation The indicator depends on the choice for energy sources used by the building for heating, cooling, and electric appliances.

This KPI falls under the environmental category of the multiple-benefits and is suitable for other asset types, i.e., residential buildings, even though there is a differentiation between CO_2 impact reduction of residential and non-residential buildings since there is a deviation between the achieved goals between the two categories, as detailed in EU Report[5].

3.2.3 Number of Jobs created

The Number of Jobs Created Indicator refers to new long-lasting jobs created as a result of the investment in energy renovation projects. It is challenging to assess the actual number of jobs created as a direct cause of an investment since numbers might fluctuate depending on the project demands, market dynamics, geographical location of the project, etc. The KPI is based on a BPIE study[6] which states that 18 long-term jobs are created on average per 1 million euros invested in energy efficiency projects in the EU. This represents an average proxy with considerable deviation within the EU community. Countries and regions where employment costs are considerably low and the renovation potentials are still underserved usually depict higher rates (Croatia for instance, with an average of 29 long-term jobs/ €1 mil. invested scores considerably higher than Finland with 16 long-term jobs/ €1 mil.). This might be taken into consideration by investors seeking an accurate performance on this indicator and is especially important in post-pandemic times, when job creations will play a fundamental role in the economic recovery of the block.

To set up a three-value scale, the average number of jobs created in the EU per €1million invested was divided into 3 meaningful intervals for the renovation projects: (i) Project investments of up to €0,5 mil. will be allocated to the low impact category for generating a respective number of jobs. For (ii) projects with a total investment ranging between €0,5 mil. and €1 million the number of jobs is expected to rise to 18 as the estimates forecast, and as such will be categorized as a medium impact investment. Lastly, any energy renovation (iii) projects with more than €1 million invested will supposedly generate more than the average target, thus being considered a high impact investment concerning this multiple-benefit KPI.

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[5] European Commission, Directorate-General for Energy, *Comprehensive study of building energy renovation activities and the uptake of nearly zero-energy buildings in the EU: final report,* Publications Office, 2019, **https://data.europa.eu/doi/10.2833/14675**

[6] Retrieved from https://www.bpie.eu/wp-content/uploads/2020/09/LTRS-Assessment_Final.pdf.

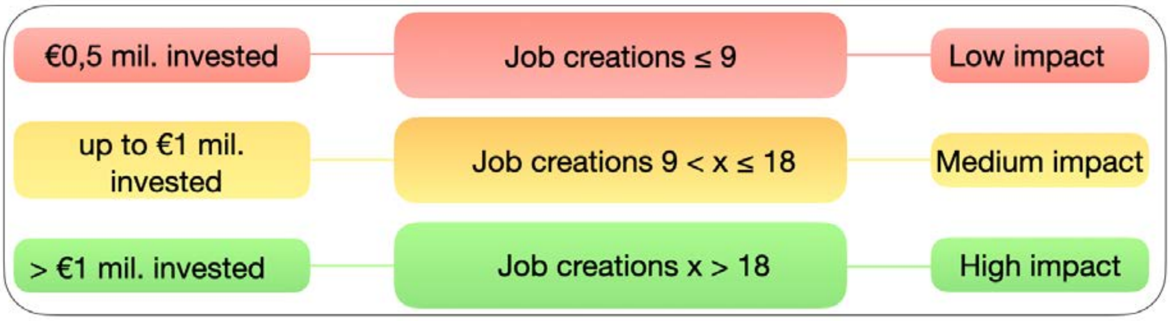


Figure 7: The three-value scale for assessing the impacts on Jobs creation based on total investment made.

3.2.4 EU Taxonomy compliance KPI

The EU Taxonomy is one part of the EU Renewed Sustainable Finance Strategy[7] that aims to set the necessary market conditions to propel the financial and industrial sectors towards sustainable investments and therefore carbon neutrality. In the light of such a quest, the EU Taxonomy has the objective of classifying sustainable investments across six specific environmental objectives. From investors' point of view, the EU Taxonomy is extremely relevant as it is the means of determining whether their investments can be classified as sustainable[8] and therefore, have the potential to be marketed and communicated as such. On the contrary, if an investment opportunity does not classify as a sustainable investment - as per the guidelines of the EU Taxonomy - then investors may decide not to allocate capital in these ventures or may divest on those investments that cannot be classified as sustainable.
The six environmental objectives of the EU Taxonomy are:

- Climate Change Mitigation;
- Climate Change Adaptation;
- Sustainable and protection of water and marine resources;
- Transition to a circular economy;
- Pollution prevention and control; and
- Protection and restoration of biodiversity and ecosystems.

In practical terms, only those investments that comply with Technical Screening Criteria (henceforth TSC) for one of the six environmental objectives and Do-No Significantly Harm for the other five objectives, and meet common minimum social safeguards, can be communicated as sustainable.

As part of the EU Taxonomy, the European Commission established the "technical screening criteria for determining the conditions under which an economic activity qualifies as contributing to climate change mitigation or climate change adaptation and to determining whether that economic activity causes no significant harm to any of the other environmental

[7] Retrieved from https://www.europarl.europa.eu/legislative-train/theme-a-european-green-deal/file-renewed-sustainable-finance-strategy.
[8] Retrived from https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance/eu-taxonomy-sustainable-activities_en.

objectives."[9] The technical screening criteria is composed of three articles and two annexes. The first Annex fixes the parameters to determine whether an economic activity qualifies as contribute to climate change mitigation and it causes no significant harm to any other environmental objectives. The second Annex, set-up the criteria to establish if an economic activity qualifies as contributing to climate change adaptation and it causes no significant harm to any other environmental objectives. It is important to mention that this technical criterion applies since the 1 of January of 2022, which means that some of the KPIs and criteria previously established inside the EEnvest project had to be adapted to it.

To ease the understanding, usability and implication of the EU Taxonomy, the European Commission has developed the EU Taxonomy Compass tool. In brief, the EU Taxonomy Compass is a visual representation of content of the EU Taxonomy and has the objective of making the details of the EU Taxonomy accessible for all user types. As such, the EU Taxonomy Compass enables users to check which activities are included in the Taxonomy (i.e., taxonomy-eligible activities), to which objectives they substantially contribute and what criteria they have to meet. The European Commission remarks that minimum safeguards (social standards) have to be met for an economic activity to be considered taxonomy-aligned[10].

In the case of Energy Efficiency renovations of buildings, the specific technical screening criteria can be found on the numeral 7.2 of Annex 1 and on the numeral 7.2 of Annex 2. The building renovation economic activity, the EU Taxonomy classifies this activity as part of the Construction and Real Estate umbrella. More in depth, the EU Taxonomy defines the following economic activities for the Construction and Real Estate sector[11]:

1. Construction of new buildings
2. **Renovation of existing buildings**
3. Installation, maintenance, and repair of energy efficiency equipment
4. Installation, maintenance, and repair of charging stations for electric vehicles in buildings (and parking spaces attached to buildings)
5. Installation, maintenance and repair of instruments and devices for measuring, regulation and controlling energy performance of buildings
6. Installation, maintenance, and repair of renewable energy technologies
7. Acquisition and ownership of buildings

In this regard it is important to mention that, although other activities taken during the DER project – such incorporating renewable energy technologies for purposes of electricity generation – may be compliant to the EU Taxonomy, since the purpose of the EEnvest platform is to assess the Energy Efficiency renovation project, it has been decided just to analyze this specific KPI to determine whether a project complies to the EU Taxonomy.

Since the projects to be analyzed through the EEnvest platform refer to DER which intend to guarantee major Energy Efficiency changes on existing non-residential buildings, it has been

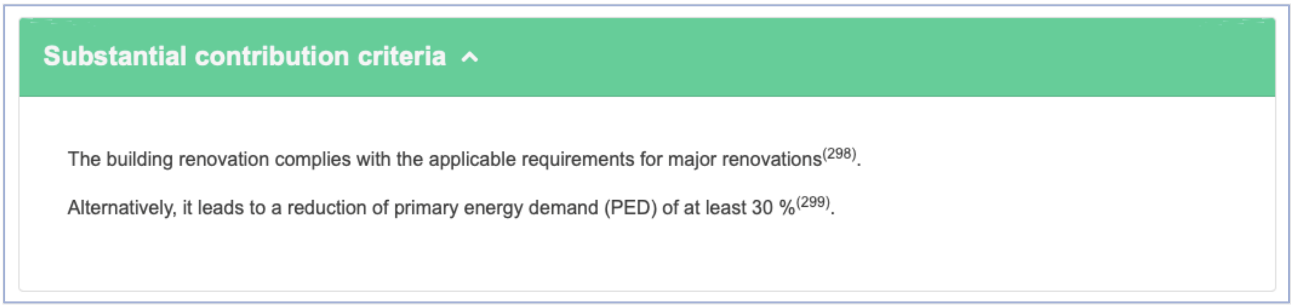
[9] European Commission, Directorate-General for Financial Stability, Financial Services and Capital Markets Union (EU) 2020/85 C/2021/2800 final June 2021 **supplementing Regulation (EU) 2020/852 of the European Parliament and of the Council by establishing the technical screening criteria for determining the conditions under which an economic activity qualifies as contributing substantially to climate change mitigation or climate change adaptation and for determining whether that economic activity causes no significant harm to any of the other environmental objectives** C/2021/2800 final.

[10] Retrieved from: https://ec.europa.eu/sustainable-finance-taxonomy/index.htm.

[11] Retrieved from: https://ec.europa.eu/sustainable-finance-taxonomy/activities/sector_en.htm?reference=7.

determined that the EEnvest platform needs to comply to the Climate Change Mitigation technical screening. For the Climate Change Mitigation objective, the EU Taxonomy defines two main indicators to determine whether a building renovation investment complies with the Taxonomy or not. The first indicator states that the building renovation complies with the applicable requirements for major renovation[12] and the second criteria defines that the building renovation leads to a reduction of the primary energy demand of at least 30%.

Further on the second criteria, the EU Taxonomy states that *"…The initial primary energy demand and the estimated improvement is based on a detailed building survey, an energy audit conducted by an accredited independent expert or any other transparent and proportionate method and validated through an Energy Performance Certificate. The 30 % improvement results from an actual reduction in primary energy demand (where the reductions in net primary energy demand through renewable energy sources are not taken into account), and can be achieved through a succession of measures within a maximum of three years..."*[13]. Figure 8 below better showcases these two criteria as defined in the EU Taxonomy Compass.


Substantial contribution criteria

The building renovation complies with the applicable requirements for major renovations[298].

Alternatively, it leads to a reduction of primary energy demand (PED) of at least 30 %[299].

Figure 8: Source: EU Taxonomy Compass. Retrieved from: https://ec.europa.eu/sustainable-finance-taxonomy/activities/activity_en.htm?reference=7.2

To provide investors with an actionable KPI that could complement their investments analysis and most importantly, their technical screening criteria, it is proposed to leverage on the second substantial criteria that alludes to a reduction of primary energy demand of at least 30%, since it would be difficult to assess on a European level the first criteria given the difference between national regulations to define and measure major renovations. In specific, a binary metric is proposed to determine whether the renovation project complies or does not comply with the EU Taxonomy. This is presented in Figure 8.

[12] As set in the applicable national and regional building regulations for 'major renovation' implementing Directive 2010/31/EU. The energy performance of the building or the renovated part that is upgraded meets cost-optimal minimum energy performance requirements in accordance with the respective directive.
[13] Retrieved from: https://ec.europa.eu/sustainable-finance-taxonomy/activities/activity_en.htm?reference=7.2.

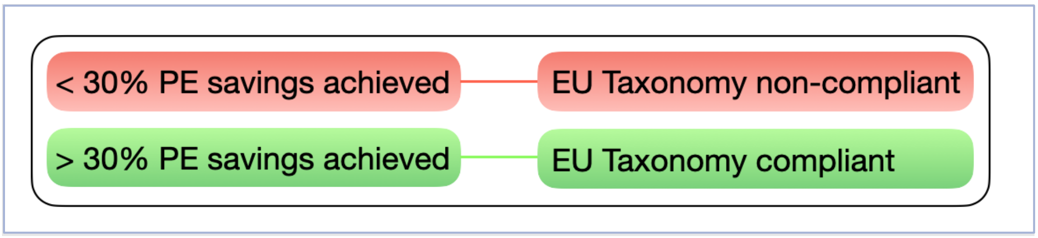


Figure 9: The binary scale for assessing EU Taxonomy compliance of an energy renovation project.

In conclusion, it could be concluded that any renovation project that is classified as EU Taxonomy non-compliant almost immediately translates into a red flag for investors and thus should be discarded from the investment options at hand.

3.2.5 Property value increase

When it comes to building renovation, property value increase refers to the possible increment in the value of the asset after the renovation works has been carried out. This increment in the asset value, as result of the renovation project, can either increase its resale price and/or rental value. This is what it is known as green premium or "greemium". On the opposite, a "brown discount" refers to the loss of value as result of holding a brown building asset, which means a poor-performing, malfunctioning and high-energy consuming building. The brown discount goes hand-by-hand with asset stranding, which will become immensely significant for those building owners who do not manage climate related risks associated to the built asset.

As an example, in a recent article[14], Guy Grainger, from Jones Lange Lasalle (JLL), stated that in one specific case of a building in the U.K was hit with a brown discount of about a third of its price. "It was valued last year at a certain level, and then when you took into account the costs of transitioning it to net-zero carbon, then the price was reduced by 30%...That's compared to a general 5% to 12% increase in value for a net-zero building, he said—a so-called green premium…" As explained by Guy Grainger, there is an increasing concern on the negative impact of the brown discount in built assets.

In practical terms, predicting the value increase on an ex-ante basis, i.e., before renovation works, might be hampered by several uncertainties and specific local context variables. This complexity may be observable in the difference between the appraisal resale value and the transaction resale value definitions.

The appraisal value is defined as the objective value of the asset that is defined by an unbiased external professional or appraisal body. To do so, the third party typically considers external factors such as location, market trends and comparable listings as well as internal factors such as size of the built asset (square meters), interior conditions and local regulation compliance. On the other hand, the market value refers to the tradable value of the asset (or transactional value) in a specific point in time that is shaped and influenced by market conditions such as supply and demand interaction, popularity of the location, and the overall performance of the economy. It may be concluded that the impact on the estimated value of the asset using one method or the other can be significant and thus leaves little room for an accurate estimation of the future sales or rental price of the asset as the result of the renovation works.

[14] https://fortune.com/2021/11/12/buildings-not-retrofit-net-zero-face-brown-discount-real-estate-green-premium/.

Another definition that is worth mentioning refers to the assessed value of a building. In brief, the assessed value is the parameter used to determine the property taxes of the specific asset and therefore is typically updated and used by the local governments. This definition of value is strongly subjected to the local context and may not be transferable from one country to another.

Other limitations to estimate the asset value on an ex-ante basis include the evaluation of ex-post environmental features applied in the renovation works, such as the added value from the appraisal and market value angle of having an environmentally friendly building. Furthermore, it is difficult to define an unbiased method to transform the benefit that occurs indoor and accrues to building occupants (such as indoor air quality, thermal, acoustic and visual comfort) into monetary value. In fact, any formula or method that attempts to compute such impact in monetary terms will be based only on the subjective perception of value by building occupants that perceive these benefits. This is, by definition, a subjective approach that by no means would be accepted in the market. Furthermore, EEnvest's previous research[15] exposes that there is little to zero exhaustive data on this specific topic, reinforcing the rationale that there is no standard nor accepted method to reliable determine the greemium of a built asset.

Under this context, it was decided to conduct an in-depth research task force on the most used building valuation methods with the objective of finding any signs or initiatives that consider renovation works within the valuation methods. The scope of research was set as per the most relevant appraisal bodies in the market, such as the Royal Institution of Chartered Surveyors (RICS[16]), the International Valuation Standards Council (IVSC[17]), The European Group of Valuers' Association (TEGoVA[18]), Cushman & Wakefield, JLL, TINSA and other relevant entities. The result of this research led to the definition of three widely used valuation methods. These are i) the market approach, ii) the cost approach, and iii) the income approach[19]. The outcome of these efforts can be found in Annex 3

Despite the efforts to develop a property value increase KPI as result of the renovation project, it was concluded that it is not possible to compute such an increase on an ex-ante basis due to the previously mentioned barriers. Further, as per the research on the valuation methods and their acceptance and credibility levels in the market, it was also concluded that property value increase is strongly subjected to the unique local context as well as the moment in time the asset is being marketed. To cope with this scenario, a quantitative information based on literature provides ranges that showcases the possible expected increase in rental and (re)sale value of the asset. The EEnvest methodology is developed to be adaptable, and its tools are designed to perform evenly for different kinds of assets and adapt to the market variables.

Table 1 presents property value increase according to a diversity of studies[20].

[15] Deliverable 4.1 conducted exhaustive research on the topic and especially on the available data sets. For interested readers, please refer to: Deliverable D4.1 "Energy Efficiency Investment Evaluation Framework". Cartagena P., Salat F., Gomez-Ramirez, J. 2020. Deliverable of the EEnvest project.
[16] They deliver the Red Book a single, international standard which influences policy and promotes high professionalism and ethics, ensuring the protection of clients and costumers.
[17] Their goal is to build confidence and public trust in valuation techniques, and they produce globally accepted standards.
[18] It represents the interest of qualified valuers, they set standards similar to those of RICS, but they publish only international and European regulatory frameworks through their Blue Book.
[19] Retrieved from https://www.rics.org/globalassets/rics-website/media/upholding-professional-standards/sector-standards/valuation/international-valuation-standards-rics2.pdf.
[20] Retrieved from https://www.iea.org/reports/multiple-benefits-of-energy-efficiency/asset-values

Study	Rental Premium	Sale Price Premium
European Commission Joint Research Center	2% - 5%	+10% - 20%
Center for Regional Economic Development (CREM[21])	NA	9% - 17%
Miller et al (US)	4% - 5%	25 – 26%
Eichholtz et al (a) (US)	3.3% - 5.2%	11% - 19%
Eichholtz et al (a) (US)	2.1 % - 5.8%	11% - 13%
Pivo & Fisher (US)	2.7%	8.5%
Wiley et al (US)	7% - 17%	16% - 18%
Miller et al (US)	9%	NA

Table 1: Property value increase categorized by study

The previously presented metrics are positioned as complementary parameters that can be put next to traditional financial metrics (Internal Rate of Return, Net Present Value and Payback Period, etc.) and therefore contributes to the analysis of DER projects. In specific, the Predicted Energy Savings, CO2-eq Emission Reduction and Number of Jobs Created can be computed case by case. In addition, the EU Taxonomy Compliance KPI supports the metrics in a binary fashion, by stating whether the energy efficiency project complies or not with the EU Taxonomy requirements. In respect of the Property Value Increase a conservative-informational approach is adopted.

3.3 Link to SDGs

With the objective of reinforcing the added value of these impact metrics, a closer look into the relation of these metrics and the Sustainable Development Goals is performed and presented in the next chapter.

The connection to SDGs depicts which specific Sustainable Development Goals (SDGs) the DER project contributes to. It is a qualitative approach that showcases the non-financial impact of investing in the deep energy retrofit project.

The SDG goals are a set of 17 interlinked global goals to take action to end poverty, protect the planet, and to ensure that by 2030 all people enjoy peace and prosperity. The SDGs were

[21] Retrived from https://www.knightfrank.com/research/article/2021-09-29-green-building-value-do-greenrated-buildings-add-a-premium-to-sales-price.

adopted by the United Nations in 2015 to become a blueprint to achieve a better and more sustainable future for all[22]. The figure below better showcases the 17 SDGs.

Figure 10: Sustainable Development Goals (SDGs)

Looking in depth at the SDGs, an array of targets with specific indicators are assigned to each SDG with the objective of measuring progress achieved in one specific SDG. Levering on this approach, the next paragraphs expose how the Predicted Energy Savings, CO2-eq Emission Reduction and Number of Jobs Created KPIs are correlated with specific SDGs and more in detail, to which specific targets.

