European Commission

Economic Appraisal Vademecum 2021-2027

General Principles and Sector Applications

Regional and Urban Policy

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FOREWORD

Elisa Ferreira
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In the aftermath of COVID-19 pandemic, the European Union mobilised unprecedented funding to cope with the economic and social consequences of the crisis and to prepare for a green, digital and resilient recovery. Cohesion Policy 2021-27 remains the main investment arm of the EU, ensuring that no region and no person is left behind.

In our path to a more innovative, sustainable and cohesive growth model, the role of economic appraisal is more important than ever. Our projects need to provide the best value for money and offer the best return for the society by providing services and goods in an effective and efficient manner. In order to achieve that we need evidence-based analysis, intellectual integrity and investment decisions based on objective and verifiable methods. At the same time, we aim to make Cohesion Policy rules simpler and leaner, to reduce administrative burden for beneficiaries, especially for SMEs and promoters of small projects.

Several analytical methods including cost-benefit analysis, cost-effectiveness, least-cost and multi-criteria analysis, can be used to verify whether projects achieve relevant objectives of our programmes in an effective and efficient manner.

This Vademecum presents all these methods, based on vast experience that has been gathered in 2014-2020 by the Commission and JASPERS. The Vademecum is based on internationally recognised standards and good practices. Member States can now tap into this experience when preparing their national selection and appraisal systems in 2021-27.

I am thrilled to see how Cohesion Policy can positively change the lives of our citizens! Through the Cohesion policy trademarks of genuine partnership, multi-level governance and bottom-up approaches, Member States and the Commission should be prioritising those projects that will turn our inclusive, green and digital vision into reality in every region, ensuring the more resilient and competitive Europe that we want for our children and for ourselves.

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ACRONYMS

B/C	benefit/cost
CAPEX	capital expenditures
CBA	cost–benefit analysis
CEA	cost-effectiveness analysis
CEF	Connecting Europe Facility
CF	conversion factor
CO_2e	carbon dioxide equivalent
CPR	common provisions regulation
EA	economic appraisal
EAV	Economic Appraisal Vademecum
EBRD	European Bank for Reconstruction and Development
EIB	European Investment Bank
ENPV	economic net present value
ENTSO-E	European Network of Transmission System Operators for Electricity
ENTSOG	European Network of Transmission System Operators for Gas
ERR	economic rate of return
FDR	financial discount rate
GHG	greenhouse gas
JASPERS	Joint Assistance to Support Projects in European Regions
LCA	least-cost analysis
MCA	multi-criteria analysis
MFF	multiannual financial framework
O&M	operation and maintenance
OPEX	operating expenses
PLMCA	policy-led multi-criteria analysis
RI-PATHS	Research Infrastructure Impact Assessment Pathways
SDR	social discount rate
SE	stakeholder engagement
SRTP	social rate of time preference
WACC	weighted average capital cost

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Part I - General Principles

INTRODUCTION

Background

The common provisions regulation for the 2014–2020 programming period included an obligation for major projects to undertake a cost–benefit analysis (CBA) in line with the methodology described in legislation (Commission Implementing Regulation (EU) No 207/2015) ([1]), supported by the European Commission *Guide to Cost–Benefit Analysis of Investment Projects* published in 2014 ([2]) – hereinafter referred to as the 2014 CBA guide.

The methodology and the 2014 CBA guide strengthened several aspects of the concrete application of CBA in project preparation, notably in relation to economic analysis. The Joint Assistance to Support Projects in European Regions (JASPERS) initiative, which supported the European Commission in the development of the last two editions of the European Commission CBA guide, was strategically positioned to ensure quality standards across projects with proven benefits in terms of both consistency of approach and optimisation of public spending across sectors. The requirement for CBA has contributed significantly to ensuring good value for money and has encouraged rigour in the project selection process.

Through the application of CBA to major projects in the 2014–2020 programming period, EU Member States gained a lot of experience in using CBA as a tool to support decision-making on EU-funded investments. In many Member States, the use of CBA in project appraisal extended beyond major projects, confirming the growing appreciation of the benefits of carrying out economic appraisal (EA) to ensure an optimal allocation of available funding. On the other hand, the conduct of CBA in certain sectors and certain projects appeared overly complex and time-consuming, implying that simpler methods that offer similar explanatory value are required. Building on the experience gained, a more flexible, yet rigorous, analytical framework for project EA is proposed for the 2021–2027 programming period, for voluntary use. This framework reflects the principle of delegation of approval to the national authorities to better take into account specific and national project contexts.

In the context of the European Green Deal and Europe's commitments to fighting climate change, it is more important than ever to use a methodology that offers a wider perspective than looking only at financial cash flows between stakeholders of European projects and policies, including quantifying and monetising the effects on those stakeholders that are indirectly affected by those policies.

EU and national recovery plans that have been developed to mitigate the economic recession triggered by the COVID-19 crisis provide Member States with funding and financing opportunities for investments in several sectors. Public grants and loans will be used in combination with regulatory measures and public fiscal interventions to promote the recovery from the crisis in the long term, including addressing the infrastructure backlogs observed in the EU. In this context, it will be important to secure the sound selection and prioritisation of projects – based on, among other criteria, the results of EA.

In recognition of the above, and considering the exclusive responsibility of national authorities to assess and approve cohesion policy projects in the 2021–2027 programming period, the Directorate-General for Regional and Urban Policy has launched, with the support of JASPERS, the preparation of this *Economic Appraisal Vademecum* (EAV), for possible wider voluntary use across EU funding sources in the 2021–2027 programming period. This EAV is based on established good practices at both EU and national levels and it is consistent with the approach to EA followed by the European Investment Bank and other international financing institutions.

The EAV aims to provide methodological insights and tools to use EA methods in support of the early screening of investments and for the assessment of projects for which a more detailed CBA might not be necessary.

To complement the EAV, the Directorate-General for Regional and Urban Policy developed a spreadsheet template with the objective of standardising how to structure the cash flows underpinning EA. The use of a standardised template is considered useful, as it provides project promoters with some practical guidance on the format of the content of a CBA or other EA tool. At the same time, this template helps evaluators to assess project proposals faster. This template is a tool that is complementary to both the 2014 CBA guide and the EAV ([3]).

Objective and scope

The objective of this EAV is to further promote and simplify the voluntary use of EA for EU co-financed investments in the 2021–2027 programming period. Carrying out EA is good practice for any EU-supported project, as it helps to ensure the optimal allocation of available funding and to verify that the projects supported are good value for money.

In this document, EA is defined as the process aimed at assessing if a project will contribute to overall social welfare and to economic growth. It takes into account benefits and costs to society and gauges the value that the project generates for all stakeholders, to determine if society will gain from the investment.

The EAV intends to ensure that appraisal is 'fit for purpose' and provides the necessary information for decision-makers at various decision points throughout the project cycle, while reducing the administrative burden not only for beneficiaries but also for those bodies involved in the management of EU funds.

[1] See: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015R0207&from=EN

[2] See: https://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/cba_guide.pdf

[3] The spreadsheet template was prepared by Dr. Linas Jasiukevičius under a consulting assignment led by the European Commission and also benefitted from advice of experts from JASPERS and from Julien Bollati of CINEA.

For the 2021–2027 programming period and the cohesion policy funds, the use of CBA is not a legal requirement, and the 2014 CBA guide is not a legally binding document. It is recommended, however, to keep following its provisions to assess the economic viability of large infrastructure investments. Starting from this basis, the EAV does not replace the 2014 CBA guide, but instead complements it in the following ways:

- it introduces the principles of proportionality and flexibility to EA, in particular for projects on a small scale or simple projects for which developing a fully fledged CBA might be unnecessarily burdensome or costly;
- it facilitates the practical application of the EA methodologies through the identification of established good practices;
- it covers additional sectors deemed to be relevant in the multiannual financial framework (MFF) for 2021–2027.

CBA remains the recommended appraisal tool, but other tools are suggested in specific circumstances based on sector, project type and scale.

The EAV is not prescriptive and should not be understood as an enforcement tool of EU legislation. Member States can draw on the information presented to set up a framework for both project appraisal and selection that is in line with international good practices. In particular, they can use it to better define their methods and criteria to approve investments in a context of transparency and accountability of public expenditure.

As EA tools can be used across different EU/national policy sectors and institutions, the EAV is not linked exclusively to the cohesion policy and is a resource that can be used across different funds in the 2021–2027 financial perspective.

Finally, it is worth underlining that the EAV covers economic (and to some extent financial) appraisal only. Other important aspects of project appraisal (e.g. demand; technical, environmental, legal and procurement aspects; and risk assessments) are not discussed in this document. This is not to say that these aspects should not be assessed, but they would be better dealt with within a project preparation guide than within a guide for EA. Where relevant, the EAV makes reference to existing guidance documents and methodologies that help in dealing with these aspects in a sound manner.

Structure

The EAV is structured in two parts.

Part I – general principles

- Chapter 1 discusses why it is important to carry out an EA and how this should be proportional to the project's type and flexible enough to account for the specificities of the project's context. A simplified approach for the screening of investment options is presented in this chapter.
- Chapter 2 illustrates CBA as the recommended EA voluntary tool. It complements the guidance provided in Chapter 2 of the 2014 CBA guide with additional/updated information, clearly stating when this represents a development or a further specification compared with that guide. The text promotes a more flexible approach to setting some of the parameters relevant for CBA than the requirements of the 2014–2020 programming period.
- Chapter 3 presents the guiding principles, key features and scope of application of alternative EA tools such as least-cost analysis (LCA), cost-effectiveness analysis (CEA) and multi-criteria analysis (MCA). This chapter updates and expands upon Annex IX of the 2014 CBA guide.
- Appendix I provides a non-exhaustive overview of existing CBA national guidance.
- Finally, a bibliography of relevant references is provided.

Overall, Part I provides the general analytical framework for using EA during the 2021–2027 MFF.

Part II – sector applications

- Annexes I to VII set out good practices in EA in the following sectors to complement the corresponding chapters of the 2014 CBA guide: research and innovation, renewable energy, energy efficiency, municipal waste management, transport, broadband, and water and wastewater. The focus is on topics in which the state of the art (in terms of data sets or guidance) has developed since the 2014 CBA guide or conclusions have been drawn from the lessons learned in 2014–2020.
- Annexes VIII to X present methodologies for EA in sectors that were not covered in the 2014 CBA guide but are considered relevant in the 2021–2027 MFF, namely healthcare, ICT and urban development.

These annexes are structured as follows: an introduction presenting the policy context, a discussion of what EA tool to use and what simplifications to apply at the different stages of the project cycle, and guidance on the key aspects featuring EA for the relevant projects in the sector.

These annexes align with and further develop the general principles illustrated in Part I.

Even though they have some obvious connections and synergies, these annexes are intended as relatively independent sectoral good practice guidance ('living documents') that can be updated over the course of the MFF once additional sources of information or empirical data become available. Also, new sectors might be added at a later stage.

1. ROLE OF ECONOMIC APPRAISAL

1.1 Economic appraisal in the EU 2021–2027 policy framework

The use of economic appraisal (EA) methodologies is relevant to several proposed sources of EU funding in the financial perspective for 2021–2027. The key linkages between EA and the EU 2021–2027 policy framework are described in this section.

The policy framework for the **cohesion policy** outlines five main objectives in 2021–2027:

1. a more competitive and smarter Europe, by promoting innovative and smart economic transformation and regional ICT connectivity;
2. a greener, low-carbon transition towards a net-zero carbon economy and resilient Europe, by promoting a clean and fair energy transition, green and blue investment, the circular economy, climate change mitigation and adaptation, risk prevention and management, and sustainable urban mobility;
3. a more connected Europe, by enhancing mobility;
4. a more social and inclusive Europe implementing the European Pillar of Social Rights;
5. a Europe closer to citizens, by fostering the sustainable and integrated development of all types of territories and local initiatives.

The Just Transition Fund shall support the specific objective of enabling regions and people to address the social, employment, economic, and environmental impacts of the transition towards the Union's 2030 targets for energy and climate and a climate-neutral economy of the Union by 2050, based on the Paris Agreement.

According to the common provisions regulation (CPR) ([4]) approved in June 2021, there are no legal requirements for 'major projects' with EU *ex ante* approval, nor does the regulation explicitly mention the need to perform a CBA ([5]).

However, the CPR calls for managing authorities to ensure proper value for money for the selection of operations to be financed, with a major shift of responsibilities from the EU to Member States. The rationale for such a shift is based on the acknowledgement that, over the years, best practices in the field of project preparation and EA were systematically promoted and developed at the national level in line with EU requirements. At the same time, the CPR aims to foster the promotion of national quality standards and practices.

At the national level, establishing and enforcing a methodology and related criteria for the selection of operations falls within the responsibilities of managing authorities and of monitoring committees ([6]). The results of EA can be used as, among other things, selection criteria to verify that projects are good value for money (i.e. to verify the maximisation of the ratio between resources used and expected achievements).

Table 1 at the end of this section provides an overview of the main simplifications introduced in the approach to EA for cohesion policy-funded investments in the 2021–2027 programming period, compared with 2014–2020.

EA in general and CBA in particular are becoming increasingly relevant in other investment contexts beyond the cohesion policy.

CBA remains a requirement for most projects applying to the **Connecting Europe Facility** (CEF). According to the regulation laying down the next CEF long-term budget (2021–2027) ([7]), CBA is among the criteria for the eligibility and awarding of grants for cross-border projects in the field of renewable energy. For other sectors such as transport and energy transmission, CBA requirements are specified in the work programmes and calls for proposals. Information included in CBAs will be assessed in the framework of the selection process for Projects of Common Interest (PCIs). The European Climate, Infrastructure and Environment Executive Agency has designed and made available to its beneficiaries a spreadsheet template to present the CBA results in the submission of project proposals in the field of transport (CEF-T). In addition, a dedicated section of the spreadsheet template that is complementary to this EAV and provides unit values of benefits and costs at the country level is being considered for smaller projects applying to the CEF transport call for proposals for 2021–2027. In the field of energy (CEF-E), it is recommended that the CBA methodology drawn up by the European Network of Transmission System Operators for Electricity (ENTSO-E) ([8]) and forGas (ENTSO-G) ([9]) is followed.

[4] Regulation (EU) 2021/1060 of the European Parliament and of the Council of 24 June 2021 laying down common provisions on the European Regional Development Fund, the European Social Fund Plus, the Cohesion Fund, the Just Transition Fund and the European Maritime, Fisheries and Aquaculture Fund and financial rules for those and for the Asylum, Migration and Integration Fund, the Internal Security Fund and the Instrument for Financial Support for Border Management and Visa Policy.

[5] According to Article 100 of Regulation (EU) No 1303/2013, a major project is an investment operation comprising "a series of works, activities or services intended in itself to accomplish an indivisible task of a precise economic or technical nature which has clearly identified goals and for which the total eligible cost exceeds EUR 50 000 000 […]".

[6] In some Member States, methodologies are also centrally adopted at the coordinating body level, to be applied consistently by the various managing authorities.

[7] Regulation (EU) 2021/1153 of the European Parliament and of the Council of 7 July 2021 establishing the Connecting Europe Facility and repealing Regulations (EU) No 1316/2013 and (EU) No 283/2014. (http://data.europa.eu/eli/reg/2021/1153/oj).

[8] ENTSO-E (2020), 3rd ENTSO-E guideline for cost benefit analysis of grid development projects, draft version, 28 January 2020 (https://eepublicdownloads.blob.core.windows.net/public-cdn-container/tyndp-documents/2020-01-28_3rd_CBA_Guidleine_Draft.pdf). Final draft pending European Commission approval.

[9] ENTSOG (2019), *2nd ENTSOG methodology for cost-benefit analysis of gas infrastructure projects 2018* (https://www.entsog.eu/sites/default/files/2019-03/1.%20ADAPTED_2nd%20CBA%20Methodology_Main%20document_EC%20APPROVED.pdf).

The **InvestEU** regulation ([10]) introduces climate, environmental and social sustainability of investments as crucial elements in the decision-making process when approving the use of the EU guarantee. These sustainability aspects should be verified for the financing of investment operations under all windows of the InvestEU Fund, in particular in the area of infrastructure, also taking into consideration the principle of proportionality. Operations with a significant climate, environmental or social impact must be subject to a sustainability proofing assessment following the methodology developed in the InvestEU sustainability proofing guidance ([11]). The assessment, quantification and, where feasible, monetisation of environmental and climate change impacts (costs and benefits) delivered by the project fit into the more comprehensive EA that is usually carried out by InvestEU implementing partners as part of their due diligence process. The results of EA should be reported to the InvestEU Investment Committee and taken into account, among other elements, when deciding on granting the EU guarantee. For those implementing partners that do not (yet) have an established approach or procedure, this EAV (together with the 2014 CBA guide and the other EU and national manuals mentioned in this section 1.1 and in Annex I) can provide a useful reference framework.

The **Recovery and Resilience Facility** will make EUR 672.5 billion in loans and grants available to support reforms and investments undertaken by Member States by 2026. The aim is to mitigate the economic and social impact of the coronavirus pandemic and make European economies and societies more sustainable, more resilient and better prepared for the challenges and opportunities of the green and digital transitions. The Commission guidance to Member States on recovery and resilience plans ([12]) specifies the following.

> *When preparing their plans, Member States should consider an investment as an expenditure on an activity, project, or other action within the scope of the Proposal that is expected to bring beneficial results to society, the economy and/or the environment. The Proposal aims at promoting measures that, if taken now, would bring about a structural change and have a lasting impact on economic and social resilience, sustainability and long-term competitiveness (green and digital transitions), and employment.*

A simplified EA (as discussed later in this document) can be adopted in this context to assess the overall impacts of the investments included in the recovery plans financed by the facility, while at the same respecting the need for timely decision-making.

CBA will also remain a requirement in the framework of the preparatory phase of **European Strategy Forum on Research Infrastructures** projects (the priority roadmap for research infrastructures in the EU). A *Guidebook for socio-economic impact assessment of research infrastructures* was recently published by the Research Infrastructure Impact Assessment Pathways (RI-PATHS) project funded by Horizon 2020 ([13]).

In terms of international financing institutions, the **European Investment Bank** (EIB) conducts an EA of projects considered for financing. The EIB uses CBA as the default methodology to estimate a project's economic rate of return (ERR) that accounts for broader project benefits and costs to society, including environmental externalities. It also applies CEA and, more recently, MCA, taking into account the evolving circumstances of each sector. The results of the EA are entered into the overall evaluation framework of projects applying for a loan from the EIB (additionality and impact measurement framework). *The economic appraisal of investment projects at the EIB* (EIB, 2013a) presents the methodologies that the EIB uses to assess the economic viability of projects. The EIB is currently updating this manual ([14]).

The **European Bank for Reconstruction and Development** (EBRD) undertakes an economic assessment of projects with high greenhouse gas (GHG) emissions ([15]). When applying the economic assessment, a CBA is conducted, unless a CEA is deemed more appropriate in some specific circumstances, as described in the *Methodology for the economic assessment of EBRD projects with high greenhouse gas emissions* (2019) ([16]).

The use of CBA has also gained much ground for the appraisal of investment projects at the **national level**, as reflected in several manuals that were published for different sectors. Appendix I provides a non-exhaustive overview of existing CBA national guidance. Some examples include the following: for France, Quinet et al. (2013); for Sweden, ASEK (2016) and Kriström and Bonta Bergman (2014); for Poland, the experience of the Centre for EU Transport Projects (CUPT; Archutowska et al., 2014); and for the United Kingdom, the *Green Book* (last update in 2018; UK Treasury, 2018).

CBA is also used to appraise relatively small investments in smaller economies. For example, in Lithuania, CBA is required for investment projects larger than EUR 300 000. In Malta, the requirement for CBA becomes mandatory for any project proposal with a total project cost of over EUR 5 million.

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[10] Regulation (EU) 2021/523 of the European Parliament and of the Council of 24 March 2021 establishing the InvestEU Programme and amending Regulation (EU) 2015/1017 (http://data.europa.eu/eli/reg/2021/523/oj).

[11] European Commission (2021), *Technical guidance on sustainability proofing for the InvestEU Fund*, C(2021) 2632 final, European Commission, Brussels (https://europa.eu/investeu/investeu-fund/about-investeu-fund_en).

[12] European Commission (2021), Commission staff working document guidance to Member States recovery and resilience plans, SWD(2021) 12 final, European Commission, Brussels (https://ec.europa.eu/info/sites/default/files/document_travail_service_part1_v2_en.pdf).

[13] For more information, see the RI-PATHS website (www.ri-paths.eu).

[14] EIB (2013a), *Economic appraisal of investment projects at the EIB* (https://www.eib.org/attachments/thematic/economic_appraisal_of_investment_projects_en.pdf).

[15] That is, projects where the proceeds increase emissions by 25 000 tonnes of carbon dioxide equivalent (CO_2e) per year relative to a baseline or increase emissions by 100 000 tonnes of CO_2e per year in absolute terms.

[16] EBRD (2019), *Methodology for the economic assessment of EBRD projects with high greenhouse gas emissions* (https://www.ebrd.com/news/publications/institutional-documents/methodology-for-the-economic-assessment-of-ebrd-projects-with-high-greenhouse-gasemissions.html).

Since 2007, JASPERS ([17]) has been supporting the development of national CBA guidelines in several EU Member States, as well as providing extensive capacity building on the subject, also at the EU level ([18]). Based on these activities over the last two programming periods, the practice of using EA tools for decision-making on EU co-financed projects has become well established across the Member States and is likely to continue in 2021–2027.

Table 1. Approaches to EA for cohesion policy-funded investments – differences between 2014–2020 and 2021–2027

Topic	2014–2020	2021–2027
	Major projects	Projects
Legal basis for EA	According to Article 101(e) of Regulation No 1303/2013, a CBA – including an economic and a financial analysis, and a risk assessment – is mandatory in order to get approval for the co-financing of major projects	The use of EA will be left to the discretion of the managing authority and of the monitoring committee that will set up a framework for project appraisal and selection that is compliant with the requirements of Article 73 of the CPR. EA tools can be used and adapted to the size and complexity of EU-funded projects
EA tool	CBA is mandatory for major projects in any sector	A more flexible and proportional framework will be implemented; other tools such as CEA and MCA – in addition to CBA – are proposed for voluntary use, based on sector and/or project type and scale (see Section 1.3)
Results of EA	As set out in Article 101 of Regulation No 1303/2013, an economic analysis must be included in the CBA to compute the project's economic performance. The calculation of economic net present value and ERR indicators is requested to verify that the project is worth co-financing	It is good practice to use the results of EA as one of the criteria in assessing and selecting project proposals in order to verify that the selected project is good value for money (as requested by Article 73(c) of the CPR)
Option analysis	According to Annex III to Regulation No 2015/207, for major projects, the option analysis should be carried out in two steps. The first step looks at basic strategic options and is based on MCA. Once the strategic option is identified, the second step consists of a comparison of the specific technological solutions based on quantitative methods (simplified CBA or CEA). A fully fledged CBA is then carried out on the selected technical option	A simplified EA (CBA, CEA or MCA) is an established good practice for screening and ranking options. When the project is limited in size, this is normally sufficient to identify a preferred option and justify approval for its co-financing. When the project is large/strategic, or when the results of the simplified EA are inconclusive, a fully fledged EA should be carried out at subsequent stages of development of the proposal (see Section 1.2)
Analysis of financial performance	As set out in Article 101 of Regulation No 1303/2013, a financial analysis must be included in the CBA to compute the project's financial profitability. The calculation of financial rate of return of the investment and financial rate of return of national capital indicators is requested (by Annex III to Regulation 2015/207) to verify that the project is in need of co-financing	No provisions are made in the CPR to assess the project's financial performance. Member States are free to set up their methods and criteria to verify that the project is in need of co-financing. For most cases, State aid rules will apply

[17] JASPERS is a major joint technical assistance initiative of the European Commission and the European Investment Bank that provides advisory and capacity-building support to all EU Member States and pre-accession countries for the preparation of projects to be co-financed by EU structural and cohesion funds, by the instrument for pre-accession assistance and by the Connecting Europe Facility. JASPERS helps beneficiary countries to absorb EU funds intended to achieve greater cohesion in Europe through sound programmes and projects, which are planned, prepared, procured and run to the highest technical, social and environmental standards possible. For further information, visit the JASPERS website (http://jaspers.eib.org/).

[18] For more information about the EU level, see in particular the cycle of joint JASPERS / Directorate-General for Regional and Urban Policy CBA forum meetings implemented between 2015 and 2019 (www.jaspersnetwork.org)

Analysis of financial sustainability	Annex III to Regulation No 2015/207 requires an analysis of financial sustainability based on undiscounted cash flow	Article 73(d) of the CPR gives a requirement to 'verify that the beneficiary has the necessary financial resources and mechanisms to cover operation and maintenance costs for operations comprising investment in infrastructure or productive investment, so as to ensure their financial sustainability'
Financial discount rate	According to Article 19 of Regulation No 480/2014, a 4 % discount rate will be used as the single reference parameter for all sectors in all Member States, except for projects falling under State aid rules	If a financial analysis with a calculation of performance indicators is carried out, Member States are free to assess their own country- and/or sector-specific financial discount rate(s). In the absence of national guidelines, adherence to State aid rules is recommended
EU support intensity	In accordance with Article 61 of Regulation No 1303/2013, Annex V to Regulation No 1303/2013 and Section III of Regulation No 480/2014, the outcomes of the financial analysis in the CBA are used to calculate the funding gap rate and, in turn, the intensity/level of EU support (unless State aid rules prevail)	According to Article 73(c) of the CPR, the managing authority need to 'ensure that selected operations present the best relationship between the amount of support, the activities undertaken and the achievement of objectives'. This implies, amongst other, that self-financing and/or the bankability potential of an operation should be taken into account where relevant
Reference period of the analysis	Annex I to Regulation No 480/2014 provides a list of mandatory reference periods to be used per sector	There will be no mandatory fixed parameters. An indication of typical reference periods per sector is provided as indicative guidance, but project promoters/managing authorities can adjust them in accordance with the project's economically useful life (see Section 2.3 and Part II of the EAV)
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 are free to establish and use their own country-specific social discount rate (see Section 2.3); 3 % can be used in the absence of a national approach
Type of benefits	Annex III to Regulation No 2015/207 provides a list of the minimum main economic benefits per sector to be considered in the economic analysis	There will be no mandatory list of benefits. Recommendations for typical benefits per sector are provided as indicative based on good practices (see Part II of the EAV)
Compliance-driven projects	In a major project, CBA is mandatory	CEA is deemed to be sufficient to assess the economic viability of the project, regardless of its scale (see Section 1.3)
National methodol-ogies and tools	Member States are encouraged to establish their own national methodological frameworks for EA	Member States are encouraged to follow or establish their own national methodological frameworks for EA. As a complementary instrument to the EAV (the use of which is voluntary), a spreadsheet template has been made available to the Member States. The template provides project promoters with practical guidance on the format of the content of CBA (or other EA tools). At the same time, it can be used by evaluators to assess projects

1.2 Economic appraisal and the project cycle

EA is **a key component in project development** that aims to support the economic case for EU funding and project approval. It can help both project promoters and evaluators by:

- providing useful information to decision-makers at key decision milestones throughout the project development cycle;
- prioritising or ranking projects to meet a set of intended objectives with constrained resources;
- scoping out and shortlisting both strategic and technical options in the early programming and project development phase;
- enhancing transparency and accountability in project selection by using a consistent method that allows assumptions to be tested.

For EA to inform decision-making, it should be supported by robust and objectively verifiable evidence and should consider a range of options to achieve a well-defined objective or range of objectives. This will lower the risk that the analysis is used as a mere compliance tool that justifies a decision already taken.

The EA can be used in a variety of situations during the different stages of the project life cycle. During project preparation, it is used to identify and develop, in an iterative manner, the best project option to pursue the intended objectives and, ultimately, to decide whether to proceed or not with a specific investment. During implementation, it can be useful as a reference to check the actual rolling out of the investment against the intended objectives and targets for monitoring purposes. *Ex post*, it can be used to guide evaluations and extract lessons learned for future projects, in particular on the causes of possible deviations from the *ex ante* estimations and on the main drivers underlying the project's economic performance. In other words, EA should be seen as an iterative process throughout the whole life of a project.

EA is particularly important at the early planning stage, when a range of alternatives are being considered, to inform decision-makers on whether an investment is worthwhile (see Box 1 for good practices in option analysis).

Box 1. Option analysis: good practices

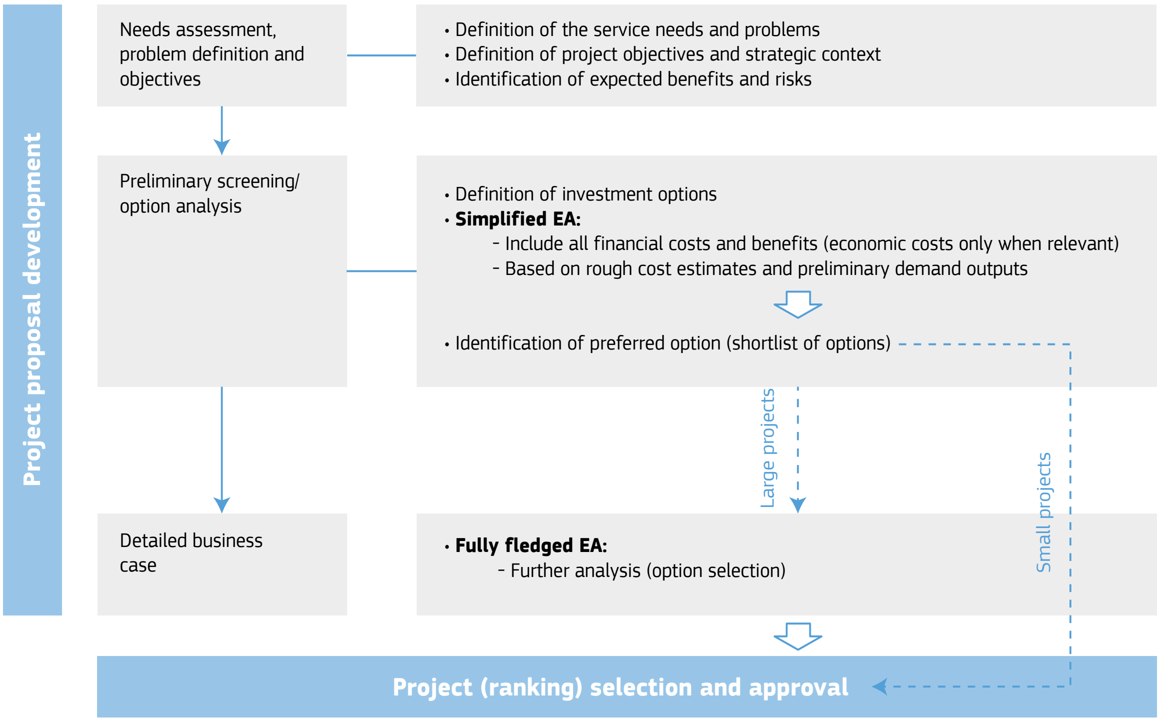
Based on an analysis of a sample of around 250 major projects in 2014–2020, JASPERS has identified the most frequent shortcomings of option analyses and formulated good practice examples.

