Project Appraisal Methodological Guidance

List of Abbreviations

BAU	Business-as-usual
CBA	Cost-Benefit Analysis
CDRA	Climate and Disaster Risk Analysis
CEA	Cost-effectiveness analysis
CPAF	Capital Project Application Form
EIB	European Investment Bank
EIRR	Economic Internal Rate of Return
ENPV	Economic Net Present Value
FDR	Financial Discount Rate
FIRR	Financial Internal Rate of Return
FNPV	Financial Net Present Value
FS	Feasibility Study
GDP	Gross Domestic Product
GHG	Greenhouse Gases
IT	Information Technology
MCA	Multi-Criteria Analysis
OPEX	Operating expenditures
R&D	Research and development
SDR	Social Discount Rate
SLDM	Straight-Line Depreciation Method
SPC	Shadow price of carbon
VAT	Value Added Tax
VoT	Value of Time
WB	The World Bank
WtP	Willingness-to-Pay
WtA	Willingness-to-Accept

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1. Introduction

The Project Appraisal Methodological Guidance aims to support project proposers in Montenegro in preparing budget requests for public investments that require a feasibility study and cost-benefit analysis. It supplements the "Feasibility study minimum content requirements" document, which defines the expected structure and content of a feasibility study, by offering detailed methodological instructions on key aspects of project appraisal.

This Project Appraisal Methodological Guidance serves two primary purposes:

- To support project proposers by setting out clear expectations regarding the content and quality of feasibility studies. This ensures that project proposers are well-prepared to engage with consultants and assess the methodological soundness of the delivered feasibility studies and cost-benefit analyses.
- To provide guidance to consultants on the standard approaches to feasibility study preparation, ensuring consistency, analytical rigor, and adherence to best practices in project appraisal.

Additionally, the document includes examples and case studies to support the completion of the Capital Project Application Form (CPAF). For projects requiring a feasibility study, the CPAF should be completed based on the results of the project appraisal presented in the feasibility study.

The Project Appraisal Methodological Guidance aims to enhance the quality and comparability of feasibility studies, leading to better-informed investment decisions and the effective allocation of public funds.

2. Demand analysis

The demand analysis identifies and quantifies the social need for the implementation of an investment. It should always consider both the current demand (based on the most up-to-date data available from service providers, statistical offices, ministries, or local governments) and the forecast demand (based on projections that include macroeconomic and social indicators, among others). The demand should be forecast for both with and without the investment scenarios.

A demand analysis is an essential element of an appraisal process and involves a quantified forecast of the anticipated demand for the project's services, encompassing the projected change in demand throughout the project's lifespan. It aims to demonstrate that there is sufficient demand for the relevant service in the target market among identified project beneficiaries to justify its implementation. Accurate demand estimation is a prerequisite for:

- **Selecting the right project design:** it guides the design of appropriately sized capital assets with parameters matching the anticipated demand. The design capacity of the project should always refer to the year in which demand is highest.
- **Conducting a sound Cost-Benefit Analysis (CBA)**: it always provides a solid foundation for estimating the financial project costs, as well as overall economic costs and benefits of the entire project.

Demand analysis should therefore precede options, financial, and economic analyses, as it provides the essential inputs required for the subsequent appraisal steps. Where possible, it is always recommended to prepare separate projections for distinct user groups, such as business, industrial, institutional, or residential. Future demand must be forecast for the entire project lifecycle, and this timeframe should be consistent with the analysis reference period applied in financial and economic analysis.

When conducting demand analysis, it is usually necessary to come up with a number of assumptions. They should always be clearly laid out and thoroughly justified in the feasibility study. The method of conducting a demand analysis is likely to differ based on the nature of projects and the availability of time and resources. Depending on the project characteristics, it can either be based on surveys and questionnaires performed among potential beneficiaries of the project, extrapolation of past trends or more complex regression models. The level of detail required in a demand analysis will vary depending on project complexity and its value. Regardless of the chosen forecasting approach, incorporating historical evidence of past trends, when available, is crucial for contextualizing the forecast.

It is important to note that numerous factors usually influence demand volume. Some of these factors are universal, while others are unique to specific sectors or projects. Accurate and comprehensive identification of these drivers is crucial for determining how demand will evolve throughout the project lifecycle.

General factors encompass demographic and socioeconomic trends, as well as the prevailing tariff system and individuals' willingness to pay. Demographic projections, changes in population size, and shifts in the age structure play a crucial role in shaping demand patterns. Meanwhile, socioeconomic trends, including national and regional economic growth, employment rates, and labour market structures, significantly affect demand across multiple industries. Additionally, the tariff system and consumers' willingness to pay further influence the overall demand landscape, reflecting both regulatory frameworks and market dynamics.

Case study: price elasticity of demand

Price elasticity of demand (PED) measures how the quantity of a good or service demanded changes in response to price variations. In the context of water supply and other utilities, it reflects how consumers adjust their consumption when tariffs increase or decrease.

City X, a city of approximately 175,000 residents, underwent significant changes in water consumption and pricing between 2005 and 2017. During this period, the average daily water consumption per capita declined by 15%, while tariffs more than doubled, increasing from $5.04 to $11.33 per cubic meter. This was largely driven by a major investment program aimed at improving water quality, which included the modernization of treatment plants, upgrades to the distribution network, and compliance with stricter environmental standards.

The case of City X highlights the complex interplay between investment costs, tariff adjustments, and demand elasticity. While improving water infrastructure was necessary to enhance service quality, the resulting price increases affected consumer behaviour, leading to lower-than-expected water usage. This demonstrates the importance of incorporating price elasticity of demand (PED) into financial forecasts, as overestimating future water consumption can lead to revenue shortfalls.

Additionally, the affordability of water services became a critical issue. To mitigate the impact of rising tariffs on vulnerable households, City X introduced a tiered pricing system, ensuring basic water needs remained accessible while covering the costs of infrastructure investments. This underscores the need for financial planning to balance cost recovery, social equity, and sustainability.

Another key aspect was long-term financial sustainability. Investment decisions accounted not only for initial capital expenditures but also for operation and maintenance (O&M) costs, debt servicing, and future reinvestments. A clear financial strategy was essential to maintaining financial stability while ensuring continued improvements in service quality.

Beyond these overarching determinants, sector-specific factors exert distinct influence on demand within various industries. In transport, demand is shaped by industrial and logistics sectoral trends, spatial transformations, and traffic management strategies. Water supply, sanitation services and stormwater management systems are affected by climate conditions and fluctuations in agricultural and industrial production. Waste management is influenced by consumption habits, institutional recycling initiatives, legislative changes, and advancements in circular economy models. Similarly, the energy sector experiences demand shifts due to climate conditions, energy efficiency measures, economic expansion, and evolving living standards.

Broadband demand is driven by digital education, urbanization, and public institutions, while R&D relies on industry scale, investment, venture capital, and skilled scientists. Competition, knowledge transfer, and public perception also shape R&D demand. These factors highlight the interplay between economic forces and sector-specific conditions, underscoring the need for targeted policies and investments.

Rigorous demand analysis ensures that capital assets are **properly sized**, cost estimates are **accurate**, project benefits are **well-assessed**, and economic viability is **robustly determined**.

3. Options analysis

The options analysis aims to identify possible solutions that can achieve project objectives and address the identified problem. The analysis serves to determine which of the considered project options is the best, i.e. the most beneficial in terms of the relation between the results and the means, and should be chosen as the implementation variant of the project.

The list of identified options may change as more data is available and more information is collected as the project develops. The options analysis is an iterative process, and should not be treated as a distinct and isolated stage of feasibility study preparation. An initial consideration and analysis of available options should be carried out before a decision is made to conduct a full-fledged project appraisal. A feasibility should discuss and provide an in-depth analysis of these initially considered variants. Appraisal may also reveal other viable options. It is recommended to mention all considered options in the feasibility study and provide a rationale behind rejecting/abandoning them, as it shows that the project proposer considered numerous alternative solutions and did not omit any significant one.