All in all, the link of the specific multiple-benefit KPI and the SDGs brings light to the full impact of the DER project. It is therefore presented as a means to foster the case for the multiple-benefit KPIs for investors as well as to showcase how investors may contribute to the specific targets of the SDGs. Over the past few years, investors have increasingly disclosed their contribution to SDGs, supporting sustainable investment criteria[23]. Currently, a general framework for corporate reporting on SDGs outcomes is taking shape as a strategic tool for investors' decision-making process.

Hence, the proposed approach represents a key development on the SDGs linkage with the impact dimension of energy efficiency retrofits investments. Table 2 below summarizes the linkage between the multiple-benefit KPIs and the SDGs.

[22] Retrieved from: https://www.undp.org/sustainable-development-goals.
[23] Retrieved from: https://unctad.org/system/files/official-document/diaepcb2021d1_en.pdf.

KPI	SDG	Target
Predicted Energy Savings	**SDG 7**. Affordable and Clean Energy	**Target 7.3.** By 2030, double the global rate of improvement in energy efficiency.
CO2-eq Emission Reduction	**SDG 8**. Good Jobs and Economic Growth	**Target 8.4.** Improve progressively, through 2030, global resource efficiency in consumption and production and endeavor to decouple economic growth from environmental degradation, in accordance with the 10-year framework of programs on sustainable consumption and production, with developed countries taking the lead.
	SDG 11. Sustainable Cities and Communities	**Target 11.b.** By 2030, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change **Target 11.6**. Reduce per capita city environmental impact.
	SDG 12. Responsible Consumption and Production	**Target 12.2.** Achieve sustainable management resources: By 2030, achieve the sustainable management and efficient use of natural resources.
N. Jobs Created	**SDG 8.** Good Jobs and Economic Growth	**Target 8.2**. Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value-added and labor-intensive sectors. **Target 8.5.** Achieving full and productive employment and decent work for all people, including young people.
	SDG 9. Industry, Innovation, and Infrastructure	**Target 9.1.** Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all.

Table 2: Multiple-Benefits KPIs and SDGs Alignment

4 The Multiple benefit assessment for investors and project promoters

Building upon the definition of the multiple-benefit KPIs for investors and their linkage with the SDGs, the upcoming chapter will present the full methodology and definition of multiple-benefits for both project promoters, which we will focus on from now on as representing building owners, and investors. The purpose of this chapter is to outline the assessment of multi-benefits within the EEnvest project framework.

To bring light to such an objective, it is first presented the decision-making process for financing a DER project. The rationale of this approach is to identify the needs of each participant throughout the process as well as the money flow between these actors. Figure 11 below presents this process.

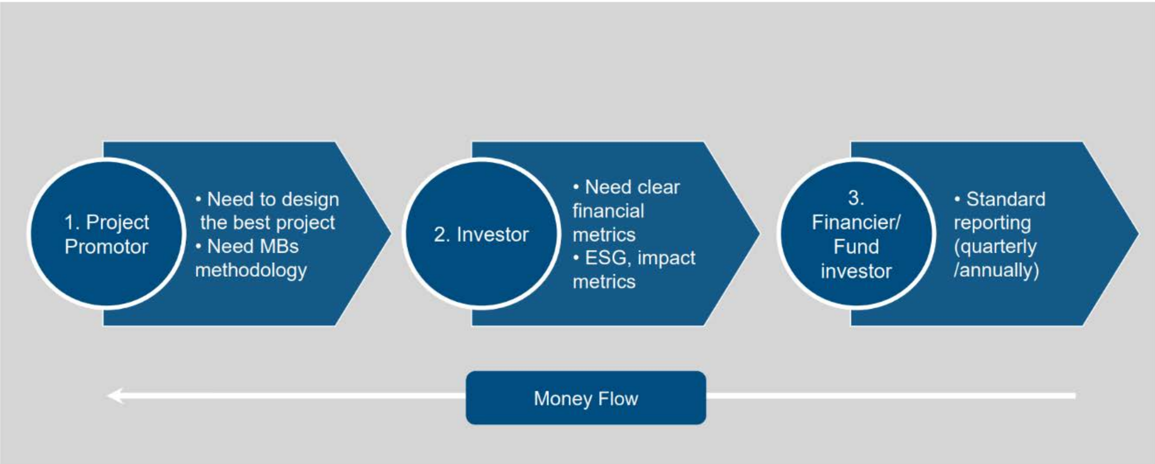


Figure 11: The decision-making process for financing a DER project

In the first step, the (1) project promoter aims to define a set of building improvements and then to build a sound investment case for convincing investors to finance the project. In some cases, the project promoter may be the building owner and in other cases, the project promoter is an external party or a representative of the building owner that has a specific agreement with the building owner or the duty of achieving the renovation project.

The promoter of the project may be particularly interested in using the multiple benefits as presented in previous deliverables as well as the computation method and the estimated impact according to literature to assess the benefits that are obtained from a DER project.

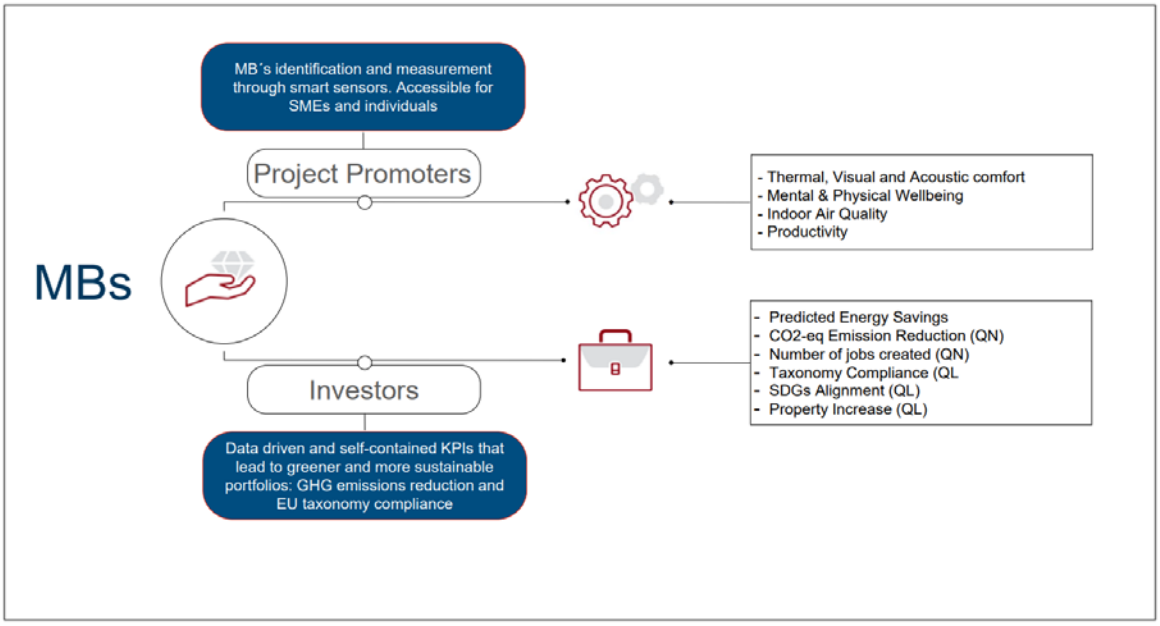
This methodology enables project promoters to measure lighting, air quality, temperature in a building before renovation to better assess not just the building's needs but people's needs (i.e., building occupants and/or employees).

Multi Benefits (MBs) can serve as a decision-making tool to undertake the renovation project guiding narrative that allows project promoters to engage with building owners and thus showcase the positive impact of undertaking the renovation works.

Ought to be remarked that the state of the art, described in previous deliverable D4.1, exposed that there is not enough data to construct a methodology that predicts the improvement on multiple benefits on an ex-ante basis. As such, a fully data-driven approach is currently not a viable solution and therefore the proposed computation methodology allows project promoters on the one hand to compute these multiple benefits and on the other hand, enables data gathering and collection to build predictive models in the medium-term. Therefore, the proposed approach comes to tackle the well acknowledged data gap barrier in the renovation sector.

Following Figure 11 above, the next stage of the process is related to investors. From the (2) investor point of view, the fundamental need is to define which metrics, information or assessment method will be used to properly assess the investment opportunity that is being presented. In other words, investors are seeking reliable methods to properly understand the impact of investment opportunities, of course beyond the traditional financial parameters. This rationale has been exposed in previous chapters. To cover this need, the multiple-benefit approach for investors utilizes KPIs that unfold the impact of the investment that goes beyond financial risks and financial returns. This outcome is summarized in the following KPIs: Predicted Energy Savings, CO_2-eq Reduction, Number of Jobs Created, EU Taxonomy Compliance and respective SDGs alignment. It further includes estimates of possible value increase of the asset at both rental and (re)sale price based on literature.

For purposes of clarity, the following Figure 12 shows the difference between Project Promoters/Building owner) and Investors in terms of multiple-benefit KPIs.



*QN = Quantitative data, *QL = Qualitative data

Figure 12: Multiple benefits KPIs for Project Promoters and Investors

As final remark, the investment size of the DER projects deserves some insight. EEnvest methodology aspires to attract renovation projects in a range of hundreds of thousands of euros to multi-millions, since such kind of project size would generate concrete and considerable impacts. Based on this, investors will probably assess the borrower only from the creditworthiness point of view instead of the multiple-benefits KPIs of the project.

The rationale of this hypothesis is backed up by the fact that, for investors, the smaller the DER project, the minor the result of multiple benefits. Therefore, it may be concluded that the impact and results of the multiple benefit KPIs for investors will be greater when the project size is larger or, alternatively, from a portfolio level perspective (i.e., sum of smaller DER projects).

To conclude this chapter, all multiple benefits KPIs - including the investors and project promoters KPIs - are summarized in Table 3 and Table 4 below.

MULTI BENEFIT PERFORMANCE for Investors	**PREDICTED ENERGY SAVINGS**
	The Predicted Energy Savings indicator is the difference between the actual energy consumption of the building (baseline) and the estimated energy consumption after the renovation project. It includes heating, cooling, lighting and ventilation.
	CO_2 EQUIVALENT EMISSION REDUCTION
	The CO_2 Emission Reduction Indicator estimates the decrease of CO2 emissions as result of undertaking the renovation project. It is derived from the predicted energy savings and it is computed by a conversion factor that varies from country to country as well as the type of energy source used in the building.
	NUMBER OF JOBS CREATED
	The Number of Jobs Created metric refers to new jobs created as a result of the investment. This KPI is based on a proclaimed BPIE study that states that per 1 million euro invested on energy efficiency projects, 18 new jobs on average are created. It can vary depending on the location of the building (i.e., country) and the amount of the investment. This KPI depends on the renovation project size and general economic framework of the country implementation, thus it will vary across project categories and countries.
	EU TAXONOMY COMPLIANCE
	The EU Taxonomy Compliance indicator defines whether the investment complies with the minimum requirements defined by the EU Taxonomy for Climate Change Mitigation. In specific, whether the project being assessed has a minimum of 30% primary energy consumption reduction. Therefore, it is a binary metric.
	LINK TO SUSTAINABLE DEVELOPMENT GOALS (SDGs)
	The Link to SDGs indicator depicts to which specific SDGs the project contributes to. It is a qualitative indicator that highlights the non-financial benefits of investing in the renovation project.
	PROPERTY VALUE INCREASE
	The Property Value Increase indicator brings light to the possible increment on the value of the asset after the renovation project. This is also referred as the "greemium". In practical terms, it is not possible to predict this increase before the renovation project. Therefore, this metric is qualitative, and it provides a range of possible value increase backed-up by literature.

Table 3: Multi benefits KPIs for Investors

MULTI BENEFIT for Project Promoters	**Thermal Comfort**
	Thermal comfort assesses whether the room temperature is safe and well-balanced. First of all, thermal comfort must protect the health of the occupants during the cold and hot seasons. Furthermore, it helps in creating an optimal living and working environment. The codification of this factor relies upon compliance with ANSI/ASHRAE Standard 55. The ASHRAE 55 recommends that floor temperatures stay in the range of 19–29 °C.
	Visual Comfort
	Visual comfort assesses the illuminance inside compared to outside illuminance of buildings. The visual comfort is calculated according to the Daylight Autonomy (DA) that quantifies the local availability of a sufficient day lighting level in the considered reference period. The light level is commonly considered to be in the range [500, 1000] lux- depending on activity. For example, for work that required detailed visual inspection and precision, the light level may even approach [1500, 2000] lux.
	Acoustic Comfort
	Noise pollution is a major environmental problem, and it is estimated that 120 million people worldwide have disabling hearing problems. The noise problem in building envelopes can be the result of impact noise or airborne noise, both need to be properly considered. The World Health Organization recommends < 30 db(A) of noise for bedrooms and < 35 db(A) in classrooms to allow for good teaching and learning environments. (WHO, 2009)
	Indoor Air Quality
	Air Quality (AQ) relies upon having installed an efficient heating ventilation and air conditioning (HVAC) system and is an environmental KPI that is gaining importance amid the COVID pandemic. Air Quality can be considered an environmental factor, but it affects the health and productivity of building tenants. The most important indoor pollutants are PM2.5 (fine particle matter), Volatile Organic Compounds (VOC), Carbon monoxide (CO), Radon and Carbon dioxide (CO_2).
	Perceived physical and mental health
	The perceived physical and mental health is assessed via questionnaire screeners. There are a few questionnaires that address the physical and mental health of individuals. For example, The Global Physical Activity Questionnaire developed by the World Health Organization or the generic 12-item Short Form Health Survey (SF-12) to measure the physical and mental wellbeing and to be compared with baseline scores.
	Productivity
	We contemplate at least three dimensions in which productivity gain after an energy renovation project can be measured. • Increase productivity value (IPV) is calculated based on the estimated increase of individual workers (e.g., 5%), the number of workers and their salary cost. Baseline 0.5%. (Berggren, Maria , & Togeröc, 2018) • Turnover employee reduction. Lower employee turnover is thought to affect positively productivity in the workforce. Baseline 0.5%. (Berggren, Maria , & Togeröc, 2018) • Number of sick days claimed by the employee. The typical value used is 4.5 active workdays person/annum can be gained in energy

	renovated buildings and Nearly Zero Energy Buildings. Baseline 7.5%. (Berggren, Maria , & Togeröc, 2018)

Table 4: Multi benefits KPIs for Project Promoters

5 Multi Criteria Decision Analysis to benchmark DER investments

The Multi Criteria Decision Analysis (MCDA) tool emerges from the need to provide investors with a reliable method to compare different investment alternatives. This is in fact the functionality pursued by this method.

The next section will take a deep-dive into the tool and will showcase how the KPIs defined by the EEnvest methodology are incorporated and used for benchmarking.

5.1 DEFINITION AND METHODOLOGY

As previously mentioned, investors utilize metrics to analyze DER investment projects. However, being left with these values for each project, the investor may not be able to make decisions in regards of which investment opportunity is the most attractive according to the investors' preferences and investment objectives. Mainly because KPIs are preferred in significantly different ways among investors, meaning that *KPI "x"* could be much more important for *investor x* and *KPI y* for *investor y*. This is not taken into consideration in the calculation of KPIs, as they are objective and thus not subject to the preferences of the investor. Under this context, an additional analysis tool is required to benchmark the DER investments.

The MCDA tool is proposed to support the decision-making process of investors and guide them in their complex search for investment opportunities. The ultimate objective of the MCDA tool is to provide benchmarking functionality for investors. In specific, the MCDA is a tool set-up to help decision-makers in choosing the right option for a particular project or activity that depends on multiple criteria points. This tool is useful when a particular project or activity is evaluated by more than just monetary terms (Laidlaw, 2014). The following example could illustrate this.

At this stage, the reader could benefit from creating a parallelism between investors and a generic public administrator. Let's assume there is a redundant area close to a city that could be used for multiple purposes, i.e., a new solar or wind park, nature reserve, the building of new houses, or farming land. To choose the best option, different criteria could be analyzed. These criteria could be social, economic, technological, environmental or legal. The decision-maker has to choose between different options based on relevant indicators with different scales that are not monetary only. Linking this example to the EEnvest methodology, the investors are the decision-makers who need to choose an option (i.e., a renovation project) to invest in. This decision is based on the KPIs from the different assessment categories and different scales. As a result, the MCDA analysis is a versatile tool to evaluate any renovation project investment, regardless of building type or size.

The methodology of the MCDA analysis enables decision makers to assess and order multiple options that may have different measurement units and in some cases the assessment criteria may be a mix between qualitative and quantitative factors. In other words, the selected indicators to analyze multiple investment opportunities can be quantitative, or qualitative data such as on a Likert scale. For instance, the predicted energy savings metric is quantified and thus serves as quantitative data whereas the EU Taxonomy Compliance is rather a qualitative parameter. From an investor's point of view, both parameters are relevant to making the decision on which investment alternative to invest in.

In the light of presenting how the MCDA tool works, the mechanics of the methodology will be explained on a step-by-step basis.

The (1) first stage of the methodology is to narrow down the decision-making context. This stage refers to selecting the different investment alternatives that are of interest to the user, as well as selecting the criteria (i.e., KPIs) that will be used to study the investment alternatives. Once these two components are set, the consequent step would be to compute the value of the criteria. For the case of choosing quantitative criteria, the result will be numerical. On the other hand, when the selected criteria refer to qualitative parameters, the result may be specific wording or a written description. For the case of DER projects and the EEnvest Project, by alternatives we refer to renovation projects, by criteria we refer to the technical, financial and multiple-benefit KPIs, and by results of the criteria we refer to the outcome of computing the KPIs.

The (2) second stage of the MCDA method consists of transforming the information retrieved about different alternatives into harmonized scores that are transversal for the different alternatives under analysis. Explained with other words, the values of each KPI will be transformed into a score with the same scale: it is necessary to compare different KPIs with different metrics. This is done by standardizing all the different types of data from the KPIs into a standardized performance matrix.

The standardized performance matrix contains the scores calculated by standardization methods ranging from 0 to 1, as shown in Figure 13 below.

	C1	C2	C3	C4	C5	C6
A1	0.91854	0.92087	0.97707	0.56327	0.98604	0.57087
A2	1	0.78593	0.58096	1	0.98282	0.68108
A3	0.8764	0.84577	0.79222	0.76916	0.9388	0.64195
A4	0.57865	0.67789	0.07922	0.51855	0.98286	0.75817
A5	0.45225	0.64252	0.55455	0.38484	1	0.97327
A6	0.44382	0.78688	0.44892	0.51228	0.76436	0.89259
A7	0.96348	1	0.89616	0.92397	0.88398	0.48633
A8	0.82584	0.96014	1	0.64118	0.92543	0.49731
A9	0.35393	0.82654	0.41984	0.43397	0.67763	0.91631
A10	0.5927	0.72057	0.54965	0.49173	0.92115	1

Figure 13: Example of a standardized performance matrix with A=Alternatives (options) and C=Criterion. Source *Laha & Biswas 2019*

Two linear standardization methods are mainly used for the calculation of the standardized performance matrix: (i) maximum and (ii) interval standardization method (Chakraborty & Yeh, 2007). The (i) maximum standardization method is used when values have a minimum value of absolute zero, which means that negative values are not possible. Whereas the (ii) interval standardization is used when the minimum value of the specific KPI is not absolute zero and thus negative values are possible.