A well-conceived option analysis:

- is drafted early enough in the project preparation stage (strategic level), continuously verified and adjusted as the preparation advances;
- is based on plausible criteria, set preferably by the relevant authorities for the entire sector to enable a level playing field for all projects (e.g. least-cost or highest benefit approach); these criteria should be formulated in a way that enables selection of the best option among relevant and feasible alternatives;
- applies these criteria in a transparent, verifiable and objective manner;
- is founded on a plausible demand analysis and based on reliable and verifiable historical demand and reasonable forecast demand;
- focuses on proper scoping out and scaling of the project, ensuring the best value for money;
- avoids gold plating of investments (i.e. the inclusion of physical elements and related expenditure that is not necessary to achieve the project objectives);
- includes a technological option analysis, particularly in sectors where technology is relevant for selection of the final option (water, wastewater, waste treatment, research and development and productive investments) or where technology has a major impact on cost (transport).

Figure 1 and the text below describe, concisely, the role of EA in the development of a project proposal.

Figure 1. Project proposal development



Source: Authors.

Step 1 – needs assessment, problem definition and project objectives

Project objectives are defined based on an assessment of the project context and an analysis of the service needs and problems.

The project objectives should be defined with an explicit link to the needs identified and, if possible, should be quantified through indicators and targets. A clear definition of the objectives is necessary to identify the intended effects of the project, which will be further evaluated in the EA, and to verify the relevance of the project vis-à-vis the needs identified.

This process is instrumental in further identifying potential investment options and their expected benefits and risks and in providing the first high-level cost estimates.

Step 2 – preliminary screening / option analysis: simplified economic appraisal (all projects)

At the preliminary stage, the EA of an investment would typically assess a broad set of options with high-level or indicative costs and effects/benefits. In this regard, the EA can be regarded as 'simplified'.

A simplified EA implies focusing on first estimates from demand analysis of the outputs (goods/services) rendered by the project ([19]) and rough estimates of the investment and operating costs.

Rough cost estimates are generally understood as being based on unit prices obtained from limited (regional) market surveys (i.e. quotations from different suppliers) or from similar projects in the same (best if regional) context. It should be ensured, however, that cost estimates are all-inclusive (i.e. that no important cost component is missing, e.g. asset replacement or decommissioning costs). Overhead costs for planning and supervision, as well as contingencies, may be excluded, but then this should be applied to all assessed options. If included, overheads should be calculated similarly for all options (e.g. as a percentage of net investment cost).

Section 2.2 provides more information on what defines a simplified CBA.

The major outcome of the preliminary screening / option analysis is the identification of a technically feasible option (or a shortlist of feasible options) that is in line with relevant strategies, policies and legislative requirements.

When the project is small – or when it is 'simple' because similar projects have already been carried out many times and benchmarks of typical economic performance are available – a preliminary, simplified, EA is generally sufficient to be able to select from the list of feasible alternatives a single preferred option that will be subject to evaluation for financing ([20]). Based on the results of this analysis, project evaluators should have enough information to take the decision with a good degree of confidence (see step 4).

It is the responsibility of Member States to define at the national level what the financial threshold is that qualifies a project as small.

[19] This may not apply to all sectors/cases. For example, large transport infrastructures usually require the use of complex demand models that are already available at the option selection stage.

[20] Or, if only one investment option is considered, to assess its economic viability and propose it for EU co-financing.

Step 3 – detailed business case: fully fledged economic appraisal (large/strategic projects only)
When the project is large and/or strategic (or when the initial results of the EA are not conclusive), the EA must be updated and detailed at subsequent stages of development of the proposal, as more information becomes available.

In other words, as the project proposal is developed further and its estimated impacts are refined, project promoters are normally expected to develop a more detailed EA as part of their business case. This could include:

- more accurate cost estimates resulting from additional detailed engineering work, more definitive project specification and design, better information about conditions of planning approval or more detailed project scoping;
- more refined effect/benefit estimates from detailed market or service demand studies and a clearer definition of target beneficiaries and other stakeholders;
- if CBA is used, a conversion of financial costs into the economic costs based on shadow prices;
- the inclusion of externalities (if not already quantified during the simplified EA).

A detailed business case is often used to assess, in depth, the merit of one project option, selected using the methodology described in step 2. However, in less frequent cases, more options can also be developed in parallel at this stage.

Appraisals are often iterated a number of times before the project proposal is accepted in its final format and moved to implementation (or a decision not to proceed to implementation is taken, as may be the case). In particular, it will usually be important to review the impact of risks, uncertainties and inherent biases as project preparation proceeds.

This information helps to provide a reasonable understanding of whether, in the light of possible changing circumstances, the proposed project is likely to continue to achieve net social benefit.

Step 4 – project (ranking), selection and financing
The results of the EA should be used by the project promoters to demonstrate the economic viability of the selected project option ultimately proposed for financing. A decision-making or financing body should use such results to assess the quality of the proposal and to instruct its decision on financing.

In addition, the results of the EA can be also used by a decision-making body to rank and prioritise competing projects in the context of budgetary constraints.

It is worth noting, however, that the results of the EA would not be the only factor taken into account when taking an investment decision (or when ranking and prioritising projects). Other aspects such as strategic relevance (national, regional, territorial or sustainable urban development perspectives), technical feasibility, affordability, environmental sustainability, climate resilience, legal compatibility, managerial capacity, etc., are also equally important ([21]).

1.3 Choice of tool

As illustrated in Section 1.1, the European Commission finances projects in a broad range of sectors, mainly (but not exclusively) covering activities in which public (and private) investment is needed to enhance the supply of services in the context of 'market failures', stemming, for example, from public goods, natural monopolies or externalities.

Depending on the type and sector of the investment, a range of EA methodologies could be considered.

CBA is the preferred approach for assessing public investment projects, as it offers a robust, objective and evidence-based analytical framework for project evaluation. In the EU, it has been and it continues to be widely used across different policy sectors and institutions as the main EA tool to identify welfare-maximising projects, subject to the resource constraints.

Conducting a CBA could be, however, a resource-intensive process and should be proportionate to the size, importance and/or risk profile of the investment. Depending on the project's scale, nature and/or data availability, a comprehensive CBA may not always be recommended or even possible. In such cases, Least-Cost Analysis (LCA) or Cost-Effectiveness Analysis (CEA) could be adopted as an alternative. A Multi-Criteria Analysis (MCA) could also be used as an alternative, even though it is more often used as a complement to the other tools.

In brief, LCA and CEA are recommended when:

- decision-makers have previously agreed on a specific objective and wish to compare only those options that aim to meet the same objective (e.g. the **compliance-driven** ([22]) projects in the environment sectors);
- there is only one project outcome (or the outcomes and the possible associated externalities are considered equivalent) across options. For example when the project focuses merely on the choice of technology or is not a self-standing unit of analysis, but a component within a larger investment that has already been subjected to CBA (e.g. an upgrade of information technology systems) and performing another CBA would not provide any explanatory value.

In these cases, the project appraisal focuses on whether the project constitutes the cheapest (LCA) or the most cost-efficient (CEA) alternative to supply a given good or service and to achieve the intended objective.

[21] These aspects should always be properly assessed from the perspective of their informative value and legitimacy in the given circumstances; in case of doubts, quantified methods should take precedence over more qualitative approaches.

[22] Compliance-driven projects are those that aim to fulfil only the (minimum) technical standards and requirements specified in the EU legislation for certain types of activities. In the case of compliance-driven projects, the EA results do not identify **if** the project should be implemented, but **how**.

MCA is typically used as an appraisal tool for structuring the option analysis during project preparation. MCA can be used to screen strategic options at the preliminary stage of the project cycle. Once the strategic option is identified, a comparison of the specific technical solutions can be carried out by means of a CBA or CEA/LCA. As discussed later in this document (Section 3.2), the MCA approach is also used in the context of investment programmes with multiple objectives, as a tool to show the relevance of project investments to overall strategic aims and policy objectives.

To sum up, the suitability of the tools for certain projects depends on the extent to which:

- the project produces multiple outputs (the greater the number of outputs, the more appropriate the application of CBA);
- these outputs can be measured and monetised (the easier an output is to monetise, the more feasible the use of CBA);
- the appraisal concerns a programme or an investment plan that includes several projects (this type of appraisal requires a clear relationship with existing polices, and MCA is suitable in this case).

Chapters 2 and 3 (as well as the annexes in Part II of the EAV) give more precise indications about the scope of application of the CBA (while remaining a voluntary option) and other tools.

Table 2 provides a framework for the potential use of EA tools across sectors/areas. The table is for guidance only and is not exhaustive, as other investment areas may be deemed to be relevant in future EU policies. The choice of EA method depends ultimately on specific circumstances and the data availability of each project.

Table 2. Suggested EA methods by investment area

Area	Investment area	Project type	
		Small projects	Large/strategic projects
Water and wastewater	Water and wastewater infrastructure (efficiency driven) ([23])	LCA/CEA	CBA
	Water and wastewater infrastructure (exclusively compliance driven)	LCA/CEA	LCA/CEA
	Flood prevention	Simplified CBA	CBA
Transport	Transport infrastructure (all modes)	(Simplified) CBA	CBA
	Transport infrastructure: compliance-driven project (all modes)	CEA/MCA	CEA/MCA
	New technology in transport	CEA/MCA	CBA/CEA/MCA
Healthcare	Disease prevention / treatment programmes / new technology	CEA	CEA
	Healthcare infrastructure	Simplified CBA	CBA
Research, development and innovation	Research infrastructure	Simplified CBA	CBA
	Innovative manufacturing	Simplified CBA/CEA	CBA
	Tertiary education	Simplified CBA	CBA
Renewable energy	Electricity generation	CEA with integration of externalities	CBA
	Heat generation	CEA with integration of externalities	CBA
Energy efficiency	Energy efficiency in buildings and plants	CEA with integration of externalities	CBA
	District heating	CEA with integration of externalities	CBA
Digital economy	Broadband infrastructure	Simplified CBA	CBA
	ICT services (data centres, e-services, etc.)	CEA	Depending on the area of application
Municipal waste management	Collection, transport, recovery, recycling, treatment and disposal of solid waste	CEA	CBA
Sustainable urban development	Integrated territorial investment schemes or community-led local development schemes, programmes in cluster development and urban regeneration programmes	MCA (including simplified CBA/CEA for individual large projects in given sectors)	MCA (including detailed CBA/CEA for individual large projects in given sectors)

1.4 Difference from financial appraisal

Unlike EA, financial appraisal is carried out from the viewpoint of the project promoter and aims to assess the profitability of the investment (i.e. the extent to which the project net revenues ([24]) are able to pay back the initial investment), as well as the sustainability of the operations.

[23] NB: Projects that have a mix of efficiency- and compliance-driven elements (in practice this is usual) should follow this line.

[24] Revenues are determined by the forecasts of the quantity of goods/services provided and their price, in the form of fees, tariffs or charges to users. The underlying concept defining a revenue is that 'it is a payment against a service'. In turn, payments received from upper level institutions/authorities to cover operational deficits and to ensure operations' sustainability are to be considered as subsidies and therefore not included in the calculation of the return on investment.

The building blocks of financial appraisal have many elements in common with EA, in particular project costs. In addition, when CBA is used as an EA tool, the assessment of the project's financial profitability (return on investment) outlines the cash flows that underpin the calculation of the socioeconomic costs and benefits.

However, economic and financial appraisals differ in the scope, the basis for valuation of the costs and benefits (e.g. financial appraisal does not consider non-cash flow items such as externalities) and the discount rate used (see Box 2).

The financial net present value on investment and the financial rate of return on investment are two indicators used to measure the project's profitability. When the former is positive and the latter is larger than the discount rate, the project is financially viable.

In general, a project that is not financially viable needs a redesign or additional sources of funding such as grants and subsidies. By contrast, a financially profitable project should preferably be supported with other forms of financing (e.g. loans).

As regards sustainability of operations, a project is financially sustainable if the cumulated cash flow (i.e. cash in hand at the end of the year) is positive (or nil) for all of the years considered for operations.

For the methodology on how to carry out the analysis of financial profitability within the CBA, see Section 2.7 of the 2014 CBA guide.

Box 2. Financial discount rate

The financial discount rate (FDR) defines the cost of capital and is used as a reference to decide whether the project is financially worth undertaking or not. Two main approaches exist in the practice of calculating the FDR.

A commonly used approach consists of estimating the actual cost of capital in a given industry/sector. Following this approach, the FDR is intended as an indicator of (minimum) expected profitability of a business and it can be estimated based on the **weighted average capital cost** (WACC) approach. The use of WACC as the FDR is considered appropriate because it integrates a risk premium into the expected return for new investments in a given sector. That is, the WACC is taken as a reference for comparison with the return an investor would have if it invested in that business. As general rule, the WACC values to be used should be those officially set at the national level by the regulating authority for those (sub)sectors where this is available. In other cases (e.g. partial sector coverage and unregulated sectors), alternative rates can be proposed by other planning authorities on the basis of a robust justification and a clear methodology. When the nature of the investment is so specific that it can be considered a 'self-standing sector' with regard to the context in which it operates, company-specific WACCs can be proposed directly by project promoters.

Another approach consists of estimating the **opportunity cost of capital** for an economy as a whole. In this case, the FDR can be proxied by the latest long-term interest rates of national government bonds (or by the long-term returns of an international portfolio of investments).

In the context of EU co-financed projects, both approaches are acceptable. The WACC is more frequently used in private investments, and the opportunity cost of capital in the public ones. Member States can assess their own country-specific FDR(s), provided that adherence to State aid rules is respected. It is Member States' responsibility to provide clear indications of what FDR applies to their beneficiaries in order to ensure a consistent application to all sectors and projects concerned.

2. COST-BENEFIT ANALYSIS

2.1 Introduction

CBA is an analytical tool used to assess the economic advantages or disadvantages of an investment decision by quantifying the welfare changes attributable to its implementation. It aims to quantify all benefits and costs for society in monetary terms. These include economic, social and environmental impacts. It was a compulsory tool in the 2014–2020 programming period for major projects financed by the European Regional Development Fund or the Cohesion Fund and is a voluntary tool in the 2021–2027 programming period with the necessary contextual adjustments.

Chapter 2 of the 2014 CBA guide discusses in detail the CBA general analytical framework, its working rules and operational steps. The EAV focuses, therefore, only on the new or specified provisions compared with what is stated in the 2014 CBA guide. This concerns the following:

- what defines a **simplified CBA**;
- **parameters:** a more flexible approach to setting the reference period than the requirements of the 2014–2020 programming period and the proposal for a social discount rate (SDR);
- **topics not specifically/fully addressed in the 2014 CBA guide:** how to treat wider, induced and indirect effects, sunk costs and in-kind contributions, as well as how to reduce the risk of overestimating operating costs and how climate change vulnerability assessment fits into EA;
- **new developments/updates compared with the 2014 CBA guide:** residual value, shadow prices of selected inputs, climate change mitigation, ranking of projects based on the performance indicators and stakeholder engagement.

2.2 Simplified cost–benefit analysis

As discussed in Section 1.2, at the preliminary stage the EA can be regarded as 'simplified', as it is based on rough, indicative estimates of costs and benefits.

If CBA is adopted as the EA method, a typical simplification at this stage consists of the use of financial costs (based on market prices) instead of economic costs (based on shadow prices). As the calculation of economic costs can be resource intensive, the conversion of market prices is not always necessary in a simplified CBA ([25]).

In addition, when the project options are expected to have similar externalities, in terms of both typology and volume, their inclusion in the analysis can be skipped and replaced by a descriptive, qualitative assessment ([26]).

2.3 Parameters

Reference period

The number of years for which cost and benefit forecasts are provided corresponds to the project's reference period.

The CPR for 2021–2027 no longer includes binding reference periods per sector, as was the case in the past regulation (see Annex I of Commission Delegated Regulation (EU) No 480/2014)([27]).

The reference period should correspond to the project's economic life to allow its likely long-term impacts to unfold. In other words, CBA projections must be long enough to capture all significant costs and benefits of the project. The project's economic life is defined as the expected time during which the project remains useful (i.e. capable of providing goods/services) to the promoter.

The economic life of an asset could be different from its actual physical life. For example, a technology product can be in optimal physical condition but not anymore economically useful to the promoter as it became obsolete.

When a project includes assets with different economic lives, a good practice is to set the reference period as the value-weighted average lifetime of these assets. This, however, should generally be restricted to a reasonable time limit of future forecastability of the net future economic cash flows, usually no longer than 50 years.

The reference period should include the years of both investment and operations (and decommissioning, when relevant).

Since the choice of the reference period affects the EA results (usually, the longer the reference period, the higher the economic performance), the project evaluators should check that the assumptions made on the project's economically useful life are realistic and justified. In this regard, it might be helpful to refer to standard benchmarks that are nationally or internationally accepted, and differentiated by sector. The sector annexes in Part II of the EAV provide some useful indications in this regard.

[25] However, when predefined conversion factors per cost item are made available in national guidelines, the conversion process is smooth and can already be adopted in a simplified CBA. Or, if VAT on construction cost is already known at the preliminary stage, it can be easily simply dropped off in the simplified CBA.

[26] However, when unit values are made available in the economic literature, as this is the case particularly for the transport sector, the valuation of externalities can be already integrated in a simplified CBA.

[27] Commission Delegated Regulation (EU) No 480/2014 of 3 March 2014 supplementing Regulation (EU) No 1303/2013 of the European Parliament and of the Council laying down common provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund, the European Agricultural Fund for Rural Development and the European Maritime and Fisheries Fund and laying down general provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund and the European Maritime and Fisheries Fund (https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02014R0480-20150511&from=EN).

Social discount rate

Costs and benefits occurring at different times should be discounted using the SDR.

The SDR reflects the long-term opportunity cost of resources for society as a whole. The SDR is used in EA to recognise that consumers have an intertemporal preference to consume goods and services from the use of resources that are scarce and often competing. In other words, the resources allocated to one project have other potential uses, which are forgone.

Different approaches have been proposed in the literature to estimate the SDR. The approach recommended here is the social rate of time preference (SRTP) ([28]).

The Member States can assess their own country-specific SDRs following the formula presented in Annex II of the 2014 CBA guide ([29]) and taking into account the following recommendations.

- **Issues related to systemic risk and optimism bias should be reflected not in the SDR but in the risk assessment.** Systemic risks lead to a reduction in the value of the expected benefits if these benefits are positively correlated with a macroeconomic scenario. Rather than adjusting the discount rate, systemic risks can be handled in the EA by accounting them directly into the net benefits' streams and testing the robustness of the project's performance against changes in the main assumptions. This can be done by using base case values to be further tested in sensitivity analysis. Additional project risks including option bias should be addressed in a (qualitative and/or quantitative) risk assessment in line with Section 2.8 of the 2014 CBA guide.
- **The SDR can decline over the reference period in projects with very long-term impacts.** In the economic literature, there is some empirical support for the view that constant discounting is inconsistent with consumers' preferences. That is, in facing the decision between a smaller reward soon and a larger reward later, individuals would apply a lower discount rate in the long term. Time-inconsistent preferences would therefore justify using an SDR that declines over time. While the rationale for such an assumption is clear, the approach suggested here is that the SDR remains stable over the reference period. In most cases, the benefits and the costs arise during a limited number of years. That is, the reference period is 'short' enough to justify the use of a single SDR and to calculate the economic net present value (ENPV) with a negligible margin of error. Only projects with very long-term impacts (e.g. beyond 50 years), involving intergenerational equity considerations, should adopt declining discount rates.
- **The SDR should not vary across sectors based on policy considerations.** Sector-specific rates would imply that one project or sector has a higher opportunity cost than another, which is not consistent with the social rate of time preference-based approach.

In this regard, a forthcoming publication (Catalano et al., 2021) presents estimations of the SDR at the national level for a sample of countries and can be a useful reference. Based on their calculations with updated data (including forecasts of economic growth rates), the SDR would currently range from a maximum of 8.13 % for Estonia to 0.80 % for Italy (calculated following the SRTP method), with an EU average of 3.6 % and a median value of 2.8 %.

As a matter of simplification, in the absence of national values, 3 % SDR can be taken as a reference point for EU-funded projects in 2021–2027.

Finally, it is worth noting that the EA is usually carried out in constant (real) prices (i.e. with prices fixed at a base year). When the analysis is carried out at constant prices, the SDR should be expressed in real terms.

2.4 Topics not (fully) addressed in the 2014 CBA guide

Wider, induced and indirect effects

CBA is typically a microeconomic approach enabling the assessment of the project's first-level impacts on users and other stakeholders of a given catchment area. This implies that:

- wider impacts achieved through the multiplier effect (e.g. contributions to regional gross domestic product or unemployment rates) should be excluded from the analysis because they are usually transformed, redistributed and/or capitalised forms of the direct effects already captured in the CBA;
- induced impacts on local economies should also be excluded because of possible displacement effects; for example, an increase of business activities in the project area can be matched by an equal decrease elsewhere ([30]);
- indirect impacts on complementary markets (e.g. cost savings achieved by the promoter's suppliers, distributors, etc.) can be included, when relevant and provided that they are not already captured in the shadow prices of the project's inputs and/or outputs.

Historical costs

The initial investment cost consists of capital expenditures (CAPEX) for all fixed and non-fixed assets occurring during the implementation period. In the case of historical costs (i.e. expenditure already incurred before the start of the analysis), the approach recommended in the EAV is to include them in the analysis (i.e. they should not be considered sunk costs). Historical costs should be capitalised (using an average inflation rate based on the consumer price index) and included in the first year of the reference period.

[28] This is defined as the rate at which the consumers are willing to postpone a unit of current consumption in exchange for more future consumption.

[29] SRTP = $p + e \times g$, where p is the pure time preference, e is the elasticity of the marginal utility of consumption (i.e. the percentage change in individuals' marginal utility corresponding to each percentage change in consumption) and g is the expected growth rate of per capita consumption. As an example, evidence of the empirical estimation of the SDR for 20 European countries is presented in Florio (2014).

[30] Unless boosting a given geographical area/region is itself an objective of the project.

The rationale is that, in the context of EU co-financed projects, the main question is not 'should the project be continued?', as this would matter in, for example, the case of purely private investments. Instead, the question is 'do the expected net benefits justify an investment that is paid with EU taxpayers' money?'. In this regard, to protect EU taxpayers' interests, the analysis of a project's economic viability should focus on the whole investment cost ([31]).

In-kind contributions

In-kind contributions supplied during either implementation or operation periods should be included in the analysis at (at least) their market value, even if they do not correspond to an actual financial cash flow.

Operating costs benchmarking

Whenever the investment is operated in house (i.e. there is no competition for selecting the operator), there is a major risk that the operation and maintenance (O&M) costs are overdue. This, in turn, reduces the economic performance of the project. To reduce this risk, the proposed O&M costs should always be checked against sectoral 'best benchmarks', which can be effectively reached through revised concession contracts between the public entities and the in-house operators, built on performance-based provisions.

Climate risk assessment and adaptation to climate change

The climate risk assessment provides a structured method of analysing relevant climate hazards and their related impacts to provide information for decision-making in relation to the proposed investment. Any potential significant risks to the project due to climate change should be managed and reduced to an acceptable level by relevant and commensurate adaptation measures.

Different adaptation measures should be assessed to find the right measure or mix of measures or even to consider deferred implementation timings (flexible/adaptive measures) that can be implemented to reduce the risk to an acceptable level. The selected measure(s) should then be integrated into the project design and/or its operation to enhance its climate resilience. Their costs (either CAPEX or operating expenses (OPEX)) are entered as inputs (outflows) into the EA of the project.

The European Commission's technical guidance on the climate proofing of infrastructure in 2021–2027 provides detailed guidance on how to carry out a climate risk assessment ([32]).

2.5 Updates and developments

Shadow prices for selected projects' inputs

According to the CBA guiding principles, cost items should be valued at their opportunity cost. The suggested approach is to convert them into shadow prices. The method generally used is to apply a set of conversion factors (CFs) to the project financial costs. In principle, CFs should be made available at the national level by a planning office and not calculated on a project-by-project basis.

In practice, however, distortions in investment projects in Europe are not so substantial; therefore, for most elements, it can be assumed that their shadow pricing corresponds to market prices.

Thus, when national parameters are not available, the default rule is that market prices equal shadow prices (i.e. CF = 1), with the exception of the items illustrated in Table 3. Labour, land, utilities and commodities are those items most frequently affected by market distortions, which an analysis of their opportunity cost is always recommended for.

Table 3. Shadow prices for selected projects' inputs

Item	Why?	Shadow price method
Labour	In the presence of unemployment, without the project, unskilled workers could remain unemployed or employed in worse economic conditions	Shadow wage
Land	Land can be expropriated by the public sector at a price different from the market value or given for free to project promoters	Market value
Utilities	To boost a given industry/sector or to attract investments, businesses can profit from subsidised prices to purchase electricity, gas and water. Energy prices are also frequently distorted by taxes and externalities	Long-run marginal cost
Commodities imported from outside the EU	Duties or quotas on imports can be introduced to protect domestic markets	Border price

[31] Some (marginal) exceptions may apply in the case of minor investment items that occurred in the very distant past, for instance feasibility studies that become outdated or the purchase of land that cannot be recovered and therefore its opportunity cost is close to zero.

[32] European Commission (2021), Technical guidance on the climate proofing of infrastructure in the period 2021-2027, C(2021) 5430 final, European Commission, Brussels (https://ec.europa.eu/clima/sites/default/files/adaptation/what/docs/climate_proofing_guidance_en.pdf).

Residual value

When the reference period is set equal to the project's economic life the residual value is normally zero. However, in cases in which, at the end of the reference period, some assets/components are still economically useful or there is a market for their resale, a residual value benefit may be included in the last year of analysis.

As regards the estimation of the residual value, unlike in 2014–2020, the method of using the remaining cash flow after the end of the reference period is no longer suggested as the preferred option. This is because of the current recommendation to set the reference period equal to the total economically useful life of the project (the two approaches are mutually exclusive, as they generate the same result).

The recommended approach is therefore to calculate the remaining value of the assets/components based on a standard accounting depreciation formula (book value).

In the case of projects with a very long economically useful life, however, it might not be convenient to show forecasts for their entire economic life (e.g. if this exceeds 50 years). In this case, the reference period can be shortened for the convenience of presentation and the residual value can be added and estimated as the (discounted) remaining cash flow of costs and benefits.

Climate change mitigation

The methodology for the quantification of a project's impact on climate remains the one that was recommended in the 2014 CBA guide. The methodology consists in estimating, through appropriate emission factors, the net GHG emissions generated or avoided by the project compared with a baseline scenario. The resulting amount of generated/avoided GHG emissions in tonnes of carbon dioxide equivalent (CO_2e) should be valued in monetary terms with a shadow price of carbon (in Euro per tonne of CO_2e) ([33]).

In line with the EC technical guidance on the climate proofing of infrastructure in 2021–2027 ([34]), it is recommend to use as **shadow cost of carbon the values recently established by the EIB** as the best available evidence on the cost of meeting the temperature goal of the Paris agreement (i.e. the 1.5 ⁰C target) ([35]) (Table 4).

Table 4. Recommended shadow cost of carbon for 2020–2050 (*)

Year	EUR / t CO_2e	Year	EUR / t CO_2e	Year	EUR / t CO_2e	Year	EUR / t CO_2e
2020	80	**2030**	250	**2040**	525	**2050**	800
2021	97	**2031**	278	**2041**	552		
2022	114	**2032**	306	**2042**	579		
2023	131	**2033**	334	**2043**	606		
2024	148	**2034**	362	**2044**	633		
2025	165	**2035**	390	**2045**	660		
2026	182	**2036**	417	**2046**	688		
2027	199	**2037**	444	**2047**	716		
2028	216	**2038**	471	**2048**	744		
2029	233	**2039**	498	**2049**	772		

(*) Prices in Euro 2016

Source: DG CLIMA (2021)

Project ranking

The project's overall socioeconomic performance is measured by the following indicators:

- **ENPV** – this is the difference between discounted total social benefit and social cost, valued at shadow prices, and is expressed in monetary values;
- **ERR** – this is the SDR producing a zero value of the ENPV and is expressed in percentage points;
- **benefit/cost (B/C) ratio** – this is the ratio between discounted economic benefits and costs.

The project is economically viable when the ENPV is positive, the ERR is larger than the SDR and the B/C ratio is greater than 1.

[33] In case of projects that offset emissions through the purchase of emission permits, including cap and trade (such as the European Emission Trading System), care should be paid to avoid any double counting. For example, increase of emissions can be offset by purchasing emission permits, which result in net zero emissions. In other words, CBA has to discriminate between situations where there are offsets and where there are not.

[34] See footnote 30.

[35] In 2020, the EIB was engaged in a review of the latest evidence on the cost of carbon, in particular drawing from modelling results that formed the basis of the Intergovernmental Panel on Climate Change *Special Report on Global Warming of 1.5 ⁰C*. In the light of the Paris Agreement, the review of the EIB's carbon pricing approach focused on the full cost of the marginal measure required to drive the economy to meet the 1.5 ⁰C global temperature target (abatement cost approach; see https://www.eib.org/en/publications/the-eib-group-climate-bank-roadmap).