The analysis should be based on a series of assumptions, estimates, detailed data such as cost estimates, the best knowledge, and the experience of project proposer. All assumptions and data sources should be duly justified and presented in the feasibility study.

3.1. Project options

3.1.1. 'Do nothing' and 'Do minimum' options

Considered options should be compared against a baseline/benchmark option, which is called 'business-as-usual' (BAU) scenario, i.e. a scenario in which the investment is not implemented, but still a minimum input is necessary to maintain services at or as close as possible to their current level. This option should be appraised even when it is not considered a realistic option.

The BAU scenario should not be considered an investment variant, due to the fact that it does not solve the identified problem(s), although it may involve some capital costs (e.g., replacement costs of obsolete assets).

3.1.2. Investment options

Depending on the characteristics of a particular project, the following option categories can be taken into account when conducting the options analysis:

- **Location options**

In most cases, the location should have been determined at an earlier stage (e.g. during strategic planning) and the feasibility study should focus on explaining the reasons behind such a choice. However, it is not always the case, as more detailed data may be necessary to determine the best location. While comparing different location options, it is recommended to take into account climate change-induced risks and other relevant issues, like land ownership (if applicable, Resettlement Action Plan shall be explicitly mentioned and discussed in the feasibility study in the Social Impact Assessment chapter), site access and/or spatial planning.

- **Strategic options**

This category focuses on analysing different strategic approaches on how to address the identified problem(s), e.g. establishing a number of small, local clinics instead of constructing one large medical facility or rehabilitation vs. construction of new facilities.

- **Technical/Technological options**

The use of different technologies or technological approaches may significantly increase or reduce the overall investment and/or operating costs. Also, capacity of an operating entity to ensure proper maintenance of the planned infrastructure should be considered when choosing technological solutions.

- **Different timing/phasing/scale options**

It is recommended to always consider varying the timing, phasing and the scale of capital investment projects. In some cases, it is more viable to initially invest on a smaller scale, but secure an option to expand the infrastructure in the future, e.g. when demand reaches higher levels.

- **Institutional options**

Project options may include various solutions in terms of institutional set up for both implementation and operation (i.e. which institutions are to be involved).

The catalogue of categories for options analysis is by no means a closed one, thus the scope of the assessment can be expanded depending on the nature of a particular project.

3.1.3. Formulating project options

The options analysis begins with the formulation of strategic and location options. These options are typically assessed using multi-criteria analysis, considering spatial, environmental, market, socio-economic, financial, legal, and other constraints. However, in some cases, more advanced and quantitative techniques may be required to compare the available options.

Once the preferred strategic option is determined, the project proposer must identify possible specific technical/technological solutions. At this stage, quantitative techniques such as Cost-Benefit Analysis or Cost-Effectiveness Analysis should be applied to determine the optimal project variant.

Furthermore, based on the results of the climate risk analysis, options also may be differentiated by the level of climate resilience. The assessment of climate resilience options involves comparing project options with and without resilience to the BAU scenario. For pure adaptation projects, such as stand-alone flood protection project, the same methodology applies, though there are no options without adaptation (as this is the BAU scenario).

3.2. Methods for evaluating project options

In order to evaluate each identified project option and determine which one is the most beneficial, several quantitative and qualitative methods can be used. The three most common methods of comparing options are:

- Cost-benefit analysis (CBA) - quantitative,
- Cost-effectiveness analysis (CEA) - quantitative,
- Multi-criteria analysis (MCA) - qualitative.

CBA is the most complex and demanding method, as it requires precise and detailed estimation of benefits and costs for each individual option. It should be used for selecting the preferred option only if neither CEA nor MCA has produced conclusive results regarding the choice of the optimal project variant. However, the economic viability of the project (i.e. the preferred variant) shall be always determined using CBA method. The CEA method is used to compare the costs over the entire life cycle of the project to its estimated outputs and determine which option is the most cost-effective one. The simplest method to use is the MCA, which uses a system of criteria and weights in order to evaluate each individual option by assigning it scores.

3.2.1. Cost Benefit Analysis (CBA)

CBA enables a comparison of the costs against project benefits and other non-market impacts expressed in monetary terms in present value. Using this technique to choose the best project variant means performing financial and economic analysis for each option and then comparing the results. At the options analysis stage, CBA can be applied in a simplified form, using rough estimates of costs, revenues and demand, based on market prices, provided that cost estimates are all-inclusive, i.e. that no important cost component is missing. A more detailed discussion on how to perform CBA can be found in Chapter 4.

3.2.2. Cost-effectiveness analysis (CEA)

CEA is similar to CBA; however, it is simpler in the sense that it does not involve monetization of project benefits and externalities. Instead, benefits are expressed in physical units rather than in monetary terms. The aim is to determine which investment variant provides either **the expected effect at the lowest cost** or the **highest effect for a given cost** (i.e. cost minimisation or effect maximisation) – i.e. CEA aims to determine which project variant uses the public resources most effectively.

CEA is particularly useful in situations where benefits are difficult to monetize (e.g., in the health or education sectors) or when a decision has been made to proceed with an investment (for instance due to legal requirements) but the objective is to achieve the output at a minimal cost or to achieve the highest output given a specific budget. Also, project variants should not differ significantly in terms of externalities they will produce.

If project variants do not differ in terms of outcomes they generate but only in terms of costs, CEA means calculating **Net Present Cost**. A standard social discount rate should be applied (see Chapter 5). If CEA is chosen to compare project variants, it needs to be clearly presented what is the cost per unit output/outcome or Net Present Cost for each variant. The limitation of CEA is that it does not provide a criterion for accepting or rejecting a project, because costs and benefits are not directly comparable.

Cost-effectiveness ratio expresses a relation between the present value of project costs minus revenues and residual value, and the discounted changes in outputs. It can be calculated by the following formula:

$$R = \frac{\sum_{t=1}^{t=n}(CF_t)}{\sum_{t=1}^{t=n}(Q_t)}$$

where:
R – cost-effectiveness ratio
CFt – discounted sum of CAPEX + OPEX – revenue – residual value in year t
Qt – discounted changes in outputs (quantity) in year t
n – total number of years of the reference period.

The results of CEA should be included in a financial and economic model to be submitted along with a feasibility study document, where their interpretation is required. The table below presents exemplary results of CEA for a road project whose variants differ only in CAPEX and replacement costs, while outputs and OPEX are identical.

Table 1: Exemplary results of cost-effectiveness analysis (EUR)

	VARIANT 1 Present value	VARIANT 2 Present value
CAPEX	99 069 255	116 400 728
Replacement costs	15 038 840	18 315 458
OPEX	2 633 929	2 633 929
Residual value	4 814 254	5 682 593
Output (km)	178,11	178,11
Cost-effectiveness ratio (EUR/km)	**628 413**	**739 241**

Source: Authors

3.2.3. Multi-criteria analysis (MCA)

MCA is used as a technique that aims to establish preferences between numerous different options for achieving a given set of project objectives. It helps to identify the best investment alternative based on a specific set of criteria. MCA is particularly useful for comparing strategic options when several quantitative and qualitative aspects need to be considered but detailed financial data may not yet be available. It is used to rank options or choose a preferred option. Usually, it involves an explicit relative weighting system for the different criteria used.

