Green FORCE

FOSTER RESEARCH EXCELLENCE FOR GREEN TRANSITION IN THE WESTERN BALKANS
PROJECT 101059411

International Summer School
Cities in Just Green Transitions
Towards a 2030 climate-neutral strategy for Turin
18-22 September 2023

Cost-Benefit Analysis (CBA)

An Approach to Measure Just Green Transition

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Cost-Benefit Analysis (CBA)

An Approach to Measure Just Green Transition

1. Why CBAs?
2. What is the CBA?
3. How to do a CBA?
4. Sensitivity and risk analysis

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1. Why CBAs?

- Cities in **JUST GREEN TRANSITION**
- 194 Parties (193 States plus the European Union) have joined the Paris Agreement on climate change;
- All interventions require, among others, **financial resources**.
- With limited resources, decision-makers are left with the difficult problem of **evaluating and choosing investment projects and assessing policies** in a context of significant complexity and uncertainty.
- For this purpose, decision-makers need a **framework that structures information** in a way that makes this evaluation and selection process feasible and transparent.

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1. Why CBAs?

- For any given project (or policy) we might want to know: **is this a good project or policy**?
- For any given group of project (or policies) we might want to know: **which project or policy is better**?
- Given a set of options all achieving a given objective, we might want to know: **which of these options is better**?
- However, **good or better for whom**: for the project proponent, for the government or the society?
- **How do we measure the good or better**: for the project proponent's profit, for the government's public finances or society's welfare?

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2. What is the CBA?

- A study describing all relevant **financial, economic, environmental, societal, technical and institutional/legal** impacts of a project on society.
- A method to **quantify** and **monetise** advantages and disadvantages of decisions/projects that are proposed (ex-ante analysis or as broadly used – project appraisal).
- Serves as an **organising framework** for stakeholders to discuss the various positive and negative aspects of projects or policies).

TOOL FOR INFORMED DECISION MAKING

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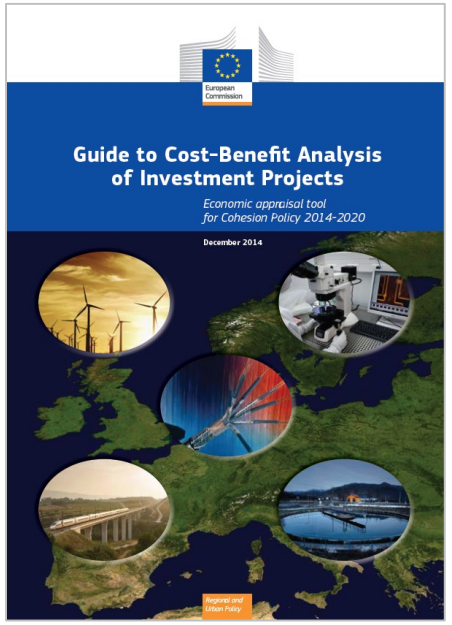
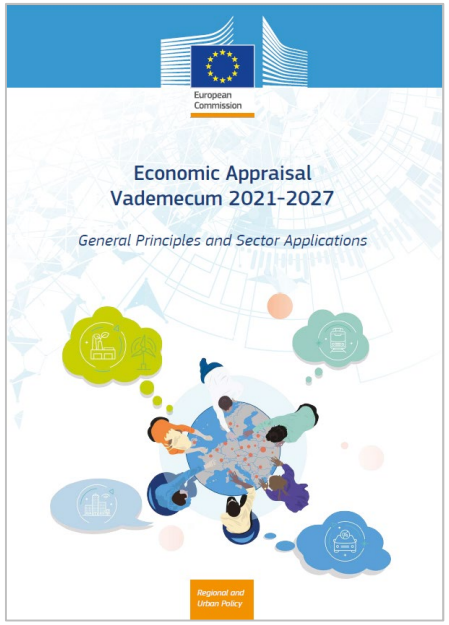
2. How to do a CBA?