As illustrated in Annex XI of the 2014 CBA guide, each indicator has its own particular merit, pros and cons. In this respect, the choice of economic indicator to be used for selecting options (or when ranking alternative projects) depends on the circumstances.

When comparing options within a single investment proposal, usually the better performing option has both a larger ENPV and a larger ERR than the option performing less well. There might be, however, some (infrequent) cases in which, owing to the different scales of the options, one has a larger ENPV but a smaller ERR than the other. In such a case, it is suggested that the ERR is used because it would (usually) allow the promoter to save resources that could be reused for additional investments ([36]).

In ranking alternative projects from a group, if there is a constraint on the number of projects that can be financed, then the ENPV should be used as the default indicator. By contrast, in the more frequent case of projects competing under budget constraints, the ENPV becomes less relevant (because it is biased towards more expensive projects) and the ERR is the preferred option, provided that it can be calculated for all projects.

Owing to its limitations, it is not recommended to use the B/C ratio to rank options/projects ([37]).

Stakeholder engagement

Stakeholder engagement (SE) is the process of identifying and incorporating stakeholder concerns, needs and values in the decision-making process. The overall goal is to achieve a transparent decision-making process with greater input from stakeholders and their support on the decisions that will be taken. **To secure successful project implementation and operations, stakeholders should be involved during the process of project preparation following a participatory approach.** The advantages of SE include an increase in the reliability and legitimacy of the public administration, an increase in the sense of social responsibility among local communities related to the project, an increase in social equity and a decrease in barriers.

As discussed in Section 2.8.10 of the 2014 CBA guide, stakeholder identification and an analysis of the distributional effects of the project are useful complements to the results of the CBA, helping to meet the objective of putting into practice a clear decision-making process with a strong involvement of stakeholders to support the project decision. In operational terms, **a matrix can be developed, linking each project impact with the sectors and the stakeholders affected by such impacts**.

While traditional CBA does not explicitly consider SE in its computation, there are some recent developments in this field attempting to monetise the costs and benefits of SE (e.g. the cost of engaging stakeholders (events, negotiations, etc.) and the benefits of their participation) ([38]).

[36] The option with the larger ERR, usually, has a smaller investment cost than the option with the larger ENPV.

[37] As discussed in Annex XI of the 2014 CBA guide, the B/C ratio is sensitive to the classification of the project effects as benefits rather than costs. It is relatively common to have project effects that can be treated both as benefits and as cost reductions and the converse. As the B/C ratio rewards projects with low costs, considering a positive effect as a cost reduction rather than a benefit would result in only an artificial improvement of the indicator.

[38] One of the first attempts proposed in the international literature related to the introduction of SE within CBA was that of Pagliara and Di Ruocco (2018). In this paper, the authors recomputed all of the costs and benefits of the Turin–Lyon high-speed rail project following an *ex post* approach. They demonstrated how the monetisation of the costs and benefits of SE could provide a way forward in project evaluation.

3. OTHER ECONOMIC APPRAISAL TOOLS

3.1 Least-cost and cost-effectiveness analyses

CEA is used to compare two or more project options in relation to their effectiveness and life-cycle costs in accomplishing a single policy-specific objective. By combining information on effectiveness and costs, the project promoter can determine which investment option provides the best effect at the lowest cost (or, conversely, which option provides the highest effect for a given cost). In this respect, CEA can take the forms of cost minimisation or effect maximisation.

Like CBA, CEA is a method used for the evaluation of a project's effects at the microeconomic level. CEA differs from CBA because it does not evaluate the benefits in monetary terms. This is based on the **assumption that all options considered are technically and economically viable and deliver the same single typology output (or process the same single type of input) even if in different intensities/volumes**.

Table 5 reviews the differences between CBA and CEA in terms of the inclusion and treatment of the main project's cash flow items.

Table 5. Differences between CBA and CEA

Cash flow items	CBA	CEA
CAPEX	Yes (shadow price)	Yes (market price)
OPEX	Yes (shadow price)	Yes (market price)
Residual value	Yes (shadow price)	Yes (market price)
Revenues	No (*)	Yes (market price) (**)
Outputs / direct effects	Yes (in monetary terms)	Yes (in quantitative terms only)
Externalities	Yes	No (***)

(*) Unless not used as a proxy of willingness to pay for the services rendered by the project.

(**) However, when there is only one revenue and this reflects cost-based fees following regulatory considerations, its inclusion can be omitted as not affecting the results of the comparison.

(***) In the energy sector, however, it is common practice to quantify in monetary terms air pollutants and GHG emissions and include them in the CEA ratio.

If the options achieve the same output with the same intensity/volume, they differ only in costs, and the CEA can be simplified to an LCA, whereby options are compared based only on the present value of their life-cycle costs.

CEA usually aims to identify the possible alternatives for achieving a set goal and the related costs, and to choose the most effective option. That is, it allows us to choose which one among several alternatives is most cost-effective, but it does not tell us if an alternative is worthwhile in some absolute sense. In other words, unlike CBA, CEA cannot indicate if the preferred option provides a net benefit to society. Therefore, it is always useful to compare the results of the analysis with established benchmarks to verify that the chosen option meets the generally acceptable cost performance criteria.

When an option is both more effective and less costly than the alternative, it is said to 'dominate' the alternative. In this situation, there is no need to calculate cost-effectiveness ratios, because the decision on the strategy to choose is obvious.

However, in most circumstances, the option under examination is simultaneously more (or less) costly and more (or less) effective than the alternative(s). In this situation, **cost-effectiveness ratios allow appraisers to rank the options**, eliminate those whose cost-effectiveness ratio is higher than others and then identify the optimal option.

The 'levelised cost' concept is often used to assess the project's cost-effectiveness.

The **levelised cost** is a life-cycle cost indicator, commonly used to gauge long-run unit costs. It is calculated as the ratio of the present value of the total (capital, operating, replacement and decommissioning, if relevant) costs over the entire project reference period to the present value of the total amount of output produced over the same time horizon ([39]).

When the project does not generate revenue, and all options have the same economic lifetime, the levelised cost can be used directly as a cost-effectiveness ratio. This is the most common application of the CEA for EA.

On the other hand, when the project options are revenue generating, and when the reference period is not equal to the economic lifetime of the asset, revenues and residual value must be calculated and included in the analysis.

[39] This is the simplest and most commonly used definition of levelised cost based on financial items (market prices). In some cases, in particular in the energy sector, it is possible to calculate levelised costs based on economic items (shadow prices), which are also a factor in the margin cost of externalities.

The cost-effectiveness ratio can therefore be calculated by the following formula:

$$Ratio = \frac{\sum_{t=i}^{t=n}(CF_i)}{\sum_{t=1}^{t=n}(Q_i)}$$

where:

CF_i is the discounted sum of CAPEX + O&M ([40]) – revenue – residual value

Q_i is the discounted changes in outputs (quantity).

Finally, this indicator can also easily be adapted to incorporate key economic externalities (e.g. carbon dioxide and air pollutant emissions), when these differ substantially between the options appraised. When this indicator is negative, externalities can be included as costs in the numerator of the formula ([41]).

The CEA methodology is often used in the economic evaluation of **healthcare programmes**, but it can also be used to assess some **education and environmental** projects. For these examples, simple CEA ratios are used, such as the cost per student, cost per unit of emission reduction, cost per unit of water, wastewater or waste treated, and so on.

CEA is less helpful when a money value can also be given to the benefits, not just to the costs. In addition, CEA cannot be used to compare projects or programmes with several different outcomes or objectives that are not directly comparable.

To sum up, CEA is a practical tool for project comparison when the following conditions apply:

- the project produces only one output that is homogeneous and easily measurable;
- the aim of the project is to achieve the output at minimal cost;
- costs can be completely assessed for each alternative (i.e. hidden costs are more or less irrelevant);
- there is a wide range of benchmarks to verify that the chosen technology meets the minimum cost performance requirements.

3.2 Multi-criteria analysis

The MCA methodology can be useful at both programme and project levels.

At the project level, it is recommended to consider the MCA as a tool to complement CBA, CEA and/or LCA, for example to compare project strategic options (see Section 1.3). This practice was already recommended and used during the 2014–2020 MFF for the appraisal of major projects. The use of simple MCA as a tool for the analysis of options in project appraisal is described in Annex IX of the 2014 CBA guide, as well as in Chapter 9 of *The economic appraisal of investment projects at the EIB* (EIB, 2013a), and is not repeated here.

This section provides additional practical indications on how to perform an MCA at the programme level, where it is advisable to use a policy-led MCA (PLMCA) ([42]).

A PLMCA could be used to assess multisectoral territorial programmes (e.g. regional transition and urban development programmes) or to prioritise and select projects within a given policy area or projects that have multiple sites/objectives (e.g. smart specialisation or integrated programmes dealing with climate change). At such programme levels, PLMCA can provide a clear record of the decision-making process, which is particularly useful when projects need to be prioritised from a larger pool of alternatives. PLMCA assigns scores based on a process that starts with the highest level objectives informed by existing policies, and it illustrates the steps taken to reach the final decision. Annex X of Part II of the EAV provides an example of a PLMCA used to assess an urban regeneration programme.

PLMCA aims to provide a sound basis for programme/investment plan evaluation by referencing an explicit set of objectives that decision-makers have identified on the basis of existing policies (at local, regional, national, EU and other international levels). Decision-makers establish both measurable criteria and proxy indicators to assess the extent to which the objectives are likely to be met.

There are many ways to design a PLMCA exercise. However, a 'typical' approach (e.g. the one shown in Annex X of Part II of the EAV) usually comprises some standardised steps:

- **Problem structuring.** This step defines the context in which the programme takes place, the stakeholders' standpoints that are to be considered and the definition of the overarching policy framework and associated objectives to enable decision-making. These objectives should not be redundant, but could be competing (the achievement of one objective could partly preclude the achievement of another). The decision-makers should assign a weighting to each objective in order to reflect its relative importance. It is highly desirable that the definition of the policy objectives is guided by reference to international, national and local policy goals alongside secondary information sources. Within a given policy area (transport, environment, urban development, etc.), typical objectives refer to institutional, social, territorial, environmental, technical, financial and

[40] This includes replacement costs.

[41] In this case, the CEA embraces some aspects typical of CBA (i.e. the monetary evaluation of externalities) and can be regarded as an 'in between' methodology or a simplified CBA. This approach applies in particular to energy investments.

[42] The PLMCA tool represents the output of a holistic and consistent approach to the appraisal of programmes by aligning programme objectives with policy and identifying qualitative and quantitative criteria/indicators for measuring performance objectives.

economic dimensions.

- **Model building.** Once the policy framework and the set of objectives have been determined, a technique should be defined to aggregate information and to make an informed choice. This step focuses on defining, for each objective, a number of appraisal criteria or indicators. Appraisal criteria or indicators can be qualitative or quantitative and they can refer to the priorities pursued by the different parties involved or to particular evaluation aspects. When relevant, minimum thresholds can be set for some criteria for the programme to be accepted.
- **Analysis of impact and programme performance.** This step involves forecasting, for each of the objectives, the impact produced by the programme. All of the decision-makers must decide by consensus the scores that determine the performance in relation to each objective. It is important to note that application of the model is likely to include the consideration of both quantitative and qualitative aspects of performance, including, where feasible, outputs from CBAs ([43]). This process requires that the decision-makers review together how the programme delivers under each aspect represented by the columns in the PLMCA model.
- **Reporting results.** Scores under each objective are then aggregated to give a total score for the proposal as a whole (all dimensions considered). The results of the appraisal may either inform a decision directly or result in the need for further iteration (e.g. to adjust problem definition or the nature and weights applied to the objectives) and/or sensitivity testing.

To sum up, MCA is particularly suitable at the programme level to evaluate different investment configurations/scenarios, which may need to be supplemented with further economic analysis at the project level (CBA or CEA/LCA). Its key benefit is the appraisal of territorial investment programmes including those with cross-cutting objectives, such as smart specialisation plans, to set the framework for the individual investment projects. Such programmes pose a challenge if appraised using CBA/CEA methodologies because they cut across sectors and involve many dimensions (economic, technological, territorial, etc.).

The main limitation of MCA arises when assigning weights and allocating scores because of the potential discretion/subjectivity. Rules and good practices can be established to mitigate these shortcomings. For example, one good practice involves setting up focus groups to bring together the project's stakeholders in order to achieve a consensus on weightings and scores to be assigned to the objectives (as well as the programme objectives themselves).

Annex X of Part II of the EAV lists risks and potential remedies in the context of MCA.

[43] For example, the B/C ratio may be one criterion and a minimum value may be required. In this way, the CBA result is fully integrated into the MCA. Where CBA is not part of the MCA, capital and operating costs are important criteria. Similarly, not only policy objectives but also technical feasibility and risk criteria are often set, which may also have minimum thresholds.

APPENDIX I. Overview of existing cost–benefit analysis national guidance

Country	Sector	Subsector	Title of the guidance document	Source
Bulgaria	Transport		Requirements for Preparation of CBA in Transport Sector	http://www.rail-infra.bg/
Croatia	Transport	Road, rail	Smjernice za CBA za projekte prometnica i željeznica	
Cyprus	General		Manual for pre-selection and appraisal of public investment projects	http://www.dgepcd.gov.cy/dgepcd/dgepcd.nsf/
Czechia	Transport	Road, rail, Inland Waterways	Rezortní metodika pro hodnocení ekonomické efektivnosti projektu dopravních staveb – schváleno Ministerstvem dopravy dne 31.10.2017, aktualizace CBA tabulek schválena 24.9.2019	https://www.sfdi.cz/pravidla-metodiky-a-ceniky/metodiky/
Denmark	Topic specific		Practical Tools for Value Transfer in Denmark – Guidelines and an example	https://www2.mst.dk/udgiv/
Denmark	Transport	Cycling	CBA of Cycling	https://norden.diva-portal.org/smash/get/diva2:702237/FULLTEXT01.pdf
France	General		Guide de l'évaluation socioéconomique des investissements publics	https://www.strategie.gouv.fr/sites/strategie.gouv.fr/files/atoms/files/fs-guide-evaluation-socioeconomique-des-investissements-publics-04122017_web.pdf
France	Transport	All	Fiches outils du référentiel d'évaluation des projets de transport	https://www.ecologie.gouv.fr/evaluation-des-projets-transport
France	Transport	Public transport	Recommandations pour l'évaluation socio-économique des projets de TCSP	https://it.scribd.com/document/243815417/CERTU-Recommandations-pour-l-evaluation-socio-economique-des-projets-TCSP-pdf
Germany	Energy efficiency		Kosten-/Nutzen-Analyse von Instrumenten zur Realisierung von Endenergieeinsparungen in Deutschland	https://www.bmwi.de/Redaktion/DE/Publikationen/Studien/kosten-nutzen-analyse-von-instrumenten-zur-realisierung-von-endenergieeinsparungen-deutschland.pdf?__blob=publicationFile&v=7
Germany	Environment	Legislation impact assessment	Leitfaden zur Kosten-Nutzen-Abschätzung umweltrelevanter Effekte in der Gesetzesfolgenabschätzung	https://www.ecologic.eu/de/11154
Germany	Transport	Regional/local PT	Standardisierte Bewertung von Verkehrswegeinvestitionen im schienengebundenen ÖPNV – Version 2016 – Intraplan Consult GmbH	https://www.intraplan.de/
Germany	Transport	Major transport projects	Methodology manual for the federal transport infrastructure plan 2030	https://www.bmvi.de/SharedDocs/EN/Documents/G/methodology-manual-for-the-ftip-2030.html
Hungary	General		Módszertani útmutató TOP és VEKOP területi kiválasztási eljárásrendű projektek költség-haszon elemzéséhez	https://www.ozd.hu/content/
Hungary	Transport	Road, rail	Módszertani útmutató egyes közlekedési projektek költség-haszon elemzéséhez	https://www.palyazat.gov.hu/node/54834
Ireland	General		Public Spending Code – A guide to economic appraisal: carrying out a cost benefit analysis	https://www.gov.ie/en/publication/public-spending-code/
Ireland	Topic specific		Public Spending Code Supplementary Guidance – Measuring & valuing changes in greenhouse gas emissions in economic appraisals	https://www.gov.ie/en/publication/public-spending-code/
Ireland	Topic specific		Central Technical Appraisal Parameters	https://igees.gov.ie/wp-content/uploads/2019/07/Parameters-Paper-Final-Version.pdf
Ireland	Transport	Roads	Project Appraisal Guidelines for National Roads	https://www.tiipublications.ie/

Ireland	Transport	All	Common Appraisal Framework	https://www.gov.ie/en/organisation-information/800ea3-common-appraisal-framework/
Ireland	Transport	All	2016 guidelines on a common appraisal framework for transport projects and programmes	https://www.gov.ie/en/organisation-information/800ea3-common-appraisal-framework/
Italy	General		Guida all'analisi costi-benefici dei progetti d'investimento	https://www.invitalia.it/chi-siamo/area-media/notizie-e-comunicati-stampa/fondi-europei-online-la-guida-all-analisi-costi-benefici-dei-progetti-di-investimento
Italy	Transport	All	Linee guida per la valutazione degli investimenti in opera pubbliche nei settori di competenza del Ministero delle Infrastrutture e dei Trasporti	https://www.mit.gov.it/sites/default/files/media/notizia/2017-07/Linee%20Guida%20Val%20OO%20PP_01%2006%202017.pdf
Italy	Transport	Urban	Tabelle di sintesi dell'analisi della mobilità urbana/ACE/ACB	https://www.mit.gov.it/sites/default/files/media/documentazione/2018-10/Appendice%20all%27ADDENDUM.pdf
Lithuania	General		Metodikos ir modelio, skirto įvertinti investicijų, finansuojamų europos sąjungos struktūrinių fondų ir lietuvos nacionalinio biudžeto lėšomis, socialinį-ekonominį poveikį, sukūrimas galutinė ataskaita	http://www.ppplietuva.lt/wp-content/uploads/2015/06/SNA_metodika_galutine_ataskaita.pdf
Malta	General		Guidance manual for cost benefit analysis (CBAs) appraisal in Malta	https://eufunds.gov.mt/en/Operational%20Programmes/Useful%20Links%20and%20Downloads/Documents/Guidance%20Manual%20for%20CBAs%20Appraisal_May2013.pdf
Netherlands	General		General Guidance for Cost-Benefit Analysis	https://www.pbl.nl/sites/default/files/downloads/pbl-cpb-2015-general-guidance-for-cost-benefit-analysis_01512.pdf
Northern Ireland	General		Northern Ireland guide to expenditure appraisal and evaluation (NIGEAE)	https://www.finance-ni.gov.uk/topics/finance/northern-ireland-guide-expenditure-appraisal-and-evaluation-nigeae
Norway	General		Cost-Benefit Analysis	https://www.regjeringen.no/
Norway	Transport		Transport for NSW Cost-Benefit Analysis Guide	https://www.transport.nsw.gov.au/projects/project-delivery-requirements/evaluation-and-assurance/transport-for-nsw-cost-benefit
Poland	Transport	Road	Niebieska Księga Infrastruktura drogowa (Blue Book Road Infrastructure)	https://www.pois.gov.pl/strony/o-programie/dokumenty/niebieskie-ksiegi-dla-projektow-w-sektorze-transportu-publicznego-infrastruktury-drogowej-oraz-kolejowej
Poland	Transport	Railways	Niebieska Księga Sektor kolejowy Infrastruktura kolejowa	http://www.pois.gov.pl/strony/o-programie/dokumenty/niebieskie-ksiegi-dla-projektow-w-sektorze-transportu-publicznego-infrastruktury-drogowej-oraz-kolejowej/
Poland	Transport	Public transport	Niebieska Księga Sektor Transportu Publicznego w miastach, aglomeracjach, regionach	http://www.pois.gov.pl/strony/o-programie/dokumenty/niebieskie-ksiegi-dla-projektow-w-sektorze-transportu-publicznego-infrastruktury-drogowej-oraz-kolejowej/

Poland	General		Guidelines on issues relating to the preparation of investment projects, including revenue generating projects and hybrid projects for the period 2014–2020	https://www.funduszeeuropejskie.gov.pl/media/5193/NOWE_Wytyczne_PGD_PH_2014_2020_podpisane.pdf
Romania	Environment	Water and wastewater	Metodologie de analiză cost-beneficiu pentru investițiile în infrastructura de apă și canalizare finanțate din fonduri publice	https://www.fonduri-structurale.ro/stiri/18389/poim-metodologie-de-analiza-cost-beneficiu-pentru-investitiile-in-infrastructura-de-apa-si-canalizare
Romania	Environment	Solid waste	Guidelines for cost benefit analysis of solid waste projects to be supported by the Cohesion Fund and the European Regional Development Fund in 2007–2013	
Romania	Transport	All	Romania general transport master plan, national guide for transport project evaluation, Vol. 2 – Appendix A: guidance on economic and financial cost benefit analysis and risk analysis	http://www.mt.gov.ro/web14/documente/master_plan/Volume%202_Appendix%20A_CBA%20Guidance_En.pdf
Slovakia	Environment	Waste, water, air, prevention of risks, remediation of polluted areas	Príručka k analýze nákladov a prínosov environmentálnych projektov	https://www.minzp.sk/files/iep/cba_metodika.pdf
Slovakia	Transport	Road, rail	Metodická príručka k tvorbe analýz výdavkov a príjmov (CBA)	https://www.opii.gov.sk/metodicke-dokumenty/prirucka-cba
Spain	Transport	All	Economic evaluation of transport projects	http://www.evaluaciondeproyectos.es/EnWeb/Results/Manual/PDF/EnManual.pdf
Sweden	Transport	All	Economic principles and calculation values for the transportation sector: ASEK 6	
United Kingdom	General		The Green Book – Central government guidance on appraisal and evaluation	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/938046/The_Green_Book_2020.pdf

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Part II - Sector Applications

ACRONYMS

CAPEX	capital expenditures
CBA	cost–benefit analysis
CEA	cost-effectiveness analysis
CO_2	carbon dioxide
DALY	disability-adjusted life year
EA	economic appraisal
EAV	Economic Appraisal Vademecum
EIB	European Investment Bank
EPBD	energy performance of buildings directive
ERR	economic rate of return
ERTMS	European rail traffic management system
ETCS	European train control system
GDP	gross domestic product
GHG	greenhouse gas
GJ	gigajoule
GSM-R	global system for mobile communications for railway
GWh	gigawatt-hour
IPTV	internet protocol television
JASPERS	Joint Assistance to Support Projects in European Regions
LCOE	levelised cost of electricity
LCOH	levelised cost of heat
LRMC	long-run marginal cost
LUC	levelised unit cost
Mbps	megabits per second
MCA	multi-criteria analysis
Mtoe	million tonnes of oil equivalent
MWh	megawatt-hour
MWh_{el}	megawatt-hour of electrical energy
NO_x	nitrogen oxides
NPV	net present value
O&M	operating and maintenance
OPEX	operating expenses
PLMCA	policy-led multi-criteria analysis
PM	particulate matter
RES	renewable energy source
RI	research and innovation
SO_x	sulphur oxides
VOT	value of time
WFD	water framework directive
WTP	willingness to pay

ANNEX I. RESEARCH AND INNOVATION

I.1. Introduction

This chapter discusses the use of CBA for investments in Research and Innovation (R&I), a sector that is at the core of the EU's development policies and funding programmes in 2021–2027. The methodology presented was developed in the 2014–2020 programming period for the *ex ante* analysis of investments in infrastructure and applied to numerous types of projects, from science parks and innovative manufacturing facilities to university campuses. The focus was on basic and applied research facilities, which have a broad range of benefits that overlap with other types of infrastructure in the sector. This chapter retains this focus and is, therefore, likely to be most applicable for strategic infrastructure projects in R&I, including those that could be financed by the InvestEU fund. The methodology should also be relevant for research-funding programmes and other non-infrastructural investments financed from Horizon Europe and other funding mechanisms.

The information provided is complementary to the methodology presented in the 2014 CBA guide, which was further developed in the JASPERS staff working paper *Economic analysis of research infrastructure projects in the programming period 2014–2020* (JASPERS, 2017).

The economic appraisal of infrastructures and programmes engaging in research will, to varying extents, be subject to a common problem: the impact of the research can be difficult to predict, fully capture and monetise. While this is particularly true of fundamental research, the unpredictability of the economic benefits of R&I is inherent to the field. It is a factor that any quantitative method that attempts to predict the economic impact of research is likely to encounter.

For this reason, a promoter may judge CBA to be an inappropriate mode of assessment for certain investments in 'blue sky' research, namely where the research outputs and the eventual benefits realised by society are not immediately apparent. In these instances, it may still be useful to quantify the outputs of the research where possible (e.g. the number of publications) and describe their impact qualitatively instead of attempting to monetise the benefits.

I.2. Project development cycle and methods

The economic analysis of a project can be performed at various stages of the development cycle of R&I . The CBA model described in this document may be used by project promoters as part of a comprehensive *ex ante* analysis of the economic impact of a proposed investment or in a simplified form to compare the economic viability of alternative project configurations ([1]) (usually as part of a multi-criteria analysis (MCA) exercise) during the option analysis.

Promoters will need to carry out additional analyses to facilitate the CBA. As a minimum, beneficiaries should analyse the demand for the infrastructure and its outputs, consider the alternative options for reaching the objectives of the investment and model the future financial performance and sustainability of the infrastructure and beneficiary. Each of these analyses provides information and inputs that are required to perform a CBA. The 2014 CBA guide outlines these steps in detail.

Table 1 provides a summary of the questions and information that project promoters and decision-making bodies should consider when preparing or appraising the demand and options analyses.

I.3. Economic appraisal

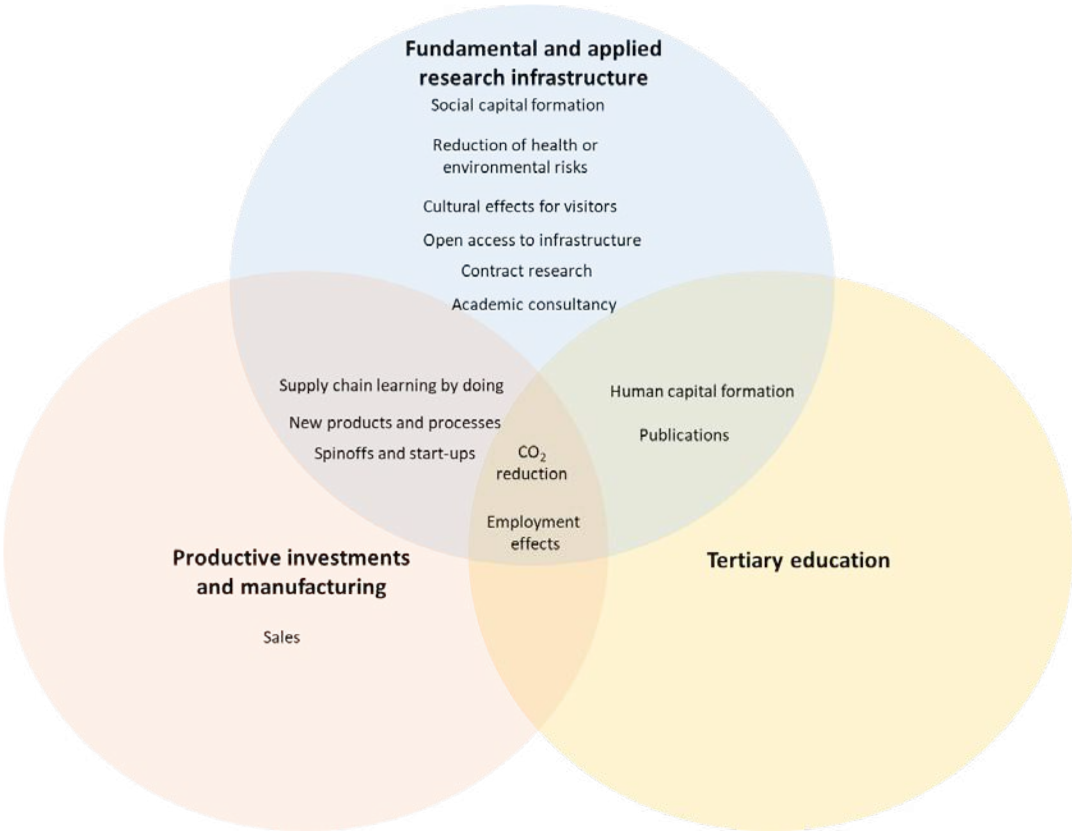
A variety of methods are used in the economic appraisal of R&I depending on the scope of the analysis, the type of impacts that are assessed and the target users. The methods range from quantitative approaches, such as macroeconomic modelling or cost–benefit analysis (CBA), to more qualitative approaches such as narratives and case studies. While there is not a single methodological approach in its original formulation that can appropriately answer all of the questions that an EA addresses, the CBA is one of the most scientifically robust analytical frameworks for evaluating welfare changes attributable to R&I (see Giffoni and Vignetti, 2019).

Figure 1 illustrates at glance the **common economic benefits associated with the different types of infrastructure** discussed in this chapter. Table 2 below provides a description of benefits, methods to calculate their value and potential sources of data to perfrom a CBA. Additional benefits should be considered depending on the objectives of the specific project ([2]).

[1] Configurations of R&I infrastructure projects include aspects such as location, choice of technologies, operating model and size.

[2] A full explanation of the methodologies can be found in JASPERS (2017). Readers should also consult Florio (2019).

Figure 1. The economic benefits of R&I infrastructure



NB: CO_2, carbon dioxide.

Source: Authors.