Once possible strategic options are identified (at least 2 investment variants), they should be assessed using at least the following criteria:

- Economic aspect (qualitative assessment of social and economic impact)
- Financial aspect (budget affordability),
- Legal and administrative aspects (feasibility of the investment, compliance with spatial plan),
- Functionality of the solution, including accessibility (e.g., gender equality, adaptation to the needs of people with disabilities, as well as adaptation to climate change and resilience to natural disasters),
- Impact on the environment and climate (qualitative).

It is likely that some criteria are more important than others depending on the circumstances and current priorities. The 'weighted method 'of MCA is designed to reflect this reality.

In the example shown in Table 2, weights are given to each of the criteria as a factor of 1.0. The total weighting for all criteria therefore equals 1.0 and the highest values should be given to these criteria that were subjectively identified as the most impactful/important ones. In this particular case, scoring range was set to 0-3 and points were given depending on the performance of each option. The most important criteria in this example are Financial and Economic aspects, each with a weighting of 0.3. In the weighted scoring method, the score given for each criterion is multiplied by the weighting to produce a 'weighted score'.

Table 2: Multi-Criteria Analysis example

Criterion	Option 1			Option 2		
	Score	Weight	Weighted score	Score	Weight	Weighted score
Economic	3	0,3	0,9	1	0,3	0,3
Financial	1	0,3	0,3	3	0,3	0,9
Legal and administrative	3	0,2	0,6	3	0,2	0,6
Functionality	3	0,1	0,3	2	0,1	0,2

Criterion	Option 1			Option 2		
Impact on environment and climate	3	0,1	0,3	1	0,1	0,1
		Total weighted score	**2,4**		**Total weighted score**	**2,1**

Source: Authors

As presented in the example above, two investment options were compared using MCA, where according to the applied criteria option 1 should be chosen. Scoring range, choice and justification of weights and interpretation of scores must always be presented in the feasibility study.

The selected project option will undergo a full-fledged cost-benefit analysis, including both financial and economic appraisals. If a simplified CBA was used to select the preferred project variant, a full-fledged CBA will reconfirm the initial estimates using more detailed market data, apply shadow prices when necessary, and re-evaluate project benefits. In rare cases involving particularly complex projects and when simpler methods failed to produce conclusive results, more than one project variant may undergo a full-fledged CBA.

4. Financial appraisal

Financial appraisal aims at assessing the **profitability** of the project for its owner and key stakeholders, verifying the project's **financial sustainability** and determining its **budget affordability**, as well as developing the cash flows which serve as input to economic appraisal. The key element of the financial appraisal of public investment projects is to determine their financial sustainability. A project can be considered sustainable when the risk of running out of cash in the future is expected to be nil.

Financial profitability of a project means that there is a positive difference between the present values of the project's cash inflows and outflows (including capital and operational costs).

Financial sustainability of a project means that it will generate sufficient funds to meet its commitments throughout its life-cycle or sufficient funds will be secured by the relevant entity.

Determination of the project's **budget affordability** is a task of the Ministry of Finance, which is to be carried out based on the contents of the financial appraisal in the feasibility study prior to the inclusion of the project in the State Budget. It aims to examine whether there are sufficient funds available to implement the project and how the cash flows (including loan repayment) related to or generated by the investment will impact the budget.

4.1. Project appraisal period

An analysis period over which the benefits and costs of the project (and its alternative variants) will be assessed must be decided upon. The analysis period should normally correspond to the useful life of the fixed asset created and should be the same for all options. In reality, some major infrastructure assets have almost indefinite lives, provided that they are well maintained. It is a common practice to curtail the analysis period and include a residual value as a positive cashflow in the final year of the analysis. The following table presents the reference analysis periods by sector recommended by the European Commission[1] that should be used for the purpose of financial appraisal in Montenegro.

Table 3: Recommended project analysis (reference) periods by sector

Sector	Number of years
Railways	30
Roads	25-30

[1] *Guide to Cost-Benefit Analysis of Investment Projects: Economic Appraisal Tool for Cohesion Policy 2014-2020*, European Commission, 2014.

Sector	Number of years
Ports and airport	25
Urban transport	25-30
Water supply and sanitation	30
Waste management	15-25
Energy	15-25
Broadband	15-20
Business infrastructure	10-15
Other sectors	10-15

Source: Guide to Cost-Benefit Analysis of Investment Projects, European Commission, 2014

4.2. Basic rules of financial analysis

The financial analysis should be conducted in real terms, i.e. excluding the effect of inflation. However, macroeconomic trends may still be relevant and should be considered in certain situations (e.g., growth of energy prices exceeding the inflation rate or real wage growth). All assumptions should be explained and justified in the feasibility study.

The financial analysis should be done by comparing the costs (both investment and operational) of a particular project variant to its estimated revenues over its lifespan, i.e. a period of time it is expected to operate, and by adopting the following methods and rules:

- Only cash inflows (revenues) and outflows (costs) should be considered in the analysis (i.e. depreciation, price and technical contingencies or any other accounting items that do not correspond to actual flows must be disregarded).
- **Differential Cash Flow Method** – analysed investment variant(s) should always be compared to the so-called variant 0 (a BAU scenario or 'without-the-project' scenario). Importantly, the BAU scenario may also involve some capital expenditures (e.g. replacement costs for the existing infrastructure) and changes in demand or OPEX (e.g. due to climate impacts) compared to the existing situation.
- **Discounted Cash Flow Method** – future net cash flows, calculated in line with the Differential Cash Flow Method, should be discounted using the **Financial Discount Rate (FDR)**, which should be the same as discount rate applicable in the economic analysis (see Chapter 5: Economic appraisal), if not determined otherwise. The purpose of discounting is to account for the time value of money, reflecting the principle that money today is worth more than the same amount in the future due to

its potential earning capacity. This allows for the comparison of cash flows occurring at different times by converting future amounts into their present value equivalents.

- The financial analysis should be carried out net of VAT if it is recoverable by the investor.

4.3. Project investment costs

The scope of the project may include various cost categories, including capital costs of all the fixed assets and non-fixed assets. Examples of typical capital costs:

- Purchases of land and buildings,
- Fees for licenses and permits related to the project,
- Site preparation costs,
- Related infrastructure works (site access road, utility connections),
- Construction,
- Social and environmental mitigation costs,
- Purchases of equipment, vehicles, hardware and software related to the project,
- Installation, implementation and commissioning costs,
- Supervision costs,
- Contingencies.[2] [3]

If replacement of obsolete assets is planned according to the project design, this constitutes a **replacement cost** i.e. capital costs occurring during the operational phase of the project. Replacement costs should be included in relevant years of the financial projections. Replacement costs refer to the costs of replacing assets that have been created / acquired as part of the project but whose operational lifetime is shorter than the entire economic lifetime of the project adopted in the CBA. For example, the “Construction of hydroelectric dam” project starts with an initial capital investment of €200 million, which covers the construction of the dam, turbines, and other essential infrastructure. However, over the dam's operational lifespan, certain key components will degrade or become outdated, necessitating their replacement to maintain the project's efficiency and safety. The financial projections for the project include the following replacement costs:

[2] Maximum amount that can be included in the project budget constitutes 10% of the CAPEX.

[3] If contingencies are included in the project budget, it shall be remembered to exclude them from the calculations of financial and economic indicators.

- in year 15: the project anticipates the need to upgrade the turbines, which are essential for converting the energy from flowing water into electricity. This upgrade is expected to cost €20 million.
- in year 30: another upgrade of turbines is expected. The cost for this replacement is projected to be €20 million.

Thus, the total replacement costs over the operational life of the project are estimated at €40 million. These costs shall be factored into the financial planning to ensure the project's long-term viability.

4.4. Operational expenditures and revenues

Operating expenditures should include all costs related to the operation and maintenance of the new or upgraded service being a result of the project throughout the years of the reference period. OPEX must not include the cost of financing.