Sartori, D., Catalano, G., Genco, M., Pancotti, C., Sirtori, E., Vignetti, S., & Del Bo, C. (2015). Guide to Cost-Benefit Analysis of Investment Projects Economic appraisal tool for Cohesion Policy 2014-2020. Brussels: European Commission Directorate-General for Regional and Urban Policy. doi:doi:10.2776/97516

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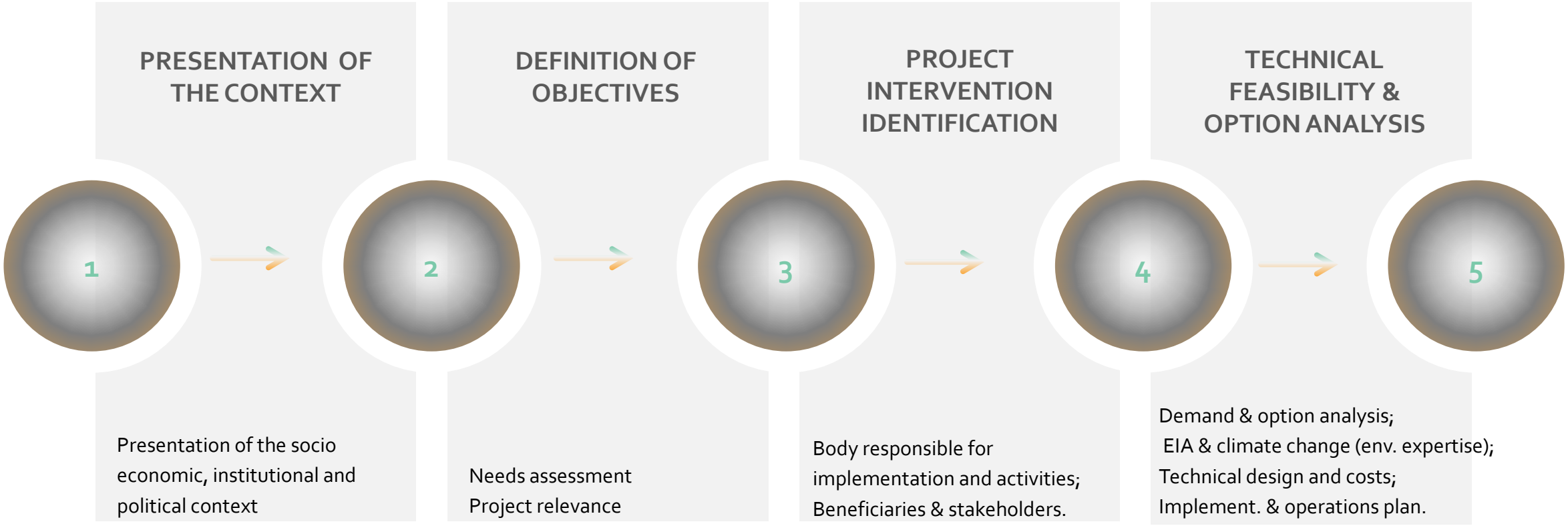

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FINANCIAL ANALYSIS

5

Cash flow for project costs and revenues, including residual value;
Tariff and affordability analysis (where applicable);
Sources of financing;
Financial profitability & sustainability.

5A

FNPV > 0

The project **does not** require financial support (unless adequate justification is provided).

5B

FNPV < 0

The project **does** require financial support

6

ECONOMIC ANALYSIS CBA

Fiscal corrections;
From market to shadow pricing;
Evaluation of non-market impacts and externalities;
Economic viability.

