Interreg CENTRAL EUROPE

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MESTRI-CE

D.3.2.2 Green financing methodology with supporting documentation and performance-tracking models

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Contents

List of abbreviations

- B/C - benefit/cost
- BAU - business as usual
- CACN - climate adaptation and carbon neutrality
- CAPEX - capital expenditures
- CBA - cost-benefit analysis
- CEA - cost-effectiveness analysis
- CF - conversion factor
- CO_2e - carbon dioxide equivalent
- CPR - common provisions regulation
- DCF - discounted cash flow
- DPP - discounted payback period
- EA - economic appraisal
- EE - energy efficiency
- EIB - European Investment Bank
- ENPV - economic net present value
- ERR - economic rate of return
- FDR - financial discount rate
- FRR - financial rate of return
- FRR(C) - financial rate of return of the investment
- FRR(K) - financial rate of return on national capital
- FNPV - financial net present value
- GDP - Gross Domestic Product
- GHG - greenhouse gas
- JASPERS - Joint Assistance to Support Projects in European Regions
- LCA - least-cost analysis
- MCA - multi-criteria analysis
- MFF - multiannual financial framework
- O&M - operation and maintenance
- OPEX - operating expenses
- RES - renewable energy sources
- SCBA - simplified cost-benefit analysis
- SDR - social discount rate
- SE - stakeholder engagement
- SPP - simple payback period
- SRTP - social rate of time preference
- WACC - weighted average capital cost

Introduction

Green financing methodology represents the structured approach to financing of building renovation or construction projects that deliver environmental benefits. These methodologies align financial activities with sustainability goals, including reducing carbon emissions, enhancing energy efficiency, and promoting the use of renewable energy. The main issue that the investors face with green financing methodology is the lack of standardization, transparency, and accountability, which leads to greenwashing, misallocation of funds, and regulatory inconsistencies. While green financing aims to channel capital into environmentally sustainable projects, several challenges undermine its effectiveness.

With greenwashing, financial institutions or project developers from all sectors falsely claim that their investments or bonds are environmentally friendly. Due to vague criteria and a lack of clear guidelines, many projects marketed as "green" may not provide substantial environmental benefits or may even contribute to pollution in other ways. Without strict verification mechanisms, investors may be misled into supporting projects that fail to deliver meaningful sustainability outcomes.

Another critical issue is the lack of standardized metrics and reporting frameworks. Different countries, financial institutions, and rating agencies employ varying definitions of what constitutes a "green" investment. This inconsistency makes it difficult to compare projects, assess their actual impact, and ensure that funds genuinely support climate action rather than business-as-usual operations with a sustainability label.

There is also the challenge of regulatory gaps and enforcement. While initiatives like the EU Taxonomy for Sustainable Finance and the Task Force on Climate-Related Financial Disclosures (TCFD) aim to create more straightforward guidelines, compliance varies across regions. Risk assessment and financial returns also remain challenging for investors and project developers. The deep renovation of buildings may be perceived as high-risk projects and usually has much longer payback periods than traditional investments. This can deter institutional investors unless governments or financial institutions provide de-risking mechanisms or financial instruments with grant components. Faced with the requirement to invest heavily in the decarbonization of their buildings, which yields slow financial returns, public authorities need to change their methodological approach and consider not only the financial benefits but also the wider socioeconomic impacts on their community.

Another limitation is the insufficient tracking of environmental impact. Even when funds are allocated correctly, continuous performance monitoring is necessary to ensure projects meet their sustainability goals. Many green finance frameworks lack long-term impact verification, leading to uncertainties about whether financed projects contribute to carbon reductions, biodiversity preservation, or sustainable energy transitions.

To overcome these issues, MESTRI-CE projects have developed a methodology based on recognised EU tools and guidelines to enhance the transparency and credibility of investments in climate-neutral buildings.

1. Green Financing Methodology

1.1. Purpose and Scope of the Methodology

The MESTRI-CE project aims to accelerate the transition towards carbon-neutral buildings in Central Europe through innovative financing and evaluation tools.
The MESTRI-CE Green Financing Methodology is based on three key pillars:

- Evaluation of financial feasibility and economic impacts of the transformation of buildings towards their climate neutrality
- Harmonisation of projects with the EU Taxonomy and their contribution to climate mitigation and adaptation
- Integrating EU Taxonomy principles into post-investment performance monitoring and impact reporting

By integrating green financing mechanisms, structured documentation, and advanced performance-tracking models, building construction and refurbishments can be effectively managed to ensure climate neutrality. MESTRI-CE green financing methodology enhances investor confidence, ensures regulatory compliance, and drives long-term sustainability.

The methodology incorporates key sustainability indicators identified in **D.2.2.1 Criteria for creation of MESTRI-CE Sustainable Building Methodology**, focusing on high-impact areas such as energy performance, emissions reduction, materials circularity, climate resilience, and life cycle cost optimisation. It also addresses the challenges of evaluating complex sustainability criteria, aiming to streamline the process for stakeholders while maintaining alignment with long-term European sustainability goals.

This Green Financing Methodology is developed to:

- Increase transparency for green building and energy efficiency projects
- Prepare project developers for sustainable investments
- Align building renovation projects with green financing requirements
- Enhance capacity for EU Taxonomy requirements
- To help bridge the financial gap through alternative financing
- To reduce dependence on grants and enable a gradual transition to alternative and sustainable financing (e.g. green loans, sustainable finance instruments, green and sustainable bonds)

1.2. Integration with MESTRI-CE Sustainable Building Methodology and Smart Data Hub

Within the WP3 project, partners have jointly developed the first version of the Evaluation Toolbox for assessing financial feasibility and monetization of economic costs and benefits of building renovation and construction projects (D.3.2.1). The Evaluation Toolbox is based on standard practices from the financial sector and the EU CBA[1] methodology which was needed for economic assessment of investments.