Regarding the two linear standardization methods, they are both used in the MCDA model. The values of the financial KPIs IRR and NPV could be both negative and positive. Especially in case of energy efficiency investments, these KPIs are likely to be negative, thus an absolute zero is not the minimum value of this KPI. This results in using the interval standardization method for the IRR and NPV KPIs. The rest of the KPIs use the maximum standardization method, as their values are highly unlikely to be negative, where the absolute minimum value is zero. It must be noted that the scores are dependent on the data of projects, which means that these scores change when the projects being compared are altered (i.e., removing or including additional projects into the scope of the comparison exercise). This also means that multiple alternatives are necessary and individual projects cannot be analyzed by this tool. This distinction is relevant, as single projects need to be analyzed in a different way. This is done by using the values of each KPI and arranging them into categories based on a scale. As a result, the values of the KPI could be independently analyzed as ‘good’ or ‘bad’ by the investor.

The next step EEnvest, this will rank the different investment projects according to the preferred KPIs of the investors. This weighting is carried out by assigning percentages to the different KPIs that need to sum up to 100%[24] at the end. These percentages are multiplied by the scores of the standardized performance matrix, which results in scores for the technical, financial, multiple benefits assessment and a final multi criteria scoring for all the projects. The weighting definition is strictly subjected to the investor's preference and investment strategy.

Finally, the (3) third stage is about the actual decision resulting from the analysis. With the final multi-criteria score values, the projects can be ranked and the preferred projects for the investor are shown. As a result, the investor can choose the preferred project according to the MCDA analysis. Figure 14 below summarizes the MCDA methodology and shows the different stages and steps.

[24] The sum of all weights must be 100%.

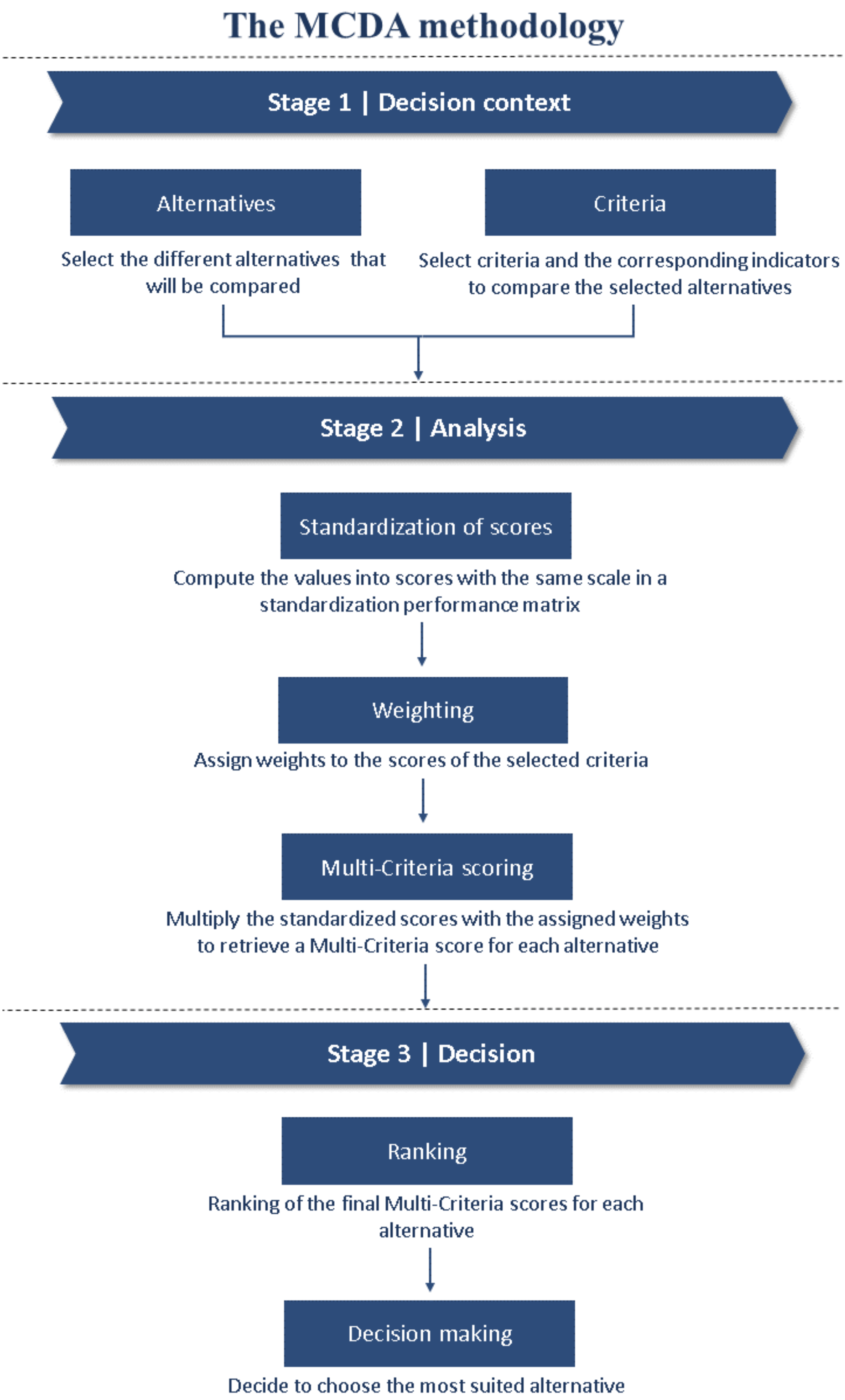


Figure 14: The MCDA methodology

However, it must also be noted that there are potential shortcomings from the use of this particular comparative tool. Lai et al. (2008) reviewed the MCDA analysis and the study identified two relevant shortcomings with the use of MCDA, which are:

- **Double counting and undercounting**

The shortcoming of double counting occurs when weights are assigned to redundant criteria which are already taken into consideration. For example, when predicted energy savings is a criterion for the overall environmental impact, this may overestimate this particular impact dimension. On the contrary, undercounting occurs when the criteria provided are not sufficient and missing relevant aspects.

- **Transparency of MCDA**

The MCDA analysis could appear complex at first sight for external stakeholders. Thus, the necessity to display it as clearly as possible. Therefore, transparency about the functionality and methodology behind the tool is something highly valued by stakeholders (Söderberg and Kain, 2002). An explanation or disclaimer about the limitations and usage of the methodology must accompany the tool to make users aware of the correct usage. This would consist of a short description of how the MCDA works with scoring and weighting and a description of the selected criterion and the rationales for including them into the MCDA.

These two identified shortcomings of the MCDA analysis tool are important for the implementation and usage of this tool in the EEnvest project, as they must be taken into consideration and dealt with accordingly. The next paragraph explains how the MCDA method is applied in the EEnvest Project.

5.2 EEnvest MCDA model

As previously mentioned, the MCDA analysis tool is used to order different options based on different criteria that are quantitative or qualitative data. This means that not all the KPIs defined in the EEnvest Project are eligible for the MCDA approach. Table 5 below shows the eleven KPIs that are fit for the MCDA assigned to DER projects' investment opportunity comparison. The Property Value Increase indicator and the SDGs alignment are not included because those KPIs are qualitative, and these cannot be quantified in a discrete manner.

TECHNICAL RISK PERFORMANCE	**DAMAGE**
	The Damage indicator quantifies the investment deviation due to possible malfunctioning or failures of the energy renovation measures adopted in the renovation project. Such deviation is expressed as a percentage of the planned investment.
	ENERGY GAP
	The Energy gap indicator quantifies the energy performance deviation. It is expressed as a percentage of the calculated energy performance after the renovation project.
FINANCIAL PERFORMANCE	**PAYBACK TIME**
	The Payback time is the amount of time that the investment will take to recover the initial cost, when the investment over time reaches a breakeven point.

	MATURITY
	The Maturity is defined as the total duration of the project needed to achieve a zero NPV (IRR equal to cost of capital).
	INTERNAL RATE OF RETURN (IRR)
	The Internal Rate of Return (IRR) is the discount rate that makes the net present value (NPV) of a specific project equal to zero.
	NET PRESENT VALUE ON INVESTMENT (NPV/investment)
	The Net Present Value (NPV) is the value of all future cash flows (positive and negative) over the entire life of an investment discounted to the present. The NPV/investment ratio gives a measure of profitability of the project.
	DEBT-SERVICE COVERAGE RATIO (DSCR)
	The Debt-Service Coverage Ratio (DSCR) is an indicator of the project's ability to repay a debt. It is calculated as the ratio between the operative cash flows generated by the project and the cash flows for debt, lease or other obligations (debt service, both for interests and principal payment) due in one year.
	FINANCIAL RISK INDICATOR – VALUE AT RISK
	As a result of the financial risk analysis, this indicator represents the "distance" between the median value of the probability distribution of payback time and the value of the 95th percentile of the distribution. In more practical terms, this indicator tells how far a very unlikely value is (a value that has less than 5% probability) from the median value (which is the value that divides the distribution into 2 equal parts, each with 50% probability). The higher this value, the higher the financial riskiness of the project, as a higher distance of the 95th percentile of the payback time distribution from the median value means that there is a higher probability of one outcome to be much higher than expected.
MULTI BENEFIT PERFORMANCE	**PREDICTED ENERGY SAVINGS**
	The Predicted Energy Savings indicator is the difference between the actual energy consumption of the building (baseline) and the estimated energy consumption after the renovation project. See Table 3.
	CO_2 EQUIVALENT EMISSION REDUCTION
	The CO_2 Emission Reduction Indicator estimates the decrease of CO_2 emissions as result of undertaking the renovation project. See Table 3.
	NUMBER OF JOBS CREATED
	The Number of Jobs Created metric refers to new jobs created as a result of the investment. See Table 3. This KPI depends on the location of the building (i.e., country) and the amount of the investment.

Table 5: KPIs eligible for the MCDA analysis

Having determined the KPIs that are eligible for the MCDA, the question arises whether they can all be inserted as indicators in the MCDA analysis. Especially in light of the double counting risk that was explained before. The MCDA analysis used for the EEnvest project must therefore limit the double counting as much as possible. To avoid this shortcoming, the relationship between the different KPIs was analyzed. These relationships are important to assess whether specific KPIs are redundant (not independent of each others), because their criteria are already represented in other KPIs.

First of all, the financial KPI *maturity* is removed from the MCDA analysis. This is because this KPI is strictly connected and directly derived from the IRR and NPV indicators. In fact, in the base case, for the calculation of IRR and NPV, the time horizon of the analysis was the same for all the options and set to 20 years. Then, *maturity* is defined as that time horizon that brings the NPV equal to zero (if possible). As a result, the *maturity* KPI is excluded to avoid double counting.

Secondly, the definition and relationships between the other financial KPIs (IRR, NPV, DSCR and Payback Time) were deeply analyzed. It was acknowledged that these KPIs provide significantly different types of financial information, but that they are highly related. Including all four financial KPIs would therefore heavily contribute to the double counting of the MCDA tool. However, as mentioned before, the four KPIs did provide different types of indicators of financial performance. Investors may prefer to use one specific financial indicator, but this preference could differ among other investors. Therefore, it was decided to make all four KPIs available in the MCDA tool, but only one can be used in the calculation of the final scores. This means that the weights assigned to the financial assessment package by the investors is for only one KPI, but investors can choose which one specifically. This will decrease the double counting risk of the tool and assist investors simultaneously.

Thirdly, it was recognized that projects may significantly differ from each other in terms of investment costs and the type of the project. Investors might be looking for projects in a particular range of investment costs. It was therefore acknowledged about the importance of informing investors on the risk of comparing projects significantly different for size (i.e., total investment cost) and type of renovation project by the MCDA tool. Compared projects should lay in investor's preferred range of investment size and preferred project type.

Furthermore, the specific units of the indicators that will be included in the MCDA model are relevant for the credibility of the model, but also for the facilitation of the platform use. The units of the technical and financial KPIs are standard and expressed in years or as ratio. Also, the units for the multiple benefits assessment are easy to manage as the financial and technical KPIs ones, especially the CO2-eq emission and predicted energy savings. As already mentioned, the projects on the platform may differ in terms of size. This means that absolute values (i.e., the actual magnitude of the numerical value, irrespective of its relation to other values) are difficult to use and compare with this tool, as these numbers are highly dependent on this project size. In other words, the larger the project the greater the absolute values of these KPIs. As a result, the units of these two KPIs should be relative (i.e., the actual magnitude of the numerical value is related to other values, such as euros per m2) to be able to include them in the tool.

The indicators calculated within the technical assessment and the financial assessment are, in statistical terms, "position indicators" as they express a measure of central tendency of a probability distribution, telling "where" the distribution is located. The ones related to the technical assessment (Damage and Energy performance gap) express the expected value of the risk distribution while the ones related to the financial assessment express the expected value of the financial performance. The latter ones are calculated considering the expected value of the former one, but are not correlated, so there is no overlapping and double counting issue.

In order to provide the user with additional information about the riskiness of the project, it is important to calculate an additional “dispersion indicator”, representing how much probability there is for the project outcomes to deviate from the expected (mean or median) value. Usually, the typical indicator to express this variability is the standard deviation. However, standard deviation makes sense only for symmetric distributions, such as the normal distribution, but the probability distribution of technical risks used in the EEnvest technical-financial risk model are not symmetric. In this case, standard deviation is not able to adequately describe the variability of the results, as it does not take into consideration that probability is distributed differently on the “left” and on the “right” sides. To avoid this issue and to provide the user with a useful and consistent information about the riskiness of the project, another indicator needs to be calculated. One indicator that could support the user in understanding the variability of the result could therefore be the distance between the central (median) value of the probability distribution of one financial indicator (could be Payback time or IRR) and the most unlikely negative outcomes of the distribution. These unlikely negative outcomes could easily be calculated, for any probability distribution, by taking the percentile of the distribution representing the threshold of a wide enough confidence interval. For example, considering a confidence interval of 95%, the 95th percentile of the probability distribution of payback time is that value of payback time (in terms of years) that leaves only 5% probability of an outcome to be higher than that. Assuming an investment with a median value of payback time of 10 years, if the value corresponding to the 95th percentile of the distribution is 12 years, it means that there is only 5% probability that the actual payback time of that investment is over 12 years.

In order to make this indicator neutral and comparable between projects, its relative value with respect to the median value is calculated. So, it can be expressed as a percentage between the “distance” and the median value. According to the previous example, the distance is 2 years, the mean is 10 years, then the value of the indicator would be 20% and means, in practical words, that there is only 5% probability that the payback time will be 20% higher than the median value.

All in all, Table 6 below provides the selected KPIs that are included in the MCDA analysis.

Technical Risk Assessment	Damage Energy performance gap
Financial Performance Assessment (only one KPI is selected by each investor)	IRR Payback time NPV DSCR Distance from 95th percentile
Multi Benefits Assessment	Predicted Energy Savings CO_2-eq emission savings Jobs created

Table 6: KPIs selected for the MCDA analysis

6 The EEnvest Evaluation Methodology for EE Investments

In order to fully grasp the EEnvest Methodology, first it is necessary to comprehend the investment assessment process from a financial standpoint and especially, from the investor´s point of view.

Any investment assessment consists of at least three common steps. The first step alludes to determining the scope of investment opportunities to be evaluated. The second comprises the definition of a set of KPIs and their weights to analyze the investment opportunity and of course, the methodology to compute these KPIs. Last, the benchmarking of the different investment opportunities at hand. These steps are also reflected in the MCDA benchmarking tool previously presented.

The results of these steps lead to strategic capital allocation. Further, the chosen investment project -or the aggregation of investments- can reflect the investor's profile. For instance, if the chosen investment alternative has a higher scoring in the environmental dimension in relation to the financial dimension, it may allude that the investors have a greener investment strategy. This refers to the preferences of the investor, which are reflected on the KPIs and respective weights to assess the investment[25].
For example:

- Investor (A): Portfolio composed of energy efficiency and renewable projects.
- Investor (B): Portfolio composed of commodity futures and cryptocurrencies.

Although both investors performed their investment assessments on opportunities of their choice, it is observable that Investor (A) invests in green projects whereas Investor (B) invests in other types of projects/assets.
Now, from a corporate reporting standpoint, it is also observable that the Investor (A) has a higher possibility of reporting the positive impact of the investment choice in comparison to Investor (B). In fact, Investor (A) may be classified as an Impact Investor or ESG Investor. It is precisely the distinction between Impact Investor, Green Investor, ESG Investor, SDG Investor, as described in Chapter 3 of this document, that is in the spotlight in the financial realm nowadays. For an exhaustive review of how investors are shifting their investment profiles and preferences refer to Deliverable 4.1 of EEnvest project[26]. For further detail on the different types of investors mapped please refer to Chapter 3.1 of this report.

All in all, the main difference between investors is found in what type of investment they specialize in or the types of assets they hold. This can be observable throughout the decision-making process they perform and the impact of their portfolio.

The next paragraphs will depict the connection between investors' decision-making process using a typical EE Investment Evaluation Framework and the holistic EEnvest Energy Efficiency Investment Evaluation Framework.

[25] For further explanation on the typical decision-making process of investors, refer to deliverable D4.1 of the EEnvest project.

[26] Deliverable D4.1 conducted exhaustive research on the topic and specially on the available data sets. For interested readers, please refer to: Deliverable 4.1 "Energy Efficiency Investment Evaluation Framework". Cartagena P., Salat F., Gomez-Ramirez, J. 2020. Deliverable of the project EEnvest.

6.1 UNFOLDING THE LINK BETWEEN THE EE INVESTMENT EVALUATION FRAMEWORK AND THE EENVEST ENERGY EFFICIENCY INVESTMENT EVALUATION FRAMEWORK

In Deliverable 4.1 the decision-making process of investors was mapped, and it was labeled as the EE Investment Evaluation Framework. Figure 15 below presents the EEnvest EE Investment Evaluation Framework and how it can be incorporated as part of the decision-making process of investors, specifically on Level 1 and Level 2, specifically in steps 2, 3, 4, 5, 6 and 7.

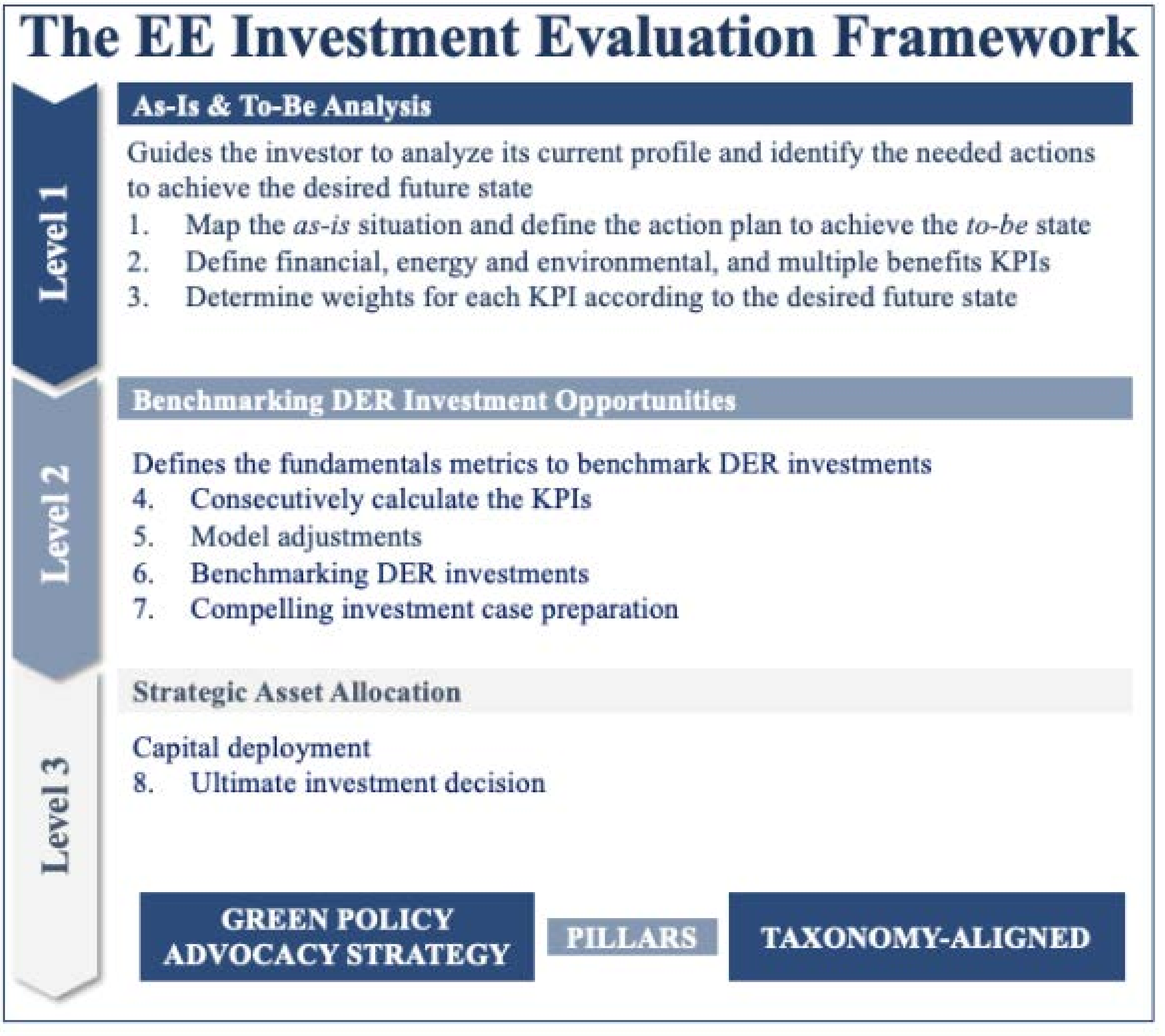


Figure 15: The Energy Efficiency Investment Evaluation Framework. Retrieved from Deliverable 4.1

In brief, the Framework defines three levels. The first level aims to map the investors profile which guides the definition of KPIs and their weights. The second level benchmarks two or more DER investment opportunities by comparing the KPIs and preparing the investment case. This is crucial as DER investments are not attractive from a raw-financial standpoint. Especially in the case of external investors who seek a return on their investment. Last, the third level refers to the strategic decision of deploying capital to one or more projects.