The typical operating costs include:

- Labour costs (wages and salaries, social securities);
- Utility costs;
- Fuel;
- Materials;
- Costs related to the security of the infrastructure;
- Maintenance costs (maintenance or minor repair of assets);
- Office services (e.g. online services, data processing);
- Leasing and rental costs;
- Cleaning.

The **revenues** of a project include cash inflows for the goods and/or services provided as a result of the project, e.g. direct charges for the use of infrastructure (e.g., highway tolls), rent of land/buildings (renting out office space or classrooms).

The annual values of these revenues should be determined in the forecast by their prices and the estimated quantities of goods and/or services provided throughout the years of the operational phase of the project. The basis for these estimations and final results should be presented in line with the demand analysis.

The operating revenues used in calculations of financial profitability **must not include transfers or subsidies** (e.g. transfers from state or regional budgets or national health insurance) and **must not include other financial income** (e.g. interests from bank deposits), because they cannot be directly attributed to the project's operations. However, these shall be included in the financial sustainability verification.

Finally, the **residual value** of the fixed assets should be included as a positive cash flow in the last year of the reference period for the purposes of conducting financial analysis. Although, it is not an operational revenue nor is it a cash flow per se (unless the assets are actually liquidated), the residual value reflects the remaining value of assets whose economic life has not been exhausted yet and should be calculated using depreciation rates for each particular category of capital costs that is a part of the investment.

The most common method of calculating residual value uses **Straight-Line Depreciation Method (SLDM)**, which estimates an average decline in value of an asset over a period of time. The time period should correspond to the reference period of analysis mentioned in Chapter 4.1. The annual expense amount (i.e. annual value of depreciation) should be calculated based on depreciation rates for specific asset types, as defined in applicable accounting regulations in Montenegro.

If an estimated usage, wear and tear, or obsolescence that reduces the value of an asset is expected to be higher or lower due to the specificity of an investment, depreciation rates should be adjusted accordingly and rationale behind it should be provided.

Calculating the residual value for one asset category is presented in **example**:

- Initial value of an asset: €100 000
- Depreciation rate: 2,5%
- Annual depreciation value (using SLDM): €100 000 x 2,5% = €2 500
- Operating period: 5 years

Table 4: An example of calculating the residual value (in Euro)

Year	Value of an asset at the beginning of period	Annual depreciation value (SLDM)	Cumulative depreciation value	Value of an asset at the end of period
1	100 000	2 500	2 500	97 500
2	97 500	2 500	5 000	95 000
3	95 000	2 500	7 500	92 500
4	92 500	2 500	10 000	90 000
5	90 000	2 500	12 500	87 500

Source: Authors

As shown in the example, the residual value of an asset after 5 operational years was estimated at €87 500.

4.5. Financial indicators

The results of the financial cash flow analysis should be presented in the form of two financial indicators:

- **Financial Net Present Value (FNPV)** – defined as the discounted difference between the revenues plus residual value and the costs of the project. When the indicator has a positive value, then the project is profitable. The NPV indicator can be calculated using the formula:

$$NPV = \sum_{t=0}^{t=n} \frac{CF_t}{(1+i)^t}$$

where:
NPV – net present value,
t – time of the cash flow (year 0, 1, 2, ... year n),
n – total number of years of the reference period,
CFt = net cash flow (revenue + residual value – CAPEX – OPEX) in year t,
i – discount rate.

- **Financial Internal Rate of Return (FIRR)** – defined as the discount rate that produces FNPV indicator equal to zero. If its value is higher than the discount rate applied, then the project is considered financially viable. Thus, FRR is given by the solution of the following equation:

$$0 = \sum_{t=0}^{t=n} \frac{CF_t}{(1+FRR)^t}$$

The assessment of the financial profitability of public projects should not be a decisive element when considering whether to implement or abandon the investment, as public investments usually do not generate any revenues, thus indicators discussed above are often negative. Thus, making a decision to implement the project, despite negative values of the financial indicators, should not be considered exceptional, but the final confirmation of the viability of an investment should be reflected in the economic analysis.

4.6. Project financing and financial sustainability

Sources of funding shall be indicated for the total project cost. The main sources of financing usually are, among others:

- public funds;
- private funds (e.g. private loans or equity);
- grants;
- International Financial Institutions' preferential loans.

If any consultations have been held or initial agreements have been signed with financing institutions, they need to be discussed in the feasibility study.

Financial sustainability should be proven for all projects. The financial sustainability analysis shows how the net financial loss, if occurs, will be covered. If applicable, costs related to debt financing must also be considered when assessing financial sustainability (although they should not be included in the calculation of financial profitability indicators).

Thus, in a workbook attached to the feasibility study, a separate spreadsheet should be prepared where the project's capital, operational and financing costs will be presented for each year of the reference period along with sources of their financing. For instance, part of the costs may be covered by operating revenues, while the rest will require additional funding from the State Budget, e.g., in the form of subsidies or direct transfers. In the sustainability analysis, residual value should not be considered as it does not represent an actual inflow to the budget, unless assets are to be sold in the last year of the analysis. If costs related to debt financing are included, they should be clearly indicated so that it is clear what is the principle and the interest to be paid each year from the State Budget. Some projects may also decrease OPEX compared to the BAU scenario, then the sustainability analysis will reveal savings for the State Budget in a given year, for instance in projects aiming energy efficiency.

5. Economic appraisal

Economic analysis, also called economic appraisal, is the process of evaluating whether a project will benefit society as a whole and contribute to economic growth. It offers a broader approach than financial analysis but is closely related to it and largely builds on it.

5.1. The concept of economic analysis

Most public sector projects are not financially profitable (they often do not generate any financial revenues). However, the justification for their implementation is verified by assessing to what extent they address the needs of society and determining whether the expected benefits exceed economic resources to be allocated.

The economic analysis is conducted in monetary terms. The financial flows used in the financial analysis should be verified and adjusted to economic flows, eliminating significant market distortions. Project costs and benefits for which there are no market prices (e.g. time, health, education) need to be valued.

The following rules should be adopted when carrying out economic analysis:

- the economic analysis, just like financial analysis, should be conducted using the **Differential Cash Flow Method**, comparing 'with-the-project' scenario and the BAU scenario, as well as **Discounted Cash Flow Method**.
- The reference period must be the same as in the financial analysis.
- Just like the financial analysis, the economic analysis should also be conducted in real terms.
- In the economic analysis financial discount rate is replaced with social discount rate (SDR), which should be adopted based on the relevant regulations.
- The conversion of financial cash flows to economic cash flows should be done using methodologies described in Chapter 5.2. of this document and internationally recognized methodologies.
- The effort made to conducting economic appraisal should be proportional to the size of the project. Larger projects require a more in-depth analysis. In the case of smaller projects or minor aspects simplifications are possible, provided that all the decisions and assumptions are well presented and justified.

For the sake of consistency and comparability, a standard social discount rate should be used in all project appraisals. Unless an official SDR is published by the Ministry of Finance, it is recommended to use 5%, based on the European Investment Bank guidelines for projects in non-EU countries.

5.2. From financial to economic analysis

5.2.1. Fiscal transfers

Financial cashflows often contain items that are merely transfers within the national economy and do not represent actual economic costs, i.e. the utilization of resources. Fiscal duties, such as import duties, excises, VAT and other indirect taxes represent such transfers and should be excluded from the economic analysis. Importantly, social insurance payments (i.e., social security, health insurance) should not be excluded as they represent a so-called delayed salary.

5.2.2. From market to shadow prices

Converting market prices into economic or shadow prices becomes necessary when market prices do not accurately represent the opportunity cost of inputs and outputs.