This Green Financing Methodology is the overall planning approach for implementing the financing actions within the MESTRI-CE project, which consists of two different project phases:

- The piloting of the Financial and Economic Evaluation Toolbox and the Green financing methodology with supporting documentation and performance tracking models
- The roll-out and wider market implementation of finalised tools and methodologies

Since public sector building owners represent the primary focus of the MESTRI-CE project, the economic assessment was integrated into the Toolbox to provide a different (socioeconomic) perspective on the cost-effectiveness of their investments. Economic analysis is also becoming increasingly important for financial institutions due to Environmental, Social, and Governance (ESG) requirements to which their financial products and investments must comply. Green financing methodology is the structured approach to fund projects and investments that deliver environmental benefits, and these methodologies align financial activities with sustainability goals, including reducing carbon emissions, enhancing energy efficiency, and promoting renewable energy. The Toolbox aims to provide all parties with a transparent financial and economic evaluation methodology, including environmental impacts and key financial performance indicators (KPIs).

For benchmarking and decision-making purposes, the Toolbox will also include a comparator of the overall costs associated with investing in different funding/financing sources. Depending on the Evaluation Toolbox's results and the market circumstances, project partners will develop supporting documentation and performance-tracking models for the specific type of financing model they wish to implement within their region.

The Evaluation Toolbox and the supporting documentation will ideally be piloted and tested on buildings from the database of MESTRI-CE Smart Data Hub (D.1.2.3), whose technical assessment has been made following the Sustainable Building Methodology (D.2.2.2) for (re)construction of buildings.

[1] EC: Guide to Cost-Benefit Analysis of Investment Projects Economic appraisal tool for Cohesion Policy 2014-202. Available at: https://ec.europa.eu/regional_policy/sources/studies/cba_guide.pdf

Sustainable Building Methodology (D.2.2.2) key takeaways should be included in the introduction of D.3.2.2 Green Financing Methodology:

- **A total of 11 priority thematic areas:** thematic areas of building sustainability were selected based on Activity 2.1: **Energy, Emissions, Materials, Adaptability, Water, Adaptation and resilience to climate change, Site and biodiversity, Health and indoor comfort, Mobility, Cost & Value, and Management.**
- A total of **68 Indicators** were assessed by project partners, and **References** were given based on the sustainability framework: **Energy Performance of Buildings Directive (EPBD), EU Taxonomy, Level(s) by EC**

The Green Financing Methodology is a critical bridge between technical sustainability assessments (D.2.2.1) and financial mechanisms necessary for scaling green building projects across Central Europe (Figure 1).This deliverable integrates evaluation criteria with innovative financing models, empowering stakeholders—including project developers, financial institutions, public authorities, and citizens - to drive the transition toward a sustainable built environment that meets regional needs and global climate commitments.

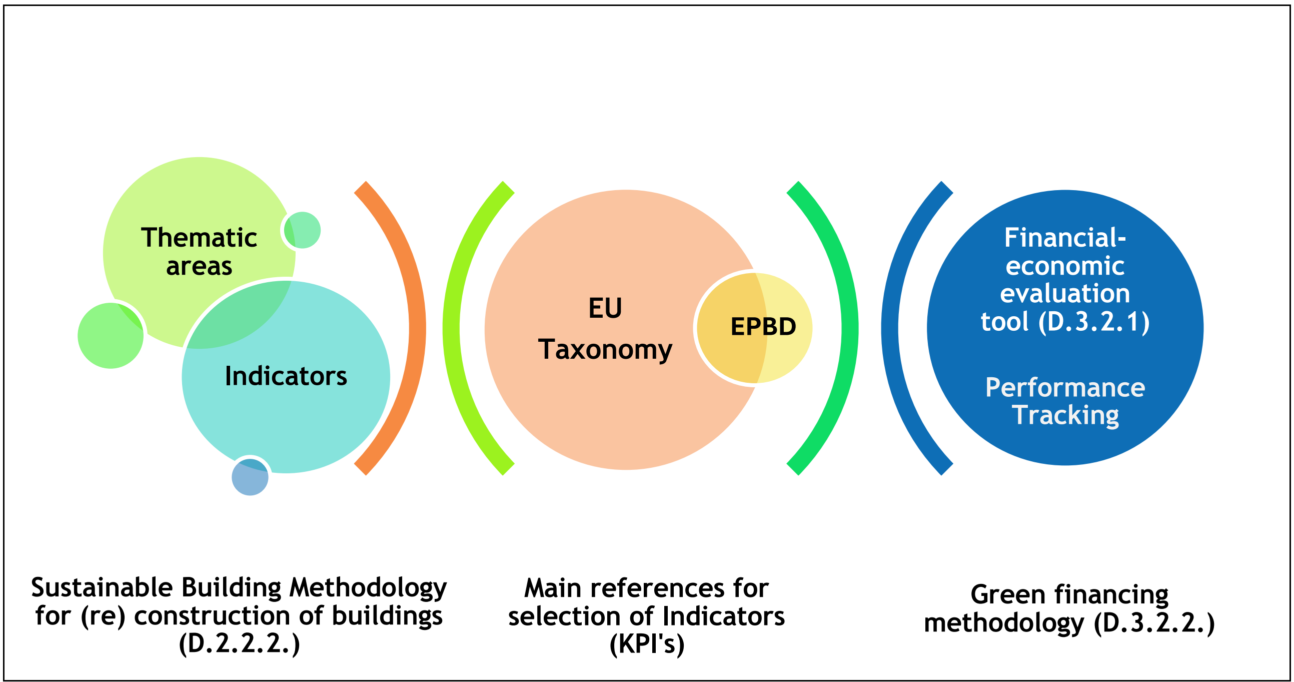

Figure 1 Sustainable Building Methodology (D.2.2.2) key takeaways leading to introduction of Green Financing Methodology (D.3.2.2)

2. Financial and Economic Evaluation

Financial and economic analysis plays a critical role in preparing and selecting building renovation projects, particularly when public or blended financing is involved. These assessments provide a solid evidence base to justify investments, evaluate long-term viability, and support informed decision-making that prioritizes the most cost-effective and impactful solutions.