It is observable that the EE Investment Evaluation Framework manifests two rationales that are deeply embedded in any sort of EE assessment. First, it is a step-by-step process and, at the end, the investment analysis depends exclusively on the investors' valuation procedures. Second, and because of the prior, the Framework does not offer standardization nor a reliable valuation methodology to benchmark EE investment opportunities yet.

Under this frame, the EEnvest Energy Efficiency Investment Evaluation Framework comes to light for those investors who are seeking to invest in DER projects in commercial buildings and thus are willing to assess and benchmark these opportunities in a reliable and standardized way.

Consequently, EEnvest Methodology allows for investors to de-risk and assess DER opportunities from three dimensions: technical, financial and multi-benefits. Specifically, it aims to assess DER projects with their specific characteristics, risks and impact. Under this context, impact alludes to the dimensions that go beyond energy savings.

The EEnvest Methodology lies at the very core of the EEnvest EE Investment Evaluation Framework. The next paragraphs provide an in-depth explanation of the EEnvest Methodology.

6.2 THE EENVEST METHODOLOGY

The EEnvest methodology assesses DER projects from three dimensions and works on an input-output basis. The results both project promoters and investors are reflected in the EEnvest Platform. The assessments dimensions of the EEnvest Methodology are the (i) Technical Risk Assessment, (ii) Financial Performance and Assessment and the (iii) Multi-benefit Assessment. In fact, each of these three dimensions has been better explained and developed previously. Figure 16 below better showcases the full EEnvest Methodology process.

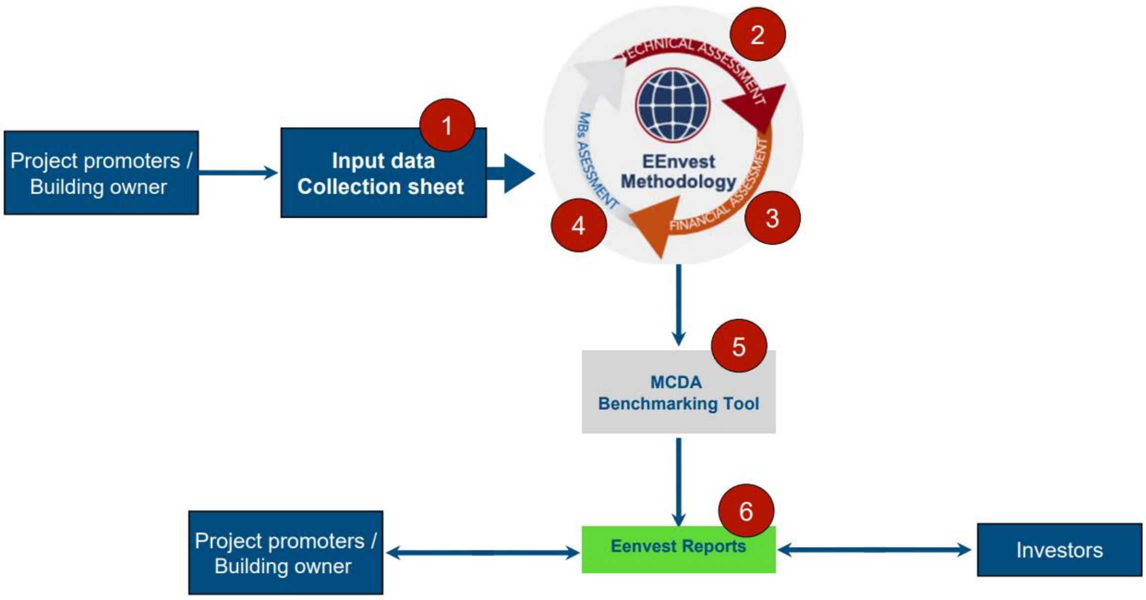


Figure 16: EEnvest Methodology Mechanics

In brief, the EEnvest Methodology is composed of six major blocks or steps. The (1) first step refers to the Input Data Collection Sheet that has the objective of gathering the needed input from the renovation project that serves to run the assessments. The first assessment is the (2) technical risk assessment, building on the technical risk assessment comes the (3) financial assessment. Then, the (4) multiple-benefit assessment takes place. The result of these assessments is the set of KPIs that investors can use to analyze the DER project under study. Further on the process comes the (5) MCDA benchmarking tool, that has the objective of benchmarking different DER project alternatives. Last, EEnvest Reports come to play and provides jargon-free information for both project promoters and investors. The next paragraphs will explain each part of the EEnvest Methodology more in depth.

6.2.1 EEnvest Data Collection Sheet

The core of the EEnvest calculation process is the data collection sheet where the user fills in all the necessary information about the building itself as well as the unique characteristics of the renovation project under analysis.

The calculation process has been developed based on a correlation methodology[27] of EEnvest project, dedicated to the structuring of the complete data sets and the data flow. Figure 17 below outlines the calculation process in terms of Inputs and Outputs sorted by source category.

[27] Deliverable D5.1 of the EEnvest Project

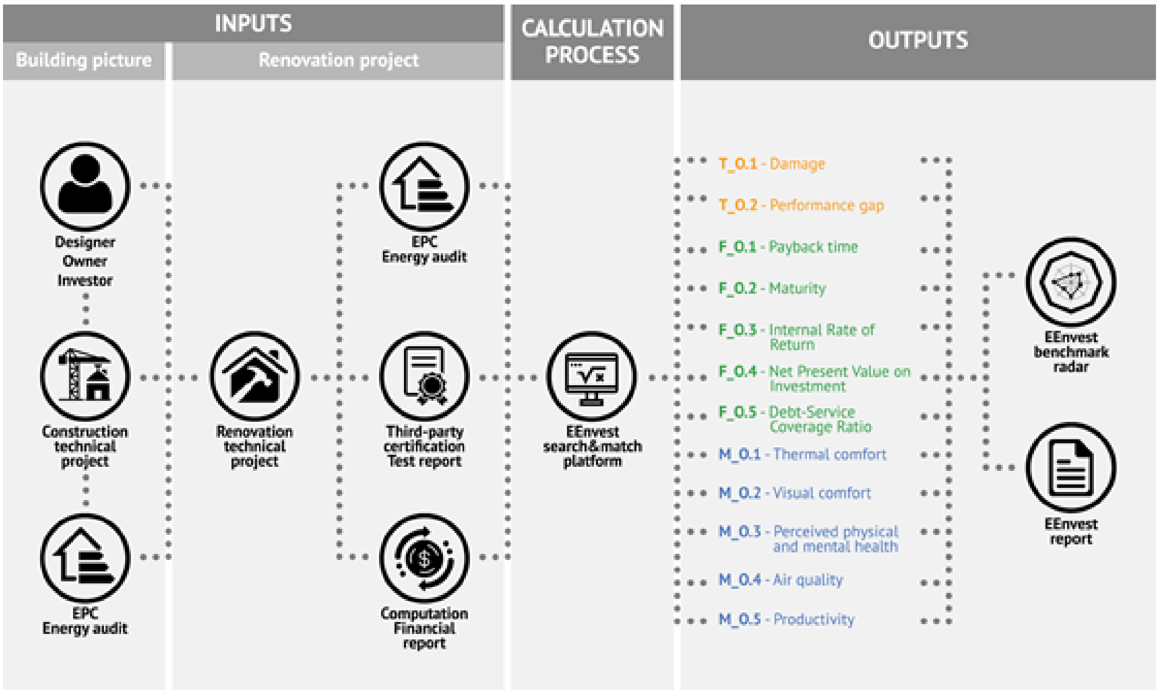


Figure 17: Schematic representation of the EEnvest data flow

To support the EEnvest platform users an “Instruction guidelines” sheet was developed to understand the minimum information that the users need to fill in the two data collection sheets, respectively called:

- “Inputs1” about several parameters on building general information, consumption data (pre- and post-renovation), energy renovation projects, solution sets, mitigation measures adopted, multiple benefit data.
- “Inputs2” about renovation measures adopted.

The data collection sheets were designed to ease the data input process from a project developer point of view. The data collection sheet is composed of several parameters divided between mandatory, not mandatory, that can require the users to either type the requested value or choose it from a dedicated drop-down menu.

EEnvest_WP2_Matrix for the definition of risks frenquency

INSTRUCTION

EEnvest technical risk calculation process aims to identify the most frequent technical risk associated to each building components.

Technical risk is defined as "an exposure to loss arising from activities such as design and engineering, manufacturing, technological processes and test procedures" . Related to the building sector a technical risk is the probability or threat of damage or any other negative occurrence (thermal bridge, air or water infiltration …) to the building components (architectonical elements of the building envelope, HVAC systems or RES systems) caused by different reasons (project, calculation, installation, or management) in the different phase of the construction process (design, construction, operation). Such problematics affect negatively the energy performance of technical solutions and the pre-estimated return of the investment with the high probability of a next investment that resolves the component failures. Technical risks are identified as possible failures in design, construction or operation phase, but it is supposed that each solution has no technical risk associated, ex. windows, emission systems: warranty from the constructor.

The EENVEST approach aims to support investors and owners during the decision making phase in building renovation. Regarding the thecnical risk identification and calculation, that is a fundamental part of the overall process, a dedicated spreadsheet has been developped and structured to host the thechnical data required for starting the calculation process. The spreadsheet is intended as a tool ready-to-use where the users will upload building technical data of the renovation project, as technical information of the buildings (solution sets, dimension and costs) and as the verification process implemented (design, construction and operation) to check the achievement of several quality requirements. In detail spreadsheet "Inputs1" and spreadsheet "Inputs2" includes the required detailed information related to the building renovation project divided in section corresponding to the renovation sets that owners or investors intend to apply to the building.

Before starting to use the platform users need to collect the following information:
- the renovation solution sets. Detailed information regarding the renovation strategies must be collected (geometrical and physical properties of the building elements)
- the final energy demand at the end of the renovation. The building performace expected after renovation must be known and well described reporting the heating, cooling, and electric final energy demand in kWh/m2year. Note: by final energy demand is meant the amount of energy that the technical system provides to the building for maintaining the minimum indoor thermal requirements, and it is strictly related to the technical system planned.
- the mitigation measures that will be applied. These measures contribute to improve and guarantee the overall quality of the building renovation, and in case, the investment cost for their implementation should be considered in the total investment cost. The mitigation measures will practically be adopted to reduce the risk of the overall building renovation investement reducing to a minimum level the "performance gap".

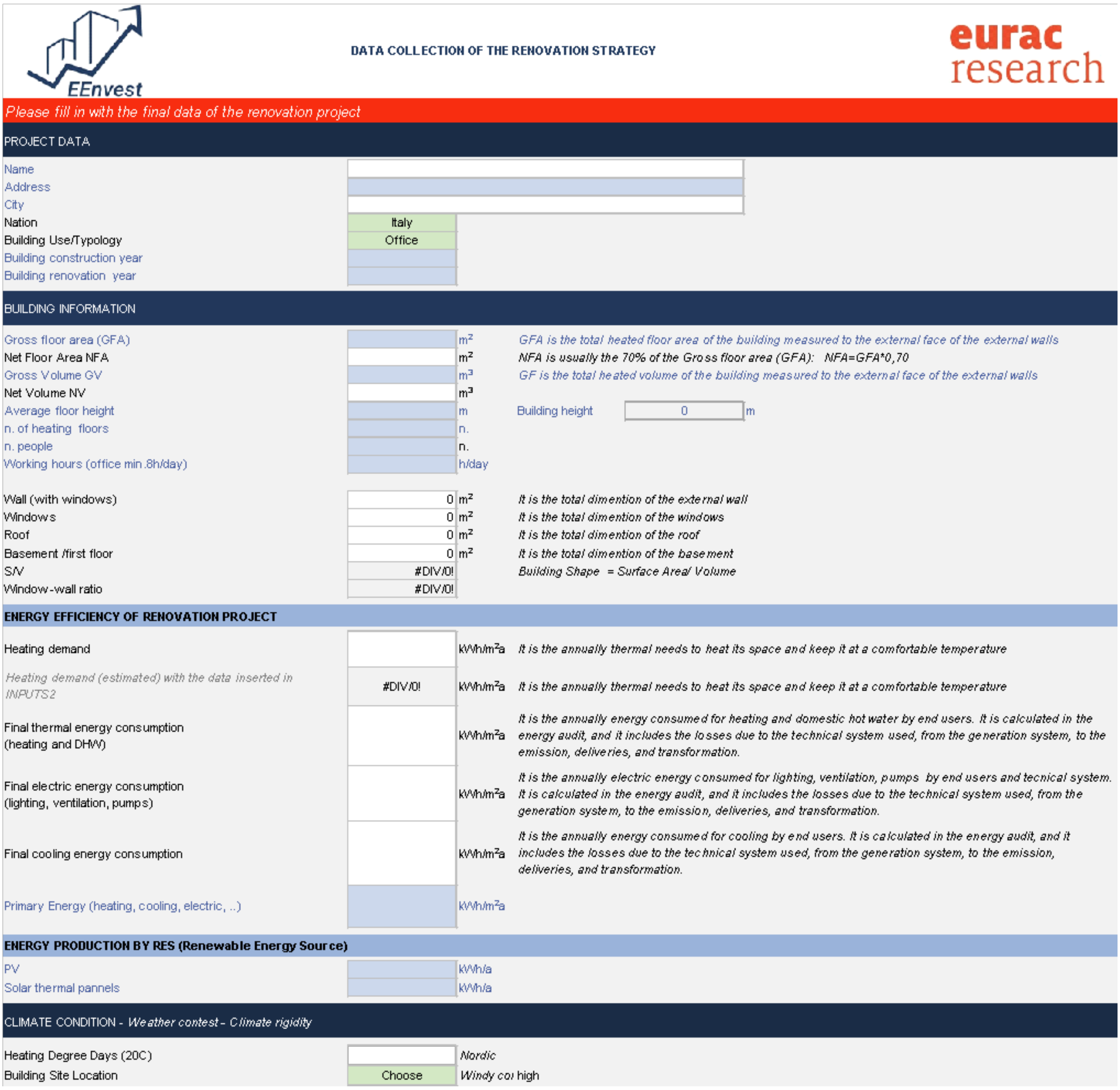
Note: In the energy performacne calculation of the renovation project should be included the uncorrected thermal bridges that cannot be solved due to functional, architectural or economic problems.
Probability: is a percentuage (occurrency)

Impact: is a value (severity)

Instruction:

Manadatory data	Insert the data with the right unit - Mandatory data
Optional data	Insert the data with the right unit - Optional data
Choose	Choose in a dropbox menu
Automatic calculation	Automatic calculation

Figure 18: Instruction guidelines



EEnvest

DATA COLLECTION OF THE RENOVATION STRATEGY

eurac research

Please fill in with the final data of the renovation project

PROJECT DATA			
Name			
Address			
City			
Nation	Italy		
Building Use/Typology	Office		
Building construction year			
Building renovation year			
BUILDING INFORMATION			
Gross floor area (GFA)		m²	*GFA is the total heated floor area of the building measured to the external face of the external walls*
Net Floor Area NFA		m²	*NFA is usually the 70% of the Gross floor area (GFA): NFA=GFA*0,70*
Gross Volume GV		m³	*GF is the total heated volume of the building measured to the external face of the external walls*
Net Volume NV		m³	
Average floor height		m	Building height 0 m
n. of heating floors		n.	
n. people		n.	
Working hours (office min 8h/day)		h/day	
Wall (with windows)	0	m²	*It is the total dimention of the external wall*
Windows	0	m²	*It is the total dimention of the windows*
Roof	0	m²	*It is the total dimention of the roof*
Basement /first floor	0	m²	*It is the total dimention of the basement*
S/V	#DIV/0!		*Building Shape = Surface Area/ Volume*
Window-wall ratio	#DIV/0!		
ENERGY EFFICIENCY OF RENOVATION PROJECT			
Heating demand		kWh/m²a	*It is the annually thermal needs to heat its space and keep it at a comfortable temperature*
Heating demand (estimated) with the data inserted in INPUTS2	#DIV/0!	kWh/m²a	*It is the annually thermal needs to heat its space and keep it at a comfortable temperature*
Final thermal energy consumption (heating and DHW)		kWh/m²a	*It is the annually energy consumed for heating and domestic hot water by end users. It is calculated in the energy audit, and it includes the losses due to the technical system used, from the generation system, to the emission, deliveries, and transformation.*
Final electric energy consumption (lighting, ventilation, pumps)		kWh/m²a	*It is the annually electric energy consumed for lighting, ventilation, pumps by end users and tecnical system. It is calculated in the energy audit, and it includes the losses due to the technical system used, from the generation system, to the emission, deliveries, and transformation.*
Final cooling energy consumption		kWh/m²a	*It is the annually energy consumed for cooling by end users. It is calculated in the energy audit, and it includes the losses due to the technical system used, from the generation system, to the emission, deliveries, and transformation.*
Primary Energy (heating, cooling, electric, ..)		kWh/m²a	
ENERGY PRODUCTION BY RES (Renewable Energy Source)			
PV		kWh/a	
Solar thermal pannels		kWh/a	
CLIMATE CONDITION - *Weather contest - Climate rigidity*			
Heating Degree Days (20C)		*Nordic*	
Building Site Location	Choose	*Windy co* high	

Figure 19: “Inputs1”