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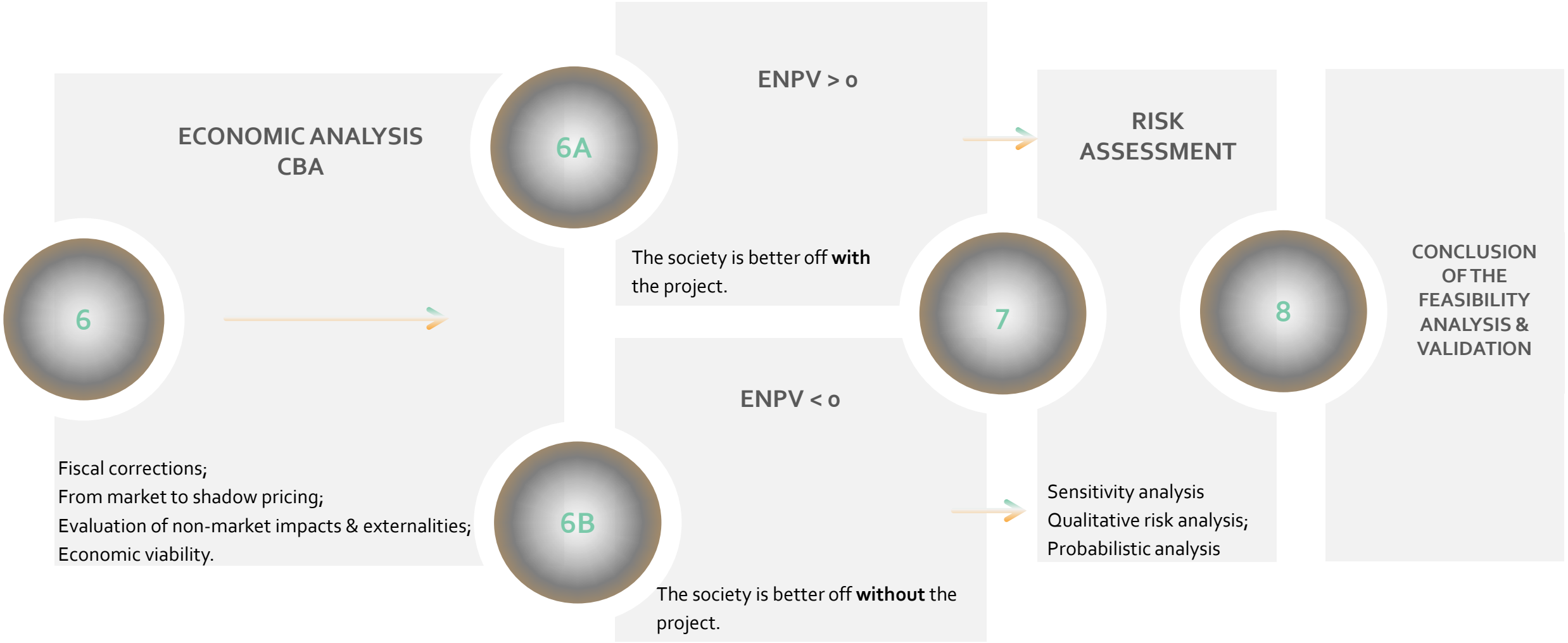

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For the Green Climate Fund, all projects must conduct an economic analysis.

If the project includes activities that generate revenues (like water supply systems, wastewater treatment, waste management or others), then a financial analysis must also be conducted.

In some cases, it is not possible to start with pre-feasibility, feasibility and move to CBA:

- Human resources;
- Financial resources
- Time (sometimes decisions must be taken quickly!).

Simplified CBA:

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Simplified CBA:

A. **The context**, the **project**, the **objective** and the description of the **methodology** used in the analysis;

B. ***Identification of the outcomes*** (positive and/or negative) deriving from project implementation, combining information from desk review, technical project, expert judgement and international practice;

C. ***Quantification and monetisation*** of outcomes regarding costs and benefits from project implementation (when possible, conditional on data availability and/or benchmarks).

D. ***Assessment of net impacts***, as the difference between the "with the project" versus "without the project" scenarios (the counterfactual). The counterfactual (without the project scenario) considers the amount of change that might have happened, regardless of the intervention. This approach captures the "net change" that can be explicitly attributed to the proposed intervention.

E. ***Assessment of cost and benefits behaviour over the reference period*** – assess how costs and benefits will change in time (using average growth rates, trends when available or introducing assumptions);

F. ***Discounting of costs and benefits*** to obtain present values – convert future costs and benefits into present value using a social discount rate;

G. ***Computation of economic performance indicators***: the net present value (NPV), the internal rate of return (IRR) and the benefits-to-costs ratio (BCR).

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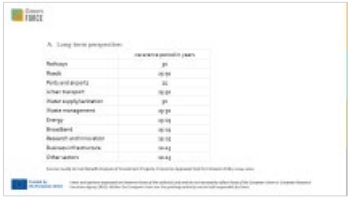
Underlying concepts for the CBA analytical framework:

A. Long-term perspective, ranging from a minimum of 10 to a maximum of 30 years or more, depending on the intervention sector.

B. Incremental approach – comparison of a scenario with the project vs. a counterfactual scenario without the project/do minimum scenario;

C. Move from assessment with market prices in the financial feasibility to shadow pricing/opportunity costs in CBAs – the potential gain from the best alternative foregone when a choice needs to be made between mutually exclusive alternatives), accounting for non-market impacts and externalities.