- **Financial analysis** - focuses on the project's bankability from the perspective of the promoter or investor, evaluating cash flows and returns to ensure investment attractiveness;
- **Economic analysis -** considers broader societal impacts, such as reduced emissions, improved health, and enhanced comfort, through shadow pricing and the inclusion of externalities that are often absent from market valuations.

Together, these analyses enable public authorities and project developers to identify and prioritize financially sound and socially valuable investments. They also ensure alignment with EU funding requirements and investment-grade evaluation standards for energy efficiency and building renovation projects.

This section introduces a robust financial and economic evaluation framework based on two key EU guidance documents:

1. **Guide to Cost-Benefit Analysis of Investment Projects: Economic appraisal tool for Cohesion Policy 2014-2020**[2] is obligatory for all major projects (typically those above EUR 50 million) applying for EU co-financing and was created to provide a standardized, practical methodology for evaluating major investment projects seeking funding from the European Structural and Investment Funds (ESIF) during the 2014–2020 programming period.
2. **Economic Appraisal Vademecum (EAV) 2021-2027 for Cohesion Policy 2021-27**[3] expands the focus beyond cost-benefit analysis (CBA) and promotes and simplifies the voluntary use of various economic appraisal methods - including, but not limited to, cost-benefit, cost-effectiveness, least-cost, and multi-criteria analysis—to ensure EU-funded Cohesion Policy 2021-27 projects deliver optimal value and support a greener, smarter, and more inclusive Europe.

Based on these frameworks, project developers can select the appropriate evaluation method—Cost-Benefit Analysis (CBA), Cost-Effectiveness Analysis (CEA), or Multi-Criteria Analysis (MCA) - according to the specific objectives and context of the project.

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[2] EC, DG REGIO, 2014, https://ec.europa.eu/regional_policy/sources/studies/cba_guide.pdf

[3] EC, DG REGIO with the support of JASPERS experts, Economic Appraisal Vademecum 2021-2027 General Principles and Sector Applications. Available at: https://jaspers.eib.org/LibraryNP/EC%20Reports/Economic%20Appraisal%20Vademecum%202021-2027%20-%20General%20Principles%20and%20Sector%20Applications.pdf

→ **Use CBA** when: full justification of public investment is needed and robust data on monetised benefits are available.
→ **Use CEA** when: the goal (e.g. 40% energy savings) is fixed and you're comparing alternatives for efficiency.
→ **Use MCA** when: projects involve trade-offs among multiple values (e.g. energy savings, comfort, urban design) or strong stakeholder involvement is needed.

Table 1 Evaluation methods for energy projects

Feature	***Cost-Benefit Analysis (CBA)***	***Cost-Effectiveness Analysis (CEA)***	***Multi-Criteria Analysis (MCA)***
Purpose	Determine whether a project delivers net benefits to society	Identify the least-cost solution to achieve a defined goal	Compare project options using multiple qualitative and quantitative criteria
Use Case	EU grant justification, major renovation investments	Ranking technologies or packages by efficiency	Complex decision-making with competing objectives and stakeholder values
Key Inputs	- Shadow-priced CAPEX/OPEX - Monetized benefits (energy, CO_2, pollutants) - Residual value - Social discount rate	- CAPEX/OPEX - Defined output target (e.g., energy saved, GHG reduced) - Scenario variations	- Project options - Evaluation criteria (economic, environmental, social, technical) - Weighting factors per criterion - Stakeholder inputs
Indicators	- ENPV - EIRR - B/C Ratio	- Cost per unit output: €/kWh saved, €/tCO_2 avoided	- Weighted aggregate score across criteria (non-monetary and monetary)
Monetization of Benefits	Required	Not required (outputs are fixed)	Not required; may include qualitative or ordinal scoring
Advantages	Comprehensive economic justification of investment	Focused on efficiency and cost optimization	Integrates diverse criteria, flexible, participatory
Limitations	Data- and effort-intensive; not always feasible at early stages	Does not assess social or environmental co-benefits	Subjectivity in weights and scoring; less standardized

These guides offer harmonized principles and sector-specific methodologies for assessing public investments, including in the buildings sector. Their integration into this methodology ensures alignment with the requirements of EU co-financed programmes (e.g., ERDF, Cohesion Fund, RRF) and best practices in evaluating sustainable infrastructure.

2.1. Financial Evaluation

The financial evaluation of investments in climate-neutral buildings is an integral part of the project's preparation process. It is a comprehensive assessment that evaluates the economic viability, risks, and potential returns of an investment in energy infrastructure or upgrades. It involves estimating the project's total costs, including capital expenditures for equipment, installation, and operational costs over time. This analysis also considers projected revenue streams, such as energy savings, government incentives, carbon credits, or power purchase agreements if the project involves renewable energy generation.

A key aspect of financial analysis is determining the payback period, which calculates how long it will take for the investment to generate enough savings or revenue to cover the initial costs. Beyond payback, more advanced financial metrics are used, such as net present value (NPV), which assesses the profitability of the project by comparing future cash flows to the present value of the investment, and internal rate of return (FRR), which indicates the expected rate of return based on projected performance.