INVESTMENT DATA				
Total Investment (all costs without VAT)	1.000,00	€		Estimention of the total ammount of the renovation project completed of building design costs (total cost of all experts involved), constructor costs, other costs as building permissions, … , taxes. VAT excluded.
PREVENTION ACTION				
Protocols used				
Verification design and process	Choose			Cerification of the design and contraction phase, as : CasaClima, Passive House, …
Passive House		€		(Cost of certification - it is payed on time) - VAT excluded
Casaclima		€		(Cost of certification - it is payed on time) - VAT excluded
LEED		€		(Cost of certification - it is payed on time) - VAT excluded
Verification and monitoring:	Choose			Monioting of the energy consumption and the RES system, as International performance measurement and verification protocol (IPMVP)
Monitoring		€/a		(Cost for the evaluation of the monitoring) - Excluded VAT and Monitoring System
Process feature				
Blower door test	Choose			€ (Cost of BDT - it is payed on time) - VAT excluded
Thermography	Choose			€ (Cost of thermography - it is payed on time) - VAT excluded
ETICS guarantee/system	Choose			
Programme and tools				
Maintenance program - Construction	Choose	Annual cost €/a		Maintenance program for building envelope elements is an annual contract with a Private partner. It must be conteined a documentation plan of mangament and verification actions, completed of identification of the reference persons. Excluded VAT and Material costs for the maintenance.
Maintenance program - Thermic plant	Choose	Annual cost €/a	0,00	Maintenance program for technical systems (such as heating, cooling, ventilation, emission system) is an annual contract with a Private partner. It must be conteined a documentation plan of mangament and verification actions, completed of identification of the reference persons. Excluded VAT and Material costs for the maintenance.
Maintenance program - Electric plant	Choose	Annual cost €/a	0,00	Maintenance program for electric system is an annual contract with a Private partner. It must be conteined a documentation plan of mangament and verification actions, completed of identification of the reference persons. Excluded VAT and Material costs for the maintenance.
BASELINE ENERGY CONSUMPTION AND COSTS (PRE-RENOVATION)				
Fuel source	Choose			
Consumption of pre-selcted fuel		kWh/a		It is the average annual energy consumption of natural gas of the last 3 years
Price pre-selcted fuel		€/kWh		It is the average cost of preselected fuel of the last 3 years
Baseline preselected fuel expenditure	-	€		It is the average historical expenditure of preselected fuel for the last 3 years, that will be used to calculate the economic convenienve of the energy efficiency investment
Consumption of electricity		kWh/a		It is the average annual energy consumption of electricity of the last 3 years. In case of existing renewable energy plants (i.e. PV) or cogeneration plants, don't include self-production but only consider the energy bought from the grid.
Electricity price		€/kWh		It is the average cost of electricity of the last 3 years
Baseline electricity expenditure	-	€		It is the average historical expenditure of electricity for the last 3 years, that will be used to calculate the economic convenience of the energy efficiency investment
Electricity used for heating	Choose			If the heating system is fueled by electricity, flag "yes"
If yes to the above, average % of total electric energy consumption due to heating		%		If electricity is also used for heating (case of electric heat pumps), include the estimate of the percentage of electricity bought from the grid and used for heating.
O&M cost		€		It is the average cost for operation and maintenance of the last 3 years. The maintenance program contract is e
Tot. O&M cost	0,00	€		Total cost of maintenance: contracts + operations + replaced/substituted materials
POST-RENOVATION ENERGY CONSUMPTION AND COSTS				
Fuel source	Choose			
Consumption of pre-selcted fuel		kWh/a		It is the expected annual energy consumption of preselected fuel after the renovation
Price pre-selcted fuel		€/kWh		
Consumption of electricity (excl. RES)		kWh/a		It is the expected annual energy consumption of electricity after the renovation (without considering RES production or production from cogeneration plants, thus only considering the energy bought from the grid)
Electricity used for heating	Choose			If the heating system will be fueled by electricity after the renovation, flag "yes"
If yes to the above, average % of total electric energy consumption due to heating		%		If electricity will be used for heating (case of electric heat pumps), include the estimate of the percentage of electricity bought from the grid and used for heating
O&M cost		€		It is the expected cost for operation and maintenance after the renovation. Excluded the maintenance program
Tot. O&M cost	0,00	€		It is the expected cost for operation and maintenance after the renovation: contracts + operations + replaced/sul
FINANCIAL DATA				
Financial leverage		%		Percentage of the investment financed by bank loan (if private financing insert "zero")
Interest rate on loan		%		Interest rate applied on the bank loan
Banking fees		%		One-time fees applied by the bank for the issuance of the loan, as percentage of the loan
DSCR Covenant		-		Covenant on DSCR required by the bank
Equity	#REF!	€		Automatically calculated
Debt	#REF!	€		Automatically calculated
Cost of capital		%		To be used as discount factor to calculate WACC and NPV
WACC	-	%		Automatically calculated according to financial leverage and cost of capital
Expected inflation rate		%		Expected inflation rate to be applied to energy and O&M costs to calculate cash flows

Figure 20: "Inputs1"

MULTIPLE BENEFITS DATA				
Certificates				
WELL Certificate	Choose			
Fitwell Certificate	Choose			
Any related certificate	Choose		Detail which certificate, issued date and expiration day if applicable	
Smart sensors				
Installed smart sensors	Choose		Detail which gadget, brand and cost. Most importantly, functionality of the smart sensor	
Thermal Comfort			**Equipment**	**Procedure**
Winter minimum room temperature	18,0	°C	Smart sensors eg. Inbiot, FLIR ONE or alike.	Check min temperature fall within the saesonal permitted range.
Winter maximum room temperature	23,0	°C		Check max temperature fall within the saesonal permitted range.
Summer minimum room temperature	21,0	°C		Check min temperature fall within the saesonal permitted range.
summer maximum room temperature	25,0	°C		Check max temperature fall within the saesonal permitted range.
Visual Comfort				
Daylight Autonomy DA	500,0	lux	Luxmeter or Chlorimeter	1. (Baseline or ambient light level) Turn off all lighting in the room about to measure. 2. (illuminated level) Turn on lights from a central area of the room 3. (Compute Delta) Subtract the baseline or ambient light level from the illuminated level to get the the amount of light the existing
Acostic Comfort				
Impact noise through smart noise sensor	5,0	db(A)	Sound level meter	The curves are compared to standard STC reference curves. The Sound Transmission Classification of walls above 50Hz blocks shouting
Airbone noise (room noise) through smart noise sensor	30,0	db(A)	Sound Level meter	Acquire Ambient noise level with the sound level meter in dB
Air quality				
Carbon dioxide CO2 emission	600,0	ppm	Smart sensors eg. Inbiot (inbiot.es)	Install smart meter to acquire continuous measurement during one week. Acquire a signal as long as possible and with the best quality (SNR).
PM2.5 exposure	10,0	µ g/m³	Smart sensors eg. Inbiot	Install smart meter to acquire continuous measurement during one week. Acquire a signal as long as possible and with the best quality (SNR).
Volatile Organic Compounds VOC exposure	100,0	ppm	Smart sensors eg. Inbiot	Install smart meter to acquire continuous measurement during one week. Acquire a signal as long as possible and with the best quality (SNR).
Carbon monoxide CO exposure	35,0	ppm	Smart sensors eg. Inbiot	Install smart meter to acquire continuous measurement during one week. Acquire a signal as long as possible and with the best quality (SNR).
Radon exposure	30,0	WL	Smart sensors eg. Inbiot	Install smart meter to acquire continuous measurement during one week. Acquire a signal as long as possible and with the best quality (SNR).
Perceived physical and mental health				
Perceived physical and mental health before renovation	[1..5]	Survey	WHO Survey, visit: https://www.who.int/mental_health/who_qol_field_trial_1995.pdf Questions with response scales (1 to 5)	
Perceived physical and mental health after renovation	[1..5]	Survey	WHO Survey, visit: https://www.who.int/mental_health/who_qol_field_trial_1995.pdf. Survey must take place at least 6 months after the renovation work. Questions with response scales (1 to 5)	
Productivity				
Estimated increase of individual worker productivity		%	Data provided by Business Owner	Employer valuation of worker productivity
Number of workers		-	Data provided by Business Owner	
Workers salary cost		€/y	Data provided by Business Owner	
Employee turnover rate		%	Data provided by Business Owner	
Number of sick days claimed per employee		d/y	Data provided by Business Owner	

Figure 21: “Inputs1”

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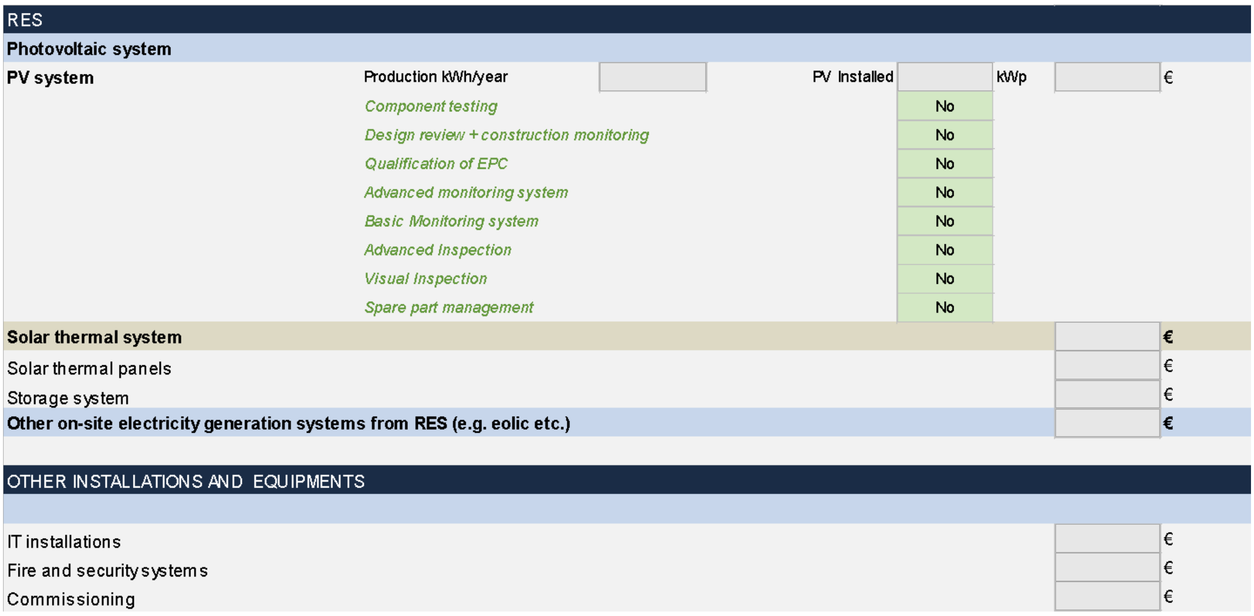
Please fill in only the elemts that will be renovated with the infromation on dimension and costs.

BUILDING ELEMENTS			Dimension / number		Tot. Costs	
Roofs			0,0 m2			
Flat roof						
Flat roof	External insulation	Area		m²		€
Flat roof	Internal insulation	Area		m²		€
Pitched roof - Ceiling next to air (outside)						
Pitched roof - Ceiling next to air (outside)	External insulation	Area		m²		€
Pitched roof - Ceiling next to air (outside)	Internal insulation	Area		m²		€
Floors			0,0 m2			
Floor next to ground (outside)	new insulation	Area		m²		€
Floor next to air (outside)	new insulation	Area		m²		€
Floor next to unheated area (like garage)	new insulation	Area		m²		€
Walls (with windows)			0,0 m2			
Ext.Wall - External cladding (insulation, glue and plaster)		Area		m²		€
Ext.Wall - Ventilated façade with external cladding (insulation, achoring, fixing system, and external f		Area		m²		€
Ext.Wall - Prefabbricated façade (insulation, final caldding, achoring, fixing system)		Area		m²		€
Ext.Wall - Internal insulation (insulation, glue and plaster)		Area		m²		€
Ext.Wall - Window façade system - Curtain wall (frame, insulated glass unit, gasket system, anchorir		Area		m²		€
Ext.Wall - Window façade system - Double skin - new elements		Area		m²		€
Ext.Wall - Window façade system - Double skin - addition of second skin		Area		m²		€
Wall next to unheated area (garage..) - New insulation (of any kind)		Area		m²		€
Wall next to ground (outside) - New insulation (of any kind)		Area		m²		€
Windows						
Wall windows		**Area**	**0,0**	**m²**	**0,0**	**€**
North windows - Shading position	Choose	Area		m²		€
East windows - Shading position	Choose	Area		m²		€
South windows - Shading position	Choose	Area		m²		€
West windows - Shading position	Choose	Area		m²		€
Roof windows - Shading position	Choose	**Area**		**m²**		€
Automatic control of windows (opening/closing)				n.		€
Shading Systems						
Internal Shading Systems		Area		m²		€
External Shading Systems		Area		m²		€
Shading Systems integrated in the glasses		Area		m²		€
Automatic control of Shading Systems (opening/closing)			Choose			€
	Automatic controll by meteo station		Choose			
External Doors						
Single slide	Choose	n. door		n.		€
Single swing	Choose	n. door		n.		€
Revolving	With vestibule	n. door		n.		€
Automatic control of external doors (opening/closing)				**n.**		€

Figure 22: Inputs 2. Building elements

BUILDING SERVICES				Units		Tot. Costs
Heating System						
Heating generation unit:						
Heat Pump (air)			kW		n.	€
Heat Pump (water)			kW		n.	€
Heat Pump (geothermal)			kW		n.	€
District heating substation			kW		n.	€
		Automatic meter reading system		Choose		
		Certification (PED, F10/VF103-3)		Choose		
		Fouling detection		Choose		
Condensing Gas boilers	Choose: Tech.system located		kW		n.	€
GPL boilers	Choose: Tech.system located		kW		n.	€
Biomass boiler	Choose: Tech.system located		kW		n.	€
		Pellet quality(UNI EN ISO 17225-2)		Choose		
		Maintenance program - Thermic plant		Choose		
		Remote monitoring system		Choose		
		Wood boiler		Choose		
Cogeneration, combined heat and power (CHP)			kW		n.	€
Decentralized heating system	Split system		kW		n.	€
Emission system (heating)						
Emission system (heating)	Radiator system	Heating surface area			m²	€
Emission system (heating)	Radiant floor heating system	Heating surface area			m²	€
Emission system (heating)	Radiant ceiling heating system	Heating surface area			m²	€
Emission system (heating)	Radiant wall heating system	Heating surface area			m²	€
Emission system (heating)	Fan coil unit				n.	€
	Pressure test based on UNI EN 1264-4/ISO EN UNI 11855-6			Choose		
	Screed stress test (EN-1264)			Choose		
	Material labelled CE, DOP			Choose		
	Humidity control installed			Choose		
Distribution system						
Completed of pipes, fittings/valves/circulators/expansion vessel						€
Regulation system	*Switch cabinet already included in heating/dhw/cooling*					0 €
Regulation system	Field devices (Sensors) and thermostats				n.	€
Regulation system	Energy metering				n.	€
DHW generation dedicated						0 €
Electric boilers			kW		n.	€
GPL boilers	Choose: Tech.system located		kW		n.	€
Condensing Gas boiler	Choose: Tech.system located		kW		n.	€
Air/air HP			kW		n.	€
Air/water HP			kW		n.	€
Geothermal HP			kW		n.	€
Cooling system						
Cooling generation unit					n.	€
Emission cooling system	*the same of heating system*			Choose		
Emission cooling system						
Emission cooling system	*The emission cooling system is the same of heating system*			Choose		
Emission cooling system	Radiant floor heating system	Cooling surface area			m²	€
Emission cooling system	Radiant ceiling heating system	Cooling surface area			m²	€
Emission cooling system	Radiant wall heating system	Cooling surface area			m²	€
Emission cooling system	Fan coil unit				n.	€
	Pressure test based on UNI EN 1264-4/ISO EN UNI 11855-6			Choose		
	Screed stress test (EN-1264)			Choose		
	Material labelled CE, DOP			Choose		
	Humidity control installed			Choose		
Mechanical ventilation system (VMC)						0 €
VMC	(Air handler/ Ventilation duct/Built-in components/Outlets/diffuser)					€
	Fouling detection			Choose		
VMC integrated in the window frame					n.	€
Lighting system					tot.	0 €
Lights type						
Low power consumption lights, LED		P_N	W/m2 area		m2	€
Sensors, Controllers, Dimmers			Automatic control	Choose		€
Building Energy Management System (BEMS)						
Building Energy Management System (BEMS)						€
BEMS project by an expert certified	*UNI-EN 15232*			Choose		
Building automation system of:	*Lighting*			Choose		
	Shading system			Choose		
	Thermal system (heating and cooling)			Choose		
	Ventilation			Choose		
	Monitoring system of energy consumption			Choose		
	Meteo station			Choose		€
Heating storage						€
Electric system						€

Figure 23: Inputs 2. Building services



RES						
Photovoltaic system						
PV system	Production kWh/year		PV Installed	kWp		€
	Component testing		No			
	Design review + construction monitoring		No			
	Qualification of EPC		No			
	Advanced monitoring system		No			
	Basic Monitoring system		No			
	Advanced Inspection		No			
	Visual Inspection		No			
	Spare part management		No			
Solar thermal system						**€**
Solar thermal panels						€
Storage system						€
Other on-site electricity generation systems from RES (e.g. eolic etc.)						**€**
OTHER INSTALLATIONS AND EQUIPMENTS						
IT installations						€
Fire and security systems						€
Commissioning						€

Figure 24: Inputs 2: Renewable Energy Sources

6.2.2 Technical Risk Assessment – First Dimension

The strategy developed in the EEnvest technical risk assessment was to (i) identify the technical risks of DER projects and to (ii) systematically compute these risks as accurately as possible. This is supported by the EEnvest technical risk database that holds all the possible risk combinations for each single renovation measure.
The Technical Risk Assessment works on a computation-based input-output data structure where the input is provided by the user and the output is computed. From the building owner's standpoint, they will only interact with the input and the output of the calculation.

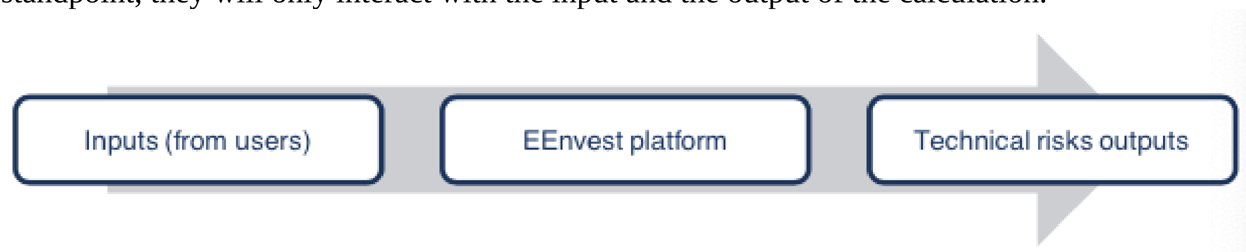


Figure 25: Retrieved from Deliverable 2.1 of EEnvest Project

The outputs of the Technical Risk assessment are two:

- Performance Gap
- Damage

All in all, the Technical Risk KPIs serve as input for the following dimension of the EEnvest Methodology, which is the Financial Risk Assessment. This is better presented in Figure 19 below.

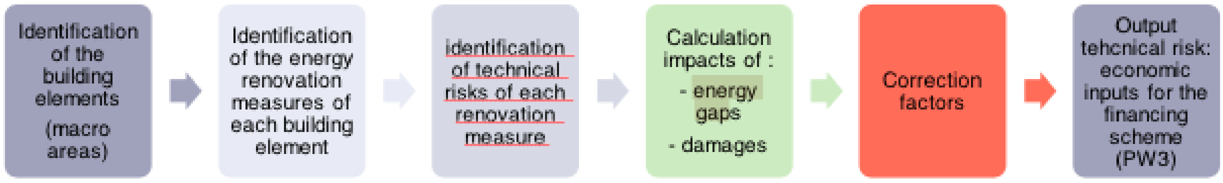


Figure 26: Identification process of the technical risks connected to the EE renovation projects.