D. Calculation of economic performance indicators using the discounted cash flow method.



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A. Long-term perspective:

	Reference period in years
Railways	30
Roads	25-30
Ports and airports	25
Urban transport	25-30
Water supply/sanitation	30
Waste management	25-30
Energy	15-25
Broadband	15-25
Research and Innovation	15-25
Business infrastructure	10-15
Other sectors	10-15

Source: Guide to Cost Benefit Analysis of Investment Projects. Economic Appraisal Tool for Cohesion Policy 2014-2020

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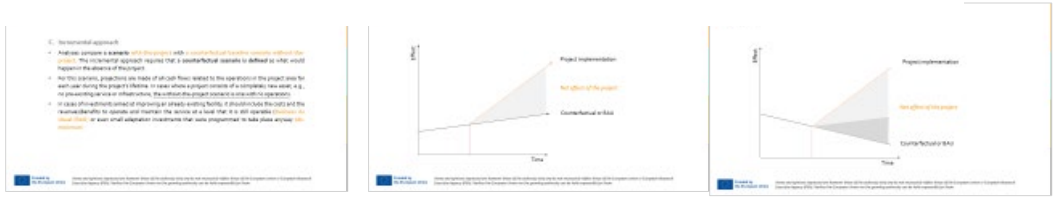

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C. Incremental approach

- Analyses compare a **scenario** with-the-project with a counterfactual baseline scenario without-the-project. The incremental approach requires that a **counterfactual scenario is defined** as what would happen in the absence of the project.
- For this scenario, projections are made of all cash flows related to the operations in the project area for each year during the project's lifetime. In cases where a project consists of a completely new asset, e.g., no pre-existing service or infrastructure, the without-the-project scenario is one with no operations.
- In cases of investments aimed at improving an already existing facility, it should include the costs and the revenues/benefits to operate and maintain the service at a level that it is still operable (**Business As Usual (BAU)** or even small adaptation investments that were programmed to take place anyway **(do-minimum)**.

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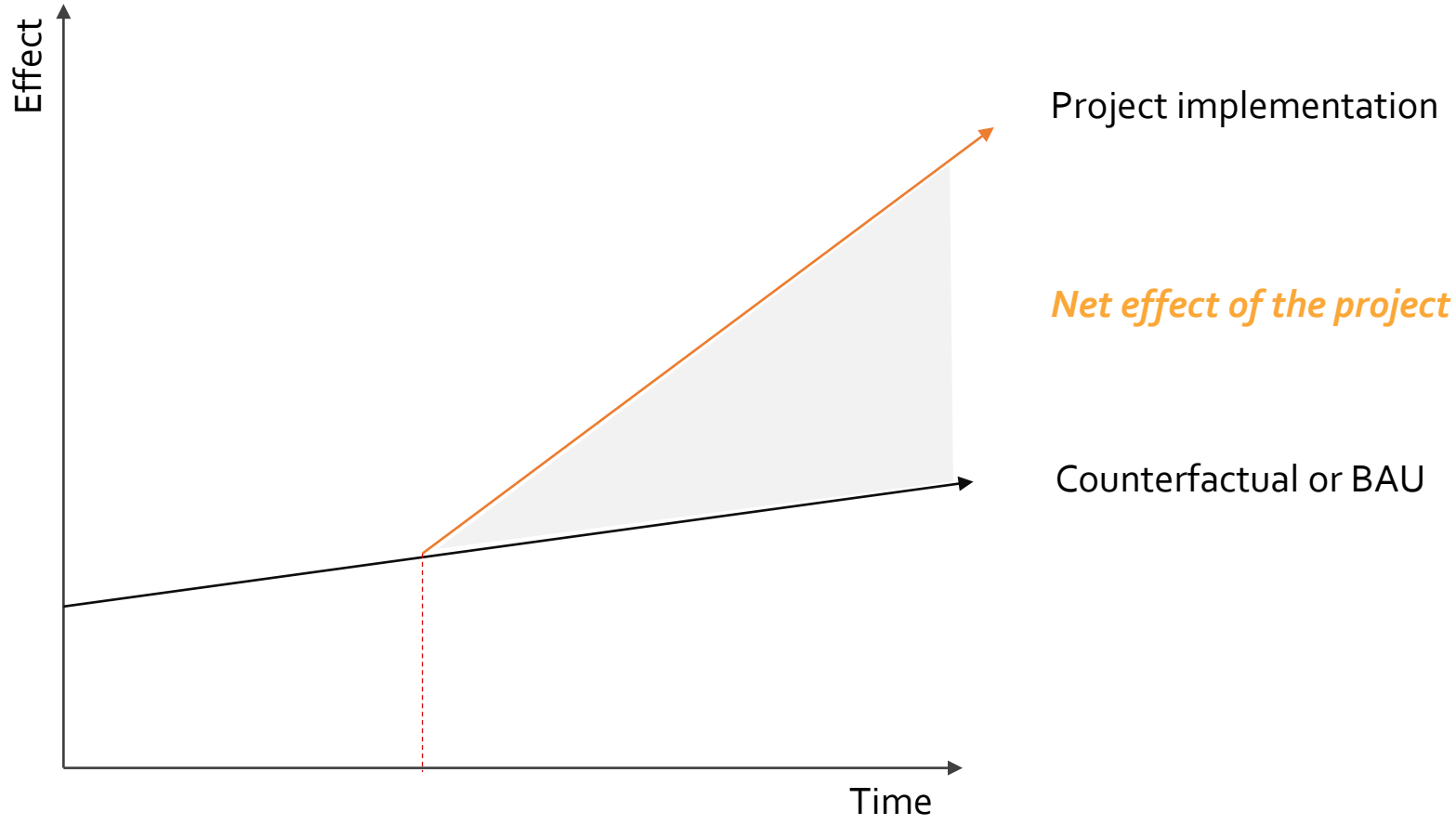