Sensitivity analysis is often conducted to account for uncertainties, such as fluctuating energy prices, interest rates, or changes in government policies. Risk assessment is also crucial, evaluating potential financial, operational, and regulatory risks that could impact the project's success.

Financial models use real-world data to ensure accuracy, including energy consumption patterns, efficiency gains from new technologies, and market trends. If external financing is involved, such as loans, grants, or investor funding, the analysis also considers debt service coverage ratios and cost of capital to determine the most viable funding structure. Ultimately, a financial analysis provides decision-makers with a clear understanding of whether an energy project is economically feasible, how long it will take to achieve a return on investment, and what financial risks and benefits are associated with its implementation.

The MESTRI-CE methodology for project financial and economic evaluation has been incorporated into and implemented within the Evaluation Toolbox. Financial analysis is integral to the socioeconomic and overall cost-benefit analysis methodology. It assesses a project's financial feasibility, profitability, and risks before making investment decisions. Evaluating costs, revenues, and financial returns helps determine whether a project is worth pursuing from a monetary standpoint. Although both parts of the CBA differ in scope, financial and economic analyses are the basis for valuation of the costs and benefits (e.g., financial analysis does not consider non-cash flow items such as externalities) and the discount rates used.

Key components of a financial analysis include:

- **Initial Investment (Capital Expenditure - CAPEX) -** includes costs for preparation activities, equipment, infrastructure, technology, and other required assets (e.g., licenses, fees).
- **Operating Costs (OPEX)** - include recurring expenses such as energy, utilities, maintenance, salaries, insurance, etc.
- **Revenues** - can result from financial savings (e.g. lower energy consumption and maintenance and operation costs) or revenues generated from the production of energy or other services provided on the market
- **Cash flow analysis** - evaluates inflows (revenues) and outflows (expenses) to ensure liquidity

2.1.1. Key parameters and assumptions

When conducting a financial analysis, several key assumptions must be made to ensure accurate and meaningful projections. These assumptions provide the foundation for forecasting future financial performance and evaluating investment decisions. Here are the most important ones:

- **Reference period (time horizon)** - defines the period the financial analysis will cover (e.g., 5, 10, 20 years). It should align with the project's economic life, investment horizon, or expected repayment period. The reference period used in the CBA depends on the type of the project, but Article 2(14) of the EPBD defines the life cycle of new non-residential buildings as 20 years (30 for residential buildings). Therefore, the chosen reference period for evaluating MESTRI-CE projects will generally be 20 years.
- **Financial discount rate (FDR)** - represents the required rate of return, often based on the Weighted Average Cost of Capital. A higher discount rate reflects greater risk and can vary depending on the specific sector, market conditions, risk premiums, and cost of financing. The WACC values should be those officially set at the national level by the regulating authority for those (sub)sectors where this is available. A 4% financial discount rate, which was used as a standard in the CBA 2014-2020 period, will also be used to evaluate building renovation projects, although a different rate can also be applied if needed.
- **Residual Value** - is the estimated value of an asset, project, or investment at the end of its useful life or reference period. It represents the remaining worth after depreciation or after a project has been completed. In cases where the reference period is set equal to the project's economic life, the residual value is usually zero. However, in cases where, at the end of the reference period, some assets are still economically useful or there is a market for their resale, a residual value benefit can be included in the last year of analysis as a form of the project's revenue.
- **Risk and sensitivity assumptions** – determines how changes in key assumptions affect core financial metrics (KPIs), variables with the highest risk and impact have to be pre-determined. In building renovation projects, these commonly include CAPEX variations and expected energy savings or revenues.
- **Value Added Tax (VAT)** – the treatment of Value-Added Tax in financial analysis depends on the context and purpose of the analysis. Whether VAT is considered an eligible cost depends on whether it is a recoverable/refundable cost or not. Public sector or non-profit

organizations do not reclaim VAT meaning that building renovation projects should include VAT as CAPEX and OPEX in their financial analyses.

2.1.2. Core metrics - Key performance indicators

The financial analysis's key performance indicators or profitability metrics for climate neutrality projects are:

- **Financial Net Present Value (FNPV)** - is a financial metric that calculates the present value of future cash flows, discounted at a required rate of return, and subtracts the initial investment. It helps determine whether a project or investment is financially viable.
- **Financial Internal Rate of Return (FRR)** - represents the discount rate that makes the Financial Net Present Value (FNPV) of a project equal to zero. It represents the expected annual rate of return on an investment or project. In simpler terms, IRR is the rate at which the present value of cash inflows equals the present value of cash outflows. It helps investors and businesses determine whether a project is financially worthwhile.
- **Simple Payback Period (SPP) -** This represents the time it takes for an investment to fully recover from its cash inflows without considering the time value of money. It is a quick way to evaluate how long a project takes to break even.
- **Discounted Payback Period (DPP)** - is the time required to recover an investment, considering the time value of money. Unlike the regular payback period, DPP discounts future cash flows to their present value before summing them up.
- **Return on Investment (ROI)** - is a financial metric used to measure an investment's profitability relative to its cost. It is expressed as a percentage and helps investors determine how efficiently an investment generates returns.

The financial sustainability analysis at the project level aims to assess whether the project can balance out its positive and negative cash flows during the reference period.

2.1.3. Additional Key Performance Indicators

The financial analysis also recognises several additional key performance indicators or profitability metrics that can also be used for the assessment of projects in specific cases:

- **Financial Net Present Value (FNPV(C))** and the financial rate of return of the investment (FRR(C)) are no different than the standard FNPV and FRR KPIs. However, (C)' is added when the assessment of the investment is done in the context of EU or national funding. FNPV(C) and FRR(C) compare the investment costs to net revenues and measure the extent to which the project net revenues can repay the investment, regardless of the sources or methods of financing while FNPV(K) and FRR(K) take into account the amount of EU or national financial contribution.
- **Financial Rate of Return on National capital (FRR(K)),** where K represents the discount rate, is a metric used in financial analysis to measure the return on capital invested from a national perspective, considering factors like government investments, subsidies, and public infrastructure projects. Instead of just looking at private financial returns, FRR(K) considers the broader financial impact on a country's economy. The objective of the return on national capital calculation is to examine the project performance from the perspective

of the assisted public, and possibly private, entities in the Member States ('after the EU grant').