6.2.3 Financial Performance and Risk Assessment – Second Dimension

The Financial Performance and Risk Assessment starts from the output of the Technical Assessment previously described. Indeed, the two parameters of the Technical Assessments (Damage and Energy Gap) are the foundation of the financial model. These two variables, and particularly their probability distributions, are the main input to calculate the probability distribution of the Financial KPIs, by combining them together with the probability distribution of energy prices and expected climate conditions through a Monte-Carlo simulation.
This process allows for obtaining not only the expected values of the outputs, but also their probability distribution. This additional information, which is a particular feature of the model, is extremely valuable for an investor that is assessing the riskiness of an energy efficiency renovation project. In fact, probability distribution of the KPIs can play a key role in the decision-making process of an investment, supporting the investor in understanding the riskiness of the project with information such as: how asymmetric is the probability distribution (meaning where the risk is more concentrated); what is the maximum payback time that I can expect from the investment in worst case scenarios; etc.
A very simplified scheme of the EEnvest financial model is represented in the following Figure 27:

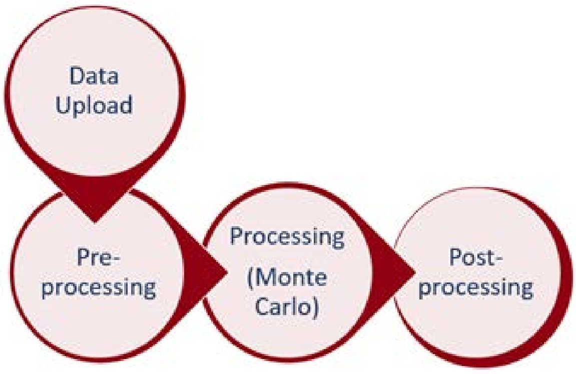


Figure 27: Retrieved from Deliverable 3.2 of EEnvest Project

The outputs of the Financial Performance Risk assessment, as shown and described in Paragraph 5.2, are the following:

- Payback Period
- IRR

- NPV
- DSCR

Each KPI is described through its expected value (mean of the probability distribution) as well as its probability distribution (through a graph showing the density of probability). Then, to help the user better understanding the meaning and the consequences of the probability distribution of a KPI, a synthetic indicator was elaborated, calculating the distance between the median value and the 95th percentile of the distribution.
All these KPIs, together, will provide the user, particularly the investor, with all the necessary information to assess the performance and the riskiness of the investment project.

6.2.4 Multi-Benefit Assessment – Third Dimension

The multiple-benefit assessment was already covered in Chapter 4. As a summary, Figure 28 below showcases the multiple-benefit KPIs for Project Promoters (related as well to Building owner) and Investors, as well as their relevance for both parties.

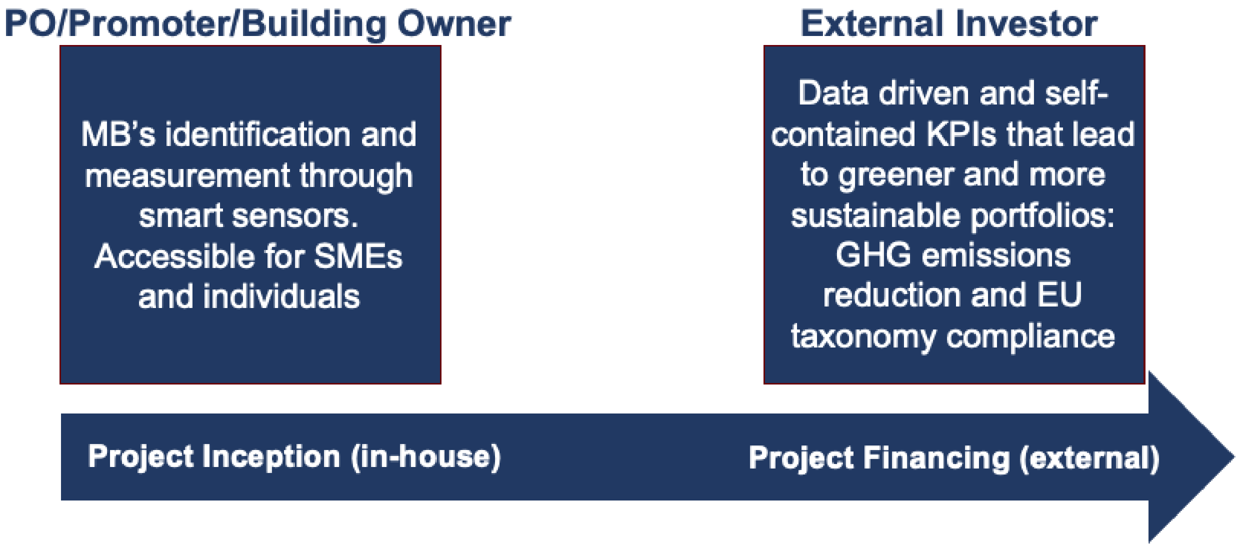


Figure 28: Multiple-benefit KPIs for Project Promoters and Investors

The outputs of the Multiple-Benefit assessment are the following:
For Project Promoters

- Thermal Comfort
- Acoustic Comfort
- Visual Comfort
- Air Quality
- Perceived physical/mental health
- Productivity

For investors

- CO_2 Emission Reduction
- Predicted Primary Energy Savings

- Jobs Created
- EU Taxonomy Compliance
- Property Value Increase
- SDGs Alignment

6.2.5 Multi-Criteria Decision Analysis

Once the outputs from the technical, financial and multi benefits assessment are calculated, they will be used as inputs for the MCDA tool. As discussed in Chapter 5, not all calculated KPIs can be used as input for the MCDA, mostly because of the double counting risk. Once the MCDA tool has been validated and points to be improved have been mapped it should be fully defined so it can be translated into the platform through the required coding system.

Figure 29 below shows the input table that is used for the MCDA tool. It displays the selected alternatives, the buildings of the proposed projects, and their investment costs. In addition, the KPIs of the different assessment packages, sorted by color, are inserted for each alternative. Grey color refers to the project specific characteristics such as project size or total investment costs. Blue reflects the technical risk assessment whereas light red represents the financial assessment. Finally, the multiple-benefit assessment is highlighted in light green.
Additionally, dark red and dark green colors are inserted above each KPI separately to help users better understand how to assess each KPI. This is because a KPI can be either a cost (red), where the lower the value the better, or a benefit (green), where the higher the value the better. The calculations of the standardization methods need to take this into account, as the maximum and minimum values are different between a cost and benefit KPI. Indicating this by using a red or green color is therefore important.

PROJECT SIZE			TECHNICAL RISK ASSESSMENT		FINANCIAL PERFORMANCE ASSESSMENT					MULTI-BENEFITS IMPACT ASSESSMENT		
Building	Investment	Net heating area (m2)	Damage	Energy Performance gap	Payback time with technical risks	IRR	NPV	DSCR	Distance from 95th perc	CO2 emission savings (kg CO2/m2)	Energy savings	Jobs Created
1	€ 404.253,00	7809,67	0,93%	2,36%	23,15	-0,5%	-38,54%	0,77	12%	8,51	35%	7,28
2	€ 110.000,00	9225,00	0,15%	2,14%	6,76	14,6%	98,89%	2,64	17%	6,20	24%	1,98
3	€ 638.361,00	3193,00	0,68%	0,81%	58,70	-7,8%	-77,98%	0,30	70%	15,99	68%	11,49
4	€ 24.067,00	1718,67	0,21%	2,18%	6,63	14,9%	94,96%	2,69	16%	7,44	26%	0,43
5	€ 684.088,00	6335,00	0,55%	0,78%	58,70	-7,8%	-77,98%	0,30	70%	8,26	61%	12,31
6	€ 748.788,00	4061,33	0,24%	0,83%	61,64	-8,1%	-79,03%	0,29	62%	12,06	40%	13,48
7	€ 165.340,00	2669,33	0,90%	0,92%	14,99	3,8%	-13,77%	1,19	40%	15,56	28%	2,98
8	€ 80.000,00	3364,33	0,05%	1,06%	6,29	15,9%	105,40%	2,84	11%	13,06	25%	1,44
9	€ 1.742.890,00	4648,00	0,24%	0,62%	85,32	-10,2%	-84,85%	0,21	17%	17,70	93%	31,37
10	€ 4.800.000,00	3003,00	0,18%	5,24%	104,60	-11,5%	-87,64%	0,17	43%	45,32	91%	86,40
11	€ 1.306.000,00	24470,79	0,30%	1,04%	7,57	12,7%	70,81%	2,36	9%	21,35	68%	23,51
12	€ 201.850,00	645,00	0,80%	0,16%	40,08	-5,0%	-66,93%	0,46	10%	34,88	86%	3,63
13	€ 250.000,00	347,34	0,38%	32,33%	21,96	0,0%	-41,05%	0,77	23%	75,60	97%	4,50

Figure 29: Input table of the MCDA analysis

Once the input table is filled in, the standardized performance matrix is created. This matrix is shown in Figure 30 below. The standardized scores are calculated for each alternative and for each KPI. The KPIs are again sorted by the same color of their assessment package of the input table. It can be noticed that all the scores are between 0 and 1, which means that they are on the same scale and can be compared. The scores for each KPI are ranked in terms of color, where the highest scores have a green color and the lowest scores a yellow color. With this visualization formatting, the users could easily see which alternatives have high or low scores on the different KPIs.

Building	Damage	Energy Performance Gap	Payback time with technical risks	IRR	NPV	DSCR	Distance from 95th perc	CO2 emission savings (kg CO2/m2)	Energy savings	Job creation
1	0	0,93	0,78	0,40	0,25	0,27	0,83	0,03	0,36	0,08
2	0,84	0,93	0,94	0,95	0,97	0,93	0,76	0,00	0,25	0,02
3	0,27	0,97	0,44	0,14	0,05	0,11	0,00	0,14	0,70	0,13
4	0,77	0,93	0,94	0,97	0,95	0,95	0,77	0,02	0,27	0,01
5	0,41	0,98	0,44	0,14	0,05	0,11	0,00	0,03	0,63	0,14
6	0,74	0,97	0,41	0,12	0,04	0,10	0,11	0,08	0,41	0,16
7	0,03	0,97	0,86	0,56	0,38	0,42	0,43	0,13	0,29	0,03
8	0,95	0,97	0,94	1,00	1,00	1,00	0,84	0,10	0,26	0,02
9	0,74	0,98	0,18	0,05	0,01	0,07	0,76	0,17	0,96	0,36
10	0,81	0,84	0,00	0,00	0,00	0,06	0,39	0,56	0,94	1,00
11	0,68	0,97	0,93	0,88	0,82	0,83	0,87	0,22	0,70	0,27
12	0,14	1,00	0,62	0,24	0,11	0,16	0,86	0,41	0,89	0,04
13	0,59	0,00	0,79	0,42	0,24	0,27	0,67	1,00	1,00	0,05

Figure 30: Standardized performance matrix

With this standardized performance matrix, weights can be assigned, and the final multi-criteria scores can be calculated. Figure 31 shows this process in the Excel model.
First, weights are assigned to each KPI in percentages at the top of the figure. These percentages must sum up to 100% and sorted by assessment package. An important remark is that the weighting is subjected to the investors' choice and investment strategies.
It can be noticed that for the four financial KPIs, there is an extra row of percentages included. This is because an Excel formula is used to make sure that only 1 out of the 4 KPIs is included in the analysis, as explained in Chapter 5. As a result, the scores are only calculated when weights are assigned to a single financial KPI. When weights are assigned to two or more of these KPIs, the scores will not be calculated.
After the weights are inserted, the final score on each KPI is calculated for all the alternatives. These scores are summed up in their assessment packages and eventually total multi-criteria score for each investment alternative is produced. This is shown in the grey 'total' row. This specific score is the ultimate outcome of the analysis, serving as the specific value to be benchmarked against the rest of the investment alternatives. In other words, the highest score between all selected investment alternatives represents the most attractive investment opportunity as per the investors' preferences and assigned weights.

	Weights													
	Damage	Energy Performance Gap	Payback time with technical risks	IRR	NPV	DSCR	Distance from 95th perc	CO2 emission savings (kg CO2/m2)	Energy savings	Job creation	Technical assessment	Financial assessment	Multiple benefits assessment	Total
			0,0%	0,0%	0,0%	25,0%								
	20,0%	5,0%	0,0%	0,0%	0,0%	25,0%	15,0%	7,5%	20%	7,5%	25,0%	40,0%	35,0%	100,0%
Building	Damage	Energy Performance Gap	Payback time with technical risks	IRR	NPV	DSCR	Distance from 95th perc	CO2 emission savings (kg CO2/m2)	Energy savings	Job creation	Technical assessment	Financial assessment	Multiple benefits assessment	Total
1	0,00	0,05	0,00	0,00	0,00	0,07	0,12	0,00	0,07	0,01	0,05	0,19	0,08	0,32
2	0,17	0,05	0,00	0,00	0,00	0,23	0,11	0,00	0,05	0,00	0,21	0,35	0,05	0,61
3	0,05	0,05	0,00	0,00	0,00	0,03	0,00	0,01	0,14	0,01	0,10	0,03	0,16	0,29
4	0,15	0,05	0,00	0,00	0,00	0,24	0,12	0,00	0,05	0,00	0,20	0,35	0,06	0,61
5	0,08	0,05	0,00	0,00	0,00	0,03	0,00	0,00	0,13	0,01	0,13	0,03	0,14	0,30
6	0,15	0,05	0,00	0,00	0,00	0,03	0,02	0,01	0,08	0,01	0,20	0,04	0,10	0,34
7	0,01	0,05	0,00	0,00	0,00	0,10	0,06	0,01	0,06	0,00	0,06	0,17	0,07	0,29
8	0,19	0,05	0,00	0,00	0,00	0,25	0,13	0,01	0,05	0,00	0,24	0,38	0,06	0,67
9	0,15	0,05	0,00	0,00	0,00	0,02	0,11	0,01	0,19	0,03	0,20	0,13	0,23	0,56
10	0,16	0,04	0,00	0,00	0,00	0,01	0,06	0,04	0,19	0,08	0,20	0,07	0,30	0,58
11	0,14	0,05	0,00	0,00	0,00	0,21	0,13	0,02	0,14	0,02	0,18	0,34	0,18	0,70
12	0,03	0,05	0,00	0,00	0,00	0,04	0,13	0,03	0,18	0,00	0,08	0,17	0,21	0,46
13	0,12	0,00	0,00	0,00	0,00	0,07	0,10	0,08	0,20	0,00	0,12	0,17	0,28	0,57

Figure 31: Assigned weights and calculation of multi-Criteria scores

When the multi-criteria scores are calculated, the options can be ranked and visualized. Figure 32 is an example of how the results could be shown in a bar chart. The final scores are sorted by the contribution of each assessment package. This visualization helps investors to immediately see which option is more aligned with their preferences and which assessment package is contributing most to the total scoring because of the assigned weights.

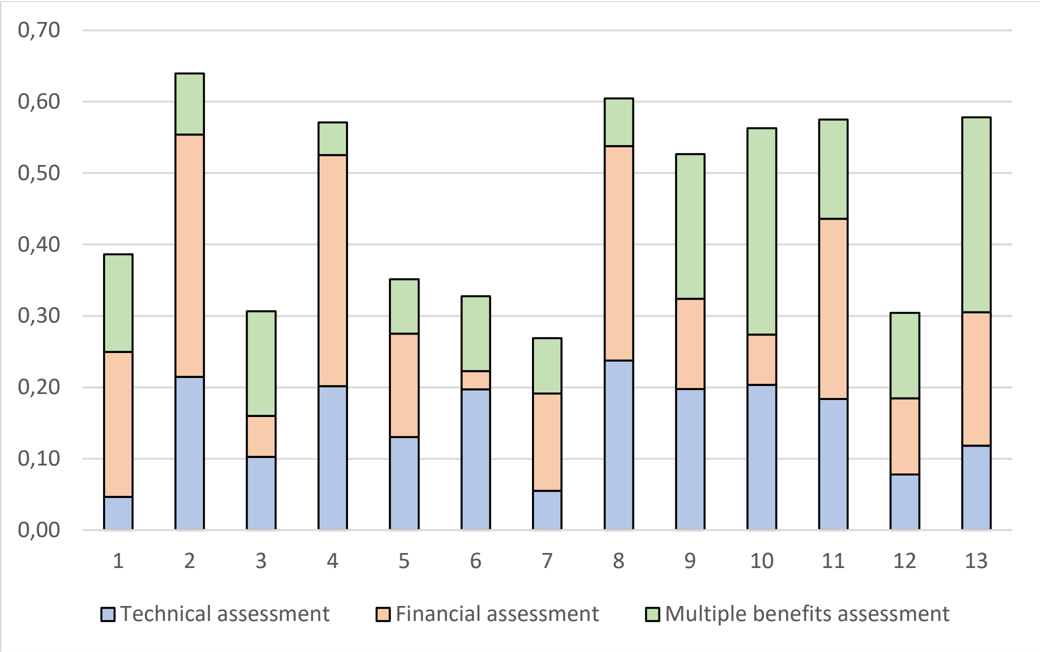


Figure 32: Ranking of the alternatives

6.2.6 The EEnvest Report

This chapter is dedicated to the description of the main output of EEnvest Methodology: the EEnvest Report, a key report for investors where to gather information on investment highlights along with useful recommendations.

The Report turns the EEnvest methodology into practice: starting from general and technical data, it produces a full and straightforward assessment of technical risks, financial and multi-benefit performance, quantifying and categorizing the specific KPIs outputs.
The MBs assessment KPIs selected are the most relevant to facilitate the decision-making process for investors.

The Report consists of a detailed but user-friendly interface, available as PDF document as well as digital on the platform, that enables investors to compare different DER projects based on the uploaded data. The report allows investors to also perform several operations: on one side, uploading data for the knowledge base with different levels of specificity, displayed in a simple and effective graphic; on the other side, it permits to compare investment opportunities visualizing possible financing mechanisms available for a determined asset renovation.
The front end will be based on dashboards to maximize the accessibility of information and will include benchmarking with similar investments. The platform front end will be designed to provide an investment option report to the end user.

Figure 33: EEnvest Report first page

6.2.7 Report Overview

The second page (Figure 34) of EEnvest Report indicates general information about renovation projects under investigation for investment.
The general data (Figure 34, on the left), structured in five points, gives a general overview of the building, with a picture, including:

- Name
- Address
- Building Type
- Owner
- Contact

The technical data (Figure 34, centered), structured in five points, provides main information about the building under consideration:

- Construction year
- Last renovation year
- Gross floor area
- Gross volume
- HDD

EEnvest RISK ASSESSMENT REPORT

GENERAL DATA

Name: xx

Address: xx

Building use/typology: xx

Owner: xx

Contact: xx

TECHNICAL DATA

Construction year: xxxx

Last renovation year: xxxx

Gross floor area: xx m^2

Gross volume: xx m^3

HDD: xx

Project size:

xx €

Financing amount requested:

xx €

Investment cost:

xx €/m^2

Expected M&O costs:

xx €/m^2y

Primary Energy savings:

x%

Primary Energy demand:

xx kWh/m^2y

PV production:

Yes/No xx KWh/y

Solar thermal production:

Yes/No

Expected start date of the renovation:

xx/xx/xxxx

Expected end date of the renovation:

xx/xx/xxxx

Renovation and mitigation measures adopted:

- X
- X
- X
- X

Project ambition:

Minimum primary energy cost saving of xx%.

Project Quality Self-Assessment score:

High probability of reliable, consistent and achievable energy savings. **XXX/XX**

Technical average risk

Mitigated	Needs attention	Needs action

Financial average performance

High	Medium	Low

Multi-benefit average performance

High	Medium	Low

Model version: XXX - Date: XX/XX/XXXX - 2 -

Figure 34: Second page of EEnvest report

Based on this information, the report provides six categories articulating the renovation and investment outlooks:

1. Investment: Investment cost, Financing amount requested, Expected maintenance and operation costs.
2. Energy: Primary Energy savings, PV production, Solar thermal panels production
3. Project timeline: Expected start date of the renovation, Expected end date of the renovation
4. Project ambition
5. Project Quality Self-Assessment score
6. Renovation and mitigation measures adopted

At the end of the page, a simple graphic resumes the project in three different categories, Technical risk, Financial performance, Multi-benefit performance classified as:

- Technical risk classified in Mitigated, Needs Attention, Needs Action
- Financial performance, qualified in High, Medium and Low
- Multi-benefit performance qualified in High, Medium and Low

Following on the next page (Figure 35), it is displayed in more detail the assessment schematized in the first page. The second page of the report provides a deeper insight specifically designed for investors to assist them in the investment evaluation, so the KPIs selection was carefully customized for the investors as end users.