Input prices may be distorted and require adjustments through conversion factors or other methods to reflect the true economic cost of resources. This is often observed in non-efficient markets with a significant influence exerted by the public sector, for instance through energy subsidies. Also, in-kind contributions need to be included in the economic analysis, as they represent a cost to society. For example, when an investor donates a plot of land which could potentially be sold or used for other purposes, it represents an economic cost that should be valued at its opportunity cost.

Conversely, outputs are occasionally provided at no cost or with reduced fees regulated by law, potentially not capturing the true opportunity cost of inputs due to considerations of affordability and equity (e.g., in the case of water or energy sectors). Therefore, evaluating users' willingness-to-pay is essential for establishing an economic price.

Willingness-to-Pay (WtP) is the maximum payment a beneficiary would give up to receive a public service. In principle, in the economic analysis, WtP should replace financial revenues to accurately reflect the value of a service provided. In addition, Willingness-to-Accept (WtA) is the minimum payment someone would accept to live with a nuisance. Estimating WtP and WtA can be a challenging task and should be done when it may have a major impact on the results of economic appraisal. For more information about the methodology of conducting WtP and WtA analyses, please refer to sources presented in Chapter 7. References.

5.2.3. Valuation of project benefits and externalities

As explained above, public investment projects are usually not profitable from a financial point of view. However, they should bring benefits to society that justify their implementation. Therefore, the economic analysis aims to quantify and express in monetary terms economic benefits (and costs) generated by the project which are not captured in the financial appraisal.

Examples of **benefits** that projects may bring to **direct users** of the public infrastructure include: savings on travel time; reduction of the number of accidents; improved reliability of energy supply; increased resilience to current and future disaster risks and climate conditions.

Moreover, projects may also generate impacts falling on **uncompensated third parties**. These impacts are defined as **externalities**. Externalities may be both positive (e.g., noise reduction in the vicinity of a local road due to traffic redirection to a newly built city by-pass.) and negative (e.g., increased noise and air pollution in the vicinity of a new road), understood as economic costs. Also, if the project is expected to significantly increase/reduce Greenhouse Gases (GHG) emissions, this effect should be monetized in the economic analysis. Project benefits and externalities constitute project non-market impacts. In economic appraisal both direct and indirect beneficiaries of the project should be identified and quantified.

Willingness-to-Pay is the preferred but also the most challenging method of valuing project benefits and externalities. When feasible and justified, WtP should be estimated. Alternatively, less complex valuation methods can be applied, using defined or determined values, e.g. Statistical Value of Life (e.g., to monetize the benefit of reducing the number of fatalities in car accidents) or Value of Time (VoT). Estimating the value of non-market impacts can also be done by linking a specific project's impact for which there is no market with an effect occurring on some related market. For instance, reduction of soil pollution may be valued based on the effect on crop production. Furthermore, if similar projects have been implemented either in Montenegro or elsewhere, estimates of economic benefits/costs made for those projects can be used after necessary adjustments (e.g., for GDP per capita, inflation, etc.) for the project in question.

For the sake of comparability of public investment projects, it is essential to use exact same monetary values when estimating economic costs and benefits. Instructions of how to monetize two oft-valued non-market impacts: GHG emissions and VoT are provided below.

Greenhouse Gases emissions

In the absence of an official, nationally established shadow price of carbon (SPC) or a carbon trading system or taxes, project proposers should apply the World Bank's (WB) low estimate of SPC, adjusting the value for the base year using the seasonally-adjusted US Consumer Price Index, in accordance with the approach explained in the WB note.[4]

The emissions should be estimated, converted into CO_2 equivalent (CO_2e) and monetized. This process needs to be done in the following steps:

[4] *Guidance Note on Shadow Price of Carbon in Economic Analysis*, The World Bank, 2024, http://documents.worldbank.org/curated/en/099553203142424068/IDU1c94753bb1819e14c781831215580060675b1.

Estimation of absolute emissions

Absolute emissions are simply GHG emissions generated by the project. Importantly, they may involve both direct emissions (e.g., from burning fuel) or indirect (e.g., from heat or electricity consumption or generated by traffic on a new road).

In the case of a new solar power plant, for example, they might consist of:

Direct emissions, which would include emissions from construction equipment and vehicles used to build the plant. For example, if the construction equipment emits 1,000 metric tons of CO_2 during construction, this is part of the absolute emissions.

Indirect emissions: These could involve emissions from the energy used during the production of solar panels or the operation of maintenance vehicles. For instance, if the manufacturing of solar panels indirectly results in 500 metric tons of CO2, these are also included in the absolute emissions.

Total absolute emissions for the abovementioned project are in this case 1,500 metric tons of CO_2.

Estimation of baseline emissions

Baseline emissions should be understood as emissions in the BAU scenario. However, when calculating baseline emissions, it is key to consider a scenario that meets the project demand. Thus, in the case of an investment that does not replace existing assets but create entirely new ones, the baseline scenario does not mean there are no emissions. For instance, when building a new power plant, the carbon intensity of electricity production in Montenegro for the volume of electricity to be supplemented by the project needs to be considered as a baseline scenario.

*Assuming the solar power plant is expected to produce 100,000 MWh of electricity annually and the current electricity generation mix in the area, which includes coal and natural gas, emits 0.7 metric tons of CO_2 per MWh, calculation of baseline emissions would be the following: 100,000 MWh * 0.7 metric tons CO_2/MWh = 70,000 metric tons CO_2 per year.*

Estimation of relative emissions

Relative emissions mean the difference between absolute emissions and baseline emissions (absolute emissions minus baseline emissions) and thus can be positive or negative.

For the exemplary solar power plant, calculation of relative emissions shall be done the following way: Baseline emissions (70,000 metric tons CO_2) - Absolute emissions (1,500 metric tons CO_2) = 68,500 metric tons CO_2. In this case, the relative emissions are negative (-68,500 metric tons CO_2), indicating that the project results in a net reduction of GHG emissions compared to the BAU scenario.

The methods of calculating emissions will depend on their nature. For instance, in the case of direct emissions, technical specifications of engines should be known, while for emissions *related to electricity consumptions emission factors are needed. If relevant, emissions of GHG other than CO_2 should also be estimated and converted into CO_2e.*[5]

Once the volume of emissions is determined, relative emissions need to be monetized using the WB SPC and included in the economic analysis as an either positive or negative externality.

Value of Time

In the absence of a nationally determined VoT, based on the estimate of Willingness-to-Pay, a simplified approach can be adopted. The average monthly gross salary in Montenegro, derived from official statistics, can be divided by 168 (representing the number of working hours per month). This will yield average gross hourly rate. 100% of the obtained value may be assumed to represent the value of time for business-related travels, 35% for commuting and 25% for leisure.

Calculating the VoT saved necessitates conducting surveys or making realistic and justified assumptions regarding the relative share of each type of travel (business, commuting, leisure). It is also necessary to estimate the average number of passengers in a given type of a vehicle (passenger cars, buses), if not yet done in demand analysis.

Time savings may also be included in non-transport related projects, if this is the case, 100% average gross hourly rate shall be used in calculations.

5.3. Results of the economic analysis

After quantifying and assigning monetary values to all project costs and benefits, the economic performance of the project can be assessed using the following indicators:

- **Economic Net Present Value (ENPV)** is the difference between the discounted total social benefits and costs.
- **Economic Internal Rate of Return (EIRR)** is the discount rate that produces a zero value for the ENPV.

In principle, any project with an EIRR lower than the social discount rate or a negative ENPV should be declined. A project with a negative economic return utilizes socially valuable resources excessively, yielding meagre benefits for the broader population.