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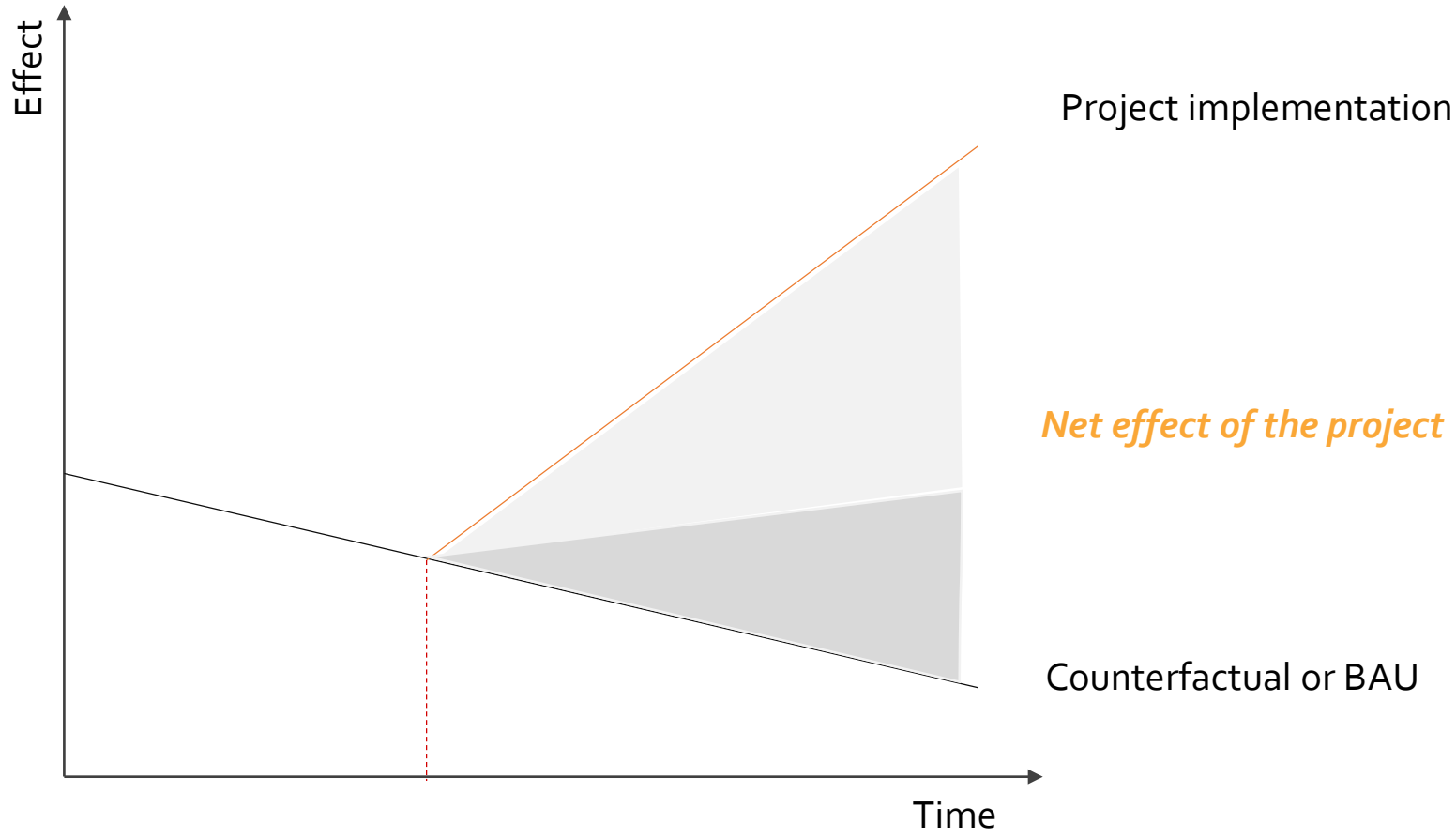