Table 1. Information to be considered in the demand and option analyses, by infrastructure type

Analysis	Basic and applied research	Investments in innovative manufacturing	Tertiary education
Demand analysis	- Has the need for investment been demonstrated? Is there a gap analysis of equipment, infrastructure and staff? - Is the equipment requested justified and reasonable in view of the intended research results? - Is there demand/buy-in from researchers for the project? - Is there a market for research outputs? - Is there demonstrated interest from industry for the infrastructure and its outputs? - Is the project aligned with national and/or regional strategies?	- Are the sales forecasts justified by market analysis? - Has the competition been analysed? - How vulnerable is the project to regulatory changes? - How will the innovation help to retain or accelerate the company's market share? - Does the company have a track record of introducing innovations into the market? - Is the whole value chain aligned (e.g. sufficient supply for production) with the offering of the new good/service?	- Do economic and demographic trends support the need for the investment? - Are tuition fees falling or rising nationally or being introduced? - What are the dropout and repetition rates of the institution? - What are the past and future enrolment rates? - What is the ratio of graduates to students enrolled? - Is there evidence of demand for skilled labour in the academic disciplines concerned?
Option analysis	- Is the scale of the infrastructure and equipment justified? - What impact will the investment have on regional development? - What are the alternatives to the investment? Could the beneficiary rent or share facilities or make use of existing facilities owned by another institution?	- Is the choice of technology, suppliers, site, etc. sensible? - Should a new plant be built or the existing one enlarged/modernised? - Is the scale of the infrastructure justified?	- Is the scale of the infrastructure justified? - What are the alternatives to the investment? Could the beneficiary rent or share facilities or make use of existing facilities owned by another institution?

Table 2. A summary of economic benefits, quantification methods, valuation calculations and data sources, by infrastructure type

Infra-structure type	Description	Benefit	Quantifica-tion method	Value calculation	Potential data sources	Considerations and lessons learned
RI, IM	Establishment of spin-offs and start-ups	Incremental shadow profits generated by spin-offs and start-ups	Number of jobs	Number of newly established entities × average number of employees per entity × shadow profit per employee	National accounts. Data should be available on gross operating surplus of one employee in the scientific research and development sector (Nomenclature of Economic Activities (NACE) sector M.72)	The estimated number of newly established entities should be based on the track record of the promoter or comparable institutions
RI, IM	Develop-ment of new/improved products and processes	Benefit attributed to patents granted	Market value as proxy for WTP	Market value of patent × num-ber of patents granted	EIB (2013), European Commission and World Intellectual Property Organization	The estimated number of patents should be based on the track record of the promoter or comparable institutions. On average, patents represent a cost; therefore, the estimated market value should be conservative
IM	Sales	Increases sales as a result of the investment	Incremen-tal shadow profit	Net present value of incremental profit gross of depreciation, taxes and interest (assuming shadow prices equal market prices)	Beneficiary's data	
RI	'New knowl-edge'	Benefit to society of new scientific publications by researchers who are users of the facility	Marginal production costs (re-muneration of authors)	(Average gross annual salary of scientist ÷ average per-centage of time researcher spends on one publication) × overall number of publications by project per year	Beneficiary's data	The estimated number of publications should be based on the track record of the promoter or comparable institutions, or averages for the discipline

RI, TE	Human capital formation	Benefit to society of an educated labour force	Market value as proxy for WTP	Economic benefit in year t = number of graduates in year t × (present value in year t of incremental gross salary ÷ average number of years of working career ahead of graduates)	Market values for the salaries of MA, MSc and PhD graduates can be taken from the Organisation for Economic Co-operation and Development statistics for the specific country and compared with statistics on average salaries	For the benefit to occur, there should be a bottleneck in the supply of courses so that, in the absence of the project, students do not receive it or have to go abroad bearing relocation costs
RI	Social capital development	Benefit from the creation of networks between researchers and between researchers and private companies (through conferences, networking events, etc.)	Market value as proxy for WTP	(Average travel costs + average event or conference fees paid by participants) + (average daily wage of attendee × days at event) × (average number of attendees) × (number of events or conferences organised per year)	Beneficiary's data	
RI	Reduction of health risks	Benefits to the general public of research that leads to a reduction in health risks	See Annex VIII	See Annex VIII		
RI	Cultural effects for visitors	Benefits from outreach activities to the general public (e.g. visitors, tourists)	Travel cost method or benefit transfer approach	Approach according to JASPERS working paper on cultural projects (JASPERS, 2011)		
RI, IM, TE	Climate change benefits (or costs)	Change in carbon footprint (if reduction then benefit, if increase then cost)	Incremental change in associated GHG emissions valued per tonne of CO_2e	GHG savings in CO_2e × shadow price of CO_2e	Commission notice on technical guidance on the climate proofing of infrastructure in 2021–2027 (EC 2021)	

RI, IM	Learning-by-doing benefit	Economic benefit to firms supplying equipment for RDI infrastructure	Incremental shadow profit	Volume of high-tech procurement × sales multiplier × average profit margin	Beneficiary's data	The benefit should apply only when the suppliers are local; otherwise, the benefit is lost
RI	Open access to RI	The value of research carried out by visiting researchers with open access to the RDI facility	The same productivity is assumed for open access as for project promoters	Economic benefits per unit of capacity used by project promoter × units of capacity to be utilised by visiting researchers under open access policy	Beneficiary's data	
RI	Fee-paying access to RI	Value of research carried out by paying users with access to the facility	Market value as a proxy for benefit	Fees paid by private sector for access to the facility; alternatively, a WTP approach	Beneficiary's data	
RI	Benefits arising from academic consultancy or contract research	Value of research carried out for public or private sector on the basis of contract research or a consultancy contract	Market value as proxy for WTP	Average financial revenues from contracts × number of research contracts	Beneficiary's data	The estimated value and number of contracts should be based on the track record of the promoter or comparable institutions

NB: CO_2e, carbon dioxide equivalent; GHG, greenhouse gas; IM, innovative manufacturing; RI, research, development and innovation; RI, research infrastructure; TE, tertiary education; WTP, willingness to pay.

ANNEX II. RENEWABLE ENERGY

II.1. Introduction

The EU has set itself an objective to reach carbon neutrality by the middle of the century. According to the pathways to reach 'net zero' greenhouse gas (GHG) emissions by 2050 developed by the European Commission, the power sector will need to have almost fully decarbonised by 2040. Similarly, although at a somewhat slower pace, the decarbonisation of the heating sector is also required to reach net zero emissions by 2050.

In the medium term, the EU climate and energy framework had initially set a target of a 40 % reduction in GHG emissions (compared with 1990 levels) by 2030; this includes a binding target of renewable energy sources (RESs) making up 32 % in EU final consumption by 2030.

Following a proposal from the European Commission, however, the European Council has recently endorsed a more ambitious binding EU target of a net domestic reduction of at least 55 % in GHG emissions by 2030 (compared with 1990). Higher RES penetration targets for 2030 will accordingly be required. The country-specific targets and the measures put in place to achieve them are presented in the national energy and climate plans of the Member States. The legal framework for the promotion of RESs in the EU is set out by the 'recast' of the renewable energy directive (Directive (EU) 2018/2001).

Several instruments in the EU budget (e.g. the 'greener, carbon free Europe' policy objective of the European Structural and Investment Funds, the Just Transition Fund and the Modernisation Fund) can support investments in renewable energy. In addition, in the context of its 'climate bank roadmap' (EIB, 2020), the European Investment Bank (EIB) is planning to strengthen its financial and advisory support for the decarbonisation of energy supply on the basis of the criteria set out in its energy lending policy (EIB, 2019).

The objective of this chapter is to provide an overview of the EA of investments in renewable energy generation in the electricity and heating sectors.

II.2. Project development cycle and methods

At the stage of prefeasibility/strategic option analysis, the assessment of the 'levelised cost' of electricity (LCOE) or of heat (LCOH) is typically a good life-cycle, cost-effectiveness indicator to compare alternative technologies (see Box 1). This indicator can also easily be adapted to include the key economic externalities (e.g. carbon dioxide (CO_2) emissions), as discussed in the next paragraphs.

Box 1. The levelised cost

The levelised cost is a commonly used concept in energy economics, particularly when comparing alternative technologies. This is calculated as the ratio between (i) the present value of the project costs over its life cycle and (ii) the present value of the supplied power/heat over the same reference period. Assuming that, in the long run, all production factors (including capital) are variable, the indicator can be used as a proxy for the long-run marginal cost of a given technology or a project. By adding to the project costs the shadow cost of 'externalities', the levelised cost can also be estimated in socioeconomic terms.

Here we will assume, for example, that we want to estimate the LCOH generation from the installation and operation of a new 20 thermal megawatt (MW_t) biomass hot-water boiler in a district heating system with an initial investment cost of EUR 9 million. Over the expected economic life (15 years of operations), the following costs, externalities ([3]) and heat generation are estimated:

	Net present value at 5%	2021	2022	2023	2024	2025	2030	2035
LCOH – biomass boiler (million EUR)								
Investment cost	8.4	4.5	4.5					
Fuel costs	25.6	—	—	2.7	2.7	2.7	2.7	2.7
Other operating and maintenance costs	2.5	—	—	0.3	0.3	0.3	0.3	0.3
Total costs (without externalities)	36.5	4.5	4.5	3.0	3.0	3.0	3.0	3.0
Shadow cost of CO2 emissions	—	—	—	—	—	—	—	—
Shadow cost of airborne pollutants	4.6	—	—	0.5	0.5	0.5	0.5	0.5
Total socioeconomic cost	41.2	4.5	4.5	3.5	3.5	3.5	3.5	3.5
Heat produced (GWh)	1 089	—	—	115.6	115.6	115.6	115.6	115.6
LCOH – financial (EUR/MWh)	34							
LCOH – economic (EUR/MWh)	38							

NB: GWh, gigawatt-hour; MWh, megawatt-hour.

By dividing the net present value (NPV) of the single cost components by the NPV of the energy generated, the levelised cost subcomponents can also be estimated.

LCOH – biomass boiler (EUR/MWh)	
Capital cost	8
Fuel cost	24
Other operating and maintenance costs	2
LCOH – financial	34
Shadow cost of CO2 emissions	-
Shadow cost of airborne pollutants	4
LCOH – economic	38

NB: MWh, megawatt-hour.

[3] Direct CO_2 emissions from the combustion of biomass are assumed to be zero if the fuel sourcing is done in compliance with the applicable sustainability criteria. Supply chain emissions (e.g. from biomass preparation and transportation) are not considered in the example. In addition to the emissions of airborne pollutants (e.g. sulphur oxides, nitrogen oxides and particulate matter), costs for externalities related to the security of supply of the required biomass could be considered if relevant to reflect, for example, availability or price volatility risks.

At the stage of a full feasibility analysis, a fully fledged CBA is normally carried out for the selected option.

For certain RES technologies that are innovative but have not yet been developed on a commercial basis (e.g. floating wind farms and concentrated solar power), however, a cost-effectiveness/qualitative approach is usually more appropriate. As a matter of fact, for these technologies, the economic benefits estimated according to the methodology presented above would normally not outweigh the related project costs, so the resulting economic rate of return (ERR) would fall short of the social discount rate. A benefit related to the 'learning curve' of the specific technology would in this case need to be assessed. This would hinge on the analysis of the expected 'learning rate' (typically estimated as the expected percentage reduction in the unit investment cost at each doubling of the installed capacity) and the forecast pace of deployment of the technology in terms of cumulated installed capacity (see, for example, European Commission, 2018). A monetary valuation of the incremental learning effect associated with a specific project is challenging and might require rather subjective assumptions. A very rough estimate could be based on a share of future capital expenditures (CAPEX) reductions (inferred from the learning rate) proportional to the project capacity in the overall installed capacity over the reference period. However, given the high uncertainty related to such an estimation, it is advisable that the EA of innovative RES projects mainly relies on the estimation of the LCOE, complemented by a qualitative assessment of the market potential of the technology.

II.3. Economic appraisal

Power generation

The investment and operating costs to be considered in the economic analysis of RES projects are typically those used in financial analysis or feasibility studies. Adjustments of certain cost components to better reflect their social opportunity cost may be necessary, in particular for labour costs and land use. Further adjustments to the costs may be necessary for certain technologies in relation to fuel costs (i.e. to consider the relevant 'border price' plus transportation – excluding taxation) and/or possible negative externalities (e.g. airborne pollutants such as nitrogen oxides (NO_x), sulphur oxides (SO_x) and particulate matter (PM) – which are particularly relevant for biomass projects). In addition, it is important to verify that the grid connection costs are taken into account – in some cases (e.g. offshore wind) these costs can be significant and are not necessarily already included in the project investment cost.

On the benefits side, the CBA of a project to increase the supply of electricity from RES essentially hinges on the determination of an appropriate estimate of the economic value of the power generated by the project. The change in 'social welfare' associated with the project can in principle be gauged by the reduction in social marginal generation costs (including externalities) triggered by the investment ([4]). The price formed in the wholesale power market cannot typically be deemed to adequately reflect the social value of the avoided costs, because of certain distortions (e.g. subsidies to RES generators or incomplete internalisation of environmental externalities). A 'shadow price' should then be estimated for the economic value of power. For this purpose, a relevant LCOE can be taken as a starting point ([5]), to be adjusted to include the following elements, whenever relevant to the specific technology and market situation assumed to define the economic value of electricity generation.

- A capital cost (CAPEX) component. Intuitively, the economic value of new generation capacity added to the system depends on the level of scarcity on the market. The system adequacy – as gauged, for example, by the expected evolution of the 'reserve margin' ([6]) – can be taken into account to possibly adjust downwards the value of this component in case of overcapacity ([7]).

- A fuel cost component (if relevant). This is calculated on the basis of the plant's efficiency and the cost of the delivered fuel ('border price' plus transmission/distribution costs – net of taxation) ([8]).

- Other (fixed and variable) operating and maintenance (O&M) costs component, not including fuel and CO_2 / air pollutant emissions, which are separately monetised. This typically includes, for example, personnel costs, insurance, maintenance, etc.

- The social cost of carbon. The shadow price to be used for the monetisation of the CO_2 emissions component can be taken from the values used by the EIB (see Section 2.5 of Part I of this *Economic Appraisal Vademecum* (EAV)). Attention should be paid to excluding from other components of the LCOE the possible cost of European Union Emissions Trading System allowances to avoid double counting.

- The socioeconomic value of emissions of airborne pollutants (e.g. NO_x) as unit damage values (e.g. from the Needs project) could be used ([9]). The values can be escalated over the reference period on the basis of the expected real gross domestic

[4] This means focusing on the changes associated with the project in the area underneath the social (e.g. externalities-adjusted) supply curve. For large investments (relative to the power system), where the project may also trigger an impact on power demand because of a price effect, the willingness to pay for the incremental demand would also have to be considered – which is possibly relevant for small, isolated systems.

[5] In the absence of specific modelling allowing the identification of the mix of marginal generators displaced by the project and the related average time-weighted benefit, the following shortcut can be used: in a hypothetical system where investment in power generation is optimised on the basis of the social (as opposite to market) generation costs, the (distortions-adjusted) levelised cost of a base-load generator that operates at full technical availability would adequately reflect the socioeconomic long-run value of power (see, for example, Lamont, 2008).

[6] The reserve margin is the ratio between the available generation capacity (with intermittent technologies such as wind and solar considered on a 'de-rated' basis) and the peak load to be covered, minus 1. The availability of intermittent technologies such as wind and solar needs to be considered on a 'de-rated' basis, expressing an equivalent firm ('dispatchable') capacity. Transmission constraints are ignored here. An estimation of reserve margin can be found in adequacy studies or from energy consultancy companies.

[7] A rule-of-thumb approach could, for example, be (i) to include the full CAPEX component for cases in which the medium-term forecast of the reserve margin is lower than 30 %, (ii) to assume that a reserve margin above 50 % signals the presence of overcapacity and hence no CAPEX component is included in the shadow price, and (iii) for a reserve margin between 30 % and 50 %, to use a partial CAPEX component, declining linearly from the full value to zero as the value within the interval increases (e.g. for a reserve margin of 40 %, only half of the CAPEX value would be considered).

[8] European Network of Transmission System Operators for Electricity (ENTSO-E) and for Gas (ENTSOG) scenarios prepared for the 10-year network development plan exercises include assumptions on fuel price developments that can, for example, be used. As regards gas transmission costs, where relevant, data from Eurostat can be used.

[9] See the Needs project website for more information (http://www.needs-project.org/); in particular, see RS3a D 1.1, *Report on the procedure and data to generate averaged/aggregated data*.

product (GDP) growth [10].

- A security-of-supply cost related to the use of (imported) fuels. The EIB uses, for example, a value equal to EUR 10/MWh_{el} (megawatt-hours of electrical energy) for power generated from a gas-fired combined-cycle gas turbine.

The sum of those components would provide a reasonable estimate of the base economic value of electricity produced by the project.

However, if the technology assumed to define the economic value of electricity is firm ('dispatchable') generation, when evaluating the value of power from a project installing variable (i.e. intermittent, non-dispatchable) RES, such as wind and solar, two downward adjustments would need to be made to account for the following aspects [11].

- 'Profiling' costs. Power demand varies over the day (and seasons) and so does its value, given that a different mix of generation sources, with different generation costs, is called on to produce power at different moments in time (storage and demand-response are typically limited, and generation basically needs to meet demand in real time). So, for example, generation at times of peak demand has a higher value than in the middle of the night, when demand is low. Owing to the weather-dependent variability of generation of intermittent RES, RESs cannot extract value from the entire profile of power demand, as a baseload generator would. For this reason, a 'profiling' (or utilisation) cost would typically need to be deducted from the base value of the shadow price. This would depend on (i) the extent to which the expected generation profile of the specific project under appraisal correlates with the relevant demand profile and (ii) the current and expected overall penetration of variable RES in the system – the higher the share of intermittency, the higher the profiling cost.

- 'Balancing costs'. The uncertainty associated with the output variability may lead to mismatches between the scheduled RES generation (e.g. at the time of closure of the day-ahead market) and the power actually fed to the grid. This would lead to additional costs for the 'balancing' of demand and supply in the system.

In the estimation of the economic benefits, the different components of the shadow price can be singled out for presentation purposes (e.g. CO_2 reduction benefit or security-of-supply benefit).

As regards the reference period over which the CBA is performed, an operational phase of 15 to 20 years (the latter for mature RESs, such as onshore wind and solar photovoltaic systems) is typically appropriate to adequately reflect the economic life of the project assets without the need to consider major replacement cost or residual value.

Heat generation

The CBA of RESs in heating can be based on a similar conceptual framework to that presented above for the case of power generation. The reference period can usually be taken to be 15 years, but a longer time horizon can be used for projects related to a district heating system, provided asset replacement costs are adequately taken into account.

As regards the economic investment and operating costs, the same considerations presented above for electricity projects apply. For generation investments in the context of district heating, it is important to also take into account the costs associated with heat distribution and the related losses.

As regards the benefits, the economic (i.e. externalities-adjusted) LCOH [12] from the next best alternative to the RES heat generated by the project can be used as a relevant shadow price.

The use of the LCOH can be particularly useful at the stage of option analysis, to compare different decarbonisation options, for example for district heating systems. Similarly to electricity, two types of levelised cost can be estimated: financial and socioeconomic. The financial levelised cost should be based on observed market prices and the related forecasts of future costs and prices that are going to be borne by the owner(s) of the heat generation/distribution assets. The socioeconomic levelised cost should be based on the financial levelised cost and complemented with the assessment of external costs that would be borne by society at large (e.g. the damage value of airborne pollutants, GHG emissions and security-of-supply considerations for certain fuels). For combined heat and power options, the value of power generation can be netted out from the heat generation cost, where appropriate. Table 3 summarises the elements typically considered in the financial and economic LCOH.

[10] In the Needs project, evidence was found that monetary values for health risks for future years increase with an intertemporal elasticity to GDP per capita growth of 0.7 to 1.0.

[11] A description of the methodological approach can be found in Hirth (2013). There are several studies on the valuation of those 'system costs'. An overview of the literature and value estimations is, for example, available in OECD and Nuclear Energy Agency (2018) – see Section 3.3.

[12] The LCOH can be considered a life-cycle average incremental cost or long-run marginal cost. This is calculated as the ratio of (i) the present value of all costs (CAPEX, operating expenses, fuel, etc.) associated with a given technology over the appropriate reference period and (ii) the present value of the heat supplied by the related plant(s) over the same time horizon.

Table 3. Levelised unit cost elements

Financial LCOH	Economic LCOH
+ CAPEX	+ CAPEX
+ O&M costs	+ O&M costs
+ Fuel costs (if relevant)	+ Fuel costs (if relevant)
+ CO_2 Emission Trading System allowance costs (if relevant)	+ Social cost of CO_2 emissions
	+ Social cost of SO_2, NO_x and PM
	+ Security-of-supply cost ([13])
– Revenue from power sales (if relevant)	– Economic value of power sales (if relevant) ([14])
= Net LCOH (financial)	= Net LCOH (economic)

Options should primarily be ranked on the basis of the socioeconomic LCOH (the lower the better), particularly if public support (e.g. EU financing) is foreseen. At the same time, it is important that the related financial cost can be deemed to be competitive and affordable. The financial LCOH can be considered as a rough approximation of a heat tariff regulated on a cost-plus basis ([15]).

[13] This would, for example, be the case of imported fuels such as natural gas or possibly biomass. The consideration of this cost would (slightly) favour the use of locally sourced fuels over imported fuels, whose availability and price volatility may be more problematic.

[14] To be estimated on the basis of the methodology presented in the 'Power generation' section above.

[15] Differences could, for example, stem from (i) differences between the *ex ante* cost estimates and the actual costs incurred for the different alternatives, (ii) differences in average investment costs in the LCOH and the related depreciation included over the same reference period in the heat tariffs by the regulator, (iii) differences between the return on capital embedded in the discount rate used in the LCOH and the allowed profit included in the regulated tariffs, (iv) the fact that, if the investment is co-financed by public grants (e.g. EU funds), the capital component in the related heat tariffs is likely to be lower than in the financial LCOH estimated *ex ante*, and (v) in the case of co-generation assets, differences between the cost allocation method to transfer common heat and power costs to the heat tariff and the residual net LCOH after deduction of power sales revenue.

ANNEX III. ENERGY EFFICIENCY

III.1. Introduction

Energy efficiency is expected to play an important role in the context of the ambitious decarbonisation targets of the EU and is one of the key elements of the European Green Deal. Buildings account for around 40 % of energy consumption in Europe. According to the European Commission, the renovation rate of the building stock will need to at least double compared with the current level to meet the relevant EU targets. The EU as a whole will have to reduce its energy consumption by at least 32.5 % by 2030 ([16]), according to the amended energy efficiency directive (Directive (EU) 2018/2002). With a more ambitious decarbonisation target for 2030 agreed in December 2020 (i.e. an EU-wide 55 % reduction in GHG emissions instead of 40 % – both compared with 1990 levels), energy efficiency efforts will also need to be further increased.

In the case of buildings, as of 2021, all new buildings in the EU have to be nearly zero-energy buildings ([17]) in line with the requirements of the amended energy performance of buildings directive (EPBD – Directive (EU) 2018/844).

Each country's specific targets and policy measures are set out in the national energy and climate plans, as well as the long-term renovation strategies being prepared by Member States under the EPBD. EU funds can support the related (significant) investment needs ([18]), for example through the 'renovation wave' initiative of the EU Green Deal and the 'greener, carbon free Europe' policy objective of the European Structural and Investment Funds, the Just Transition Fund and the Modernisation Fund.

This chapter focuses on the EA methods for energy efficiency projects in buildings. A similar conceptual framework can also be applied to investments in other typologies of assets, for example for the evaluation of energy savings stemming from the refurbishment of district heating networks, industrial facilities or public lighting systems.

III.2. Project development cycle and methods

At the beginning of the project development cycle, national energy performance standards for buildings complying with the EPBD – in line with the cost-optimal levels – define the (investment) measures to improve the energy performance of the buildings. For large projects, an energy audit is required to assess the building's existing situation and to screen and define the investment measures. At this preliminary stage, the comparison of possible alternatives is typically done on the basis of a cost-effectiveness analysis (CEA) and financial criteria, including the expected payback period of the measures. In the case of projects seeking to obtain financial support from the EU, the analysis can be complemented by including monetised externalities (e.g. CO_2, airborne pollutants, security of supply). This can help define renovations measures going beyond the financial cost-optimal level, with a view to maximising the decarbonisation effect.

For large energy efficiency projects (or schemes) where a full feasibility analysis is developed, the EA should be based on a CBA that, in addition to the energy savings benefits and associated externalities, should also include other effects related, for example, to the extended life of the building or the reduced maintenance costs. ([19])

At the stage of the selection and approval of projects to be financed by EU funds, it is important that the national authorities responsible for project evaluation base their decisions on an assessment of the expected economic benefits (e.g. the value of energy savings and associated CO_2 emissions) relative to the project costs, to ensure efficiency and effectiveness ([20]). In this respect, a simplified CBA tool with a set of predefined unit benefit values could be developed by the national authorities to be used in call-for-project proposals to rank and select energy efficiency investments.

III.3. Economic appraisal

While the financial analysis is mainly done from the point of view of the owner of the building, the economic CBA attempts to evaluate the socioeconomic impact of the energy efficiency investments on society as a whole. The cost savings monetised in the financial analysis do not necessarily reflect society's willingness to pay (WTP) for the avoided energy generation, for example because energy tariffs may be subsidised and may not (fully) include the value of externalities such as CO_2 emissions or the increased security of supply. For this reason, the economic analysis should be based on a shadow price reflecting the socioeconomic value of the energy saved thanks to the project – typically heat, but also electricity. Annex II ('Renewable energy') provides a detailed description of the different components of the shadow price of heat (and electricity) that can be used to monetise the energy savings associated with the project.

[16] The target is set relative to the 2007 modelling projections for 2030.

[17] Nearly zero-energy buildings are buildings that have very high energy performance and whose (limited) energy consumption is mostly covered by energy from renewable sources.

[18] There are several market failures that prevent a socially optimal level of investment in energy efficiency and justify public intervention. Access to capital is one of those, with other examples from the literature being imperfect information, hidden costs, split incentives and bounded rationality. A recent EIB working paper found that the availability of favourable financing together with the provision of technical assistance increased by one third the probability of investment in energy efficiency (EIB, 2020).

[19] For example, in the case of projects funded by EIB loans, the bank's economic assessment is based on a CBA that includes energy savings and reductions in GHG emissions (tier 1 benefits), but also other economic benefits such as the extension of the economic life and a reduction in maintenance costs (tier 2 benefits), when they are measurable and quantifiable. In the case of bank-intermediated EIB operations, the economic case is assumed ex ante to be met for the individual measures on the basis of the cost optimality of the national standard measures. However, in the latter case, economic assessment is also required at an aggregate level, based on the expected energy savings of the overall operation and other quantifiable benefits.

[20] According to the European Court of Auditors, the allocation of EU cohesion policy funds to energy efficiency projects in buildings was in most cases done on a first-come-first-served basis, without a proper consideration of the relative costs and benefits of the projects. The court recommends that, for the 2021–2027 period, improved selection procedures are used to '(i) set minimum and/or maximum thresholds for key parameters (e.g. the quantity of energy to be saved, the minimum energy rating the building should reach after project, the net present value, the simple payback time or the cost per unit of energy saved); (ii) assess the relative costs and benefits of projects and select those delivering higher energy savings and other benefits at lower cost' (European Court of Auditors, 2020).

Moreover, owing to the existence of split incentives in building renovations, some benefits are appropriated by different individuals. For instance, tenants normally benefit from a reduction in energy bills, whereas property owners benefit from the extension of the economic life of the building elements. However, regardless of the beneficiary, all of the benefits contribute to the overall economic return of the project.

The reference period used in the CBA would depend on the project measures and the components and equipment replaced. In general, it can range from 10 to 25 years for projects also investing in the building's envelope. For new construction, Article 2(14) of the EPBD defines the building life cycle as 30 years for residential buildings and 20 years for non-residential buildings.

On the costs side, only investment costs directly related to energy efficiency are usually included in the CBA. Changes in operating costs associated with the project are normally presented as part of the (energy) cost savings that underpin the economic benefits. Where relevant, costs taken from the financial analysis can be adjusted to better reflect social opportunity costs (e.g. using a 'shadow wage' for the labour cost component).

On the benefits side, the International Energy Agency has identified no less than 15 different sources of benefits (International Energy Agency, 2014). Energy efficiency investments generate not only energy savings and reductions in GHG emissions, but also other economic benefits, such as the extension of the economic life of the replaced building elements, a reduction of maintenance costs and an increase in property values. In addition, energy efficiency investments in buildings improve the comfort and quality of the working and living environment. When these benefits are quantifiable, they should be incorporated into the CBA. However, the value of certain direct benefits (e.g. energy savings) may be partly embedded in some other indirect benefits (e.g. an increase in property values), so particular attention should be paid to not double counting benefits.

In general, the economic analysis of building refurbishments should aim to include the following two groups of benefits.

1. **Energy-related cost savings, including externalities** ([21]) (Box 2). The following benefits should be included in the CBA, as the methodology used to estimate these benefits is well documented (EIB, 2013) and the data needed to produce robust estimates are generally available.

   - **Avoided energy (heat/electricity/cooling) generation/transportation costs**, including capital (where justified) ([22]), operating costs and fuel costs. Where data on local energy production are available, these should be used in the analysis (fuel costs should ideally be expressed at border price plus transportation cost, net of taxation).

   - **Avoided emissions of GHGs**. The shadow price to be used for the monetisation of the estimated changes in CO_2 emissions can be taken, for example, from the values used by the EIB (see Section 2.5 of Part I of the EAV).

   - **Avoided emissions of air pollutants** (e.g. SO_x, NO_x and PM). Unit damage values (e.g. from the Needs project) can be used ([23]). The values can be escalated over the reference period using the expected real GDP growth ([24]).

   - **Enhanced security of supply**, in cases where the primary energy saved comes from imported fossil fuels, such as natural gas. For electricity from a gas-fired combined-cycle gas turbine, the EIB uses, for example, a value of EUR 10/MWh_{el} – assuming a plant efficiency of 58 %, the value of the unit economic benefit can be estimated at approximately EUR 1.60/gigajoule (GJ) of natural gas saved by the project ([25]).

[21] This group of benefits would typically also apply to projects for the refurbishment of district heating networks that result in a lower level of heat losses.