- **Debt Service Coverage Ratio (DSCR)** is a financial metric used to assess an entity's or project's ability to cover its debt obligations with its operating income or savings. A DSCR lower than "1" means that the entity or project does not generate enough income or savings to cover its debt obligations, which could signal financial distress.

Table 2 Key Financial Indicators and assumptions summary

Category	*Indicator / Parameter*	*Description*
Assumptions	Reference Period	Usually 20-30 years; aligned with project life cycle and EPBD norms.
	Financial Discount Rate (FDR)	Typically 4%, adjusted by sector, risk profile, or national guidance.
	Residual Value	Estimated remaining asset value at end of evaluation period.
	Inflation and Price Basis	Use constant or current prices consistently across lifecycle.
	VAT Treatment	Include only if VAT is non-recoverable (e.g. public sector).
	Sensitivity Analysis	Test variables such as CAPEX, savings, energy price, and financing terms.
Indicators	Financial Net Present Value (FNPV)	Present value of net cash flows minus investment cost.
	Financial Internal Rate of Return (FRR)	Discount rate at which FNPV = 0; expected project return.
	Simple Payback Period (SPP)	Time needed to recoup investment, without discounting.
	Discounted Payback Period (DPP)	Time to recover investment using discounted cash flows.
	Return on Investment (ROI)	Profitability metric: net return divided by total cost.
	Debt Service Coverage Ratio (DSCR)	Ability of project cash flow to cover debt obligations. Values below 1 indicate risk.

2.2. Economic Analysis

An economic assessment of a project evaluates its overall impact on society by analyzing economic efficiency, social benefits, and costs beyond direct financial returns. Unlike financial analysis, which focuses on profitability for investors, economic assessment considers broader societal impacts, including environmental, social, and long-term economic effects.

The key concept of the economic analysis is the use of shadow prices to reflect the social opportunity cost of goods and services, instead of prices observed in the market, which may be distorted due to fiscal requirements, subsidies and non-monetized externalities. To properly assess the true impact of building renovation projects projects on society, a move from the financial to economic analysis has to be made by:

- Making fiscal corrections by removing VAT, other taxes and subsidies from all prices used in the analysis (even if taxes are not recoverable)
- Converting market to shadow prices by using conversion factors for non-tradable goods or border prices for imported goods (prices excluding domestic taxes and subsidies but including international transportation costs and trade tariffs)
- Assessing non-market impacts and correcting for externalities

Future costs and benefits must be discounted once market prices are adjusted and non-market impacts are estimated. In investment project evaluations, the Social Discount Rate (SDR) reflects how society values future costs and benefits against present ones. However, if a simplified CBA analysis is chosen, only fiscal corrections and the assessment of non-market impacts and externalities can be conducted.

2.2.1. Key parameters and assumptions

While financial analysis primarily considers the project owner's perspective, the economic cost-benefit analysis (CBA) assesses the broader socioeconomic impact of building renovation investments on society as a whole. In the scope of the EA, with a simplified CBA methodology the following key parameters and assumptions will be used:

- **Social Discount Rate** – The EU Member States can use their country-specific SDRs, although, in the absence of specified national values, 3% SDR can be taken as a reference point for EU-funded projects in the 2021–2027 period

- **Direct project benefits:**
    - Extension of the economic life of the building (elements) or equipment - represents a deferred cost benefit, i.e. the financial advantage gained by postponing a significant capital expenditure, such as replacing or rebuilding a building, infrastructure, or equipment. By extending the economic life of an asset, the need for costly replacements or major renovations is delayed, leading to savings in present value terms. The related annual value is estimated as the constant annuity over the operational phase of the reference period whose NPV equals the NPV of the project investment cost net of the residual value of the equipment replaced by the project
    - Reduction in building maintenance costs - The possible reduction in costs relates to both preventive maintenance activities and estimated corrective maintenance
    - Improved thermal comfort – a benefit which can be calculated with a “willingness to pay” methodology by interviewing users of the facility or based on the value of hypothetical additional energy savings associated with a hypothetical higher energy consumption in the without-project scenario that would have been needed to reach the same new temperature in the with-project scenario.

- Increase in property values – the expected increase after the building renovation. The economic CBA should only include the difference between the expected increase in property value and the NPV of the energy cost savings as quantified in the financial analysis in order to avoid the double counting of benefits.

- **Environmental and energy-related externalities**:
    - Avoided energy (heat/electricity/cooling) generation, operating, and fuel costs. Data on local energy production should be used in the analysis where it is available. Fuel costs should ideally be expressed at border price plus transportation cost, net of taxation.
    - Avoided emissions or sequestered CO_2 - The shadow price used for the monetisation of the estimated reduction in CO_2 emissions can be taken from the values published by the EIB and DG CLIMA for each year until 2050
    - Sequestered or avoided emissions of air pollutants – According to the methodologies for monetization of key air pollutants developed within the NEEDS[4] and ExternEE[5] projects the following values per air pollutant (damage values) can be used in the EA:
        - Particulate matter - PM2.5:
            - Dense urban areas: EUR 100 – 250 per kg
            - Medium-sized cities and suburban areas: EUR 50 – 150 per kg
            - Rural areas: EUR 15 – 50 per kg
        - Particulate matter - PM10:
            - Dense urban areas: EUR 10 – 100 per kg
            - Medium-sized cities and suburban areas: EUR 30 – 75 per kg
            - Rural areas: EUR 2 – 30 per kg
        - Sulphur oxides (SOx):
            - Dense urban areas: EUR 10 – 50 per kg
            - Medium-sized cities and suburban areas: EUR 5 – 30 per kg
            - Rural areas: EUR 2 – 20 per kg
        - Nitric oxides (NOx):
            - Dense urban areas: EUR 20 – 100 per kg
            - Medium sized cities and suburban areas: EUR 10 – 60 per kg
            - Rural areas: EUR 5 – 40 per kg
    - Enhanced security of supply - in cases where the primary energy saved comes from imported fossil fuels, a standardised (EIB) value of EUR 10/MWh is used for the calculation of this benefit