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D. Calculation of economic performance indicators using the discounted cash flow method.

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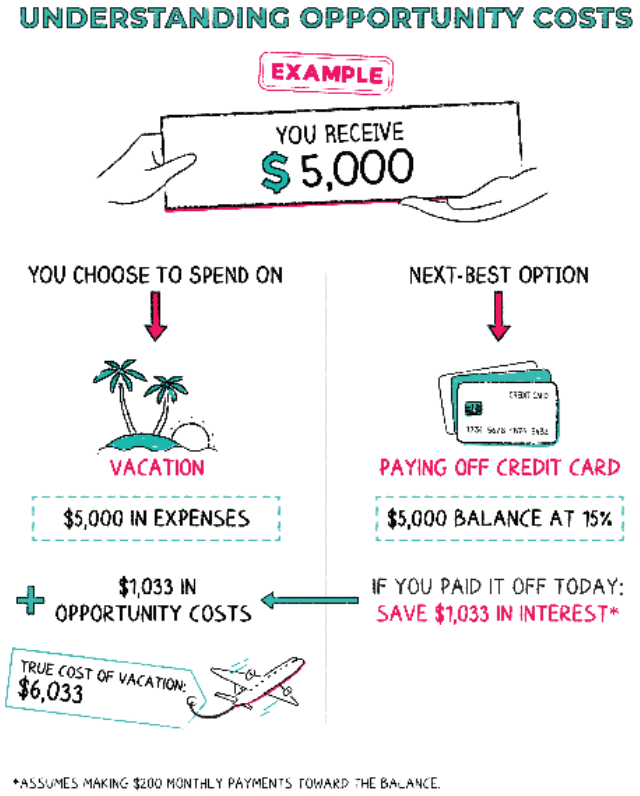
C. Market prices and opportunity costs

- In feasibility studies use **market prices;**
- In **CBA, opportunity costs/shadow prices** are used since market distortions exist.

  The opportunity cost of a good or service is defined as the potential gain from the best alternative forgone when a choice needs to be made between several mutually exclusive alternatives.

  Opportunity costs are benefits that could have been realised when choosing one alternative over another.

  In other words, the opportunity cost is the forgone or missed opportunity resulting from a choice or decision.



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D. Calculation of economic performance indicators using the discounted cash flow method.

- …the Economic Net Present Value (ENPV);
- …the Economic Rate of Return (ERR);
- …the Benefit to Costs Ratio (B/C ratio) .