[22] For example, in relation to the time deferral or capacity reduction of replacement investment

[23] See the Needs project website for more information (http://www.needs-project.org/); in particular, see RS3a D 1.1, *Report on the procedure and data to generate averaged/aggregated data*.

[24] In the Needs project, evidence was found that monetary values for health risks for future years increase with an intertemporal elasticity to GDP per capita growth of 0.7 to 1.0.

[25] In the case of projects in district heating networks, security-of-supply benefits can also be related to a reduction in heating disruptions. They can, for example, be valued at the avoided economic cost associated with the use of individual electric heaters during periods of district heating disruptions.

Box 2. The economic value of energy savings

An investment programme for the thermal rehabilitation of residential dwellings is targeting an aggregate final energy (heat) saving of 50 gigawatt-hours (GWh)/year (equivalent to some 55 GWh/year of avoided primary energy) compared with a baseline scenario without the project. The following economic LCOH generation from a domestic condensing gas boiler is used to estimate the economic value of the annual benefit associated with the energy savings:

LCOH – domestic gas boiler (EUR/MWh)	
Capital cost	16
Fuel cost	55
Other operating and maintenance costs	2
Shadow cost of CO2 emissions	40
Shadow cost of airborne pollutants	0
Security-of-supply external cost	6
LCOH – economic	**120**

NB: MWh, megawatt-hour.

The total economic value of heat savings can then be estimated to be equal to EUR 120/megawatt-hours (MWh). The annual value of the corresponding benefit to be considered in the economic analysis is then forecast at 50 GWh × EUR 120/MWh, which is equal to EUR 6 million a year. The LCOH breakdown can be used to calculate the annual value of the specific subcomponents of the energy-saving benefit.

2. **The impacts on the use and value of the building enabled by the project**. Estimating these benefits can be more challenging. Therefore, they should be included only on a case-by-case basis, subject to the availability of reliable data and a robust estimate for the specific project. In addition, specific attention should be paid to not double counting benefits. The following are examples of such benefits.

- **Extension of the economic life of the building (elements)**. The related annual value could, for example, be estimated as the constant annuity over the operational phase of the reference period whose NPV equals the NPV of the project investment cost net of the residual value of the equipment replaced by the project (e.g. heating, ventilation and air conditioning equipment, electrical equipment).

- **Reduction in building maintenance costs**. The benefit is more easily determined for commercial (and public) buildings, but can also apply to residential buildings. The possible reduction in costs relates to both preventive (i.e. scheduled) maintenance activities and estimated corrective maintenance (i.e. the repair of equipment when it breaks down) ([26]).

- **Improved thermal comfort**, for cases where a comfortable room temperature can be achieved only after the building refurbishment. Where feasible, this benefit can be monetised on the basis of the value of hypothetical additional energy savings associated with a hypothetical higher energy consumption in the without-project scenario that would have been needed to reach the same new temperature in the with-project scenario ([27]). In certain cases, better comfort would be triggered by the improved affordability of heating enabled by the project cost savings ([28]).

- **Increase in property values** associated with the improved aesthetics and comfort of buildings (in excess of what was possibly already accounted for in the previous benefits). Assumptions need to be made about the current average market price of buildings covered by the project and the expected increase in value following the thermal rehabilitation. However, the increase in property values should in principle also embed the value of avoided energy costs, which are already monetised separately. Therefore, to avoid double counting, the economic CBA should only include the difference between the expected increase in property value and the NPV of the energy cost savings as quantified in the financial analysis. The benefit can be distributed over the reference period by calculating the related equivalent constant annuity.

[26] The reduction of maintenance and repair costs is also typically a benefit of investments in district heating networks.

[27] See the numerical example provided in the European Commission's *Guide to cost benefit analysis of investment projects* (European Commission, 2014) – see the box on p. 228 on the valuation of increased energy efficiency in buildings.

[28] According to the European Commission, around 50 million consumers in Europe struggle to keep their homes adequately warm. Investment in energy efficiency can contribute to tackling energy poverty.

III.4. Other relevant information

The approach presented in this chapter can also be applied to the EA of new buildings, as opposed to the refurbishment of existing buildings. In this case, the appraiser would need to define an appropriate counterfactual scenario against which possible energy efficiency benefits could be identified and monetised. The EIB approach, for example, is to identify the project savings in relation to the minimum regulatory requirements applicable to the new construction based on the date of the building permits.

In the case of energy efficiency investments in public buildings that are used to provide services to the public (e.g. hospitals, schools and libraries), the project can also enable the continuation or even a quality improvement of the public service provision. In this case, the economic analysis may need to be complemented with the addition of indirect benefits for the relevant sectors concerned (e.g. health, education and culture).

ANNEX IV. MUNICIPAL WASTE MANAGEMENT

IV.1. Introduction

In the framework of the cohesion policy for 2021–2027, municipal waste management projects will be developed as part of the Member States' efforts to move towards a circular economy. These projects should be consistent with the Member States' waste management plan(s) as stipulated in Annex IV of the common provisions regulation. However, the transition to a circular economy does not require a modification to the EA methods for municipal waste management projects.

In July 2018, the circular economy package entered into force. The circular economy package sets new and ambitious targets for recycling municipal waste: 55 % by 2025, 60 % by 2030 and 65 % by 2035 ([29]). Member States also have to ensure that, by 2035, less than 10 % of the total amount of municipal waste generated is sent to landfill. Achieving these targets will require substantial legal, organisational and financial efforts in the Member States. Less advanced Member States, in particular, will need to try to catch up and build the basic infrastructure that they are currently missing. Essential changes and investments will be required in expanding separate waste collection, treatment and material recovery systems and in developing markets for the secondary raw materials recovered. Some of these investment projects will include circular economy components, which are consistent with the higher steps of the waste management hierarchy. Table 4 includes the circular economy categories in the waste management sector and typical projects/investments indicated in the *Categorisation System for the Circular Economy* (European Commission, 2020) published by the European Commission Expert Group on Circular Economy Financing.

Table 4. Circular economy categories of waste management activities and typical projects/investments

Circular economy categories	Examples of typical projects/investments
Separate collection and reverse logistics of waste, as well as redundant products, parts and materials, enabling circular value retention and recovery strategies	- Movable equipment (bins, containers) - Waste collection and transport vehicles - Supporting infrastructure for waste collection, transport and temporary storage (e.g. civic amenity centres, transfer and reloading stations, vehicle depots, facilities for refuelling/recharging, washing, maintenance and repair)
Recovery of materials from waste in preparation for circular value retention and recovery strategies (excluding feedstock covered under the next line)	- Material recovery facilities, process technology and mobile equipment, involving manual, semi-automated and/or fully automated mechanical processes (dismantling, separation, sorting, crushing, shredding, cutting, post-treatment technologies, etc.) - Chemical recycling plants involving various types of technologies and processes (e.g. depolymerisation, solvolysis, gasification, pyrolysis, etc.)
Recovery and valorisation of biomass waste and residues as food, feed, nutrients, fertilisers, biobased materials or chemical feedstock	- Biorefinery facilities and process technology for the extraction of biobased products and feedstock from biowastes and residual biomass, wastewater and sludge from organic origin - Anaerobic digestion and composting plants utilising the resulting digestates/composts as fertilisers/soil conditioners

Residual waste treatment projects/facilities (most importantly mechanical biological treatment, waste to energy / incineration facilities and landfills) are not included in the circular economy classification.

The objective of this chapter is to provide an overview of the now well-established EA methods for municipal waste management projects. These methods are usually applied to entire (integrated) waste management projects, which may consist of different components (some of them contributing to the circular economy and some of them not).

[29] Specifically, according to Article 6(1), subparagraphs (f) to (i), of the packaging directive (Directive 94/62/EC): (f) no later than 31 December 2025 a minimum of 65 % by weight of all packaging waste will be recycled;
(g) no later than 31 December 2025 the following minimum targets by weight for recycling will be met regarding the following specific materials contained in packaging waste: i. 50 % of plastic; ii. 25 % of wood; iii. 70 % of ferrous metals; iv. 50 % of aluminium; v. 70 % of glass; vi. 75 % of paper and cardboard;
(h) no later than 31 December 2030 a minimum of 70 % by weight of all packaging waste will be recycled;
(i) no later than 31 December 2030 the following minimum targets by weight for recycling will be met regarding the following specific materials contained in packaging waste: a. 55 % of plastic; b. 30 % of wood; c. 80 % of ferrous metals; d. 60 % of aluminium; e. 75 % of glass; f. 85 % of paper and cardboard.

IV.2. Project development cycle and methods

Waste management investments are often complex integrated systems of collection, transport, recovery, recycling, treatment and disposal, which are interconnected with the rest of the economy and society through inputs and outputs. Identifying and quantifying waste and resource flows requires a good understanding of the interaction between the different components of the waste management system, the links with other economic sectors (e.g. energy production, manufacturing, construction and agriculture) and the broader socioeconomic context.

When projects are compliance driven, it is suggested that the project options be assessed based on the cost-effectiveness of investments. The levelised unit cost (LUC) (also called dynamic prime cost or dynamic generation cost) is the cost-effectiveness indicator normally used to analyse and compare options at the early stage of the project development cycle, when options have the same or similar objectives, expected outputs and benefits. It is usually expressed in EUR/tonne of waste treated. It is derived by dividing the NPV of the total project life cost in monetary terms – comprising CAPEX, operating expenses (OPEX) and replacement costs over the reference period – by the NPV of the treated waste in physical terms (weight).

Table 5. Example of calculation of the LUC (thousand EUR)

	Years									
	1	**2**	**3**	**4**	**5–12**	**13**	**14–21**	**22**	**23–29**	**30**
Total investment cost	13 000	27 000	23 000							
Operating cost	10 300	12 000	12 300	17 000	...	17 000	...	17 000	...	17 000
Replacement cost	0	0	0	0	...	5 000	...	6 000	...	0
Total costs	**23 300**	**39 000**	**35 300**	**17 000**	...	**22 000**	...	**23 000**	...	**17 000**
Revenues	800	900	1 000	5 000	...	5 000	...	5 000	...	5 000
Residual value	0	0	0	0		0		0		20 000
Total inflows	**800**	**900**	**1 000**	**5 000**	...	**5 000**	...	**5 000**	...	**25 000**
Net costs	**22 500**	**38 100**	**34 300**	**12 000**	...	**17 000**	...	**18 000**	...	**– 8 000**
Waste collected	**150**	**150**	**150**	**145**	...	**145**	...	**145**	...	**145**
NPV (*) of net costs	**271 361**									
NPV (*) of waste collected (thousand tons)	**2 622**									
LUC (EUR/ton)	**103.49**									

(*) A financial discount rate of 4 % has been applied in the calculation.

Where there are significant differences between the various options appraised (e.g. in terms of GHG emissions), a simplified CBA (i.e. based on rough estimates of costs and outputs) should be seen as the preferred method for option analysis. For the selection of the location for project facilities, qualitative considerations are typically used based on MCA.

Only for non-compliance-driven projects, when there is a lack of benchmarks or there are significant changes in the expected externalities, the selected option should also undergo a detailed CBA at the stage of the feasibility study.

The results of CBAs are highly dependent on the quality of data used and the assumptions made, and need careful and nuanced interpretation to be used correctly. Historical data on waste flows and composition might not always be available at the required level of detail or reliability, which introduces uncertainty in long-term forecasts for waste generation, collection and treatment. The valuation of impacts is costly and time-consuming to carry out and, therefore, the results are often transferred from one study to another, adding another layer of uncertainty (i.e. regarding their transferability from one country or region to another). To address the uncertainties in the data and assumptions used, the CBA should be accompanied by a sensitivity analysis for key input parameters and assumptions, as well as a report elucidating the methodology and assumptions applied and the data sources used. Besides quantified economic costs and benefits, the report should also include a description of non-monetised environmental impacts. The large amount of resources and time needed for carrying out CBA explains why it is typically adopted mostly for large strategic investments.

The reference period for municipal waste management projects should take into account the economically useful life of the project and is typically up to 20 years (or at least 15 years of operation). In cases, when, for example, a public–private partnership contract is to be signed with an operator, the reference period should take into account the duration of the public–private partnership contract.

IV.3. Economic appraisal

Key economic impacts of waste management projects are related to the reduction of GHG emissions, air and water pollution, land use and soil pollution, as well as health risks and disamenity effects such as noise, odour, litter, dust and vermin.

The table in Section 4.2 of the 2014 CBA guide provides examples of quantifiable benefits and valuation methods in the economic assessment of EU-funded waste management projects. This section presents updates, clarifications and additional information for the calculation of economic benefits in the municipal waste management sector.

Material recovery and recycling

The economic benefits of material recovery and recycling could be estimated from the following elements.

- **Savings in landfill costs.** For the purpose of the economic analysis of waste management projects, every tonne of waste that is diverted from landfill as a result of the project reduces the cost of landfilling and should therefore be credited with the unit cost of landfill per tonne of waste. **The valuation of the unit cost of landfill should be based on the long-run marginal cost (LRMC)**, assuming that the benefits of diverting waste from landfill correspond to the avoided cost of a future landfill. The LRMC is obtained by plotting the capital and operating costs (including land cost) over the landfill's lifetime and calculating its LUC, applying the discounted cash-flow method. The size of the landfill and thus its LRMC will depend on the total annual amount of waste that is diverted from landfill as a result of the project.

- **Market value of separately collected recyclable materials.** The economic benefit of recovering secondary raw materials (e.g. plastic, glass and metals) and/or composts and other natural fertilisers from waste is typically approximated by the corresponding market value for each subproduct. The annual benefit can be calculated by multiplying the amount of recycled material expected to be recovered because of the project by its price. An assumption is made that the value captured via the market prices of such products reflects the full social value of avoided extraction, processing and transport of virgin raw materials ([30]).

Energy recovery in the form of electricity and heat (or biofuel)

As illustrated in Section 4.2.7 of the 2014 CBA guide, this benefit arises when waste is used for the production of energy in the form of electricity or heat. In this case, the energy recovered (using waste as the source) replaces the use of energy from an alternative source/fuel (e.g. coal), which, in turn, leads to cost savings.

For projects involving energy recovery from waste, the opportunity cost of the substituted and substituting sources/fuels (oil, natural gas, biomass, nuclear, solar, wind, hydro, etc.) should be considered as valuing the variation of energy costs. For example, the avoided costs of alternative fuel can be computed by multiplying the amount of fuel required to produce the same amount of energy (electricity or heat) by the prices of fuels used in the without-project scenario. For more details, please refer to the economic value of electricity/heat described in Annex II ('Renewable energy').

The opportunity cost of energy recovered from waste should be based on the LRMC of alternative energy production, reflecting the total social cost incurred to produce an extra unit of energy, plus the transport cost of the energy source from the place where it is produced to the place where it is used, if applicable.

If the substituted source is fossil fuel, an additional benefit related to displaced GHG emissions is generated through energy generation from the renewable waste fraction.

Health and environmental hazards

To estimate the external cost of pollutant emissions, the usual approach consisting of quantifying the emissions avoided thanks to the project (measured in kg/tonne of waste) and valuing them with a unit economic cost (measured in EUR/kg of emissions) applies. For changes in emissions of airborne pollutants (e.g. PM, NO_x and SO_x), unit damage values (e.g. from the Needs projects) could be used ([31]). To estimate the expected annual benefit, the forecast reduction of pollution (calculated by comparing the emissions of the pollutant in the scenarios with and without the project and expressed in tonnes/year) is multiplied by the economic cost of the pollutant (expressed in EUR/tonne).

Leachate control

The economic benefits of the avoidance and proper collection and treatment of leachate can be estimated using the avoided costs of not having to clean the affected areas and also using the marginal damage approach. These benefits would apply to projects comprising the closure and remediation of dumpsites and non-compliant landfills. In the case of projects diverting waste from landfills, such benefits would be internalised in the LRMC of landfill, assuming that such landfilling would meet the requirements of the landfill directive.

Greenhouse gas emissions

Generally, the largest GHG emission reductions are obtained at the higher levels of the waste hierarchy. However, GHG emission reductions can vary quite significantly for different materials and technological processes within the same level of the waste hierarchy (Ballinger, 2015).

The highest reduction in GHG emissions is achieved when waste is (in order of importance):

- prevented in the first place (e.g. through refuse, reduce, repair and reuse strategies);
- recovered in the form of secondary raw materials and sent for recycling, replacing virgin materials, which have a larger carbon footprint;

[30] A possible source for the price of recyclable materials can be found at the Eurostat website (https://ec.europa.eu/eurostat/statistics-explained/index.php/Recycling_%E2%80%93_secondary_material_price_indicator#Price_and_trade_volumes).

[31] See the Needs project website for more information (http://www.needs-project.org/); in particular, see RS3a D 1.1, *Report on the procedure and data to generate averaged/aggregated data*.

- recovered in the form of compost or other natural fertilisers for beneficial use (e.g. in agriculture) in the case of biowaste;
- used for energy generation as a substitute for fossil fuels (in the case of non-recyclable waste);
- treated to reduce and stabilise the biodegradable components before being properly disposed of (in the case of biowaste fractions in mixed residual wastes).

In the first and second cases, the decrease in GHG emissions results from the reduction of virgin raw material consumption (i.e. avoided emissions from raw material extraction, transport and processing). In the third and fifth cases, the decrease in GHG emissions, mainly methane, originates mainly from a reduction in untreated biodegradable waste deposited in landfills. In the fourth case, energy recovery from waste enables a reduction in GHG emissions that would have been produced by alternative energy sources using fossil fuels.

Normally, the calculations should also take into account the prevention and reuse of waste, which avoid energy-related emissions generated for the production of goods from raw materials.

As good practice, the estimation of the project economic benefits resulting from the reduction of GHG emissions requires two parameters: standard specific emission factors to quantify the reduction of emissions and standard values to monetise them. By comparing the situation with and without the project (in tonnes/year) it is possible to estimate the change in terms of emissions due to the project. The shadow price to be used for the monetisation of the CO_2 emissions component can be taken from the values used by the EIB (see Section 2.5 in Part I of the EAV).

ANNEX V. TRANSPORT

V.1. Introduction

This chapter focuses mainly on standard methods for appraising transport projects with an emphasis on updating, standardising and simplifying (where possible) the transport appraisal approach and sources of the 2014 CBA guide, while ensuring that project benefits and costs are well captured and presented in a proportionate but meaningful way.

Acceleration of the process of CBA preparation is promoted below, for example by reference to pre-prepared sets of updated country unit values at the European level such as the *Handbook on the External Costs of Transport* (Directorate-General for Mobility and Transport, 2019; the 2019 handbook).

The voluntary guidance applies to projects in all transport sectors eligible for funding from EU-funded sources (both passengers and freight).

In the context of the 2021–2027 cohesion policy funding, the voluntary guidance could be applied to transport projects meeting the specific objectives of policy objective 3, 'A more connected Europe by enhancing mobility', of the common provisions regulation for 2021–2027. The specific objectives directly relevant to transport are objectives 3.2, 'Developing a climate resilient, intelligent, secure, sustainable and intermodal TEN-T', and 3.3, 'Developing and enhancing sustainable, climate resilient, intelligent and intermodal national, regional and local mobility, including improved access to TEN-T and cross border mobility'.

The guidance also applies to actions meeting the specific transport objectives set out by the European Commission mainly to contribute to the development of projects of common interest relating to efficient and interconnected networks and infrastructure for smart, sustainable, inclusive, safe and secure mobility.

V.2. Project development cycle and methods

A transport project should ideally find its strategic justification in the framework of a comprehensive transport plan, set up at the appropriate territorial level, which should in turn be in line with climate mitigation plans.

EA tools such as CBA (with a simplified level of detail of underlying analysis) and MCA can be used/combined in a strategic way at the level of transport plans to consider alternative solutions, but always in the context of a prior thorough analysis demonstrating basic strategic issues and a clear related statement of strategic objectives.

Similarly, at the level of assessing investment programmes of projects (usually derived from a transport plan), CBA and MCA are commonly used as prioritisation tools to indicate the projects in the pipeline offering the most value for money (which is then consolidated with considerations of maturity).

The impacts of transport on GHG reduction are most achievable at strategic level, where there is greater scope to influence unit emissions of vehicles and shifts to lower emission modes. The scope for GHG reduction at the level of project option analysis is, however, also important, allowing further optimisation of the strategic choices.

The appraisal of significant individual project investments in the transport sector traditionally uses CBA, which is the primary public policy tool used to assess if a proposed project is socioeconomically viable or to compare the value for money of different project options.

MCA is used in transport for project option analysis when a project has multiple key objectives/impacts for assessment, which cannot be comprehensively or practically assessed using CBA (e.g. when key effects such as certain environmental impacts cannot be monetised or when a large set of project options are being shortlisted). Outcomes or elements of CBA can be integrated into an MCA assessment as part of the criteria set.

CEA is intended for use when a specific outcome or objective is already defined and decision-makers wish to compare how efficiently different options meet such an objective. An example in transport might be achieving compliance with the tunnel safety directive (Directive 2004/54/EC) or the mandatory implementation of European traffic management systems such as the European rail traffic management system (ERTMS) / European train control system (ETCS).

V.3. Economic appraisal

Standardised and simplified treatment of the project impacts in economic appraisal

Table 6 summarises the impacts of investments that are typically assessed in the EA of transport projects and the primary appraisal methodology for each impact.

Table 6. Transport projects: impacts

Impacts	Primary evaluation method	New content provided in this document regarding transport CBA simplification and standardisation
Perceived passenger time	Monetisation	New recommended methods/sources for unit values of value of time and detailed advice on door-to-door perceived time treatment
Freight time	Monetisation	Reference to a recent JASPERS rail freight guidance document providing a standardised approach and EU country unit values of time and operating costs (see section 'Costs and benefits of rail freight enhancements')
Vehicle operating costs	Monetisation	
Safety	Monetisation	More detailed guidance and references to new EU country unit values for accident costs
Environmental emissions / local health	Monetisation	Specific updated reference to sources of EU country unit external cost values per mode
Climate change	Monetisation	Updated references for evaluating the unit cost of carbon (see Section 2.5 in Part I of the EAV)
Noise	Monetisation	Specific updated reference to sources of EU country unit external cost values
Other environmental impacts	Qualitative assessment	Explanation of the need for qualitative assessment
Wider economic benefits	Mainly qualitative assessment	References to literature and recommendations on evaluation method
O&M costs	Monetisation	Specific advice related to the set-up of the without-project scenario and related O&M costs

Perceived passenger time

Passenger time savings are often the dominant benefit calculated in transport CBA and thus care must be taken in their calculation and monetisation.

For setting of basic unit in-vehicle values of time, a number of approaches/sources can be recommended.

- Ideally, new unit values of time should be set at the national level based on stated and/or revealed preference surveys.

- An alternative approach would be to set values of business time in line with official (Eurostat) data on average hourly labour costs (including a mark-up for overheads), with commuting estimated at approximately 25–40 % of business time and other/leisure trips estimated at approximately 20–35 % of business time.

In line with the advice of the 2014 CBA guide, it is not generally recommended that values presented in the IER Germany (2006) study be adopted for passenger value of time sets in national methodologies, primarily because that study contains an increasingly out-of-date data set, and national-level surveys represent a superior method.

Countries may opt to select different values for different modes (e.g. because of differences in user income levels) or simply select one set of values to be applied to all modes.

At least for urban and regional public transport projects, it is good practice to consider the value of door-to-door time savings: differentiating at least between walk access/egress, in-vehicle time and wait time / headway penalties, with different weightings or functions applied to each category. This is best assessed through national stated and revealed preference surveys; however, there is a wide body of international evidence available on door-to-door elements of perceived travel time.

Table 7 displays an approximate range of typical weights applied to in-vehicle unit value of time based on the international literature of stated preference survey outcomes (Wardman and Hine, 2000; Wardman et al., 2012) ([32]).

[32] See also units A1.3 and M3.2 of Department for Transport (2021).

Table 7. Time elements

Common perceived time elements	Weighting on in-vehicle unit value of time or fixed penalty	Comment
	Door-to-door trip elements	
Walk time	1.5–2	
Wait time (actual time spent waiting for a PT vehicle)	1.5–2	Not to be combined with the PT service headway approach and to be used only for turn-up-and-go services with high frequency (more than four vehicles per hour)
PT service headway (average time interval between services)	0.4–1	Lower weightings are applied to services with lower frequencies (usually longer distance) and can be expressed as a function of service frequency
PT transfer penalties	4–15 minutes fixed penalty	Intrinsic discomfort value after taking into account walking and waiting at interchanges. Lower in high-frequency well-integrated local PT services and higher for longer distance trips
	Reliability and congestion	
PT late arrival	2.5–4	Weight applied to lateness / delayed part of travel time
Congested time (in car)	1.5	Applied to time spent in congestion
Travel time standard deviation (car)	0.4–1.2	Applied to the standard deviation of travel time

NB: PT, public transport.

Regarding passenger travel time reliability, there is a body of evidence available evaluating the higher value of time related to delay (lateness) and the additional significance of delay risk (usually expressed as the standard deviation of travel time).

Assessments of the perceived time value of comfort are best made using local stated preference surveys (e.g. the comfort of different aspects of increasing comfort in a rolling stock project).

Benefits are most commonly calculated by applying unit values of time to estimated time savings derived from a transport traffic model, where time savings can be calculated using (i) aggregate modelled estimates of time savings, (ii) a link-by-link approach or (iii) demand model skims on an origin–destination basis.

When travel time savings are not derived from detailed integrated network transport models, care must be taken when calculating for users transferring between modes, ensuring that the full impact on door-to-door perceived travel times is taken into account, not just the time spent in vehicles.

Safety

Avoided accidents typically constitute a significant project benefit, especially in road projects, for public transport projects involving a significant mode shift from road, for railway crossings and cycling infrastructure projects. Section 3.8.4 of the 2014 CBA guide contains a detailed description of relevant concepts (e.g. direct/indirect costs and the value of a statistical life).

Road accidents

Projects involving, for example, a shift of traffic from single-carriageway roads (with uncontrolled accesses and no safety barriers between opposing traffic flows) to motorways or dual carriageways (with restricted accesses and barriers between opposing traffic flows) can substantially reduce accident risk ([33]). Public transport projects involving a mode shift (from cars to public transport modes) may also generate large accident savings.

A good practice in project appraisal is for countries to produce data on national accident rates (in terms of number of accidents per million vehicle-km), severity splits (the percentage of accidents involving fatalities, serious injuries, minor injuries or material damage accidents only) and casualties (average number of fatalities, serious injuries and minor injuries per fatal, serious or minor injury accident) for each carriageway type. These estimates are produced by combining information from national accident-reporting sources (e.g. police accident report forms) with data from traffic volumes on each section of the road network. To account for the phenomenon of accident underreporting and/or underrecording, correction factors may be applied to the number

[33] See Chapter 4 of Transport Infrastructure Ireland (2020).

of fatal, serious and minor injury accidents ([34]).

Estimates of the monetary value of each accident/injury (differentiated by severity), from, for example., stated or revealed preference studies, are also needed. When such surveys are not available, suitable estimates can be taken from adjacent countries with similar levels of per capita GDP, or values may be taken from Table 7 of the 2019 handbook (Directorate-General for Mobility and Transport, 2019).

In the event that the abovementioned data are not available at the country level, or if link type information was not available from the demand model, accident savings can be incorporated into CBA in a relatively rudimentary manner by the application of estimates of the per km cost of road accidents - from Table 8 of the 2019 handbook to modelled changes in vehicle-km of travel on the road network.

Rail, air and public transport accidents

Country-specific estimates of accident rates and costs per mode may be available from national appraisal guidelines. If these are not available, default accident costs per passenger-km, for each mode of transport, are available from Tables 8–10 of the 2019 handbook. These may be applied to modelled changes in vehicle-km for relevant transport modes to calculate accident savings that are the result of transport interventions.

Environmental emissions and local health impacts

The local health impacts of environmental emissions constitute a significant project benefit, especially in road projects and public transport projects involving a significant mode shift from roads.

The recommended methodology to calculate the external costs caused by air pollution remains unchanged from the 2014 CBA guide (see Section 3.8.6 of that guide).

To calculate the total air pollution costs, quantities of air pollutants additionally emitted or avoided are estimated using suitable emission factors (tonnes of pollutant per vehicle-km) and available transport performance data (e.g. vehicle-km) derived from the transport model. The estimated emission quantities are then multiplied by the unit costs per air pollutant.

Updated unit costs for air pollutants, per country, emitted in road, rail, inland waterway and maritime transport are available from Tables 14 and 15 of the 2019 handbook.

Air pollutants – road transport

A good practice in the estimation of quantities of air pollutants for road projects would be for countries to produce specific emission factors as a function of the vehicle type, road type, road condition and average speed. The vehicles are differentiated by vehicle type, capacity or weight, fuel and emission standard in order to consider the country-specific fleet composition. Calculations of the air pollutant quantities could be done on a link-by-link basis or by using aggregate modelled estimates of vehicle-km, where possible broken down by vehicle type and by road type. Technical guidance to prepare national emission inventories is provided in the European Environment Agency air pollutant emission inventory guidebook (European Environment Agency, 2019). The same source can be used for default emission factors if country-specific data are not available.

If only aggregated modelled estimates of vehicle-km are available, where possible differentiated by vehicle category, average country-specific air pollution costs per vehicle-km for road transport are provided in the annex entitled 'Complete overview of country data' accompanying the 2019 handbook ([35]).

Air pollutants – rail, air and public transport

Country-specific estimates of emission factors per vehicle type and mode may be available from national appraisal guidelines. If these are not available, marginal air pollution costs per passenger-km and tonne-km, for each mode of transport, are available from Tables 20–23 of the 2019 handbook. These may be applied to modelled changes in passenger-km and tonne-km for relevant transport modes to calculate air pollution impacts of transport interventions.

Climate change impact

The accuracy of the assessment of the increase/decrease in GHG emissions due to a project largely depends on the availability of local data on road vehicles (cars and buses), speed and road conditions, as well as energy consumption for rail-based modes (railways, tramways and metro). This allows the relevant emission factors to be properly selected. In the absence of project-specific data, the European Environment Agency (2019) air pollutant emission inventory guidebook can provide default emission factors for transport and energy production.