In cases where **monetisation is not possible**, the environmental impacts of building renovation projects should at least be identified in physical terms for a qualitative appraisal, giving decision-makers more elements to make a considered decision.

[4] Valuation of Weighting Methods for Measuring the EU-27 Overall Environmental Impact, 2011, European Commission Joint Research Centre Institute for Environment and Sustainability

[5] Externalities of Energy. Volume 2, Methodology, 1995, DG Research and Innovation

2.2.2. Core metrics - Key Performance Indicators

The economic analysis's key performance indicators or metrics for building renovation projects are:

- **Economic Net Present Value (ENPV)** - an indicator used to evaluate the economic feasibility of a project, policy, or investment by considering both financial and socio-economic costs and benefits over time. It is a variation of the Net Present Value (NPV) approach but includes broader economic and social impacts beyond direct financial returns. If ENPV > 0 the project creates net economic value and is economically viable. In cases where ENPV < 0 the society is better off without the project.
- **Economic Rate of Return (ERR)** - a measure used in economic analysis of projects to evaluate their overall benefit to society. It is the discount rate at which the Economic Net Present Value (ENPV) becomes zero. EIRR differs from the FRR because it includes non-market benefits and costs (e.g., environmental and social factors).
- **Benefit-Cost (B/C) Ratio** - an economic indicator used in cost-benefit analysis (CBA) to assess the feasibility of a project or investment. It compares the total economic benefits of a project to its total economic costs. If B/C Ratio > 1, the project is economically viable (Benefits exceed Costs), and if B/C Ratio < 1, the project is not viable (Costs exceed Benefits) and the society is better off without the project.

Table 3 Key Economic Indicators and Assumptions Summary

Category	Indicator / Parameter	Description
Assumptions	Reference Period	Generally, 20–30 years; reflects asset lifecycle and long-term societal impact.
	Social Discount Rate (SDR)	The standard rate is 3% for EU-funded projects unless country-specific rates apply.
	Shadow Pricing	Adjusted prices that reflect the actual economic value of inputs/outputs, accounting for market distortions.
	Fiscal Corrections	Excludes taxes, subsidies, and transfers to avoid double-counting and reflect the real economic cost.
	Externalities	Includes monetised impacts of CO_2, air pollution, noise, health improvements, and energy security.
	Price Basis	Use constant or current prices consistently, aligning with SDR methodology.
	Residual Value	Economic value of remaining useful life of assets beyond the reference period, if applicable.
	Sensitivity Analysis	Test key parameters affecting societal impact (e.g. CO_2 value, energy prices, shadow wages).

Indicators	Economic Net Present Value (ENPV)	Total present value of economic benefits minus costs; ENPV > 0 indicates societal gain.
	Economic Internal Rate of Return (EIRR)	Discount rate that makes ENPV = 0; represents the socio-economic return of the project.
	Benefit-Cost Ratio (B/C Ratio)	Ratio of total discounted benefits to costs; B/C > 1 indicates economic justification.
	Cost per Unit Impact (CEA-based)	Optional for benchmarking: €/tCO_2 avoided, €/kWh saved; used in cost-effectiveness comparisons.

3. EU Taxonomy Methodology Integration

The EU Taxonomy for Sustainable Activities is a cornerstone of the European Union's sustainable finance framework, designed to help direct investments toward environmentally sustainable projects and activities. Under the EU Taxonomy Regulation[6] (2020/852/EU), economic activities are assessed against six environmental objectives:

1. Climate change mitigation.
2. Climate change adaptation.
3. Sustainable use and protection of water and marine resources.
4. Transition to a circular economy.
5. Pollution prevention and control.
6. Protection and restoration of biodiversity and ecosystems.

EU Taxonomy Regulation provides a common language and clear criteria for identifying economic activities that contribute significantly to climate and environmental objectives, while ensuring transparency, mitigating greenwashing, and fostering market alignment.

3.1. EU Taxonomy and Public Sector (Government and Public Projects)

While governments and public authorities are **not directly required** to align with the EU Taxonomy in the same way as private entities, it still influences public financing, subsidies, and procurement. The EU Green Bond Standard (GBS) and ESIF funds (such as the Recovery and Resilience Facility and Cohesion Funds) increasingly align with EU Taxonomy criteria to ensure the achievement of climate and environmental objectives.

Public projects applying for EU funding (e.g., climate adaptation, energy efficiency, infrastructure) often need to **demonstrate compliance** with EU Taxonomy-aligned criteria to secure financing. Public projects seeking private financing from banks or capital markets **must align** with the EU Taxonomy, as financial market participants are legally required to disclose how their investment products comply with its criteria.

The EU Taxonomy is relevant for commercial and public projects, but mandatory disclosure mainly applies to large financial and corporate entities. However, public projects seeking EU funding or issuing green bonds are encouraged to follow EU Taxonomy principles to enhance transparency and credibility in sustainable investments.