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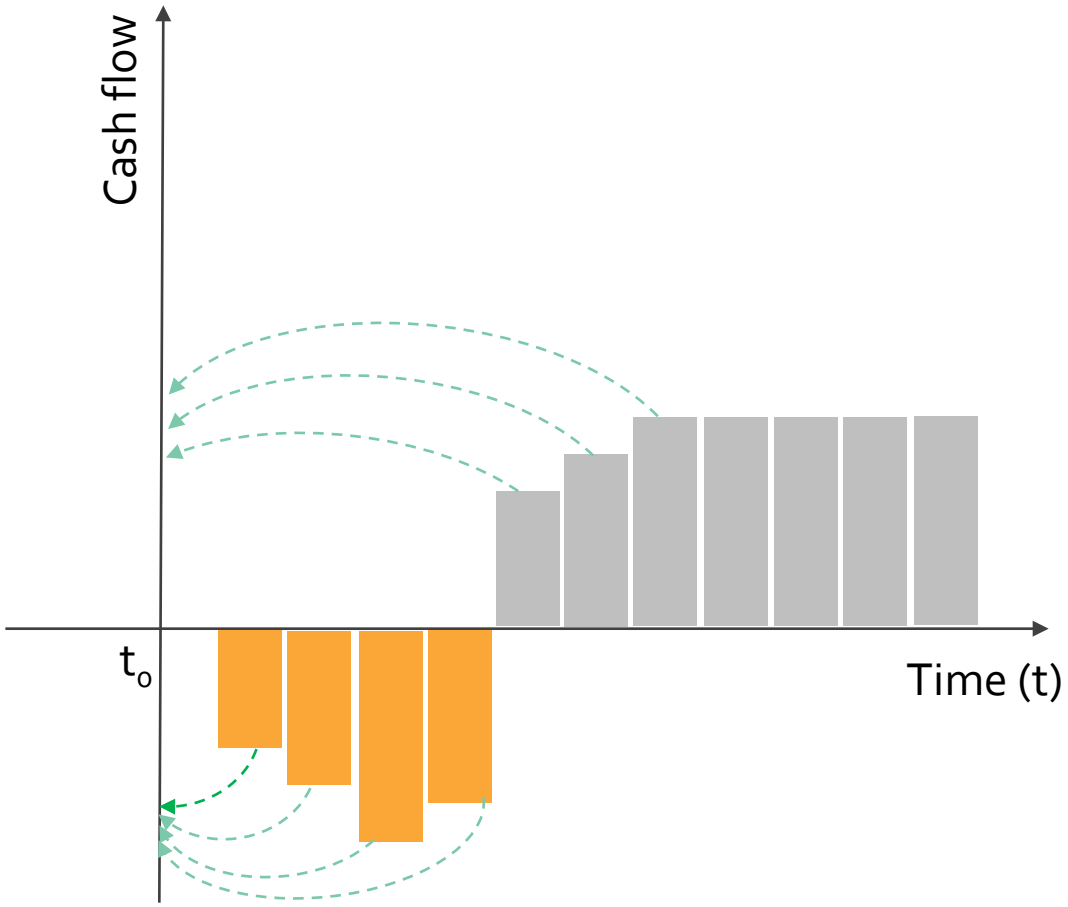

Discounted cash flow method:

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The discount rate:

The interest rate is used to determine the present value of future cash flows (in the DCF method).

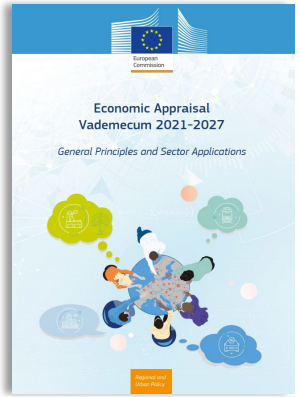
- In financial analysis, use **financial discount rate** (like Weighted Average Cost of Capital– WACC);
- In the economic analysis and CBA, use the **social discount rate (SDR);**

  SDR reflects the social view on how future social benefits and costs should be valued against present ones.

  In other words, **SDR expresses a time preference of the society (for getting benefits in the future).**

  The lower the social discount rate, the higher the value attached to the future!

Topic	2014-2020	2021-2027
	Major projects	Projects
Social discount rate	According to Annex III to Regulation No 2015/207, a social discount rate of 5% will be used for major projects in cohesion countries and 3% for the other member states.	Member states can establish and use a country-specific social discount rate (see Section 2.3). **3% can be used in the absence of a national approach.**



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The economic indicators:

- Economic Net Present Value (ENPV): the current value of all future costs and benefits and should be larger than zero;

$\mathrm{NPV} = \left(\left[\sum \frac{B_i}{(1+sdr)^i}\right]\right) - \left(\left[\sum \frac{C_i}{(1+sdr)^i}\right]\right)$ summed over o to n years. $\mathrm{NPV} = \left[\sum \frac{\mathrm{nCF_i}}{(1+\mathrm{sdr})^{\mathrm{i}}}\right] - \mathrm{C_0}$

B_i = project benefits in year i, for i {o,1…n};

C_i = project costs in year i, for i {o,1…n};

n = total number of years for project duration – the time horizon;

SDR = social discount rate.

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The economic indicators:

- Economic Internal Rate of Return (EIRR): discount factor at which the ENPV of costs and benefits is zero.

$$\left(\left[\sum \frac{B_i}{(1+irr)^i}\right]\right) - \left(\left[\sum \frac{C_i}{(1+irr)^i}\right]\right) = 0$$

As a rule of thumb, **the IRR should be higher than the discount rate used in the analysis** (it creates value added). On the contrary, the project destroys value if the IRR is lower than the discount rate.