A unit cost of carbon in EUR/tonne of CO_2 equivalent must be applied to monetise the impact for use in an economic assessment in line with the values suggested in Section 2.5 of Part I of the EAV.

[34] See Table 5 of Directorate-General for Mobility and Transport (2019).

[35] The values are also included in a dedicated section of the spreadsheet template complementary to the EAV that is currently being considered by Innovation and Networks Executive Agency for smaller projects applying to the Connecting Europe Facility transport call for proposals for 2021-2027.

In the framework of the efforts of the Member States to evolve towards carbon-neutral transport systems, an accurate assessment of the quantity of generated/avoided GHG emissions using the principles stated above provides important information for assessing the progress made towards the achievement of GHG reduction targets set at the national/regional level in sector-specific strategies or in overall climate change mitigation strategies.

Noise impact

The recommended methodology to calculate the external costs caused by noise pollution remains unchanged from the 2014 CBA guide (see Section 3.8.5 of that guide).

Tables 37 and 38 of the 2019 handbook and the accompanying annex entitled 'Marginal costs air pollution, climate, WTT, noise' provide unit values of marginal cost of noise for road and rail transport, differentiated by vehicle type, time of day, traffic situation (dense or thin) and area type (metropolitan, urban, suburban or rural). The unit costs are EU-28-specific values and they are provided in EUR/passenger-km, EUR/tonne-km or EUR/vehicle-km. To calculate noise pollution costs, they are applied to modelled changes in passenger-km, tonne-km or vehicle-km for relevant transport modes. If only aggregated modelled estimates of vehicle-km are available, where possible differentiated by vehicle category, average country-specific noise pollution costs per vehicle-km for road and rail transport are provided in the annex entitled 'Complete overview of country data' accompanying the 2019 handbook.

Other environmental impacts

Other environmental impacts (e.g. the impact on Natura 2000, namely biodiversity) are assessed qualitatively; owing to the difficulty of physically quantifying or attributing money values to such impacts, they are generally not monetised and thus are excluded from the project CBA. Impacts can, however, often be scored subjectively on a scale and, as required, included in a wider MCA process to compare options.

Operating and maintenance costs of infrastructure

The main comments here are related to the set-up of the without-project scenario and related O&M costs. As was discussed in the 2014 CBA guide, there are a number of valid ways of setting up the without-project scenario depending on the context (e.g. a business-as-usual scenario leading to further degradation of the infrastructure or a more do-minimum type of scenario with more aggressive replacement interventions in order to maintain the current operating conditions).

Whatever the approach chosen, it is very important that the operational parameters of the infrastructure (e.g. track speed) and the O&M elements in the without-project scenario are fully consistent with each other. In a number of cases seen in 2014–2020, this relationship was not always apparent or well documented.

Costs and benefits of rail freight enhancements

For many rail infrastructure development projects with strong elements of improvement for freight transport, a significant part of the economic benefits is attributable to improvements in freight travel time and travel time reliability, operating costs and external cost reduction from mode shift.

The method and parameters of appraisal of railway corridor enhancements that provide for enhanced freight operations are somewhat fragmented and often misunderstood in the wider appraisal community, often leading to double counting in CBA or underestimation of certain impacts. JASPERS therefore developed guidance on appraising rail freight measures, with the support of leading experts in the field (EIB and JASPERS, 2017) ([36]), to offer a state-of-the-art, logical and consistent framework for the appraisal of impacts of rail infrastructure projects with rail freight enhancement elements. The guidance separates freight costs into the time value of transport (the cost of crew, vehicle depreciation, overheads, etc.), the time value of goods (capital costs and degradation of the value of the goods during transport) and purely distance-related operational costs of transport (e.g. traction and track access costs). The guidance further includes reference unit values for time and operating costs per EU country with advice on escalation if countries do not have their own unit sets.

Wider economic benefits

These are induced benefits that arise because of the impact of improved transport infrastructure being transmitted into the wider economy. Research in the United Kingdom (UK Department for Transport, 2005; Venables, 2016) has highlighted a number of potential wider economic benefits including output changes in imperfectly competitive markets, agglomeration effects and the tax implications of a move to more productive jobs.

While there is robust literature supporting the existence of such benefits, the actual likelihood of these benefits occurring is very context specific. In fact, as the data requirements to establish such impacts are beyond what is normally available for CBA, they should generally only be addressed qualitatively, unless (exceptionally for very large projects) the potential impacts justify a quantitative approach.

Real growth in the unit value of benefits

Growing economies and income levels can increase the real unit value of the economic benefits (in addition to inflation effects). To capture real increases, unit values can be increased proportionally. The following provides an update on the methods for determining the real escalation elasticities of unit values of time and externalities.

[36] http://www.jaspersnetwork.org/plugins/servlet/documentRepository/searchDocument?category=Rail%20and%20Public%20Transport

Value of passenger time. The escalation elasticity of the unit value of time to real income (GDP/capita) depends on the nature of the underlying data set. Values based on multi-country data should follow the elasticities inherent in the underlying meta-equations (e.g. the Wardman et al. (2012) study data gave the real income elasticity between the value of time and GDP/capita as approximately 0.8 for business trips and 0.7 for other trips). For data sets based on official (Eurostat) data on average hourly labour costs, an elasticity of 1 may be used as a default for all trip motivations. In the case of countries developing their own sets of values based on national/local surveys, escalation elasticities should be considered consistently with the method of setting the unit values.

Value of freight time. This is covered in the EIB and JASPERS (2017) guidance and indicates that only the element of crew time would be expected to have a significant real elasticity to GDP/capita.

Externalities (including accidents). The 2019 handbook suggests escalating the unit values of the externalities (excluding CO2) proportionally to GDP/capita as well, with an elasticity of 0.8 determined based on an extensive meta-analysis by the Organisation for Economic Co-operation and Development, which concludes that the real income (GDP/capita) elasticity for the WTP of environmental and health-related goods falls between 0.7 and 0.9.

Reference period

The evaluation reference period for a transport project is ideally set to reflect the value-weighted average lifetime of the various elements of the asset. This, however, should generally be restricted to a reasonable time limit of future forecastability of the net future economic cash flows, usually no longer than 50–60 years, which is much shorter than the lifetime of tunnels and some bridges, for example.

An equivalent (and often simpler) approach is to have a fixed maximum evaluation period, for example of 30 years, but allowing projects with a shorter lifespan to have a shorter evaluation period. Added to this is any residual value of net economic cash flows over the remaining project lifetime, usually with simplified forecast assumptions and again up to a reasonably forecastable time limit.

V.4. Other economic appraisal tools to simplify analysis and improve decision-making

Use of cost-effectiveness analysis (or multi-criteria analysis) in the transport sector for compliance-driven projects

CEA is used to demonstrate solution optimality by comparing the ratio of the quantified level of accomplishment of a particular singular objective (output) with life-cycle costs between two or more project options.

In the transport sector, its main usage in the 2014–2020 funding period was for national elements of European-level projects, which represent legal compliance objectives such as the implementation of the ERTMS in the railway sector, where the output has been defined in terms of simple physical outputs such as length in kilometres. Where such simple physical outputs are considered, CEA is generally advisable only when the outputs of the options have the same quality and functionality, otherwise the CEA is not a fair comparison. Two examples follow.

1. CEA **is generally appropriate** as a decision-making tool when, for example, two technical options of the global system for mobile communications for railway (GSM-R) ([37]) are proposed (with a different solution architecture or using different technology) that, however, offer the same (required) quality and functionality. In this case, the discounted lifetime costs for each option can be divided by the output in kilometres and the resulting CEA values can be compared.

2. CEA **is not generally appropriate** when, for example, two different GSM-R options are considered and one option has a higher level of signal reliability (e.g. by using double coverage of radio base station transmitters) corresponding to higher operational needs of ETCS ([38]) level 2 and the other option is cheaper and less reliable (with only single base station transmitter coverage). CEA is not a suitable tool here, as it would automatically favour the cheaper option, which is of worse quality and may not meet the operational needs of reliability.

In the latter case, option selection may be better guided by MCA, taking into account the quality, functionality and/or risks of different solutions as the main impact criteria together with the lifetime cost as a balancing criterion. This might take place after a prior assessment of minimum operational requirements in terms of quality and functionality as a threshold for option acceptability.

The two examples above are not mutually exclusive, and a CEA (used to decide between two shortlisted options of comparable quality) might follow an MCA (used to identify the optimal balance of quality and price) in the appropriate circumstances ([39]).

International unit price benchmarking (for the type of solution chosen) and tender outcomes (when there is more than one bidder) are recommended in all cases as a complementary check on the absolute value for money.

[37] GSM-R is a standard digital railway radio communication technology, which is an element of the ERTMS and underpins the ETCS.

[38] The ETCS is part of the ERTMS.

[39] Compliance-driven projects requesting the financial support of the Connecting Europe Facility are generally not subject to the requirement of submitting a CBA (detailed requirements depend on each particular call for proposals). However, applicants are free to reinforce the economic case of their project with any type of EA approach or combination of approaches.

Use of multi-criteria considerations in decision-making

While CBA plays or could play a very important role in the appraisal of most transport projects, there are normally impacts (such as those on Natura 2000 sites) where monetary values are less readily available but nonetheless relevant for decision-making purposes. For this reason, a multi-criteria approach is useful in bringing together information on impacts in a variety of different formats (i.e. monetised, non-monetised quantitative or qualitative assessment). This information can be compiled into a predefined format with clear rules for non-monetised quantitative or qualitative assessment and presented to decision-makers at key milestone stages to aid the decision-making process.

In some cases, a formal MCA is performed, with scoring and weighting of different criteria (taking care to avoid double counting) leading to a single MCA score; in other cases, the outcomes are simply presented against various criteria without weighting to inform a consensual political decision. Finally, the multi-criteria approach can be a hybrid of both approaches.

For major political decisions, a single-value MCA outcome is often considered too opaque and subjective an indicator and is at risk of being marginalised in practice. Clear presentation of the main quantified and unquantified outcomes of various options is, in such a case, not just a presentational exercise but a fundamental input for real-life decision-making.

Examples of actual processes used in Ireland and Germany for major scheme decision-making and plan prioritisation, respectively, are described below.

Irish major project scheme appraisal approach

For major transport schemes in Ireland (similar to UK practice), an overall appraisal table is required as a key input for decision-making. Table 8 is a simplified example of an appraisal summary table.

Table 8. Simplified version of appraisal summary table for transport projects

Impacts		Summary of key impacts	Assessment		
			Quantitative	**Qualitative**	**Monetary (EUR, NPV)**
Economy	Overall economic impacts	Summary of economic impact	Investment cost estimate Usage of project (number of daily vehicles/passengers)	Qualitative assessment of economic benefits	Project NPV, B/C Ratio and ERR (note this includes the present value of impacts noted beneath)
Economy	Time savings	Summary of any time-saving benefits	Average time savings per user Hours saved per year	Qualitative assessment of time-saving benefits	Present value of time-saving benefits (passengers and freight)
Economy	Vehicle operating costs	Summary impact on vehicle operating costs	Average operating costs per vehicle (without and with project scenarios)	Qualitative assessment of vehicle operating cost changes	Present value of vehicle operating cost savings
Economy	Wider economic benefits	Summary of any wider economic benefits	Number and quality of indirect jobs created (if any)	Qualitative assessment of potential for wider economic benefits	Generally excluded but, where applicable, present value of wider economic benefits
Economy	Additional economic objectives ...	...	...	...	...

Environmental	GHG impact	Summary of impact of project on climate change	Annual average tonnes of GHG emitted from project	Qualitative assessment of impact of project on climate change	Present value of GHG emission reductions
	Environment-related local health impacts	Summary of impact of project on emissions / local health	Annual average tonnes of NO_x, CO, etc., emitted	Qualitative assessment of impact of project on environment / local health	Present value of environment-related local health impacts
	Additional environmental objectives ...	...	...	...	...
Social	Safety	Summary of impact on transport safety	Average number of annual fatalities and serious injuries saved	Qualitative assessment of impact of the project on safety	Present value of safety impacts
	Additional social objectives ...	...	...	...	...

German approach

The German methodology ([40]) used to prepare the long-term national transport infrastructure investment plan (but which could equally be used to provide a higher level of detail for a project appraisal summary assessment) is based on four modules:

1. CBA, covering all of the common elements also addressed by the 2014 CBA Guide – this is the only module based on monetisation of impacts;
2. environmental protection, addressing all topics relevant for the environmental dimension not covered by the CBA, for example land consumption, protection of sensitive areas and habitat fragmentation;
3. spatial planning, addressing the connectivity and accessibility of agglomerations in terms of distributive equity; accordingly, this differs from the allocative benefits of accessibility included in the CBA in terms of time savings;
4. urban planning, addressing the local impacts of transport infrastructure projects that affect the quality of urban areas – this applies, for example, to projects able to relieve urban areas of through traffic or decongest them (note that the national plan does not address investment in urban transport infrastructure).

Modules 2, 3 and 4 do not rely on monetisation but, for each of them, a strictly standardised and largely quantitative evaluation scheme is given, ensuring a high degree of objectivity and comparability of results. In a subsequent phase, the investment options are assessed against a detailed, multi-level set of given strategic goals. To this end, the scores resulting from each module are not aggregated to a single indicator. The particular way in which each project, as defined by its four individual scores, contributes to the strategic goals is assessed. This eventually allows a broadly based, informed investment decision to be made.

V.5. Standardising and streamlining demand modelling as an input to economic appraisal for road, rail and urban transport

Demand models generally form the key source of input and assumptions for a transport CBA, so their quality and objectivity are an essential prerequisite of a sound transport economic analysis.

Demand models provide forecasts (without and with project investment) of traffic levels that are a key basis for the assessment of time savings, cost savings and externalities. The creation of a transport model is, however, a costly and time-consuming exercise. It is therefore appropriate at an early stage of the project to consider what form the model should take.

In the 2014–2020 programming period, best practice in terms of demand modelling was outlined in Section 3.5 of the 2014 CBA guide, and this remains valid. However, based on a review of transport projects submitted to the European Commission for

[40] Bundesministerium für Verkehr und digitale Infrastruktur, Bundesverkehrswegeplan 2030 (BWP 2030), and in particular: PTV at al., Methodenhandbuch zum Bundesverkehrswegeplan 2030, Karlsruhe, 2016

approval in the 2014–2020 programming period, a number of common weaknesses have been identified relating to demand modelling practices, including:

- the need for a new transport model and the use of existing models;
- an inappropriate geographical scope of the model;
- an insufficient level of model network and zoning detail;
- insufficient attention paid to model calibration and validation, and a lack of underlying data;
- inappropriate or poorly documented forecasts;
- incomplete travel time, cost estimation and data exports from public transport models.

Need for a new transport model and the use of existing models

Transport models are both expensive and time-consuming to create and therefore the decision to create one should not be taken lightly. In the 2014–2020 programming period, in a limited number of cases, decisions were taken to create new demand models when the modification of existing models might have sufficed. There were also a limited number of cases of major projects using demand forecasts from clearly unreliable, outdated models. At an early project stage, existing models (where available) should be reviewed and pragmatic decisions should be taken on whether the demand model needs to be updated/replaced. Even when a new demand model is required, existing sources of information (in the form of traffic counts, origin–destination surveys and coded supply networks) should be used to the maximum extent possible. The proliferation of national transport models provides a useful source of information; it is possible to extract basic information from these (on supply network and demand matrices), which may aid in the creation of local models.

Incorrect geographical scope of the model

Sometimes models do not have the correct geographical scope, with the modelled area being either too small or too large. The minimum required modelled scope should be the area within which the main expected transport impacts of the types of plans and/or projects are expected to occur. Particular issues are found with major cross-border projects and investments in rail freight facilities, where European travel data are essential. European data such as from the European Transport Policy Information System (ETIS+) and Eurostat, the Trans-European Transport Network Policy (TEN-T) information system (TENtec), the latest European models (a new model called TRIMODE is being developed) and European forecasts (e.g. the EU reference scenario 2016 (European Commission, undated), which is being updated to a 2020 scenario) should be considered when possible in such cases. The development and use of national models and the data of neighbouring states should also be considered.

Insufficient level of model network and zoning detail

This is often observed when national models are applied to regional transport projects or regional models are applied to local/urban transport projects. Existing higher level models may need to be cut (taking only the relevant part of the network) and further detailing made in terms of network and zoning in order to become applicable for project assessment at a lower level, especially in the area of direct influence of the project.

Insufficient attention paid to model calibration and validation, and a lack of underlying data

Transport models require proper calibration and validation (often understood just as calibration). Calibration essentially entails estimating the multitude of constants and parameters in a given transport model based on transport data; validation establishes the credibility of the model by demonstrating its ability to replicate observed traffic behaviour.

Data used for validation should be independent (i.e. they should not have already been used in the first steps of model calibration). For four-stage models used for public transport / rail projects, production / attraction, distribution and mode share model step parameters should be calibrated based on the outcome of census data (if recording trips) and specific mobility surveys.

To confirm the suitability of a model, statistical tests such as the GEH test may be used as part of a rigorous model acceptability test in the validation process. In the 2014–2020 programming period, there were no fixed requirements for model calibration and validation. The majority of transport projects followed best practice in this regard.

Inappropriate or poorly documented forecasts

Demand forecast models normally contain mathematical relationships relating travel demand (per trip purpose) to external driving factors such as GDP, school places or population. Ideally, demand forecasts will use official forecasts of these external factors to assess probable future demand (again at the trip purpose level). In the 2014–2020 programming period, some forecasts were based not on this methodology but rather either on simple unjustified assumptions or on the application of simple growth factors. Forecasts should be transparently documented linking, underlying variables with the justification of the quantitative link between demand and these variables.

Incomplete travel time, cost estimation and exports from public transport models

When a project has a substantial impact on different elements of a door-to-door trip, such as a new railway stop, it is advisable that the model and its output into the CBA should take into account the perceived cost of each element of the trip, such as access to a public transport stop, waiting time and in-vehicle time. Without this, the full benefits of the project will not be measured, which may lead to a low ERR or a distorted option analysis.

For more detailed descriptions of best international practice relating to demand modelling, please refer to the UK Department for Transport highway assignment modelling (UK Department for Transport, 2020) and the JASPERS publication *The use of transport models in transport planning and project appraisal* (JASPERS, 2014) or, for multi-modal freight modelling, see EIB and JASPERS (2017).

ANNEX VI. BROADBAND

VI.1. Introduction

The digitalisation of society is a key component in the EU's multiannual financial framework for 2021–2027. Two of the five cohesion policy objectives for the multiannual financial framework directly address digitalisation and digital networks. Indirectly, the other policy objectives will also rely on successful measures to implement projects in these areas. The driver for continuous digitalisation in the EU is an efficient and reliable infrastructure, with high-speed fixed and mobile broadband. The previous EU programming periods employed policy initiatives and financing of ICT investments to extend the availability and take-up of high-speed broadband access in the whole of the EU and to increase the uptake and use of ICT services. The recent COVID-19 pandemic reinforced the need to further deploy digital infrastructure and build on ICT services to support all business, commercial and everyday activities in our society.

Specifically, in relation to digital infrastructure, the **European Commission introduced, in 2016, its strategy on connectivity for a European gigabit society**. The document recognises that the full economic and social benefits of the digital transformation will only be achieved if Europe can ensure widespread deployment and take-up of very high-capacity networks, in rural as well as urban areas and across all of society. The gigabit society strategy **sets out a number of targets to increase the coverage and quality of broadband infrastructure in Europe**. The vision for 2025 includes gigabit access to major social economic drivers, ultrafast internet access (above 100 megabits per second (Mbps), upgradable to gigabit speed) to all European households, and uninterrupted 5G wireless broadband coverage in urban areas and along major rail and road infrastructures.

Over recent years, there has been a shift in the type of projects that have received public support. While many of the digital infrastructure projects in the earlier multiannual financial frameworks focused on the presence of a high-capacity telecommunication backhaul infrastructure, predominantly through investment in the deployment of fibre, the 2014–2020 one concentrated more on projects related to high-speed access to end users, ensuring that they can better benefit from capacity-demanding applications, such as internet protocol television (IPTV) and various streaming services. More importantly, however, these projects have paved the way for tighter integration of ICT services in everyday life, empowering more teleworking options through more reliable, higher quality and more responsive video conferencing, as well as facilitating the deployment of several e-services in the areas of e-health, e-commerce and e-government. By unlocking investments in digital infrastructure in rural areas, the European Commission's investments have worked towards reducing the digital gap, benefiting citizens across the continent and creating new growth opportunities.

In the light of the above changes in the broadband landscape and policy objectives, this chapter also provides an update to the approach presented in the 2014 CBA guide. Whereas the focus of analysis was previously on projects deploying backhaul infrastructure, this version also takes into account the rollout of next-generation access networks all the way to the end users.

For broadband projects, it is industry practice, in both publicly and privately financed projects, to develop a project feasibility study, including a financial analysis to demonstrate the rationale for the project and its sustainability during operations. In addition, the analysis needs to demonstrate if the project is bankable or in need of EU grant support. For many projects, in particular when required by the authority providing grants or loans, the analysis extends to the economic level, aiming to demonstrate the value of the investment at large for the target population and society as a whole. **This chapter focuses on the economic analysis of broadband projects.**

VI.2. Project development cycle and methods

The economic analysis of the project builds on several steps of the project development cycle, which form a feasibility study. The 2014 CBA guide outlines these steps in more detail. The project idea needs to be developed within the framework of the overall drivers of the intervention, in particular the existing policies, regulations and sector strategies as described above for broadband investments. Publicly driven broadband projects equally need to carefully consider the EU State aid legislation.

Apart from compliance with policy, **broadband interventions are duly justified only when their scope reflects the current and expected future demand for the project infrastructure**. The current demand can be based on the national broadband map, EU and national regulator reports or information provided by telecommunication operators. Estimations of the future demand would typically be based on market research and evidence of market interest (i.e. public consultations and operator investment plans) focused on the intervention area, as well as analysis of the future services that can trigger demand and their bandwidth requirements. Demand analysis, both current and expected, should equally consider aspects of affordability, ICT literacy and patterns of increase in penetration rate in comparable markets. The results of the demand analysis, such as the number and groups of users, will form the basis of economic assessment of the project.

The broadband demand analysis is followed by option analysis, in which the most cost-effective technical and business solutions are selected, within the desired policy goals and the results of the demand analysis. **For broadband projects, there are usually also a number of strategic choices when it can be more effective to consider these qualitatively.** An MCA can allow the relative merits of possible strategic options to be compared, including different business models or considerations of different locations or size of investments. Strategic options can be assessed, for example, from a legal perspective within State aid and procurement law, the need for public oversight of investment or risk transfer between public and private partners. **The results of the first-level analysis would lead to the identification of the possible business/institutional options.** An evaluation and shortlisting of suitable technological alternatives should be done next, such as variants of FTTx, including fibre-to-the-home or fixed or mobile wireless access.

In the next level of option analysis, **it is recommended that the feasible options be compared using a simplified CBA**, as this method can help in considering the efficiency of limited public resources at the early stage of project identification and in choosing the option with the highest value for money and impact on the local society and economy. This step involves preparing the financial and economic models based on approximate values, which will be made more accurate for the chosen option. The next section gives more recommendations on the economic analysis.

Once the project option has been selected, it will be used as the basis of the technical design. For telecommunication, a number of tools and methods are used for network design and the calculation of related equipment needs. An important element of this is to take into account the presence of existing infrastructure that can be reused in the project.

Next, the financial model can be refined with more accurate project cash flows: capital and operating costs, reinvestments, financial revenues and residual value. There are different considerations related to the benefit of carrying out profitability analyses at the level of the owner or operator. For example, the selection of the private partner through fair, transparent and competitive procedures should allow the best value for money to be assured. For public owners, the calculation of financial 'profitability' may not be meaningful when the institutions are subject to budgetary balance. Moreover, there are also often specific provisions set out by State aid decisions (i.e. a clawback mechanism). However, if there are public and private partners involved in the project, it is important to carry out financial sustainability analysis at the level of each of the stakeholders. Economic analysis of the selected option can be also performed at this stage, especially if there are major changes to the assumptions on the costs or scope of the project.

The project should finally be subject to a risk and sensitivity assessment, whereby potential shortcomings are tested and mitigated to ensure the viability of the undertaking for implementation and operation.

VI.3. Economic appraisal

To verify if the project has the potential to affect society and the economy positively, it is necessary to value the project's benefits. The 2014 CBA guide discusses three broad categories of economic benefits: increased take-up of digital services by households and businesses, improved quality of digital services for households and businesses, and improved provision of digital services for public administration. Another possible categorisation of benefits is that focused on users (consumers and businesses), sectors (education, healthcare and government) and cross-cutting impacts on environmental or social inclusion effects.

The research literature on the socioeconomic benefits of broadband has been evolving in the past decades alongside the continued growth in the reach of networks, their speeds and the range of applications and services available. While the positive impact of high-speed networks is generally recognised, it is equally noted that the exact impact remains difficult to measure.

Moreover, the challenge in proposing a **generic** model is that **infrastructure projects aimed at improving access to broadband networks in a given area or region may differ significantly because of the specific needs of the intervention area**. For example, they may differ to the extent to which they aim to connect public administration, healthcare or schools, in addition to improving general broadband access. Projects focused on improving the connectivity of a particular public service or group of users would need to consider additional economic costs and benefits that are sector and project specific.

Despite these challenges, **there are studies that demonstrate that there are ways to quantify a set of economic benefits**. Consequently, decision-makers can evaluate the economic viability of publicly funded investments in broadband projects. The template CBA, developed for the beneficiaries of EU funds and available on the JASPERS website, can be adapted to be used independently of the sources of financing (JASPERS, 2020). The model assumes that the impact of the project will depend on the difference in speeds between the existing broadband provision and those resulting from the investment in the project area. This differentiation in capacity is partially also linked with the various types of services and technologies on the end user side that are enabled through the different speed ranges (from email and web surfing in the case of lower speed broadband to IPTV, streaming, video conferencing, etc. as the available speed increases; Table 9).

Table 9. Broadband speed categories used in the model

Broadband speed category	Description
From nothing/basic/fast broadband to superfast broadband ([41])	This category represents premises with no broadband, basic broadband (> 2 Mbps) or fast broadband (> 10 Mbps) currently but that will get superfast broadband (> 30 Mbps) as a result of this project
From nothing/basic/fast broadband to ultrafast broadband	This category represents premises with no broadband, basic broadband (> 2 Mbps) or fast broadband (> 10 Mbps) currently but that will get ultrafast broadband (> 100 Mbps) as a result of this project
From superfast to ultrafast broadband	This category represents premises currently getting superfast broadband, but that will get ultrafast broadband as a result of this project

Source: JASPERS (2020) broadband model.

Following a literature review of available studies, **two parameters are proposed to be used in the model: (i) consumer benefits per household and (ii) business benefits derived from productivity rises estimated per employee in the project area**. The model has a built-in flexibility, which allows it to be modified according to the particular circumstances of a given project or beneficiary. Project promoters can use other types of benefits in their assessment or can modify parameters of the benefits considered in the model (Table 10 gives a checklist of a number of possible benefits, including additional considerations to make). In such a case, however, the methodology or assumptions used should be properly explained. As a 'living document', the model is can be updated, when new data emerging so require.

The European Commission's 2014 CBA guide has promoted a microeconomic approach in the estimation of benefits and the above follows this approach. However, project promoters and evaluators often follow an alternative macroeconomic assessment of broadband investments based on GDP growth. While there are advantages and disadvantages to both methods, it is important to note that the two methods cannot be combined, as this can lead to double counting of benefits.

Table 10. Checklist of possible benefits

Topic/issue	Monetary evaluation	Qualitative assessment	Comment on treatment
Consumer benefit	√		There is sufficient evidence, although the estimates vary across studies. The values of the benefit would depend on the net increase in the available speed
Business benefit	√		
Social inclusion		√	Intangible benefit
e-Education – benefit of connectivity to home	√	√	The quantification of these benefits may be possible in the case of individual projects. Careful consideration is needed to avoid double counting with consumer or business benefits
e-Government – cost savings	√	√	
e-Health – savings from e-health initiatives	√	√	
e-Farming – increase in farm production through the adoption of new methods	√	√	
Environment – limitation of negative impact thanks to reduced travel		√	Impacts are likely to be mixed; a variety of small effects are likely, which are difficult to estimate

[41] Basic broadband is defined as being between 2 Mbps and 10 Mbps, fast broadband is defined as 10 Mbps to 30 Mbps, superfast broadband is defined as 30 Mbps to 100 Mbps and ultrafast broadband is defined as greater than 100 Mbps.

ANNEX VII. WATER AND WASTEWATER

VII.1. Introduction

The main part of water/wastewater projects are implemented within the business of integrated water utility operators and can be subdivided into those that are:

- **compliance** related, where the focus is on ensuring safe and reliable drinking water together with adequate collection and treatment of wastewater;
- **efficiency** related, where the aim is to improve resource usage, save costs and reduce carbon footprint, while also allowing for lower end user prices and reduced affordability constraints.

In practice, many projects combine elements of both, with the first group tending to result in increased operating costs, while the second has the potential to decrease such costs, reducing the impact.

Policy for compliance-driven projects is oriented towards meeting the requirements of the directives for the provision of water and wastewater services, such as the water framework directive (WFD; Directive 2000/60/EC), the directive on the quality of water intended for human consumption (Directive 98/83/EC) and the urban waste water treatment directive (UWWTD; Directive 91/271/EEC), and is measured in terms of the relevant population connected to services, but also in terms of the quality and security of supply.

The directives also make reference to the polluter pays principle, the need for full cost recovery and the importance of the end user affordability of services. This, combined with the scarcity of water, which is exacerbated by climate change impacts, sets the agenda for efficiency-related projects.

Countries find themselves confronted with the need for investments that promote climate change adaptation, risk prevention and disaster resilience in the water sector. Thus, while the larger part of existing funding has been oriented towards directive compliance, new types of projects will increasingly be considered, such as those focusing on leakage/infiltration reduction, drought resilience and water reuse schemes.