Although a positive ENPV is typically considered essential, it may not be sufficient for a favourable appraisal decision on its own. There are exceptions where a project with a slightly negative ENPV could still receive approval due to significant advantages for vulnerable societal groups or important environmental benefits that are challenging to monetize. Conversely, a

[5] Conversion factors and emission factors for various types of fuel and energy sources can be found in *EIB Project Carbon Footprint Methodologies*, European Investment Bank, 2023.

project with a slightly positive ENPV might be advised against if it has substantial unmonetized negative impacts or if it is highly sensitive to changes in the estimated costs and benefits, as indicated by sensitivity analysis.

5.4. Non-monetizable benefits and costs

Benefits and externalities (both positive and negative) of the project that cannot be expressed in monetary terms, should always be described qualitatively and, when possible, quantitatively.

Case study: Enhancing energy efficiency in public buildings

In 2015, the City Hall of City Y, a 5,000 m² municipal building constructed in the 1970s, was identified as one of the least energy-efficient public buildings in the city. An energy audit revealed:

- *High heat loss due to poor insulation, causing excessive heating costs,*
- *Outdated heating, ventilation, and air conditioning systems, leading to inefficient energy use and inconsistent indoor temperatures,*
- *Inefficient lighting, with traditional fluorescent fixtures consuming unnecessary electricity,*
- *Lack of smart energy management, resulting in unoptimized heating, cooling, and lighting schedules.*

To address these issues, the city implemented a comprehensive building retrofit in 2018, which included:

- *Installing high-performance insulation on walls and roofs, reducing heat loss by 30%,*
- *Replacing old windows with triple-glazed energy-efficient ones, improving indoor comfort and further minimizing heat loss,*
- *Upgrading the heating, ventilation, and air conditioning system to a smart, automated system with energy recovery, reducing energy consumption for heating and cooling by 25%,*
- *Switching to LED lighting and integrating motion sensors, cutting electricity use for lighting by 50%,*
- *Implementing a smart energy management system, optimizing energy usage based on occupancy and weather conditions.*

*By 2020, the City Hall's energy consumption had dropped by **35%,** leading to annual savings of approximately **€40,000** on utility bills. Additionally, CO_2 emissions were reduced by 90 tons per year, contributing to the city's broader climate goals.*

Beyond cost savings (captured in the financial analysis) and GHG emissions reductions (included in the economic analysis), the improvements also enhanced indoor air quality and comfort for employees and visitors, leading to increased productivity and satisfaction. Such benefits may be difficult to monetize but if they do not significantly impact project economic indicators, it is enough to describe them qualitatively in the FS.

6. Sensitivity and Risk analyses

Uncertainty is an inherent aspect of any investment project. The quantified economic analysis is not complete without a systematic analysis of the risks behind a project and an assessment of their likelihood and impact. Therefore, it is necessary to consider the potential impact of deviations from the assumptions and the occurrence of unpredicted events. This exercise consists of two elements: **sensitivity analysis** and **risk analysis**.

6.1. Sensitivity analysis

Sensitivity analysis aims at identifying key parameters, like capital expenditures or future demand for products/services, changes in which would have the largest impact on financial and economic indicators of the project (especially FNPV and ENPV).

The identification of these variables is done by varying only one parameter at a time and determining the effect of that variation on the performance of the project. If a 1% change in a given parameter leads to at least a 1% change in the FNPV/ENPV, then that variable can be considered as ‘critical’ to project’s success and therefore should be managed more carefully and be subject to an in-depth analysis.

The parameters that are to be analysed in the sensitivity analysis should be selected considering the specificity of a particular project, its sector and target users.

Examples of variables that may be analysed as a part of conducting the sensitivity analysis:

- macroeconomic indicators (e.g. inflation rate),
- capital expenditures,
- forecast future demand (e.g. for products/services, forecast traffic intensity),
- prices of the products/services offered,
- unit prices of the main categories of operating costs (e.g. energy prices),
- unit values of assumed economic benefits, externalities, non-market impacts (e.g. value of time, emission costs).

It is important to remember that in practice those variables are sometimes interdependent or subject to systemic estimation biases, thus conducting several scenario analyses, in which multiple key parameters are changed at the same time, is recommended to properly test the sensitivity of financial and economic indicators.

The results of the sensitivity analysis should be presented in a table, as in the example below.

Table 5: Exemplary table with the results of the sensitivity analysis – critical variables (EUR)

	FNPV	FRR	ENPV	ERR	NPV change	ENPV change
Base Value	-116 601 572	-	53 030 948	12,48%	-	-
Change in CAPEX by -1%	-115 737 415	-	53 590 781	12,72%	0,74%	1,06%
Change in CAPEX by +1%	-117 465 728	-	52 471 116	12,26%	-0,74%	-1,06%
Change in OPEX by -1%	-116 510 456	-	53 113 592	12,50%	0,08%	0,16%
Change in OPEX by +1%	-116 692 687	-	52 948 304	12,46%	-0,08%	-0,16%

Source: authors

Table 6: Exemplary table with the results of the sensitivity analysis (EUR)

	FNPV	FRR	ENPV	ERR	NPV change	ENPV change
Base Value	-116 601 572	-	53 030 948	12,48%		
Change in CAPEX by +5%	-120 922 352	-	50 231 787	11,41%	-3,71%	-5,28%
Change in CAPEX by +10%	-125 243 133	-	47 432 627	10,47%	-7,41%	-10,56%
Change in CAPEX by +20%	-133 884 694	-	41 834 305	8,89%	-14,82%	-21,11%
Change in OPEX by +5%	-117 057 148	-	52 617 728	12,39%	-0,39%	-0,78%
Change in OPEX by +10%	-117 512 724	-	52 204 508	12,30%	-0,78%	-1,56%
Change in OPEX by +20%	-118 423 877	-	51 378 067	12,12%	-1,56%	-3,12%

Source: authors

As can be seen in Tables 5 and 6, CAPEX is a critical variable as a 1% change in it leads to more than a 1% change in ENPV. However, it can be noticed that even if CAPEX increases by 20% the project remains economically viable. A discussion and interpretation of the results of the sensitivity analysis should be provided in the feasibility study.

6.2. Identification of main sources of risk and assessment of impacts

A risk refers to an event or circumstance that, if it occurs, can negatively impact the project. Risks emerge from uncertainties inherently related to crucial project aspects such as e.g., investment and operational costs, implementation timeline or demand.

Materialization of risks poses the danger of failing to:

- keep within the project budget;
- achieve the required project completion date;
- meet required design specifications; and
- achieve the project objectives.

It is recommended to prepare the risk analysis for a project in the following steps:

- risk identification and assessment,
- selection of risk prevention and mitigation measures,
- determination of residual risk levels,
- climate and disaster risk assessment and selection of adaptation measures,

- incorporation of the results of the climate and disaster risk assessment into the risk analysis.

The first step is the identification of risks, which can be classified into the following categories:

- **Construction risk** (e.g. investment is not completed on time, within a budget or according to specifications);
- **Future demand risk** (i.e. demand for products/services offered does not meet forecasts);
- **Design risk** (e.g. design does not deliver services at the required performance or quality standards);
- **Economic risk** (e.g. benefits or costs of a project are affected by external factors like inflation rate or exchange rate fluctuations);
- **Environmental risk** (e.g. negative impact of a project on the environment – impact on air pollution, noise, climate change);
- **Funding risk** (e.g. when the availability of funding changes and delays the implementation of a project or changes its scope);
- **Political and legislative risks** (e.g. changes in legislation, like tightening of environmental standards, increase costs of a project; policy changes; administrative changes);
- **Operation and maintenance risk** (e.g. operating costs of newly built infrastructure differ from the planned budget);
- **Procurement risk** (e.g. contractual disputes or a shortfall in contractors' capacities);
- **Technological risk** (e.g. when services are provided using non-optimal/out-of-date technology due to rapid technological advancement);
- **Climate change risk** (e.g. when project can be affected by any climate-change-induced hazards during the investment or operating phase);
- **Disaster risk** (e.g. when project can be affected by any natural hazards during the investment or operating phase);
- **Socio-economic, equality/gender, minority/vulnerable groups risks** (e.g. discriminatory reasons, affordability issues, public opposition, inadequate communication between actors involved in a project).