EEnvest RISK ASSESSMENT REPORT

TECHNICAL RISKS

DAMAGE

The Damage indicator quantifies the investment deviation due to possible malfunctioning or failures of the energy renovation measures adopted in the renovation project. Such deviation is expressed as a percentage of the planned investment.

For this specific project, the Damage indicator has been estimated as: **XX** %

ENERGY GAP

The Energy gap indicator quantifies the energy performance deviation. It is expressed as a percentage of the calculated energy performance after the renovation project.

For this specific project, the estimated Energy gap is: **XX** %

FINANCIAL PERFORMANCE

PAYBACK TIME

The Payback time is the amount of time that the investment will take to recover the initial cost when the length of the investment time reaches a breakeven point.

For this specific project, the estimated Payback time is: **XX** years

MATURITY

The Maturity is defined as the total duration of the project needed to achieve a zero NPV (IRR equal to cost of capital).

For this specific project, the estimated Maturity is: **> XX** years

INTERNAL RATE OF RETURN (IRR)

The Internal Rate of Return (IRR) is the discount rate that makes the net present value (NPV) of a specific project equal to zero.

For this specific project, the Internal Rate of Return is: **XX** %

NET PRESENT VALUE ON INVESTMENT (NPV/investment)

The Net Present Value (NPV) is the value of all future cash flows (positive and negative) over the entire life of an investment discounted to the present. The NPV/investment ratio gives a measure of profitability of the project.

For this project, the estimated NPV/investment is: **XX** %

DEBT-SERVICE COVERAGE RATIO (DSCR)

The Debt-Service Coverage Ratio (DSCR) is an indicator of the project's ability to repay a debt. It is calculated as the ratio between the operative cash flows generated by the project and the cash flows for debt, lease, or other obligations (debt service, both for interests and principal payment) due in one year.

For this project, the DSCR has been estimated equal to: **XX**

Model version: XXX - Date: XX/XX/XXXX - 3 -

Figure 35: Third page of EEnvest Report

This page consists of three sections: Technical risks assessment, Financial performance and finally the Multi-benefit performance.

The first section (Figure 28, first part), technical risks assessment, focuses on the technical risk evaluation, aiming to determine the reliability of the renovation project based on technical risk levels. The assessment is based on two economic indicators, both presented in percentages:

- Damage
- Energy gap

Technical risks might arise due to purely technical issues, such as components delayed delivery and faulty installation on damaged components.

The second section (Figure 35, second part) focuses on the financial risk evaluation, based on five KPIs, exploring different aspects of the investment and yet highly related to one another. The outputs are presented either in percentages, years or in ratio.

- Payback time
- Maturity
- Internal rate of return (IRR)
- Net Present Value of Investment (NPV/investment)
- Debt-service coverage ratio (DSCR)

The financial performance assessment continues on page 4 (Figure 36, first part) with two graphs corresponding to Cumulated cash flows and Project IRR Distribution. These KPIs have been explored in Chapter 5.2 of this document.

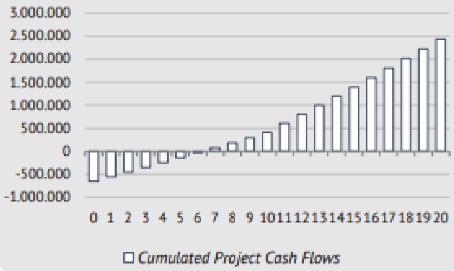
Lastly, the third section exposes the Multi benefit performance (Figure 36, second half) where the investment is evaluated regarding non-energy related benefits, quantified to ensure the investor best analysis. The Multi-benefit assessment includes six KPIs:

- CO2 Equivalent Emission Reduction, expressed in kg/kWhm2
- Predicted Energy Savings, expressed in kWh/m2y
- Numbers of Jobs Created, calculated in relation to the amount of total investment
- EU Taxonomy Compliance, assessed on as a minimum of 30% primary energy consumption reduction
- Property Value Increase, expressed in percentage
- Link to the SDGs, as qualitative indicator

The non-energy benefits increasingly play a highly relevant role in the investment market and projects evaluation, as analyzed in Chapter 3.1

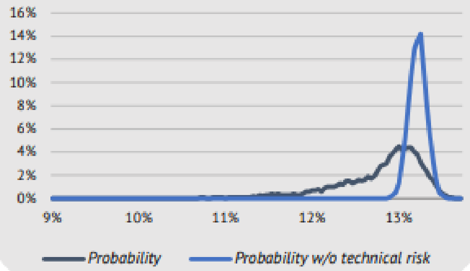
Graph n.1 - Cumulated project cash flows

This graph shows the cumulated cash flows generated by the project over time. The value for each one of the years is calculated as the simple sum of the cash flow of that year and all the previous cash flows. The graph below provides a quick view of the time needed to payback the initial investment cost.



Graph n.2 - Project IRR Distribution

This graph shows the probability distribution of IRR. Each value on the horizontal axis has a probability value. The area underneath the curve sums up to 100% probability. The dark blue curve includes all risks, so it's more extended to the left, meaning that there is higher probability that the IRR is low. The light blue curve includes only financial risks, so it's more concentrated around the expected value.



MULTI-BENEFIT PERFORMANCE

CO_2 EQUIVALENT EMISSION REDUCTION

The CO_2 Emission Reduction Indicator estimates the decrease of the CO_2 emissions as result of undertaking the renovation project. It is derived from the predicted energy savings, and it is applied a conversion factor that varies from country to country as well as the type of energy used in the building.

X kg/m²y

This KPI contributes to the following SDG targets: 8.4, 11.6, 11.9, 12.2

PREDICTED ENERGY SAVINGS

The Predicted Energy Savings indicator is the difference between the actual energy consumption of the building (baseline) and the estimated energy consumption after the renovation project. It includes heating, cooling, lighting and ventilation.

X kWh/m²y

This KPI contributes to the following SDG targets: 7.3

For this project, the predicted energy savings are:

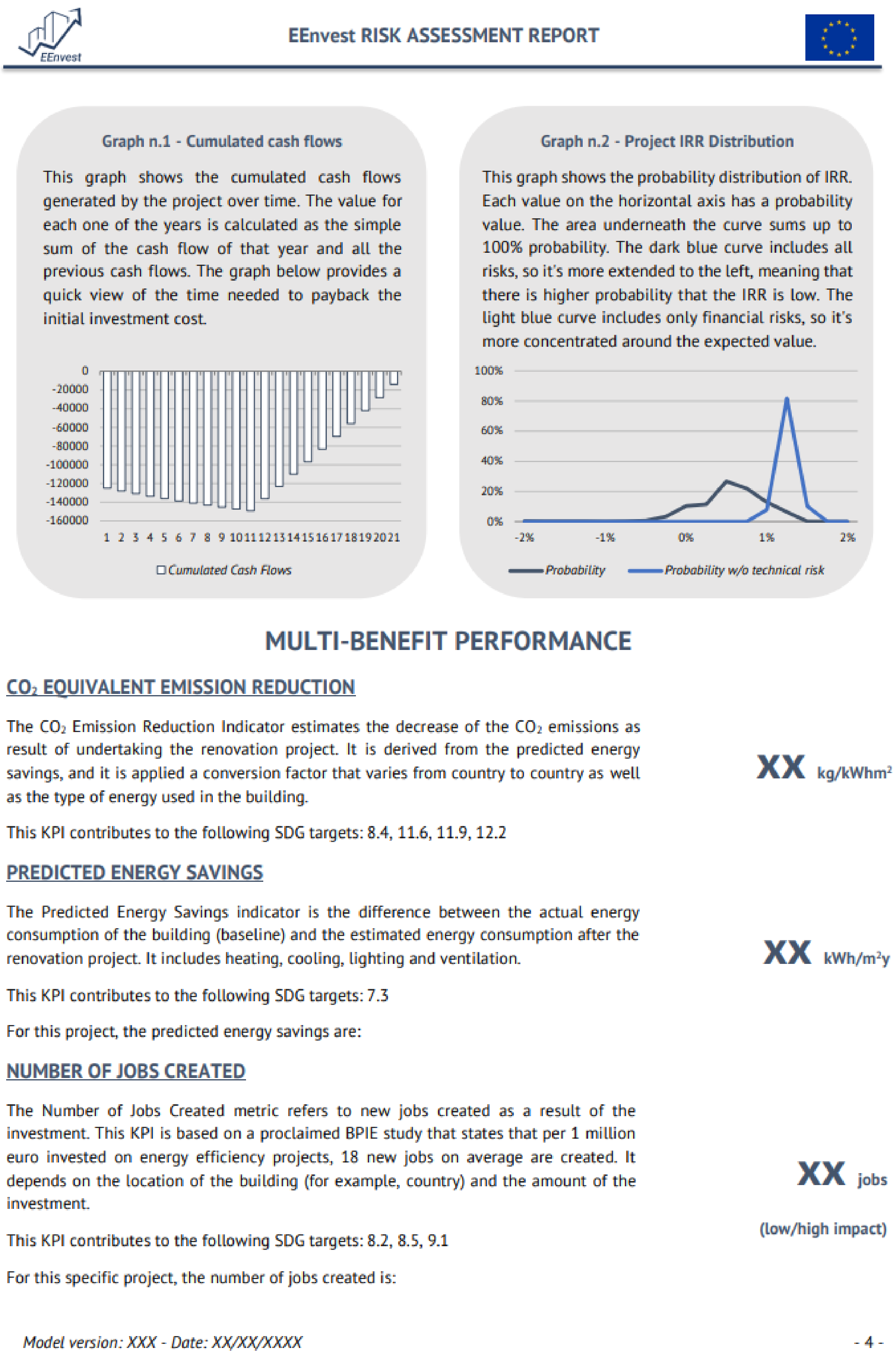
NUMBER OF JOBS CREATED

The Number of Jobs Created metric refers to new jobs created as a result of the investment. This KPI is based on a proclaimed BPIE study that states that per 1 million euro invested on energy efficiency projects, 18 new jobs on average are created. It depends on the location of the building (for example, country) and the amount of the investment.

X jobs

This KPI contributes to the following SDG targets: 8.2, 8.5, 9.1

For this specific project, the number of jobs created is:



EEnvest RISK ASSESSMENT REPORT

Graph n.1 - Cumulated cash flows

This graph shows the cumulated cash flows generated by the project over time. The value for each one of the years is calculated as the simple sum of the cash flow of that year and all the previous cash flows. The graph below provides a quick view of the time needed to payback the initial investment cost.

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MULTI-BENEFIT PERFORMANCE

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The CO_2 Emission Reduction Indicator estimates the decrease of the CO_2 emissions as result of undertaking the renovation project. It is derived from the predicted energy savings, and it is applied a conversion factor that varies from country to country as well as the type of energy used in the building.

XX kg/kWhm^2

This KPI contributes to the following SDG targets: 8.4, 11.6, 11.9, 12.2

PREDICTED ENERGY SAVINGS

The Predicted Energy Savings indicator is the difference between the actual energy consumption of the building (baseline) and the estimated energy consumption after the renovation project. It includes heating, cooling, lighting and ventilation.

XX kWh/m^{2}y

This KPI contributes to the following SDG targets: 7.3

For this project, the predicted energy savings are:

NUMBER OF JOBS CREATED

The Number of Jobs Created metric refers to new jobs created as a result of the investment. This KPI is based on a proclaimed BPIE study that states that per 1 million euro invested on energy efficiency projects, 18 new jobs on average are created. It depends on the location of the building (for example, country) and the amount of the investment.

XX jobs

(low/high impact)

This KPI contributes to the following SDG targets: 8.2, 8.5, 9.1

For this specific project, the number of jobs created is:

Model version: XXX - Date: XX/XX/XXXX - 4 -

Figure 36: Fourth page of EEnvest Report

On the last page (Figure 37, second half), the Report is concluded with sectioned recommendations to improve the overall project performance, coping with Technical Risks, Financial and Multi-Benefit assessment.

Recommendations provide with a brief list of actions that can be implemented as correction factors in each aspect of the project and the three dimensions assessed structured in correspondence: technical recommendations, financial recommendations, multi-benefit recommendations.

The recommendations provided are intended for the final user as mitigation measures.

EEnvest RISK ASSESSMENT REPORT

EU TAXONOMY COMPLIANCE

The EU Taxonomy Compliance indicator defines whether or not the investment complies with the minimum requirements defined by the EU Taxonomy. In specific, whether the project being assessed has a minimum of 30% primary energy consumption reduction.

YES/NO

PROPERTY VALUE INCREASE

The Property Value Increase indicator brings light to the possible increment on the value of the asset after the renovation project. This is also referred as the "greemium". In practical terms, it is not possible to predict this increase before the renovation project. Therefore, this metric is qualitative, and it provides a range of possible value increase backed-up by literature.

For this specific project, the Property Value Increase is:

Rental price: **X-X** %

Sale price: **X-X** %

LINK TO SUSTAINABLE DEVELOPMENT GOALS (SDGs)

The Link to SDGs indicator depicts to which specific SDGs the project contributes to. It is a qualitative indicator that showcases the non-financial benefits of investing in the renovation project.

7 AFFORDABLE AND CLEAN ENERGY | 8 DECENT WORK AND ECONOMIC GROWTH | 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE | 11 SUSTAINABLE CITIES AND COMMUNITIES | 12 RESPONSIBLE CONSUMPTION AND PRODUCTION | SUSTAINABLE DEVELOPMENT GOALS

Technical recommendations

A well-done renovation project reduces the difference between real energy consumption and estimated energy demand, guaranteeing the estimated energy savings for investments. To that hand, it is recommended to:

- engage an external expert to define the most relevant energy-efficient/mitigation measures and improve the energy performance of the building;
- adopt standard protocols for the design and process verification (e.g., Passive House, LEED);
- include different specific analyses and tests during the construction phase (e.g., Blower Door Test, thermography);
- assess the energy performance during the operation phase (e.g., energy consumption monitoring, maintenance programs).

Please note that the technical risk is calculated only on the building elements and technical systems under renovation/substitution; internal walls, slabs, furnishing are excluded.

Financial recommendations

In general terms, the financial performance of the investment can be improved by:

- revising the mix of energy conservation measures, focusing on the ones with lower payback time;
- using public incentives/grants to cover part of the investment costs;
- optimizing the financial structure of the project (e.g., through low-cost financing).

Multi-benefit recommendations

The multi-benefit performance of the project can be improved by:

- selecting the mix of energy conservation measures with the highest impact on energy savings;
- implementing a standardized procedure to compute the multi-benefits for in-doors impact, such as thermal comfort, indoor air quality, acoustic comfort and productivity through smart sensors and questionnaires;
- optimizing the energy consumption levels on a monthly basis.

EEnvest RISK ASSESSMENT REPORT

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The EU Taxonomy Compliance indicator defines whether or not the investment complies with the minimum requirements defined by the EU Taxonomy. In specific, whether the project being assessed has a minimum of 30% primary energy consumption reduction.

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- optimizing the energy consumption levels on a monthly basis.

Figure 37: Fifth and last page of EEnvest Report

7 Conclusion

To conclude this report, results and overcome challenges related to the EEnvest Methodology will be summarized.

The results of the Methodology deal with the achievement of investment evaluation models for DER investments including multiple benefits. Considering the need of investors and financial institutions to use standardized evaluation methods to support their decision-making process on whether to go for a specific financing operation or not, an evidence-based and investor-friendly method to evaluate the impact of both energy and non-energy related benefits, beyond energy reduction and greenhouse emissions, of DER investments has been developed.

The provided methodology consists of an innovative tool enabling investors to speed up and standardize internal evaluation processes. The adaptability of the method allows a wide range of users, from private investors, asset managers, financial institutions and property owners who are willing to evaluate the investments related to building energy efficient renovation in terms of associated technical risks, financial and multi-benefit performance. Throughout the document, the EEnvest methodology conception and applicability were demonstrated.

Firstly, a special focus on investors' profiles and interests has been set. To achieve a strategic identification of all relevant requirements for the investors' decision-making process, extensive desk research and dedicated technical meetings with market operators were carried out and led to a customization of KPIs.

Latest trends on multiple-benefits, ESG criteria and impact investing criteria were reviewed and monitored to enhance the methodology usefulness according to the market needs and propensity. Interviews with different types of relevant investors showed that the Sustainable Development Goals gained traction and importance among investors and on a European level, the EU Taxonomy also represents a powerful incentive for investors towards sustainable activities that comply with Commission criteria, such as DER projects. Therefore, the selected KPIs bring together readily quantifiable indicators to construct a coherent and practical overview for the investor. Technical KPIs (Damage, Energy gap) and Financial KPIs (Payback time, Maturity, Internal Rate of Return, Net Present Value on Investment, Debt-Service Coverage) are put together in a common representational framework which allow to benchmark and de-risk DER investment opportunities with one methodology.

To produce such a complex methodology, all project partners have been involved based on their domain expertise, to build a sound operational model. In particular, the model has been assessed in terms of its capability to respond to the expectations of market operators and consistency of results with market best practices.

Data and analytical models developed in the previous work packages have been consolidated into a coherent framework that combines technical-economic parameters to evaluate several types of energy efficient investment and match them with investors' preferences.

The results get doubly validated: (i) in the application of successive work packages, as consistent proof-of-concept through dedicated demonstration activities in two demo-cases; (ii) the Advisory Board positive feedback further corroborated the EEnvest methodology.

At the end of this deliverable as a completion of the Work Package 4, the EEnvest methodology is complete and ready to be further developed in the following work packages. Work package

5 will implement the methodology, while work package 6 will constitute its proof of concept and the Advisory Board feedback, included in Annex 5, constitutes a further validation. EEnvest methodology aims to be applied and further developed beyond the project scope to solidify its mechanism and enable it to reach the full potential envisioned by the Consortium. The methodology itself as presented in this document ought to show an innovative instrument, where multiple benefits represent a key factor. Overall, the methodology contributes to the achievement of expected impact in terms of (i) frameworks, standardization, benchmarking, standardized descriptions, and data evidence of financial returns of energy efficiency investments with favorable market outcome; (ii) investments in sustainable energy triggered.

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Annexes

This chapter presents the different annexes that were referenced during the writing of the report.

Annex 1 – Multiple Benefits for Investors workshop

Figure 38: Promotional leaflet of the workshop "The Future of Multiple Benefits for Investors: Accelerating Energy Renovation Investments"

Figure 38 above showcases the promotional leaflet of "The Future of Multiple Benefits for Investors: Accelerating Energy Renovation Investments" that was disseminated in different channels such as LinkedIn and Twitter. The stakeholders participating are major experts in the field of multiple benefits and the investor market. Guest speakers from CBRE global investors, JRC, BNP Paribas, Fraunhofer. The webinar discussions have majorly contributed to the elaboration of this document, providing insight on the topic and perspectives from relevant stakeholders.