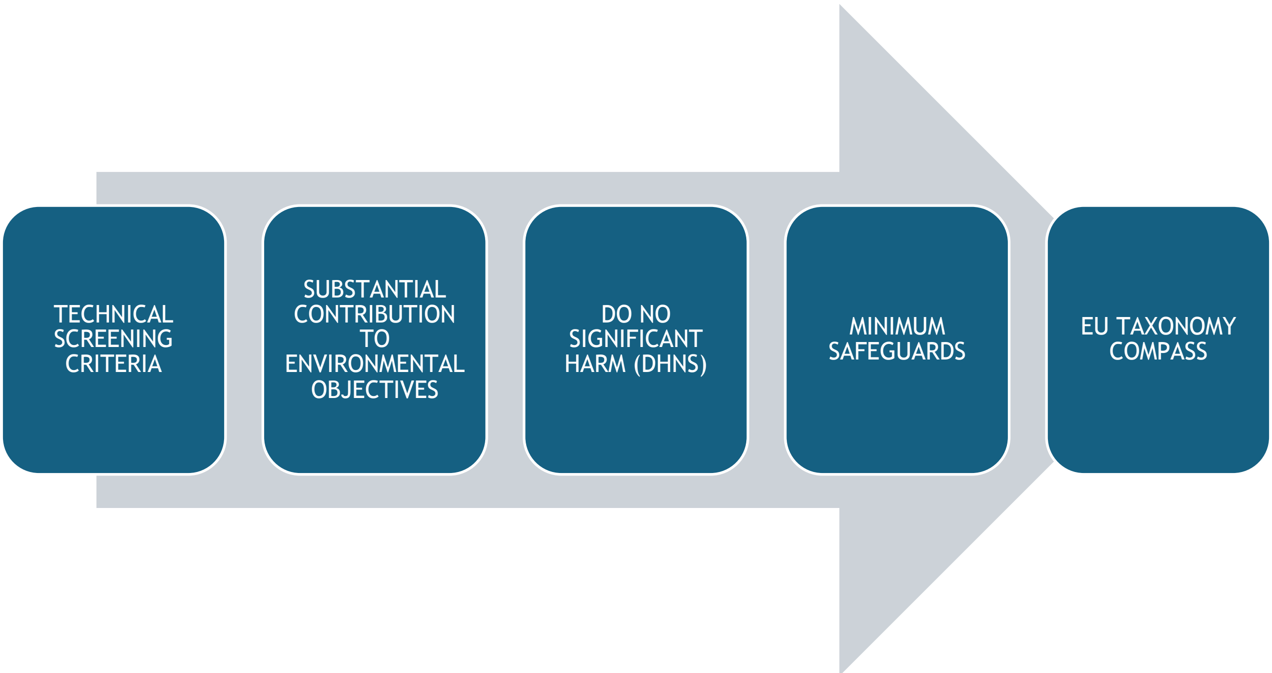
[6] European Commission: Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment, and amending Regulation (EU) 2019/2088 (Text with EEA relevance). Available at: https://eur-lex.europa.eu/eli/reg/2020/852/oj/eng.

For building renovation projects, the EU Taxonomy provides a classification system to identify environmentally sustainable projects and ensure that they comply with the "Do No Significant Harm" (DNSH) principle and Minimum Safeguards aligned with international standards such as the UN Guiding Principles on Business and Human Rights and the OECD Guidelines for Multinational Enterprises.

By leveraging the EU Taxonomy Compass, stakeholders can navigate technical screening criteria and reporting obligations effectively:

- Assess compliance with climate change mitigation and adaptation objectives.
- Evaluate substantial contributions to environmental goals, such as reducing greenhouse gas (GHG) emissions or enhancing climate resilience.
- Ensure projects "do no significant harm" (DNSH principle) to other environmental objectives, such as: biodiversity or water resources.

EU Taxonomy Compass tool is available at: EU Taxonomy Compass[7].



3.2. Application of the EU Taxonomy to building renovation projects

To integrate the EU Taxonomy into the evaluation of building renovation projects, the following methodology outlines key steps:

Step 1: Identify Relevant Environmental Objectives

Determine which of the six EU Taxonomy environmental objectives the project contributes to:

[7] European Commission, DG Fisma, EU Taxonomy Compass. Available at: https://ec.europa.eu/sustainable-finance-taxonomy/taxonomy-compass/the-compass.

- Climate Change Mitigation: Activities that reduce greenhouse gas (GHG) emissions, such as energy efficiency improvements or renewable energy installations.
- Climate Change Adaptation: Activities that enhance resilience to climate-related risks, such as flood-resistant infrastructure or water management systems.

Step 2: Assess Substantial Contribution

- Use the technical screening criteria provided by the EU Taxonomy Compass to evaluate whether the project substantially contributes to one or more environmental objectives.
- Examples of substantial contributions:
  - Reduction in GHG emissions (e.g., tons of CO_2 avoided annually).
  - Enhanced climate resilience through adaptive infrastructure solutions

Step 3: Ensure "Do No Significant Harm" (DNSH) Compliance

- Verify that the project does not negatively impact other environmental objectives:
  - Avoid disrupting biodiversity during construction or operation.
  - Ensure water resources are not depleted or polluted by project activities.
- Apply DNSH criteria outlined in the EU Taxonomy Compass to identify potential risks and mitigation measures.

Step 4: Evaluate Alignment with Technical Screening Criteria

- Use the EU Taxonomy Compass tool (link) to:
  - Navigate sector-specific criteria for eligible activities.
  - Confirm compliance with thresholds for GHG reductions, energy savings, or resilience measures.