Risks can arise at various stages throughout a project's lifecycle, making comprehensive risk identification essential. It is important to assess potential risks across all phases of the project to ensure effective management. When describing the possible impacts of a given risk (see Table 7), it should be clearly specified which stage of the project may be affected.

The second step is **risk assessment**. For each identified risk the likelihood of occurrence and the severity of its potential impact need to be determined.[6]

Determination of the likelihood of occurrence can be done by assigning a number between 1 and 5, where:

- 1 – **very unlikely** (0–10 % probability),
- 2 – **unlikely** (11–33 % probability),
- 3 – **about as likely as not** (34–66 % probability),
- 4 – **likely** (67–90 % probability),
- 5 – **very likely** (91–100 % probability).

Estimation of the severity of impact of each individual risk can also be done by assigning a number between 1 and 5, where:

- 1 – **insignificant** (no relevant effect on social welfare, even without remedial actions);
- 2 – **minor** (minor loss of the social welfare generated by the project, minimally affecting the project long run effects. However, remedial or corrective actions are needed);
- 3 – **moderate** (social welfare loss generated by the project, mostly financial damage, even in the medium-long run. Remedial actions may correct the problem);
- 4 – **critical** (high social welfare loss generated by the project; the occurrence of the risk causes a loss of the primary function(s) of the project. Remedial actions, even large in scope, are not enough to avoid serious damage);
- 5 – **catastrophic** (project failure that may result in serious or even total loss of the project functions. Main project effects in the medium-long term do not materialize).

Based on this activity, it is possible to determine a risk level for each identified risk, according to the classification presented in the table below.

Table 7: Risks levels

		Severity of impact				
		insignificant	minor	moderate	critical	catastrophic
Likelihood of occurrence	very unlikely	low	low	low	low	medium
	unlikely	low	low	medium	medium	high
	about as likely as not	low	medium	medium	high	High
	likely	low	medium	high	very high	very high
	very likely	medium	high	very high	very high	very high

Source: Guide to Cost-Benefit Analysis of Investment Projects, European Commission, 2014

[6] The approach, including the classifications of probabilities and risk severity, is based on the *Guide to Cost-Benefit Analysis of Investment Projects*, European Commission, 2014.

All risks must be presented in a way clearly indicating the severity of impact, likelihood of occurrence and an overall risk level for each individual risk. Risks should be presented as in the exemplary table below.

Table 8: Risk table

Name of risk	Causes of occurrence	Effects of occurrence	Likelihood	Impact	Risk level
Risk 1	[description]	[description]	2	3	medium
Risk 2	[description]	[description]	5	4	very high
Risk 3	[description]	[description]	3	5	high

Source: Authors

6.3. Risk management and risk reduction

Following the identification and assessment of risks, prevention and mitigation measures need be to chosen.[7] Each risk assessed as being above a low level needs to be addressed, taking into account trade-offs between additional costs associated with considered measures and their impact on the risk level.

Possible risk management responses include:

- Identifying immediate preventive measures to remove or reduce a risk, e.g.:
    - Phased implementation;
    - More flexible design; or
    - Less reliance on leading-edge or unproven technologies.
- Establishing contingency plans to deal with risks if they occur and minimize their consequences.
- Initiating further investigations to reduce uncertainty through better information, e.g., pilot projects, more site investigations.
- Avoiding irreversible decisions and/or adopting the precautionary principle with respect to unlikely, but catastrophic, events.
- Considering transferring risk to other parties, e.g., through choice of procurement method and contract design.
- Accepting the risk if the expected benefits from taking the risk outweigh the potential negative impacts (and no other courses of action seem feasible).
- Abandoning the project, because it is too risky.

[7] Mitigation means reducing the severity of a potential impact, while prevention refers to the reduction of the probability of occurrence.

Residual risk, remaining after implementing risk mitigation/prevention measures, should also be assessed. Risk management also involves designating a party that will be responsible for managing each individual risk (e.g., line ministry, IT provider, facility operator etc., there also may be shared responsibility for a given risk).

A table presenting each risk with its initial risk level, the responsible party, mitigation/prevention measures and the assessment of the residual risk, including the likelihood of occurrence and potential impact should be prepared. Risk mitigation/prevention measures must be justified. Also, it must be proven that residual risks are at an acceptable level. What constitutes an ‘acceptable risk level’ is project-specific as it depends on the scale of the project, its urgency, consequences of non-implementation and risk appetite of the competent authority. Nevertheless, the feasibility study should justify the adopted risk tolerance level.

Table 9: Risk management and residual risk table

Name of risk	Risk level	Responsible party	Prevention / mitigation measures	Likelihood	Impact	Residual risk level
Risk 1	medium	[institution]	[description]	1	2	low
Risk 2	very high	[institution]	[description]	3	3	medium
Risk 3	high	[institution]	[description]	3	1	low

Source: Authors

6.4. Climate and disaster risk analysis

Uncertainties and complexities associated with climate change and the severity of threat posed by climate-induced hazards as well as by natural and man-made disasters necessitate conducting a separate climate and disaster risk analysis (CDRA). The results of the analysis should be incorporated into the risk analysis presented in the feasibility study. CDRA follows the same logic as the general risk analysis, discussed above. Thus, only the aspects specific to the CDRA have been presented below.

6.4.1. Data sources

In order to conduct a valuable CDRA, appraisers need to begin with the identification of reliable data sources. Generally, local and national data sources are preferable. These may include:

- Municipal or local adaptation plans;
- Local and national meteorological and climate data;
- Disaster risk databases, plans and maps (e.g., flood risk maps, seismic maps);

- Disaster Risk Reduction Strategies;
- National Adaptation Plans and climate change strategies;
- Consultations with stakeholders, including local populations, regarding past disaster and climate related events.

When those sources are not available or sufficient, others can be considered:

- Copernicus Climate Change Service;
- Disaster Risk Management Knowledge Centre;
- Global Climate Monitor;
- Notre Dame Global Adaptation Initiative;
- IPCC Data Distribution Centre;
- ThinkHazard!;
- World Bank Climate Change Knowledge Portal.

6.4.2. Methodology of climate risk analysis

The recommended approach to conducting a CDRA to be presented in the feasibility study consists of two phases: **screening** and **detailed analysis**.[8]

Screening

Screening is an initial step, aiming to identify specific climate and disaster-related hazards that the project may be vulnerable to. This is conceived as a two-step activity. First, the **exposure** of the project location to climate and disaster hazards needs to be determined, regardless of the project type. It is important to consider both (1) the current situation and (2) exposure to the future climate conditions in a given location, based on climate projections.

Second, the **sensitivity** of the project needs to be analysed, i.e. all climate and disaster hazards relevant to the type of a particular project should be identified, irrespective of its location. When analysing the climate and disaster sensitivity of the project, appraisers should focus not only on its structural/physical resilience, but also consider the impact of future climate conditions on the project performance. For instance, decreasing water levels may negatively affect generation capacity of a water power plant so that the expected benefits will not be achieved. Both in the exposure and sensitivity analyses it is crucial to consider not only immediate, catastrophic impacts (such as wildfires or floods) but also slow-onset hazards (e.g., water scarcity or high mean temperatures).

[8] The approach recommended in this document is based on *Technical guidance on the climate proofing of infrastructure in the period 2021-2027*, European Commission, 2021.

Both aspects – **sensitivity of the project type** and **exposure of the project location** – can be assessed using a three-grade scale: **low, medium** and **high**. As a result, a risk matrix presenting all potential climate and disaster risks to the project can be prepared.