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The economic indicators:

- Economic benefits-to-cost ratio (BCR) is the ratio between the sum of discounted economic benefits and costs over the time horizon considered in the analysis. The BCR informs on how many euros are generated by the intervention for each euro invested over the time horizon of the project.

$$\mathrm{BCR} = \frac{[\sum B_i/(1+sdr)^i]}{[\sum C_i/(1+sdr)^i]}$$

B_i = project benefits in year i, for i {0,1…n};
C_i = project costs in year i, for i {0,1…n};
N = total number of years for project duration – the time horizon;
SDR = social discount rate.

PRISHTINA URBAN REGENERATION PROJECT (superwien & WB)

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4. Sensitivity & risk analysis

Any project or policy proposed has to deal with **uncertainty**. As CBAs present a framework for policy making, to complete the picture a sensitivity and risk analysis has to be prepared. The steps for assessing the project risks are:

- sensitivity analysis;
- qualitative risk analysis;
- probabilistic risk analysis;
- risk prevention and mitigation.

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Sensitivity and risk analysis

- The **sensitivity analysis** allows for the identification of the "**critical variables**" of the project. Such variables are those whose positive or negative variations impact **the project's financial and/or economic performance**.
- The analysis is carried out by varying **one variable at a time** and determining the effect of that change in the economic indicators.
- As a guiding criterion, **the recommendation is to consider "critical" those variables for which a variation of +/-1% of the value adopted in the base case gives rise to a variation of more than 1% in the value of the ENPV**.

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Variable	Variation of the FNPV due to a +/-1% variation	Criticality judgement	Variation of the ENPV due to a +/-1% variation	Criticality judgement
Yearly population growth	0.5%	Not critical	2.2%	Critical
Per capital consumption	3.8%	Critical	4.9%	Critical
Unit tariff	2.6%	Critical	N/A	N/A
Total investment	8.0%	Critical	8.2%	Critical
Yearly maintenance cost	0.7%	Not critical	0.6%	Not critical
Per capita willingness to pay	Not applicable	-	12.3%	Critical
Annual noise emissions	Not applicable	-	0.8%	Not critical

Source: Guide to Cost Benefit Analysis of Investment Projects. Economic Appraisal Tool for Cohesion Policy 2014-2020

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Sensitivity and risk analysis

Qualitative risk analysis shall include:

- Every project is exposed to adverse events;
- Set **up a matrix for each adverse event or risk** by indicating:
  - Identification of risk categories that might have an impact on the project
  - Define the probability of occurrence and severity of the impact;
  - Define of risk levels as a combination of probability of occurrence and severity (low, moderate, high, and unacceptable);
- A description of **mitigation and/or prevention measures** for the main risks, indicating who is responsible for the applicable measures to reduce risk exposure.

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Sensitivity and risk analysis

A **probability (P) or likelihood of occurrence** is attributed to each adverse event. A possible and recommended classification is as follows:

A. Very unlikely (0–10 % probability);
B. Unlikely (11–33 % probability);
C. About as likely as not (34–66 % probability);
D. Likely (67–90 % probability);
E. Very likely (91–100 % probability).

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Sensitivity and risk analysis

Risk severity classification:

Rating	Meaning
I	**No relevant** effect on social welfare, even without remedial actions.
II	**Minor** loss of the social welfare generated by the project, minimally affecting the project long run effects- However, remedial or corrective actions are needed.
III	**Moderate**: social welfare loss generated by the project, mostly financial damage, even in the medium-long run. Remedial actions may correct the problem.
IV	**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.
V	**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 materialise.

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Sensitivity and risk analysis

The **Risk Level is the combination of Probability and Severity (P*S).**

Risk level	Colour		Severity / Probability	I	II	III	IV	V
Low			A	Low	Low	Low	Low	Moderate
Moderate			B	Low	Low	Moderate	Moderate	High
High			C	Low	Moderate	Moderate	High	High
Unacceptable			D	Low	Moderate	High	Very High	Very High
			E	Moderate	High	Very High	Very High	Very High

Source: Guide to Cost Benefit Analysis of Investment Projects. Economic Appraisal Tool for Cohesion Policy 2014-2020

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Sensitivity and risk analysis

Once the level of the remaining risks (P and S) is established, it is important to identify the **mitigation and/or prevention measures foreseen**:

Severity / Probability	I	II	III	IV	V
A	Prevention or mitigation		Mitigation		
B					
C					
D	Prevention		Prevention and mitigation		
E					

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