In considering the method of appraisal, some common features of water operators need to be considered.

- Typically, integrated water and wastewater service providers operate in a defined geographical area with existing operations, which comprises a 'natural' monopoly, where it is not cost-effective to have multiple networks (i.e. they will usually have a mandate to operate exclusively in that area and without competition).
- Often, such entities are owned by national or regional/local governments, but can also have private sector involvement.
- Water operators typically have a relatively simple tariff structure (water vs wastewater collection and treatment) and relatively few customer types dominated by domestic consumers.
- Such entities also have a relatively simple operating cost structure with a high level of fixed costs (e.g. capital (depreciation/debt service) and salary (semi-variable)).
- Stable and predictable cash flows make operators suitable for debt finance with long tenors.

The following represents a codification of existing good practices, which have evolved over the last few funding phases.

VII.2. Project development cycle and methods

When the nature of investments is, overall, compliance driven, the key question is how to achieve an outcome considering all of the constraints, rather than identifying whether or not the investments are needed. As the cost of achieving and maintaining compliance with the directives is substantial, **it is important that, in an option analysis including all reasonable technical options, the technical design considers and selects the most cost-effective outcome based on the present value of the life-cycle costs** for each standalone investment component. This is predicated on the assumption that each option has the same economic benefits, which is usually considered the case for solving a specific compliance-related problem (i.e. least cost analysis). If this is not the case, it will be necessary to rank options based on a cost per unit of output achieved (i.e. CEA).

While assessing the measures, project promoters should carefully assess the **cost per connection, connections made per metre of pipe needed** or similar indicators, based on national (or other reasonable) benchmarks, and in the case of wastewater consider the provisions of Article 3 of the UWWTD:

> *Where the establishment of a collecting system is not justified either because it would produce no environmental benefit or because it would involve excessive cost, individual systems or other appropriate systems which achieve the same level of environmental protection shall be used.*

In the case of more complex projects not dealing exclusively with compliance with the directives but also involving investments **dealing with, for example, climate change adaptation, risk prevention and disaster resilience in the water sector**, ultimate investment decisions should or could be based on a thorough assessment of the economic costs and benefits, through **a fully fledged CBA**.

A fully fledged CBA, in terms of the development of a cash-flow/economic cost and benefit forecast model is usually done at the feasibility stage. Its development should both be driven by and inform the technical development of the project in an iterative process to ensure consistency of assumptions, and to test scenarios for prioritisation and phasing to ensure that the outcome can reach a balance between affordability and sustainability. A financial cash-flow analysis is recommended to test such scenarios (see the following section).

VII.3. Financial and economic appraisal

Owing to the overall objective of achieving full cost recovery, as defined by the WFD, together with the need for ensuring sustainability and affordability, the basic analysis follows a financial analysis approach (i.e. cash-flow projection) as the foundation. As most of the cash flows on the expenditure side also represent economic flows, the economic analysis usually builds on the financial analysis. When the project is undertaken by an existing operator (e.g. water utility), which is usually the case, then the analysis needs to be conducted at the operator level, as it is for whole operations that measures of tariff, affordability and sustainability are of greatest value.

The main considerations to be taken into account in the EA include cost recovery tariffs ensuring sustainable operations (as required by the WFD), affordability considerations and the need for cash-flow projections and economic analysis, as discussed below.

Cost recovery tariffs

The legislative requirement for sustainability comes from the WFD (Article 9), which states that tariffs need to cover:

- operating cost,
- asset maintenance cost (a minimum level may need to be set),
- capital costs through depreciation provisions ([42]) (historical asset values may need to be re-evaluated),
- 'environmental and resource cost' reflecting the scarcity value of water.

Depreciation under the third item is not a cash-flow cost, but reflects past capital outlays to be recovered over time. On the other hand, incorporating depreciation in the tariff allows a cash fund to be built up for asset replacement and/or to repay investment loans. Thus, it may be possible to charge less than 100 % depreciation in the tariff in the short/medium term, in order to keep within affordability constraints (see next point).

The regionalisation of services helps to spread costs over a larger area with a single unified tariff structure. This is also known as the solidarity principle, even if it represents an implicit cross-subsidy between more densely populated areas (i.e. cities) and less densely populated (i.e. rural) areas.

Affordability considerations

The WFD also mentions that 'water pricing policies' should 'have regard to social' effects. This is interpreted as meaning that tariffs should not result in amounts billed that exceed reasonable affordability thresholds. In current practice, these thresholds are often taken to be in the range of 2–3 % of average disposable household income (although higher levels are used, even up to 5 % in low-income areas where low incomes make such levels unavoidable and the benefits of the project are high).

In this respect, a key challenge is matching the operator's need for financial sustainability (i.e. the cost recovery tariff) and the end users' affordability constraint. It is worth noting that it is hard to be explicit about how fast a project needs to achieve cost recovery or with respect to absolute levels of affordability, as it depends on the level of needs and levels of income at the country (or even regional) level. It is normally in the interest of the project promoter that the path to full cost recovery is as short as possible, subject to the affordability constraints. Often, 3–3.5 % of average disposable household income is seen as an upper limit with respect to average household income in the EU context, but sometimes this may need to be exceeded.

As good practice in such cases, subsidy schemes for low-income users can be considered. Such schemes could, for example, give discounts to user groups that are identified as having difficulty in paying bills, and should be structured (as far as possible) as a social support measure and not imposed as a cost to the water operator. If designed to carefully target low-income users or otherwise vulnerable or displaced communities, this approach could ensure that affordability issues are addressed in a cost-efficient manner.

Table 11 reviews some good practices on how to cope with issues related to tariffing and affordability.

[42] If capital costs are financed by debt, then there may need to be an extra provision in the tariff to the extent that debt service (principal and interest) exceeds depreciation charge. This can happen if the repayment period is shorter than the expected useful lifetime of the relevant assets used for the depreciation charge.

Table 11. Tariffing and affordability: good practices

Issue	Good practice
End user charge respects full cost recovery (and, ultimately, the polluter pays principle)	It is accepted that this may be achieved over time (say 10–20 years of operations) to ensure WTP, but is conditional on cash-flow sustainability. In principle, non-domestic users should pay the full cost recovery tariff immediately
End user charge (as a percentage of estimated average disposable household income) does not exceed a reasonable threshold	Such a level (or range) should be defined at the country level or should otherwise be assessed for reasonableness, although it is accepted that some flexibility is needed to exceed thresholds to undertake investments needed
Cash flow at the operator level needs to remain cumulatively positive throughout the projection period	Apart from operating cash flow, this should include the replacement of assets and debt service on historical and new (i.e. project-related) debt
Operating costs need to be adequate to ensure proper operation – this applies especially to maintenance	These two areas overlap both with each other and with the role of the relevant regulatory authority. It may be possible to undertake country-level benchmarking of costs for different operators to determine how to ensure cost levels are both adequate and not excessive
Operating costs should not be excessive owing to inefficiency – this especially applies to staffing costs	
Cross-subsidy should be avoided between (i) non-domestic and domestic user groups for the same services and (ii) regulated and any other services performed by the same entity	No user group should pay a tariff greater than the full cost of the service provision. If industrial treatment tariffs are higher than domestic tariffs, this needs to be reconciled with requirements to pre-treat industrial wastewater. If an operator is active on other markets (other than water supply and wastewater collection and treatment), a proper cost allocation and separate accounts need to be secured

Need for cash flow projections ([43])

Cash-flow projections are needed to assess if water operators could cover the cost of providing the service while managing the trade-off between affordable tariffs and tariffs that cover the full cost of the service, in other words to show that the operator can meet day-to-day costs (including existing operations), as well as capital replacement and debt service, as and when needed. These projections:

- are built based on historical revenues and costs adjusted for the incremental impact of the project applied to foreseen changes in demand (also needed for project investment specification), foreseen operating cost developments (split between fixed and variable, expected real term growth in salaries, etc.) and adequate maintenance levels (on both existing and project assets);
- need to quantify a tariff commitment (say 5 years) for project approval, but with some flexibility with respect to future demand if actual demand varies significantly from that forecast.

The worked example in Table 12 is a very simplified cash-flow projection done at the project level simply to demonstrate the balancing of affordability with cash flow through the phased approach to charging depreciation. A tariff inclusive of full depreciation recovery is achieved in year 15, but sufficient cash is accumulated to fund replacements due in year 15 and ongoing debt service. Note that, in the example, the aim is to have affordability at 2.5 % of household income, but it is accepted that it may rise to 3 % provided that there is a long-term prospect to reduce it back to 2.5 % (which can be driven by forecast growth in household income in real terms).

[43] It is assumed that the methodology for the EU grant calculation in the next phase of the cohesion policy will specify fixed rates. If calculated rates are still allowed, then this will become an additional requirement for cash-flow projections.

Table 12. Affordability: example (million EUR)

	Year 5	Year 10	Year 15	Year 20
Revenue	55	70	85	85
Operating cost	50	50	50	50
Replacement			20	
Debt service		5	5	5
Annual cash flow	**5**	**15**	**10**	**30**
Cumulative cash flow	**5**	**40**	**100**	**150**
Cover of depreciation (new assets), %	**0**	**50**	**100**	**100**
Affordability, %	**2.5**	**2.75**	**3.0**	**2.75**

Economic analysis

As mentioned before, quantitative economic analysis should not be the main focus for compliance-driven standalone investment components. Rather, the justification should be based on showing that the least-cost solution (capital and operating costs combined over the economic life of the investment, that is, use of the life-cycle cost analysis) has been chosen after evaluating all viable alternatives.

For efficiency-related investments (especially loss reduction) and those of a multipurpose nature (e.g. combining compliance-driven measures and resource efficiency, climate change adaptation and risk prevention measures), an analysis of economic costs and benefits should be undertaken for different levels of output to show the optimal level of investment. In this respect, it can also be considered the 'resource cost' associated with the scarcity value of water as referred to in Article 9.1 of the WFD.

Different types of projects will gain precedence as Member States move closer to compliance (e.g. water resource and security (possibly induced by climate change), storm water, wastewater reuse and other). In those cases, the principles of analysis remain valid (as already discussed in Sections 4.1 and 4.3 of the 2014 CBA guide), but it needs to be shown that the economic benefits exceed the economic costs. Similarly, all kinds of interventions aiming at improving flood prevention, climate change adaptation, risk prevention and disaster resilience should be subject to economic evaluation.

The following are the main types of economic benefits applicable to water and wastewater projects:

- improved access to water and wastewater services (costs avoided in building/operating private wells and/or septic tanks);
- improved quality of drinking water (costs avoided to purchase drinking water from the market);
- improved reliability of water sources and security of water supply service, including avoided costs caused by water supply disruptions;
- variations in GHG emissions due to changes in electricity consumption and the efficiency of wastewater collection and treatment facilities, including sludge management;
- health impacts (care should be taken not to double count benefits with improved quality of drinking water);
- reduction in uncontrolled raw wastewater discharge/exfiltration;
- avoided costs of local flooding due to inefficient sewers and/or storm water systems;
- improved environmental quality of the water bodies and preservations of ecosystem services;
- benefits from recreational use of the water bodies;
- avoided opportunity cost of water (e.g. abstraction charge).

For the methodologies on how to evaluate, in monetary terms, the abovementioned benefits, please refer to the relevant sections in Chapter 4 of the 2014 CBA guide.

VII.4. Other relevant information

Projects should look for a balanced approach to the development of water and wastewater assets, with priority given to more densely populated areas based on benchmark density indicators, such as metres of new network needed for each new connection (or similar indicators). Trying to address all compliance issues at once can result in very large projects with implementation and affordability issues.

Efficiency-related measures (e.g. loss reduction through rehabilitation) should be balanced with compliance-related measures (e.g. a new treatment facility), as the operating cost savings from the former can help to balance the incremental operating costs of the latter.

ANNEX VIII. HEALTHCARE

VIII.1. Introduction

This chapter discusses specific issues concerning the appraisal of health projects, with emphasis on economic assessment. The guidance applies, primarily, to **health infrastructure projects** (e.g. the construction of hospitals and outpatient and diagnostic facilities), but also to comprehensive subsystems, such as emergency care networks. To a certain extent, it also applies to **health programmes**, focusing on a specific health threat, such as disease prevention programmes, health professionals' education programmes or **e-health** projects.

VIII.2. Project development cycle and methods

It is implicitly assumed that health investment projects should address important challenges and obstacles in fulfilling some of the key functions of the health system. Therefore, **an identification of problems and challenges ought to be the first step of the project preparation cycle**. An indicative list of typical health-related challenges is presented in Table 13.

Table 13. Typical health challenges

Problem	Character
Excessive mortality	Death is the natural end of life, which, in some circumstances, can be postponed through effective disease (or health problem) prevention or treatment
Reduced longevity	The length of life increases with civilisation's development. The life expectancy of individuals in every age category may be shortened if diseases are not prevented or treated effectively
Excessive disease incidence	Disease prevention measures may lead to a reduction in disease onset (incidence) and the consequences of disease (burden), such as reduced quality of life, loss of productivity and costs for the social (including health) protection system
Persistence of diseases	The duration of a disease, which could otherwise be cured or of which symptoms could be diminished, has an impact on the degree of consequences (burden), such as reduced quality of life, loss of productivity and costs for the social (including health) protection system
Delay in access to care	Long waiting times for health intervention may lead to the deterioration of health status (including death) and could prolong the period of deteriorated quality of life (suffering, anxiety, etc.)
Inappropriate care	Medical activity is mostly based on evidence, and the optimal patterns of care are often presented in the form of clinical guidelines, usually published by medical associations. Departure from the guidelines is regarded as inappropriate, leads to worse outcomes and the use of unnecessary resources, and may cause harms to patients' health
Diminished quality of life	Imperfect health may reduce quality of life owing to physical and mental suffering, imperfect functioning and limited capabilities
Diminished productivity of the workforce	Health threats (e.g. pandemics and substance abuse) that affect younger groups of the population may have a significant impact on goods' and services' production processes, diminishing the overall well-being of the whole population
Affordability	The development of health technologies allows for the treatment of an increasing number of cases; however, financial accessibility is limited owing to the costs of such treatment

The proper identification of challenges enables the definition of the goals, objectives and aims of the intervention. Goals and objectives should represent statements that describe what the project is expected to accomplish and should be embedded in wider strategies set at the national, regional and EU levels, if applicable. Health strategy setting and the mapping of needs, as enabling processes for the implementation of cohesion policy operational programmes, are natural points of reference when setting goals and objectives. Goals are usually high-level statements that present the overall context of what the project wants to achieve. Objectives are lower level statements that describe the specific outcomes that the project is expected to deliver (Pepper, 2007). In defining the objectives, it is useful to follow the rule of SMART (Doran, 1981). Project goals and objectives should be embedded in wider strategies that are set at the national, regional and EU levels, if applicable. The objectives should allow projects outcomes to be defined, among which should be economic gains (effects and benefits), which should be used later for economic analysis.

After defining goals and objectives, the next step is to define alternatives/options (i.e. different ways to address the problems identified) and prepare a shortlist of the most relevant ones. At the preliminary stage, the **strategic options assessment should include the development of a simplified list of costs and outputs/benefits for each alternative**, and data should be gathered to quantify them for the alternatives/options identified. **For large/strategic investments, the EA should be further updated** at subsequent stages of development of the proposal as more information comes to hand.

The following methods of EA are usually applied to health projects (Drummond et al., 2005).

- **Least-cost analysis (LCA)** is used when a well-defined / single result is going to be achieved and the only dilemma is related to the associated costs. Least-cost analysis is typically used as an element of technical option analysis, when one decides on which technical component of a complex infrastructure to adopt by comparing the costs of different options.
- **Cost effectiveness analysis (CEA)** is used when one needs to compare different options that have the same effect but with different intensities (e.g. number of lives saved). CEA particularly useful when assessing disease prevention programmes with specific health gains (e.g. breast cancer screening for reducing fatalities among cancer patients). CEA is more convenient when only one effect is achieved, and is usually carried out by calculating the cost of the intervention per unit of effect.
- **Cost–utility analysis (CUA)** – is appropriate for interventions that result in both an increase in life years and an improvement in quality of life. It compares costs with expected number of acquired disability-adjusted life years (DALYs) and quality-adjusted life years. Cost–utility analysis is appropriate for all projects that generate gains in the form of reduced mortality and improved quality of life or reduced disability.
- **Cost benefits analysis (CBA)** combines different types of gains converted into monetary values and compares them with invested resources (costs). CBA is generally the recommended tool for sizeable health infrastructure projects resulting in a series of heterogeneous outcomes. As for the quantification of benefits, this is not always an easy exercise, but some good practices exist, as described further in the document ([44]).

It is worth noting that the EA tools described above can be used in a strategic way to consider alternative solutions, but should always be used in combination with a qualitative analysis demonstrating basic strategic issues and a clear connection between the project and the overall strategic goals and objectives.

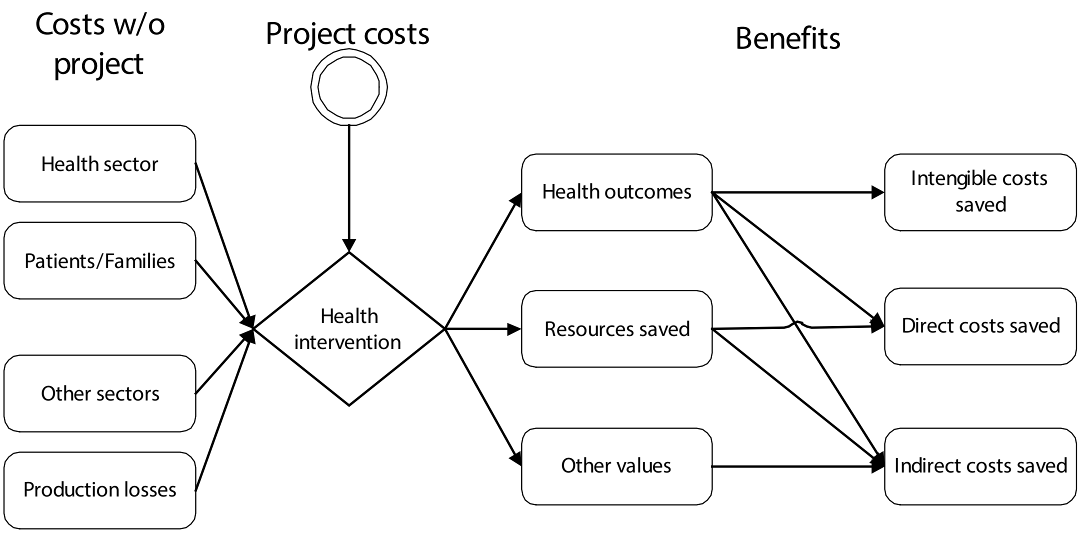
VIII.3. Economic appraisal

The purpose of EA is to provide arguments for the socioeconomic gains of a project. It is assumed that, in exchange for the public funding of the CAPEX (and possibly the incremental change of OPEX), a given project provides economic gains for society, even if it does not generate financial profit for the beneficiary.

Identifying the health-related gains of different interventions is mainly associated with presenting a cause–effect relationship between the interventions and the benefits. The project promoter should provide evidence and data that are logically connected with the expected results of the intervention, as well as its targets and size. Health interventions may have various characteristics. They may be health infrastructure development projects, possibly accompanied by organisational change (restructuring), the modification of operations or health programmes. Alternatively, they may be disease prevention programmes or projects implementing new e-health functionalities. The underlying logic is that the intervention modifies the ongoing routines of health system operations, generating incremental economic benefits several years after the project is completed (Figure 2).

[44] There are, however, cases when benefits quantification is difficult, namely in the absence of statistical data or research studies to provide values for the benefits to be quantified, or the size of the project does not justify it; in these cases, cost effectiveness or cost–utility analysis is the methodology of choice.

Figure 2. Incremental change following health interventions



Source: Adapted from Drummond et al. (2005).

Figure 2 illustrates the elements of the EA of health interventions and their associated costs; these include CAPEX and the incremental value of OPEX over the reference period, as well as effects on health gains and savings of resources. It is also commonly expected that an effect of the health intervention will be the improvement of the health status of individuals and/or the entire population.

The typical benefits of interventions in the health sector can be grouped as follows:

- **patients' health status improvement**, including mainly reduced mortality, disability, morbidity, burden of disease or adverse effects of medical procedures – the valuation of these benefits usually consists of estimating the savings in both direct costs of treatment and indirect costs such as productivity losses to society, as well as perceived value of health;
- **improved efficiency/productivity of the healthcare system**, usually resulting from cutting costs (e.g. reduced number of hospitalisations and reduced length of stay), but also from improving organisation of service delivery – this benefit usually consists of financial gains for the health system in general or time savings for patients;
- **patients' satisfaction improvement** due to the perceived increase of quality of service or health status, measured in patients' WTP;
- **reduced externalities** such as energy consumption and vehicle operating costs.

Achieving any of the above benefits is typically a result of a series of measures, of which infrastructure improvement is one component.

Table 14 at the end of this chapter provides a detailed illustration of the typical benefits of health interventions, together with a description of the benefit, the unit of measurement and the suggested monetary evaluation method. In what follows, some examples of benefit quantification (for reduced mortality, avoided hospitalisation costs and improved accessibility to services) are presented for illustrative purposes.

Reduced mortality owing to improved emergency care services

Box 3 contains an example of calculating the benefits of developing an emergency department, the aim of which is to reduce insufficient capacity that results in delays in health services provision and increases in fatalities among emergency patients (Mohan et al., 2015; Morley et al., 2018). There is an assumption that the proposed capital investment in emergency care, associated with certain operational improvements, will help to address future overcrowding and so reduce the number of deaths.

An adjustment factor (the average reduction in the fatality rate) is applied to estimate the potential number of life years saved (or avoided deaths), and a monetary value is attributed to the additional number of years of life gained (or the avoided deaths).

Box 3. Example: reduced mortality

$$Benefit = A \times \Delta\text{FR} \times \text{YLG} \times \text{vYLG}$$

where:

A = projected admissions to the emergency department

ΔFR = average reduction in the fatality rate among emergency department patients due to decreased overcrowding

YLG = assumed number of years of life gained (or avoided deaths)

vYLG = value of 1 year of life gained (or value of statistical life: vOSL)

Avoided hospitalisations owing to increased capacity of ambulatory services

Outpatient services and hospital services can be either complementary or alternative services. Medical staff take decisions on hospital admissions based on a number of factors, including the health status of a patient, the type of health interventions/ treatments that can be supplied and the possibility of providing the same services in an outpatient capacity. Sometimes, financial constraints can have an impact on decisions on admissions. Many health systems are undertaking efforts to replace hospital admissions with outpatient services whenever possible.

When considering a project that aims to replace inpatient care with outpatient care, one can consider both capital and operational cost savings of hospital care as benefits (Box 4). The avoided operating costs are estimated based on the difference between the average cost per acute hospitalisation and the average cost per non-admitted service event. The avoided capital costs are estimated based on the avoided hospital bed days.

Box 4. Example: avoided hospitalisation

$$Benefit = \Delta\ \text{DC}\ (\Delta\text{OPEX} + \Delta\text{CAPEX}) + \Delta\ \text{IC}$$

where:

ΔOPEX = average reduction in operating costs of hospital care per non-admitted patient

ΔCAPEX = reduction in capital costs of hospital care resulting from reduced hospital admissions:

$$\Delta\text{CAPEX} = \frac{\text{Avoided acute admitted bed days}}{365\ \text{days} \times \text{occupancy rate}} \times \text{Capital cost per acute admitted bed}$$

Δ DC = reduction of direct costs, composed of the reduction in OPEX and CAPEX

Δ IC = reduction in indirect costs to patients, calculated as hours saved per non-admitted service event multiplied by the value of time

Increased accessibility from e-health interventions

When considering e-health interventions – defined by the World Health Organization as 'the use of information and communications technology in support of health and health-related fields' – it is important to use the same analytical framework as for any other health intervention. This approach helps to ensure that a similar level of certainty regarding the extent of benefits and the evidence to support them is required for conventional as for e-health interventions. This is important, as e-health initiatives should not crowd out spending on other equally good but more traditional healthcare investments.

In principle, e-health interventions can help to achieve better health outcomes and save costs, for both providers and patients. The area in which the e-health intervention is applied determines the benefits. One of the most frequent applications of e-health is e-prescriptions, which bring benefits to all actors involved in the process of drug dispensing in terms of increased accessibility (Box 5). For patients, the benefits are the time saved for visiting a doctor (remote prescribing), convenience (one never loses the prescription) and certainty (the content is readable and errorless). For doctors, after some practice and if the use of e-prescriptions is economic, it is estimated that time savings can reach between 30 and 60 minutes per day. Furthermore, the whole of the health system benefits (including pharmacies, insurance companies, etc.) as a result of a reduction in errors, better control of prescription patters among doctors, and fraud detection and prevention (Cooke et al., 2010; Parv et al., 2016).

Box 5. Example: increased accessibility

$$Benefit = \Delta P * \Delta Ph * \Delta D * \Delta S$$

where:

ΔP = cost and time savings of patients

ΔD = time saving of prescribing doctors

ΔPh = time saving of pharmacies' personnel

ΔS = administrative cost savings of reimbursement entities/insurers

Table 14. Typical economic benefits, units of measurement and methods of monetary evaluation

No	Economic benefits	Description	Units of measurement	Method of monetary evaluation
1	**Reduced mortality**	This is considered a reduction in mortality in the target population due to the intervention (project). It is necessary to present a logical connection between the intervention (project) and the avoided deaths / saved years of life. Usually, a reduction in deaths can be achieved through (i) an increase in volume of life-saving health services (more patients treated),(ii) an increase in quality (the same number of patients are treated but with more effective treatments) or both. In either case, the process leading to the forecast reduction in deaths should be explained and reasoned	Avoided deaths Years of life lost/ gained	Indirect costs of deaths due to: - income/production losses (HCM) - death-related compensation benefits Alternatively calculated with WTP: - value of statistical life - years of life gained
2	**Reduced disability and ill health**	People with a disability or ill health and their informal carers are often not fully professionally active, which results in productivity losses in the economy. Disabled people also often remain under either institutionalised or informal care. A reduction in disability implies an increase in productivity and a reduction in cost for formal and informal care over the years of the lasting disability	Number of health services avoided Time of temporary inability to work Time of permanent inability to work	Direct (operating and capital) costs of health system and long-term care Indirect costs of ill health due to: - income/production losses - short-term and long-term absenteeism (self and next of kin) (HCM) - quality of life (WTP)

No	Economic benefits	Description	Units of measurement	Method of monetary evaluation
3	**Reduced morbidity**	This is considered a reduction in the prevalence (occurrence and/or duration) of a given disease due to improved diagnostic, prevention, treatment and convalesce measures	Number of health services avoided Time of temporary inability to work Time of permanent inability to work	Direct (operating and capital) costs of health system and long-term care Indirect costs of ill-health due to: - income/production losses - short-term and long-term absenteeism (self and next of kin) (HCM) - quality of life (WTP)
4	**Reduced burden of disease**	This is a synthetic measure of health status and its consequences. The DALY is the sum of the years of life lost (YLL) due to premature mortality in the population and the years lost due to disability (YLD) for incident cases of the disordered health condition (DALY = YLL + YLD).	DALY	Calculated with WTP: - value of statistical life ((VSL) value of life in perfect health) - year of life gained (value of life in perfect health) (YLG).
5	**Reduced adverse effects**	In medical practice, unfavourable developments and adverse events are common. They can include hospital infections, falls, bleeding and unnecessary pain. Adverse events have an impact on patients' treatment processes, making them longer than necessary and more costly and, in extreme situations, cause patient death	Number of health services avoided Time of temporary inability to work Time of permanent inability to work Avoided deaths Years of life lost/gained	The method depends on the category of effects of deaths or ill health (see above)
6	**Reduced hospitalisations**	Society benefits from a (long-term) reduction in preventable/avoidable hospitalisations because of the control of morbidity or the replacement of hospitalisations with non-hospital care in primary or community settings	Number of hospital admissions avoided	Direct (operating and capital) costs of health system due to hospital admissions Indirect costs related to hospitalisation due to: - income/production losses - short-term and long-term absenteeism (self and next of kin) (HCM) - quality of life (WTP)

No	Economic benefits	Description	Units of measurement	Method of monetary evaluation
7	**Reduced hospital length of stay**	Shortening the length of stay (LOS), if the quality of care and patients' safety is maintained, brings about gains such as hospital cost savings, better access to care (more patients can be served), improvements to patient safety (reduced risk of secondary infections) and increased satisfaction (assuming that a hospital stay is not the most desired way of spending time)	Avoided number of hospital days of stay	Methods such as reduced hospital admissions (see above)
8	**Improved accessibility**	Improved access is connected with the elimination of access hurdles in the public health system, which is usually connected with (i) a limited production capacity of health facilities, (ii) geographical hurdles caused by an uneven distribution of health infrastructure and competences, and (iii) financial and technical restrictions	Number of health services gained	Alternative cost saved in private sector prices, as a proxy for perceived value of the services
9	**Improved patients' satisfaction**	This is a measure of improvements in perception, which are dependent on physical conditions of the stay, organisation of care, attitudes of medical personnel, trust and confidence The mechanism of improving the perceived quality needs to be explained	Percentage of patients with higher level of satisfaction	Alternative cost saved in private sector as a proxy for perceived value of the services
10	**Reduced external costs**	Digital solutions may reduce external costs, notably in relation to the energy consumption of data centres and networks. These can be estimated well enough using emission factors and the social cost of carbon. Other external impacts can also be considered in relation to, for example, savings in transportation costs (unless these are trivially small)	EUR per tonne of CO_2 EUR per vehicle-km	Economic cost of carbon (see Section 2.5 of Part I of the EAV) Avoided vehicle operating costs (see Annex V)

NB: HCM, human capital method.