Table 10: Example of a risk matrix based on the results of a climate and disaster risk screening

		Exposure		
		High	Medium	Low
Sensitivity	High	Flood	Temperature increase	
	Medium		Rainfall intensity	
	Low			Drought

Overall risk level	High	Medium	Low

Source: Authors, based on Technical guidance on the climate proofing of infrastructure in the period 2021-2027*, European Commission, 2021*

If the screening reveals the existence of hazards with a high or medium overall risk level, appraisers should then proceed to the second step of the CDRA, i.e. a **detailed climate and disaster risk analysis**.

<u>Detailed climate and disaster risk analysis</u>

The second phase of the CDRA follows the logic of the general risk analysis.

Each climate and disaster-related hazard with the medium or high overall risk level (as identified in the first step) needs to be assessed with regard to two aspects:

- **Likelihood of occurrence** of a given risk within the lifetime of the project; the same classification of probabilities (a 5-grade scale from 1 to 5) as in the general risk analysis can be used. Probabilities should be considered throughout the whole lifecycle of the project; it is recommended to use the intermediate future climate scenario SSP2-4.5, assuming temperatures rise by 2.7C by the end of the century.[9]
- **Severity of impact** which refers to the consequences resulting from a given climate or disaster risk occurrence, while consequences may relate to (i) damages to physical assets (which can be divided into immediate ones, resulting from catastrophic events, such as floods, and those that lead to faster wear and tear of fixed assets, which increases maintenance and repair costs) and (ii) losses of benefits (e.g., due to reduced electricity generation capacity of a water power plant). The same 5-grade scale as in the general risk analysis is recommended to be used for assessing the potential impacts of climate and disaster risks.

The results of the likelihood and impact analyses are to be combined, so that an overall risk level (low, medium, high or very high) can be determined for each hazard.

[9] *Climate Change 2021: The Physical Science Basis*, Intergovernmental Panel on Climate Change, 2021.

As mentioned above, the results of the CDRA need to be incorporated into the risk analysis presented in the feasibility study document. If screening does not reveal any specific climate or disaster risks relevant to the project, a brief description of the screening results in the risk analysis section is sufficient. It should be clear what climate and disaster hazards have been considered based on the project type and its location and why they have been assessed as low in terms of the overall risk level.

In addition to this description of low-level climate and disaster risks, each hazard that has been subject to the detailed CDRA needs to be separately included in the risk table and treated in the same way as any other risk factor.

6.4.3. Selection of adaptation measures

Based on the results of the CDRA, appraisers should consider whether any adaptation measures need to be adopted. This process involves three steps:

- identification of adaptation options addressing the identified risks;
- evaluation of the identified options;
- adaptation planning which includes integrating the selected options into the project design and/or its operation.

Adaptation measures can be divided into:

structural solutions, e.g.:

- modifying the design,
- adjusting the specification of physical assets; and

non-structural measures, e.g.:

- change of location,
- land-use planning,
- improved monitoring or emergency response programmes,
- staff training and skills transfer activities,
- financial solutions such as insurance, including parametric insurance,
- contingency plans.

A decision which adaptation option(s) should be chosen must be preceded by a consideration of pros and cons associated with each solution. When the project is not prone to significant climate and disaster risks and the considered adaptation options would not have a substantial impact on the project cost, an expert judgement may be sufficient to select the solution that best addresses the risk(s).

However, if the detailed CDRA has revealed that

- climate or disaster risks may significantly affect the project; and/or
- relevant adaptation measures are expensive or difficult to implement,

a more detailed analysis may be necessary. In such a case, additional project variants may be developed to compare the costs and benefits of the adaptation measures considered. These variants may be based both on strategic options (e.g. project location) or technological solutions (e.g. road surface technology) and need to be presented in the options analysis section of the feasibility study document.

Furthermore, in the case of particularly large/complex projects, such climate-informed project variants may be subject to a quantitative CBA, with the valuation of financial and economic costs resulting from the materialization of climate or disaster risks. Such calculations should take into account the annual probability of risk occurrence (e.g. flooding) and associated costs, in terms of both damages to physical structures and losses of socio-economic benefits. Although it is a challenging task, it may be necessary to justify the choice of a more costly variant that includes climate and disaster risk reduction measures. The selected adaptation measures should reduce the remaining risks to an acceptable level and be presented in the risk management and residual risk table. Importantly, if the adaptation measures form a basis for creating additional project variants, it is crucial to ensure that the options analysis is consistent with information provided in the risk analysis part of the feasibility study.

If the selected adaptation measures reduce risks to health and property damage compared with the current situation, such conclusions should be incorporated into relevant sections of the CPAF to inform project evaluation.

Case study: Enhancing public safety through flood protection investments

In 2001, City X, with an estimated population of 150,000 residents, experienced a devastating flash flood caused by an extreme rainfall. The event resulted in severe damage to infrastructure, disruption of daily life, and loss of life. Post-disaster assessments identified the following key impacts:

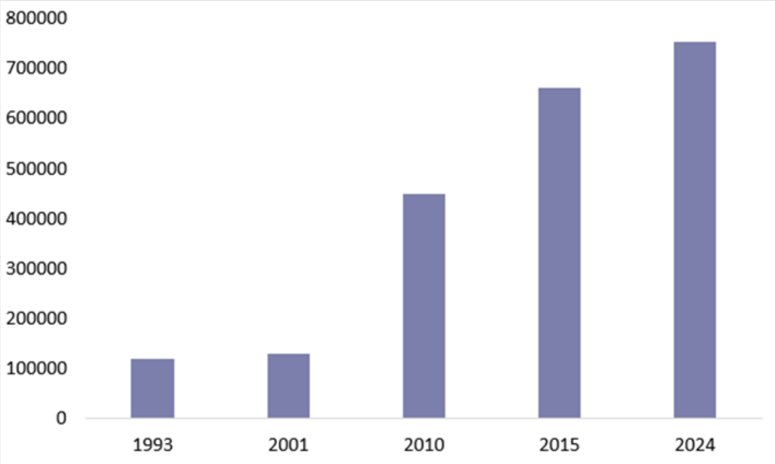
- *Four fatalities due to flood-related stress (cardiac arrests),*
- *€50 million in damages to public property,*
- *206 families directly affected by flooding,*
- *123 buildings declared unsafe and subsequently demolished.*

In response to this disaster, the city authorities initiated a comprehensive flood protection program aimed at mitigating future risks and enhancing resilience. The key measures implemented included:

- *Construction and modernization of 25 retention basins, increasing total retention capacity to 500,000 m^3,*
- *Expansion of a key reservoir, increasing its capacity from 20,000 m^3 to 124,000 m^3,*
- *Upgrading and expanding drainage channels, improving water flow and flood management capacity.*

By 2021, City X had invested over €250 million in flood protection infrastructure, further increasing retention capacity by an additional 600,000 m³ and significantly expanding the stormwater management system.

Retention reservoirs capacity (m³) between 1993-2024 is presented in the graph below:



The effectiveness of the implemented measures was demonstrated in 2022, when another extreme rainfall event occurred. Unlike the 2001 flood, the impact was substantially mitigated due to the enhanced flood management system:

- *Property damage was reduced from €50 million to €5 million,*
- *No fatalities were recorded,*
- *Only 11 families experienced flood-related disruptions.*

The newly constructed retention reservoirs successfully absorbed excess water, while the upgraded drainage infrastructure efficiently directed floodwaters to designated discharge points, preventing large-scale damage.

The flood protection project in City X has significantly contributed to eliminating health, safety, and property risks by reducing fatalities, preventing large-scale damage, and improving urban resilience to extreme weather events.

7. References

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