Step 5: Quantify Socio-Economic Benefits

- Assess broader impacts of building renovation projects on socio-economic factors:
  - Job creation in green sectors.
  - Improved public health through reduced air pollution.
  - Increased energy security and affordability.

Step 6: Monitor and Report Progress

- Establish Key Performance Indicators (KPIs) aligned with taxonomy criteria:
  - Percentage reduction in energy consumption post-renovation.
  - Reduction in GHG emissions compared to baseline levels.
- Use standardised reporting templates provided by the taxonomy framework for transparency.

4. Post-Investment Performance Monitoring and Impact Reporting

1. Energy Performance Metrics

Metric	Baseline (Pre-Renovation)	Post-Renovation (year 1)	Post-Renovation (year 2)	Notes
Total Energy Consumption (kWh/year)				
Production of renewable energy on site (kWh/year)				
Share of renewable energy in total energy consumption (%)				

2. Climate and Environmental Impact Indicators

Metric	Baseline (Pre-Renovation)	Post-Renovation (year 1)	Post-Renovation (year 2)	Notes
Carbon Emissions (tons CO_2e)				
Sequestered CO_2 from GI (NBS) (g/year)				
Air pollutant emission: PM2.5 (g/year)				
Air pollutant emission: PM10 (g/year)				
Air pollutant emission: NOx (g/year)				
Air pollutant emission: SOx (g/year)				
Average roof temperature during summer months (C)				

3. Indoor Environmental Quality (IEQ) (Optional)

Metric	Baseline (Pre-Renovation)	Post-Renovation (year 1)	Post-Renovation (year 2)	Notes
Indoor Temperature (°C/°F)				
Relative Humidity (%)				

CO_2 Levels (ppm)				
Average Lighting Levels (Lux)				

4. Financial and Economic Indicators

Metric	Baseline (Pre-Renovation)	Post-Renovation (year 1)	Post-Renovation (year 2)	Notes
Total energy costs (EUR/year)				
Revenues from produced energy (EUR/year)				
Costs of maintenance (EUR/year)				
FNPV (K)/(C) (EUR)				
FRR (K)/(C) (%)				
SPP (years)				
DPP (years)				
ENPV (EUR)				
ERR (%)				
B/C ratio				

5. Maintenance and Performance Issues

- Equipment performance issues: (Yes/No; Description if applicable)
- Unexpected operational and maintenance challenges: (Yes/No; Details if any)
- User feedback on comfort and system efficiency: (summary of occupant feedback, if available)

Annex 1

EU-based tools and platforms for **EU Taxonomy assessment** and **performance monitoring** in the context of energy efficiency and building renovation:

TOOL NAME	LINK	PURPOSE	USE CASES	DESIGN INSPIRATION
EU TAXONOMY COMPASS	https://ec.europa.eu/sustainable-finance-taxonomy	Navigate technical screening criteria, DNSH, and minimum safeguards.	Select renovation activities and verify compliance thresholds (e.g., 7.2, 7.7).	Model compliance checklist and screening logic.
LIFE LEVEL(S) TOOLKIT	https://levels.eea.europa.eu/	Monitor building performance using sustainability indicators across the life cycle.	Track energy, material use, and health metrics aligned with EU green standards.	Adopt KPIs such as carbon intensity and indoor air quality for your dashboards.
BPIE / X-TENDO TOOLBOX	https://www.x-tendo.eu/toolbox/	Support EPBD implementation and renovation innovation (e.g., Smart Readiness).	Deploy EPCs, renovation passports, and one-stop-shop evaluations.	Incorporate Smart Readiness Indicators and renovation pathways.
JASPERS CBA APPRAISAL TOOLKIT	https://jaspers.eib.org/	Provide Excel-based tools for assessing financial and economic performance.	Perform ENPV and EIRR calculations; assess the viability of public funding.	Automate economic metric calculations in backend models.
EEEF PAST TOOL	https://www.eeef.lu/tools.html	Enable evaluation of energy efficiency investments through structured templates.	Conduct pre-feasibility checks and impact monitoring of green investments.	Embed CAPEX/OPEX and grant logic into performance-based evaluations.

1. EU Taxonomy Compass

🔗 https://ec.europa.eu/sustainable-finance-taxonomy
Purpose: Navigate technical screening criteria, DNSH, and minimum safeguards.
Use: Select renovation activities (e.g., 7.2, 7.7), and check thresholds for compliance.
Inspiration for Your Tool: Use its structure to define a compliance checklist and screening module.

2. LIFE Level(s) and Level(s) Indicators Toolkit

🔗 https://levels.eea.europa.eu/
Purpose: Performance monitoring for buildings using sustainability indicators across life cycle.
Use: Supports energy, material, and health tracking—aligned with EU green principles.

Inspiration: Adapt KPIs (e.g., carbon intensity, indoor air quality) for your monitoring dashboards.

3. BPIE / X-tendo Toolbox

🔗 https://www.x-tendo.eu/toolbox/
Purpose: Innovations for building renovation and EPBD implementation (e.g. Smart Readiness).
Use: Tools for renovation passports, EPCs, and one-stop-shop evaluation.
Inspiration: Integrate Smart Readiness Indicator or cost-optimal renovation pathways.

4. JASPERS CBA Appraisal Toolkit

🔗 https://jaspers.eib.org/
Purpose: Excel-based cost-benefit tools, including economic externalities.
Use: Apply for financial and economic performance evaluation.
Inspiration: Integrate it into your backend for automatic ENPV/EIRR calculations.

5. EEEF Project Assessment Tool (PAST)

🔗 https://www.eeef.lu/tools.html
Purpose: Structured Excel tool for evaluating energy efficiency investments.
Use: Pre-feasibility, financial viability, and impact measurement.
Inspiration: Use its template logic for CAPEX/OPEX + performance-based grant design.