Annex 2 – EEFIG Plenary Meeting on February 2021

EEFIG
ENERGY EFFICIENCY
FINANCIAL INSTITUTIONS GROUP

EEFIG Plenary Meeting 2021, Day 1 (open access)
Tuesday 9 February 2021
Virtual meeting (Zoom)

Time	Theme	Speaker
9:00 - 09:10	Welcome and introduction by the convenors	Claudia Canevari, Head of Unit, European Commission, DG ENER C3 – Energy Efficiency, Policy and Financing Eric Usher, Head, UNEP Finance Initiative
09:10- 09:25	Keynote: The central role of energy efficiency investments in the framework of the recovery and the Renovation Wave	Ditte Juul Jørgensen, Director-General for Energy, EU-Commission
09:25 - 09:40	Keynote: Promoting Energy efficiency- The role of the EIB as the EU climate bank in the framework of the climate transition and the recovery	Thomas Östros, Vice-president of the EIB
09:40 - 10:40	Emerging results of EEFIG working group 1) Financial Best Practices 2) Multiple Benefits 3) Asset-level energy performance correlations 4) Energy efficiency in industry	Presentations of representatives of EEFIG working groups, followed by Q&A and discussion: Elisabeth Minjauw, BNP Paribas Carlos Araujo, Allianz IM France Karen Degouve, Natixis Andreas Guertler, EEIF Moderated by Peter Sweatman, EEFIG Rapporteur
10:40 - 11:00	*Coffee break*	
11:00 – 11:30	Panel I: Financial Institutions (FI) Panel – Energy Efficiency actions in the framework of the Recovery and the increased climate ambition for 2030	Members from financial institutions discuss the opportunities for EEFIG to contribute to the immediate European policy objectives on climate and recovery: Stefania Racolta-Cruceru, EBRD Bettina Dorendorf, KfW Bruce Schlein, CITI Moderated by Peter Sweatman, EEFIG Rapporteur

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Figure 39: Agenda of the EEFIG Plenary Meeting 2021, page 1

EEFIG

ENERGY EFFICIENCY

FINANCIAL INSTITUTIONS GROUP

EEFIG Plenary Meeting 2021, Day 2 (members only)

Wednesday 10 February 2021

Virtual meeting (Zoom)

Time	Theme	Speaker
9:00 - 09:15	Welcome and introduction	Carlos Sanchez Rivero, DG ENER
09:15 - 09:45	Best practice financial instruments – What are the best practices and how do we replicate and scale them?	Isidoro Tapia, EIB Juan Alario, GNE Finance Alex Betts, Aquila Capital Adrien Bullier, EASME Moderated by Lucas Bossard, COWI
09:45 - 10:15	Multiple Benefits – Do they affect financing decisions; can they be monetized?	Kristina Klimovich, GNE Finance Philippe Weill, Société générale Federica Saccani, CBRE Moderated by Clemens Rohde, Fraunhofer
10:15 - 10:45	Asset-level energy performance correlations – Are energy efficiency loans less risky and should it affect regulation?	Richard Crecel, GCD Daire Mccoy, LSE Tobias Horn, DB Moderated by Markus Seifert, d-fine
10:45 - 11:00	*Coffee break*	
11:00 – 11:30	Energy efficiency in industry – A part of the broader decarbonisation agenda for large industries, but what about the SMEs?	Shane McCullough, SBCI Angels Orduna, SPIRE Moderated by Rod Janssen, EE-IP
11:30 – 12:00	Energy efficiency financing in the framework of the next MFF 2021-2027 – How can EU funds leverage private investments?	Krzysztof Kasprzyk, DG REGIO Lada Strelnikova, European Energy Efficiency Fund Justinas Bučys, VIPA Hadrien Michel, DG ENER Moderated by Dinne S Hansen, COWI

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Figure 40: Agenda of the EEFIG Plenary Meeting 2021, page 2

Figure 39 and Figure 40 above are retrieved from the Agenda of the EEFIG Plenary Meeting 2021, Day 1 that was held on Tuesday 9 February 2021 as Virtual meeting (Zoom). Among the participates there were the Vice-president of the European Investment Bank, representatives from BNP Paribas, Allianz IM France, European Energy Efficiency Fund, DG Regio. The full agenda can be found in The Energy Efficiency Financial Institutions Group (EEFIG) website in the events section at https://ec.europa.eu/eefig/eefig-events_en.

Annex 3 – Definitions of Price, Value and Worth

The first aspect that needs to be understood and discussed when talking about valuation methods and the impact on building characteristics is the definition of value, worth, and price. In the past, many definitions have been given to price, value and worth. Especially after 1994 with the Mallison Report, which gave 14 different definitions, and the discussion among valuation circles began. From then on, the issue led to refine the different definitions:

1. **Price:** it is not defined in the Red Book or in the Blue Book. It is *"the actual observable money exchanged when buying or selling a property"*. Thus, it can be known only after the transition of selling the property itself.
2. **Value:** There are several different definitions of Value.
    a. **Market Value (MV):** it is defined by the IVS as "*The estimated amount for which the property should exchange on the date of valuation between a willing buyer and a willing seller in an arm's-length transaction after proper marketing wherein the parties had each acted knowledgeably, prudently and without being under compulsion"*. Basically, it consists in an expert opinion and reflects the characteristics that the Valuer can see as influencing the price. These characteristics can be the size, location, condition and tenancy details. The market value definition assumes different aspects: the participants are knowledgeable of the market, they are prudent and without compulsion. The MV is not the actual transaction price, because it can be influenced by a huge range of personal factors.
    b. **Fair Value:** There are two different definitions for the Fair Value.
        i. It is the "*estimated price that would be received to sell an asset or paid to transfer a liability in an orderly transaction between market participants at the measurement date"*.
        ii. It is "*the estimated price for the transfer of an asset or paid to transfer a liability between identified knowledgeable and wiling parties that reflects the respective interests of those parties"*. Generally, it equates the Market Value.
3. **Investment Value (IV)** or **Worth**: it is defined by the Red Book and IVS as "*The value of an asset to the owner or a prospective owner for individual investment or operational objectives. (May also be known as worth)*". By definition, it is a subjective value influenced by own investors criteria. Worth or Investment Value is assessed by DCF modelling.
4. **Mortgage Lending Value (MLV):** It is defined by the European Union regulation as "*the value of immoveable property as determined by a prudent assessment of the future marketability of the property taking into account long term sustainable aspects of the property, the normal and local market conditions, the current use and alternative appropriate uses of the property"*. This basis of Value is recognized but not promoted by the institution that creates international standards for valuation (TEGoVA, IVS, RICS). Whereas Market Value is a 'mark to market' approach, Mortgage Lending Value is sometimes described as a 'mark to model' approach, as it is essentially a risk-adjusted figure considering perceptions of the long-term risk of the loan from the lender's perspective.
5. **Adjusted Market Value (AMV):** it is derived by regression to compare current market value to long-term trend values but is only possible where such trend data is both collected and available. It is viewed as having the benefit of simplicity and low cost.

6. **Cost**: "Cost is a figure that excludes any notion of market demand. Thus, a property may have a high cost of production or be expensive (or cheap) to run in cost terms – but this will be largely divorced from its value in the marketplace. Whilst in a stable market the revenue costs of occupation may influence a tenant's bid, cost is only one factor: location, scarcity, etc. may well be more important – especially if the occupier is not specifically cost conscious".

Annex 4 – Questionnaire results

In this annex are shown the results from the survey performed in Deliverable 3.1 focused on gathering key insights from stakeholders. The results were considered to develop a useful mapping of investors perspectives and the results contributed to the selection of the KPIs exposed.
These stakeholders included: ESCOs, private investors, banks, investment funds and other types of investors, as shown in the figure below. They were asked to complete an 11-question survey divided into two parts. Figure 41 maps the stakeholders' profile. Figure 42 illustrates the main financial indicators of interest for the investment case. Last, Figure 43 depicts an initial rank of multiple benefits of interest for investors. Resulting from the questionnaire, investors are considering environmental benefit as primary non-financial focus in the investment decision-making process.

INTERVIEW KEY QUESTIONS

Objective of the document: To obtain partners' input on the short-listed set of questions. The interviewees are mainly banks and FIs and are presented in the interviewees list file.

Objective of the questions: To find out how ESG/SDG/Taxonomy-alignment KPIs are defined, converted into value (quantitative v/s qualitative) and communicated internally/externally.

Methodology: 1hr 1on1 interviews.

Expected output: (i) Specific set of ESG KPIs and their respective (ii) computation and (iii) usage methods. For example: CO2 Emission Reduction, Number of Jobs created, Taxonomy-Compliance, Employees Enhanced Working Conditions and Waste Management.

Short-Listed Questions

Q1. How representative is Deep Energy Retrofits Investments in your portfolio? Has this trend incremented in the past 5 years? Why?

Q2. How and which ESG/SDGs/Taxonomy-aligned KPIs are incorporated in the investment assessment process? Do you foresee a *standard new methodology* to assess this specific investment type? How?

Q3. Can these parameters be classified as a source of monetary value (carbon credits) and/or qualitative value (contribution to SDG 11)? How? Are these KPIs subjected to a specific reporting standard? (Monetizable v/s only reportable KPIs)

Q4. What type of processes, IT tools and reporting standards would you anticipate as result of the current trend on ESG/SDGs/Taxonomy-Aligned metrics?

Q5. Which specific functionalities and data would you expect from such a tool?

Q6. Would you trust this technical capacity to an external third-party such the EEnvest platform? Why? What would be the minimum functionalities?

Expert **interviews** to validate the metrics proposed for investors

1. RICS
2. Cushman and Wakefield
3. JLL
4. CBRE Global Investors – Sasha Njagulj
5. UNEP FI PWG Members – Matthew Ulterino
6. CBRE – Sander Paul van Tongeren
7. BNP Paribas Fortis Group - Guy Pollentier
8. Skumatz Economic Research Associates - Lisa Skumatz
9. EU Policy Manager at EPRA – Jana Bour
10. Prelios – Sara Canepa
11. Nomisma/Marcatili
12. Rosato/UNITS
13. EURAC, ENERG., SINLOC, IES, R2M, UIPI, ECROWD provide additional names

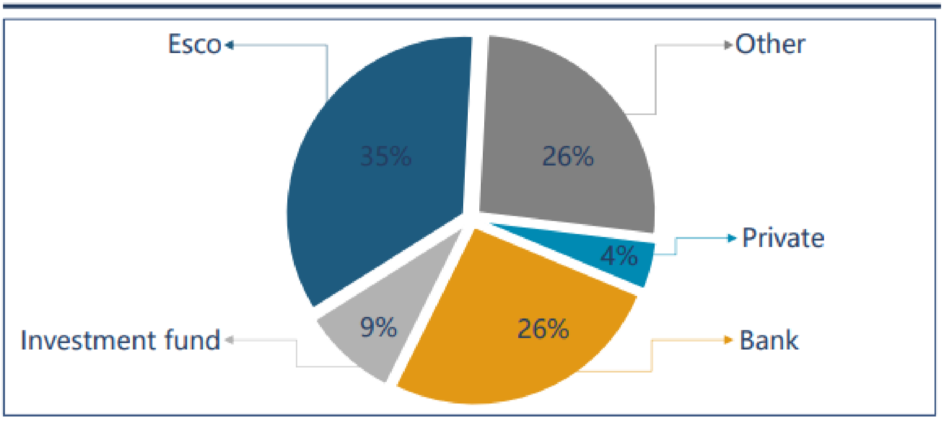


Figure 41: Distribution of user types.

Source: WP3.

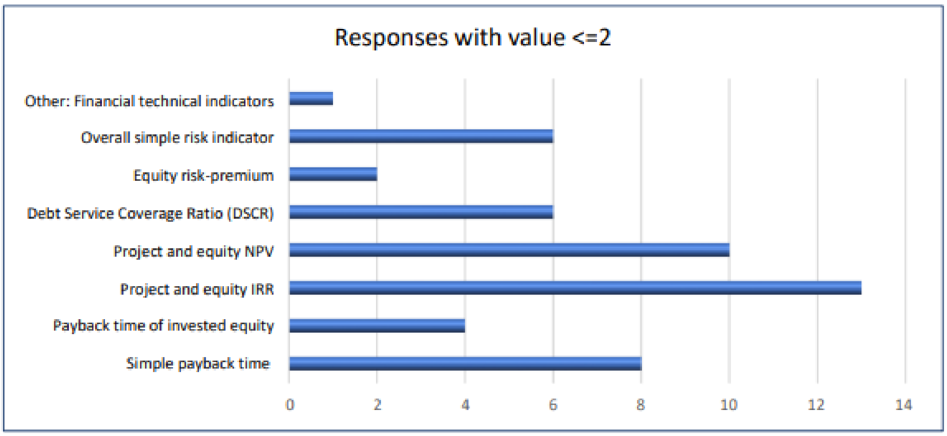


Figure 42: Indicators of importance. Results from questionnaire elaborated in WP3.

Source: WP3.

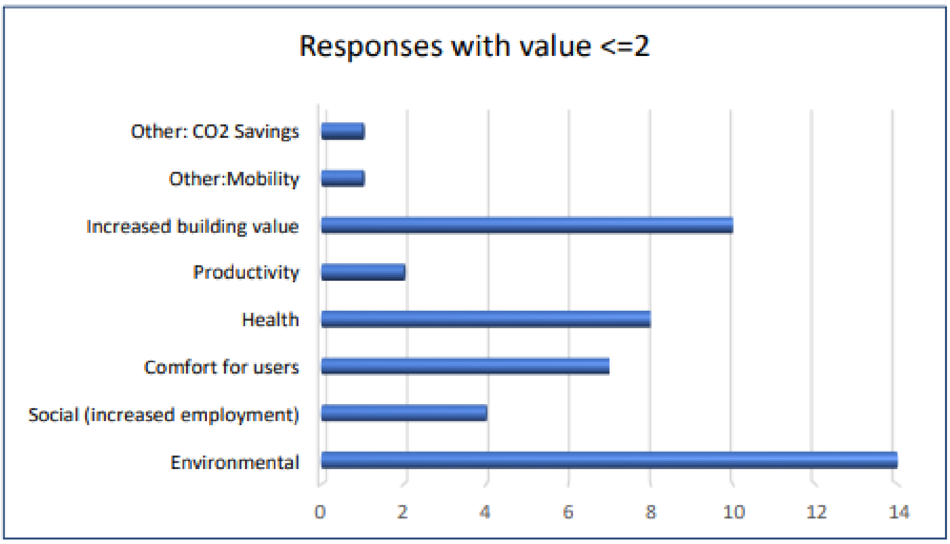


Figure 43: Multiple-Benefits importance. Results from questionnaire elaborated in WP3.

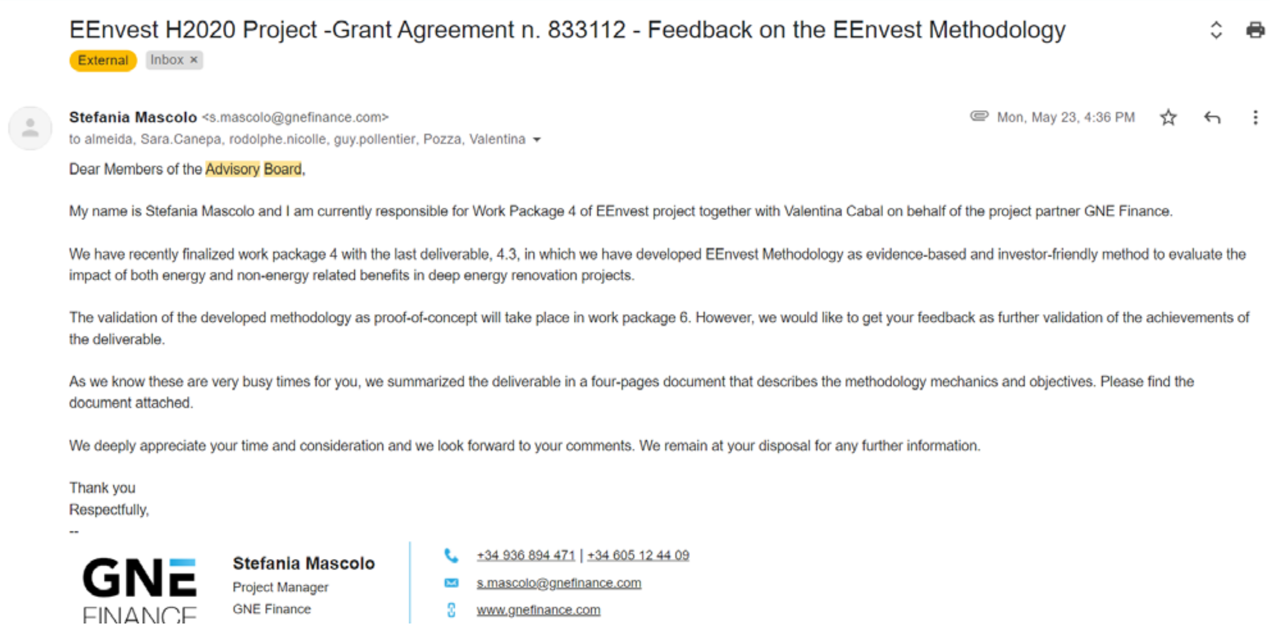
Source: WP3.

The interviewed group determined that environmental KPIs are the most important for EE investments and further maps the relevance of determining the increment of the building value post retrofit along with the importance of health.

Annex 5 – Advisory Board Feedback for the Methodology validation

On May 23rd of 2022, the Advisory Board of EEnvest project was contacted by email by GNE Finance as responsible for this deliverable D4.3 to ask for feedback about the deliverable results. The Advisory Board received a four-pages document summarizing the developed methodology of the deliverable, its mechanics, and objectives and was asked to provide feedback as validation of the achievements of the deliverable.

Figure 44 here below captures the email sent to the Advisory Board.



EEnvest H2020 Project -Grant Agreement n. 833112 - Feedback on the EEnvest Methodology

External Inbox ×

Stefania Mascolo <s.mascolo@gnefinance.com> Mon, May 23, 4:36 PM

to almeida, Sara.Canepa, rodolphe.nicolle, guy.pollentier, Pozza, Valentina

Dear Members of the Advisory Board,

My name is Stefania Mascolo and I am currently responsible for Work Package 4 of EEnvest project together with Valentina Cabal on behalf of the project partner GNE Finance.

We have recently finalized work package 4 with the last deliverable, 4.3, in which we have developed EEnvest Methodology as evidence-based and investor-friendly method to evaluate the impact of both energy and non-energy related benefits in deep energy renovation projects.

The validation of the developed methodology as proof-of-concept will take place in work package 6. However, we would like to get your feedback as further validation of the achievements of the deliverable.

As we know these are very busy times for you, we summarized the deliverable in a four-pages document that describes the methodology mechanics and objectives. Please find the document attached.

We deeply appreciate your time and consideration and we look forward to your comments. We remain at your disposal for any further information.

Thank you
Respectfully,
--

GNE FINANCE

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Figure 44: Email sent to the Advisory Board

The response of the Board has been positive about the methodology narrative and components. It was especially addressed by the Board the importance of the introduction of the EU Taxonomy compliance in the multi benefit assessment, together with the broader context of ESG criteria to enhance the attractiveness of energy efficiency renovations as investment case. The Advisory Board highlighted how the EU Taxonomy and ESG criteria result to be extremely relevant now as investors are increasingly looking for methods to analyse the sustainability of their investments, where the EU Taxonomy is a key driver of this assessment demand.

Entering in detail about the EU Taxonomy KPI, it was point out that EEnvest Methodology has focused on assessing the generation of a positive impact, based on the Substantial Contribution Criteria. Ought to remark that the Do No Significant Harm criteria was not addressed directly in the methodology. This point highlights a possible further development in the future of the methodology beyond EEnvest project to expand its field of action. Nonetheless, work package 3 does measure the climate risks associated with the renovation: as a whole, work packages 2, 3 and 4 are designed to provide a coherent picture for impact investors.

To conclude, the methodology developed is complete and ready to be implemented in the following work package 5 and tested in work package 6 as proof of concept. At today, the EEnvest methodology successfully addresses key aspects of the changing world of impact investing, providing some answers to the relevance and impact of the EU Taxonomy for the energy efficiency stimulus, however it can be extended to more in-depth assessments and new quantitative criteria.