ANNEX IX. INFORMATION AND COMMUNICATION TECHNOLOGIES: E-SERVICES

IX.1. Introduction

The aim of this chapter is to outline the key aspects of EA that decision-makers and project promoters should/could consider when designing projects with large ICT components. The European Commission has highlighted digitalisation as one of its key goals to ensure Europe's international competitiveness, to support regional cohesiveness, to improve living conditions across Europe and for Europe to deliver better services to citizens and businesses. Digitalisation enables increases in productivity, efficiency and effectiveness. The widespread use of ICT raises, however, many systemic challenges. These include, on the one hand, concerns in relation to data protection, privacy rights and cybersecurity and, on the other, the possibility of making ICT benefits available to all by deploying digital infrastructures and developing the required digital skills.

A number of EU policy initiatives and funding sources could finance investments in different digital sectors. Given that ICT cuts across all sectors, it is not possible to address the development of the sector under one policy objective. Recognising the potential of digitalisation, the European Commission presented in February 2020 three broad pillars of its strategy for Europe's digital future (European Commission, 2020). The strategy aims to provide the right legal and ethical environment for the users and the market. Possible sources of public support for projects with large ICT components include the Horizon Europe research programme, the Digital Europe (European Commission, 2018) programme, the Connecting Europe Facility, and the EU regional policy. Regarding the EU regional policy, **Smarter Europe** is one of the two priorities (together with the Green Europe policy objective) that are expected to receive the majority of EU regional policy funds in the next phase. It will encompass measures related to, among other areas, e-service development.

This section focuses on the EA of the introduction of ICT into the provision of public services. Public services delivered with the support of ICT do not differ in scope from services delivered in the traditional way. In this sense, objectives, expected benefits and evaluation methods are those typical of their relevant sectors, such as broadband, energy, transport or health, and are not discussed here. However, **when shifting to the digital provision of services, some cross-cutting, not sector-specific, issues have been observed and should be taken into account**, including efficiency gains for the service provider, improved quality of the services and the interdependency with other infrastructures. This chapter contains examples of approaches for project preparation and of the project benefits of e-services applied in e-education and e-government projects. The principles outlined below may also apply to further projects such as digital identification cards and different types of publicly run service portals, etc.

IX.2. Project development cycle and methods

e-Service development is preparation heavy. For the public sector, the success of these services is largely dependent on a clearly defined set of policies, supporting change management approaches and a defined legal framework, in particular when it concerns security and data integrity. Developing a new e-service also requires the overall processes already existing in the public sector to be taken into consideration, as well as any institutional and organisational changes that might need to be made.

For example, e-government projects often form part of wider public sector reform that aims to streamline public institution processes through ICT. In this process, it is important to consider all of the relevant stakeholders, their requirements and their existing ICT infrastructure, which may need to be updated or modified. The lack of interoperability between different actors' systems would significantly reduce the benefits achieved by the project.

Field experiments can be used to determine the effects of ICT projects. Through pilot projects, effectiveness studies can be undertaken before a national roll-out or phased introduction. The advantage of a pilot project is that the measure is tested in the 'real world', all the time bearing in mind the extent to which the results of the pilot project can be generalised (CPB Netherlands Bureau for Economic Policy Analysis, 2017).

Likewise, the integration of ICT into learning, teaching and school administration processes is a response to the need for schools to adapt to the complex and changing contexts in which they operate, including the digital era and the increasing diversity among pupils. These issues require not only the adaptation of school curricula, but also more diverse teaching and learning methods to address the needs of all students.

Regarding early screening and the selection of technology, the following aspects need to be considered for e-services projects: interoperability and compliance with standards, the availability of technology, and the overall cost of investment and the operating phase. Regarding the first element, it is critical to consider interoperability and compliance with relevant standards and other services put in place or planned at the national, European or international level. Diverting from such standards, or not taking into account other services or platforms, would render the development of the solution costly and time-consuming and would increase implementation risks. As a next step, it is suggested to consider if there are technologies readily available. Even in cases in which standard solutions are followed, existing solutions may need to be modified to meet the specific requirements of a project, and the cost of such adaptation should be taken into account. Finally, if there are a number of possible solutions, the overall cost of the project should be determined – the choice of technology may affect the design, implementation or operation phase, including possible costs of upgrades.

IX.3. Economic appraisal

Given the broad range of different types of e-service projects, it is possible to provide only a few general observations of benefits that are common to these services and quantifiable, and which should be considered in an economic analysis. Other than these general considerations, the EA of ICT projects should first be considered against the 'main' sector to which the projects belong. For example, e-health projects should follow the guidance for healthcare infrastructures, research projects with an ICT component should be aligned with the research, development and innovation approach and the urban development projects would need to consider the urban framework first.

This chapter assumes generally that the socioeconomic impact of the project is verified by means of a CBA approach. Moreover, each different type of e-service also entails qualitative benefits, which are more typical of specific areas, for instance e-pharmacy or e-school. Applying an MCA methodology could also be considered for such projects to capture the impacts beyond quantitative economic impacts, for instance quality of life or contribution to climate change.

The first general observation for projects that replace an existing service with the possibility of a digital or remote service, such as e-government, e-health or e-school projects, is their efficiency gains. They can be valued in an economic analysis by assigning monetary values to cost savings and time savings.

- Regarding the **cost savings**, these can occur first for the owner of the infrastructure / provider of a service, for example a governmental department or agency, hospital or school, but also for the service users. As a rule, all cost savings that occur for the owner of the infrastructure / provider of a service are already considered in the financial analysis (and consequently in the economic analysis). Cost savings enjoyed by users, who are – in the case of e-government projects – other government departments or agencies, citizens or businesses, are not captured by the financial analysis. They should be regarded as economic benefits and included in the economic analysis. User benefits through cost savings can be quantified in the CBA by estimating direct travel cost savings (e.g. fuel) and the reduced cost of transmitting information (e.g. phone, post or paperless interactions).
- **Time savings** can represent a significant benefit of e-service projects. For the EA of travel time savings, the length of the avoided travel time and the economic value of time need to be estimated. For example, an e-government project that enables the implementation of user interfaces that allow personal documents to be requested online will eliminate the travel time from local residents to local government agencies. In addition to the travel time saved, the implementation of an e-government project can lead to time savings due to faster service provision (e.g. because of avoided queuing at public agencies or reduced processing time of requests). The length of the time saved should be estimated based on documented assumptions.

Improvements to the services delivered, which translate into increased convenience for users, are the second most common group of impacts of e-services projects. For example, in the case of e-education through integrating ICT within schools, students can benefit from improved educational services (e.g. personalised learning curricula and innovative teaching practices). In addition, the resulting increase in digital skills can in turn also lead to better employability in the future. The benefits can be estimated by adopting the WTP approach, according to which the economic value of the service rendered by a (public) education project is usually larger than the fees applied to students, if any. In the case of e-government services, users might consider that better service delivery, reduced error rates, increased reliability and easier communication are important benefits, and it could be possible to quantify this category of benefits by means of traditional sample surveys or qualitative focus groups ([45]).

The third group of benefits of e-services projects lies in the common aim of these projects to increase the security level of electronic services, improve reputation and raise user trust and confidence. The valuation of information security solutions requires sufficient data about incidents and their consequences. While some studies have attempted to measure the benefit of improved security, and while quantification of these benefits may be possible in individual projects, as a general recommendation, it is suggested that these benefits be considered qualitatively.

Another observation common to e-services projects is the difficulty in quantifying the net environmental impact. In the case of projects that affect a large number of users, such as e-government or e-education projects, research on the impacts of GHG emissions today is not mature enough to measure the net effect of digital services on energy consumption and, more generally, on the environment. It is therefore recommended, until relevant studies become available, that this benefit be considered in qualitative terms rather than by valuing its impact in the CBA model ([46]).

It is equally important to note that ICT projects are interdependent with other infrastructure put in place, such as broadband connectivity, computers and end user applications, as well as on users having the right skills to take up new and innovative services. When the relevant infrastructure is not in place and additional substantial investment needs to be made by a third party or by users for the given type of benefits to emerge, the estimated project benefits should be distributed pro rata. The relevant net benefit ratio (calculated as the proportion of project costs in the total costs needed for the benefit to emerge) should be applied to the benefits quantification.

[45] The project analyst should, however, make sure not to double count this category of benefits with users' cost and time savings, as these can be assumed to automatically translate into an increase in users' satisfaction.

[46] If the project entails a quantifiable reduction in transportation costs (e.g. avoided car trips), the reduction in GHG emissions can be valued following the methodology illustrated in Annex V ('Transport').

Finally, the full impact of ICT projects is not straightforward to quantify in monetary terms. In the case of several economic benefits, it is very difficult or maybe impossible to find a way to monetise their value. ICT projects are also an enabler of a multitude of different services, for which ICT, infrastructure and hardware provide the backbone.

As mentioned, it is not possible to easily provide recommendations for all possible sector investments and related benefits. This section exemplifies and outlines a possible summary approach to a CBA analysis in two different sectors: e-services in public administration and in education. In general, the principles in these sectors, including the common benefits and the sector-specific benefits, can be used as a guide for other projects in the area.

Public e-service projects

The importance of the deployment of new e-government services and, where possible, the replacement of traditional governmental services with their electronic equivalent is widely recognised.

For the purpose of this document, an e-government project is designed and implemented with the aim of generating wider benefits to society. Consequently, the financial revenues and cost savings that occur to the project owner do not capture the full impact of the project. Besides a number of quantifiable benefits to the users, such as cost or time savings, there are many qualitative benefits that can significantly affect the lives of citizens, but which no firm methodology can quantify. An example of a benefit evaluation is given in Table 15.

Table 15. Example of benefit evaluation of public e-service projects

Economic benefit	Monetary evaluation	Qualitative assessment	Comment on treatment
User benefits in terms of cost savings	√		Cost saving approach, including direct travel cost saving and reduced cost of transmitting information (e.g. phone, post or paperless interactions)
User benefits in terms of time savings	√		Time savings owing to shorter travel time, reduced processing time, task elimination, etc.
User benefits in terms of increased revenues	√	√	Better and increased revenue collection (e.g. online tax filing and processing systems to enhance transparency)
Convenience benefits	√	√	Faster/better service delivery and reduced error rates
Improved data security	√	√	Avoiding loss of productivity due to work stoppages resulting from security incidents
Environmental benefits	√	√	Quantification of direct cost savings and qualitative assessment of project's broader impact on environment

Other non-quantifiable economic benefits of e-government projects may include:

- enhanced policy alignment and outcomes and support to decision-making;
- better and timely information to facilitate policymaking (allows more, greater and new data to be collected, and greater information-sharing capacity);
- better planning/pricing as a result of data generated by the system;
- an improved image of the public service provider and of administrative work;
- improved service delivery and enhanced customer service (more understandable services and personalisation);
- improved service consistency and quality (interoperability and improved multi-agency cooperation);
- greater take-up of entitlements;
- improved communication (e.g. immediate confirmation of the processing of the request).

It should be noted that, in many circumstances, e-service projects have a wide impact on the national economy and on society as a whole. For instance, investors' location decisions can be influenced by an improved level of public services in a particular country. These wider benefits may include:

- impacts on location decisions (the increased efficiency and better quality of the services enhance the attractiveness of the country as a business location and improve competitiveness and productivity);
- enhancements to democracy (increased user participation and contribution);
- enhanced transparency and reduced corruption (through making information public);
- improved ICT skills and leadership in the digital economy.

Information and communication technology in learning
For projects that aim to introduce ICT tools (training, materials and equipment) into the learning experience, it is recommended that emphasis be put on setting up the appropriate education framework and institutional structure with the objective of maximising the educational outcomes expected from the project.

The role of ICT in learning has been discussed by several studies, and its positive, as well as negative, effects are reported in the literature. Nevertheless, partially owing to the complexity of the various educational systems, and the wide differences in digital maturity between different countries, no widely accepted and tested methodologies to quantify and value benefits in monetary terms exist. It is therefore difficult to propose a uniform methodology, as only guidance can be given, depending on the scope of each ICT learning project.

Table 16 provides some initial approaches for the possible quantification of benefits. It is suggested that a CBA be carried out only on direct benefits accrued by the 'users' of the project, including students, teachers and school administrative staff.

It needs to be underlined, however, that there is limited experience of the use of CBA in the appraisal of this type of project, given the difficulties in the estimation of monetary values of benefits in education investments. Consequently, other techniques, such as MCA, may also be suitable to appraise projects that aim to introduce ICT tools into learning.

Table 16. Benefit evaluation of school digitalisation

Economic benefit	Comment on treatment
Savings in management, administration and work planning	Cost savings approach – if not already included in the financial analysis
Improved education services to students	WTP – the economic value of the improved education service rendered by a public project can be proxied by the tariff/charges applied to students of private schools offering similar services
School dropout reduction	Human capital approach – an individual is 'worth' to society what he or she will produce during his or her lifetime. The benefit can be calculated as the wage differential between workers with and without secondary education
Professional development	WTP – the wage differential between private and public sectors in the education system can be used as proxy, or the avoided cost of attending training courses supplied in the private market that allow the development of the same level of digital competence can also be used

ANNEX X. OPTIMISING PROGRAMMES FOR TERRITORIAL AND URBAN DEVELOPMENT

X.1. Introduction

Territorial development with a particular view to unlocking local economic potential, encouraging smart development, promoting climate change action and improving living conditions is a key policy focus of the EU. The European Commission has published guidance on the process of designing sustainable urban strategies for urban projects and programmes (JRC, 2020). It also supports innovation in Member States through programmes aimed at digitalisation and smart specialisation ([47]) and has launched the new European Green Deal (European Commission, 2019). These policies require multisectoral investment programmes that are anchored in integrated plans combined with spatial planning.

In the 2021–2027 programming period, in addition to the strategic emphasis on the climate change agenda (e.g. the Paris Agreement), the focus will be on economic recovery after COVID-19. It is expected that the emphasis on regional smart development (including smart city investments, the circular economy and 'just transition' projects) will continue.

The investment programmes of the regions or cities (public promoters) must reflect the development strategies embedded in their spatial development plans and the policies at local, regional, national and international levels. The authorities, through such investment programmes, attempt to stimulate local growth and development conditions and improve the quality of life (welfare) of their inhabitants, primarily through public works and the provision of public services. The funding sources for such territorial programmes may include European funds ([48]). The tool that is often used in this context is integrated territorial investment (URBACT, 2019). Integrated territorial investments allow EU Member States to bundle funding from several priority axes of one or more operational programmes (EU programmes) to ensure the implementation of an integrated strategy for a specific territory.

In this chapter, we will focus on the MCA methodology, in particular policy-led multi-criteria analysis (PLMCA), which is specifically suited to territorial and urban programmes with multisector investments.

The PLMCA methodology allows the expected benefits to be assessed against an explicit set of policies and objectives – in other words, the framework in place – that the decision-making body has identified. It also helps identify synergies between projects (e.g. transport, broadband, water and energy efficiency) and where social funds can be employed. The MCA tool can be used to consider urban–rural linkages and 'rural' municipalities in integrated territorial strategies and delivery models. It assists in bundling the projects of different local authorities and municipalities to facilitate their access to different sources of financing.

The design of a successful MCA toolkit in the urban/territorial context requires:

- the principles of sustainable urban development to be embedded locally and a rigorous integrated planning regime;
- clearly identified policies and their objectives;
- clearly articulated and meaningful indicators / appraisal criteria / benefits that are user friendly and can be applied on a comprehensive basis;
- consensus on the scoring of the qualitative and quantitative benefits;
- clear consensus on the relative importance (i.e. the weights) of the objectives and their indicators;
- consensus on the means to identify, record/register and describe key risks and opportunities.

The example used in this chapter is the application of the PLMCA tool to a sustainable urban development programme.

X.2. When to use multi-criteria analysis

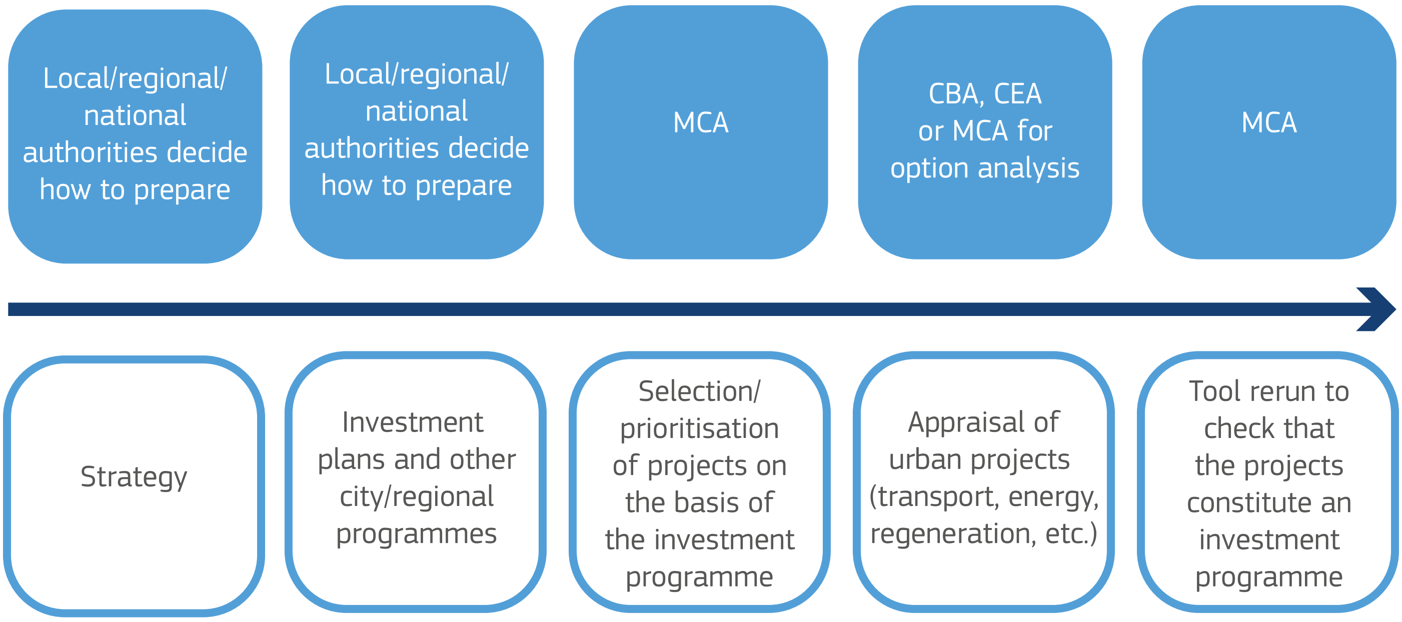
Sustainable urban programmes normally span a wide range of sectors that require integrated planning, and most projects in an area are interrelated; a framework approach is therefore the most suitable approach for the challenge of assessing a programme spanning different sectors. Although, for single urban mobility projects (e.g. a bypass or a tram extension) a CBA, for example, would be appropriate, if more sectors are involved, the assessment becomes more complex because there are joint economic benefits. This is the case even in rather simple urban regeneration schemes (e.g. linking road improvements and/or surface water drainage). To be able to undertake an EA in the context of urban development, different EA methodologies need to be considered as relevant to the different types, phases and aspects of urban development investments.

The MCA methodology can be applied in the following stages of the development of a territorial investment programme (Figure 3), including sustainable urban development.

[47] See, for instance, the Smart Specialisation Platform, which supports Member States (https://s3platform.jrc.ec.europa.eu/)

[48] Sustainable urban development programmes and projects can be financed by a number of European funds and/or a combination of other funds.

Figure 3. Appraisal stages of territorial investment programmes



- **The definition of an urban strategy or a territorial investment programme** requires an integrated, multisectoral planning approach, including the participation of the representatives / key stakeholders of all of the expected areas of investments (subsectors). A sustainable urban strategy is founded on relevant applicable policies and on local needs and can apply to different levels of urban policy. The JRC (2020) provides more information about the European Commission guidelines on how to define a sustainable urban strategy. If PLMCA is expected to be used at the selection/prioritisation stage of projects, it is helpful to set up the criteria and relevant framework at the strategy-making phase to obtain a more coherent exercise (e.g. start building the PLMCA matrix as presented in Section X.3 at this early stage of strategy making).
- **The setting up and management of an investment plan or programme** require the participation of all the stakeholders, to ensure that the programme or plan includes all of the policy objectives of the strategy that it seeks to implement. PLMCA can also be recommended for the definition of investment plans or programmes, because it clearly portrays the path and indicators of the actions and their potential benefits, helping to trace them back to the policy objectives. It also provides an assessment of the adequacy of the policy objectives themselves (i.e. it is a way to check the consistency between the policy and benefits and vice versa). As above, if work on the PLMCA has already started or if it starts at this stage, the application of the PLMCA method in the next stage (i.e. the selection/prioritisation of projects) becomes a more coherent exercise.
- **MCA can be a useful tool for the provision of a sound basis for the prioritisation of projects by reference to a specific set of strategic documents.** MCA facilitates the comparison of different projects or sets of projects, considering all of the criteria/indicators (even those that are not monetised) and relates them back to the policies that the strategic and planning documents pursue in a direct visual way. The final scores can be used to establish a list of priorities (e.g. by starting with the projects that have received the highest scores).
- **The appraisal or analysis of individual projects traditionally uses CBA or CEA.** MCA may be useful in the context of an EA to compare the strategic options for a single project (see Sections 1.3 and 3.2 of Part I of the EAV).
- **Ongoing monitoring/evaluation and continuous adjustment of the programme is necessary.** The MCA (like all EA tools) can be rerun at different stages of the project cycle to check that the final set of projects constitutes a programme.

The participation of the most relevant stakeholders from the beginning of the appraisal process improves the quality of the whole analysis. This multi-stakeholder team participates in the whole process as the analysis moves on. In this way, the city/territory develops a holistic view of investments, reducing the risk of silos and improving governance. It is important to note that the governance structure of cities is different in different constituencies and in different countries, which would need to be reflected in the stakeholder set-up. What is needed is a balanced top-down / bottom-up approach to drive integrated sustainable urban development, in other words an approach that includes the policy-driven considerations of the administrations and the needs-driven considerations of representatives of the concerned population according to the sector (mobility, education, health, energy efficiency, services, digitalisation, etc.).

X.3. Example of an urban regeneration programme supported by policy-led multi-criteria analysis

The example presented in this section illustrates the application of MCA to the appraisal of an urban regeneration programme. The method described is replicable in other stages of the process of urban/territorial development, as explained above. The key request by the local authorities pertained to the facilitation of the process of prioritising and selecting projects in order to develop the strategy's investment programme and optimise its delivery and subsequent impact. To this end, JASPERS suggested the deployment of a specific tool, a **PLMCA methodology**, as an Excel-based tool that assists decision-makers with the selection of packages of measures and the timing of the delivery of such measures. In this particular case, the regeneration packages – housing, skills, culture, transport and business – were included as columns referred to as 'priority dimensions' in the matrix.

In the example, the aim was to assess a regeneration programme developed for a run-down district in a city. The programme had identified five areas of action ('regeneration packages') mentioned above: housing, skills, culture, transport and business. Under each area, a number of potential investments had been listed (e.g. for culture, proposals included several restorations of buildings with historical and cultural value; for transport, proposals included upgrades of roads and the introduction of electric bicycles).

The PLMCA framework starts with the step of structuring the problem by defining the context of the decision, in particular the policy and institutional guidance that applies. Columns 1–5 in Table 17 illustrate this process.

Table 17. PLMCA columns 1–5

(1) Dimension	(2) Sub-dimension	(3) Policy Objective (Generic Good Practice for Sustainable Urban Development	(4) Sub-objectives (specific to the case)	(5) Justification for inclusion of objectives/sub objective in Matrix
Social	Choice and Provision of accessible facilities	Improve provision and access to facilities, amenities & services including hospitals, schools, community centres, leisure facilities, housing, transport infrastructure, retail, water, energy and e-governance	To invest in health and social infrastructure which contributes to national, regional and local development, reducing inequalities in terms of health status, promoting social inclusion through improved access to social, cultural and recreational services and the transition from institutional to community-based services (PA Thematic Objective 9 Expected Results	-PA Thematic Objective 9: Promoting social inclusion, combating poverty and any discrimination -OP1 Axis 6 Investment Priority 9b - support for physical, economic and social regeneration of deprived communities
		Improve provision and access to housing & public open spa	Regeneration of public open spaces and public social housing within deprived neighbourhoods to lift people out of risk of poverty. (MT OP1 Investment Priority 9b Specific objective SO	-OP1 Investment Priority 9
	Employment generation	Generate and provide access to employment (especially through education and training) and reduce youth unemployment	Promoting sustainable and quality employment and supporting labour mobility (PA thematic objective 8)	-PA Funding Priority 3 -PA Thematic -Objective 8 -OP1 Axis 6 Investment Priority 9b -OP1 Axis 9 Investment Priority 9

	Affordability	Encourage provision of options/ opportunities that are affordable to the greatest number of people, especially those in significant need	Integration of deprived families through the upgrading of public social housing. (OP1 Investment Priority 9b specific objective so3)	-PA Funding Priorities Malta OP1 Axis 6 -Investment Priority 9b support for physical, economic and social regeneration of deprived communities
	Social cohesion and inclusion	Promote equity & provide opportunities that are accessible to all groups of society, including women, ethnic minorities, and people with disabilities	Promoting social inclusion and combating discrimination (PA Thematic Objective 9	-PA funding priorities

NB: OP, operational programme; PA, partnership agreement.

The dimensions (column 1), should be drawn from global best practice on sustainable urban and regional development and core national policy documents. The following seven dimensions constitute a standard set and they are the ones used in the example: institutional, territorial, social, environmental, economic, financial and technical.

The subdimensions (column 2) are also identified from global best practice and national documents. In the example provided, the subdimensions of the social dimension are choice and the provision of accessible facilities, employment generation, affordability, and social cohesion and inclusion.

The dimensions and subdimensions establish the area in which the programme's impact is going to be assessed. For example, how does housing (one of the priority actions of the regeneration programme) affect the social subdimensions (one of the areas in which there will be an impact)?

The following columns (3 and 4) define the objectives and subobjectives for each subdimension obtained from local, national and international policy, including the partnership agreement, the operational programmes and other recommendations (e.g. JASPERS Guidance Notes).

Column 5, namely the justification for inclusion of the objectives/subobjectives, is a record of the sources of the objectives and subobjectives (e.g. partnership agreement thematic objective 9 – 'promoting social inclusion and combating poverty and any discrimination').

The next phase is to select appraisal criteria/indicators to use for each policy area and objective and decide on their relative importance through the use of weights and/or ranking. Column 6 depicts the first part of this phase (i.e. deciding which criteria or indicators to use for the first subdimension, that is, the choice and provision of accessible facilities; Box 6).

Box 6. PLMCA column 6

(6) **Criteria**
Qualitative - Extent of provision and/or upgrading of social infrastructure/public facilities/cultural facilities to match demographic needs and meet or exceed national standards including extent to which the proposal includes the building of thealth and wellness infrastructure to support population - Extent to which the proposal improves access to affordable, sustainable and high quality services, including health care and social services of general interest (PA Thematic Objective 9 Expected Results) - Provision of support for physical, economic and social regeneration of deprived communities in urban and rural areas (PA Thematic Objective 9 Expected Results). - Improvement to social / health service quality through measures aimed at addressing the specific needs of the social and health sectors (PA Thematic Objective 9 Expected Results). - Extent of Investment in health and social infrastructure which contributes to national, regional and local development, reducing inequalities in terms of health status, promoting social inclusion though improved access to social, cultural and recreational services and the transition from institutional to community based services (OP1 Investment priority 9a). - Extent of promotion of sustainable transport practice (PA Thematic Objective 7 – expected results) **Quantitative** - Population living in areas with integrated urban development strategies (OP 9b) - Persons benefitting from new/upgraded infrastructure (including equipment/service as). (Investment Priority 9a - Population covered by improved social services (Investment Priority 9a)

The model use phase involves determining the performance of the project/programme relative to each criterion/indicator, usually using a numerical scoring system. Columns 7–17 illustrate the results of this process (Tables 18 and 19). Columns 7–11 are exclusive to this example, as they present the five priority action areas in the regeneration programme already mentioned. A colour code has been used in Tables 18 and 20 to show the scores for each area of action. Column 12 summarises the extent to which the areas of action of the regeneration programme meet the criteria (column 6).

Table 18. PLMCA columns 7–12

(7) Priority Action 1	(8) Priority Action 2 'skills'	(9) Priority Action 3	(10) Priority Action 4	(11) Priority Action 5	(12) Priority actions 1-5 Aggregated project evidence
					All packages strongly aligned to social cohesion and opportunity. Clear intent to retain population and provide more community services and assets. A walkable electric transport community will aid health and well being.

green = maximum score; orange = medium; red = lowest

The next columns, namely columns 13–17, represent the steps in the calculation of and the final weighted score (Table 19). As the weighted scores align with the colour coding of the priorities in this example, the majority of green boxes correspond to a maximum weighted score of 10. In this example, the weights are always 2, because all of the subdimensions and objectives were considered to be equally important. In such cases, the weight column can be removed, as applying the same weight throughout does not change the relative scoring.

The risks, mitigations and opportunities (i.e. columns 13 and 14) apply to all of the subdimensions in each dimension. They inform the final decision on the scores.

Table 19. PLMCA columns 13–17

(13) Risk & Mitigation	(14) Opportunities	(15) Weight	(16) Score	(17) Weighted Score
• Once buildings are complete and upgraded they will need maintenance and ongoing life cycle expenditure which national budgets will need to consider • Policies such as the right to buy may help develop individual aspiration but can release stock to open market so will need careful consideration • Risk is older residents still move out as there is poor public realm, fear of crime, etc. this intervention needs to show early wins to have positive impact in programme period. • Heritage assets not conducive to accessibility as expensive lifts, etc. required • May create more targets if more footfall; enhanced policing needed to support especially at the outset	• Programme's ability to encourage self-help for skills development and wider intervention. As a small district adjoining the core City the movement of people is more easily addressed than a regeneration requiring greater transport focus. This is a walkable city and can be walkable for all with some provision and coordination with positive existing transport such as electric buses, consider new stops, number of stops • Other tenure models such as shared ownership can create capital for individuals, but still retain stock for public sector • The existing housing stock has very high quality views and aspect and is "inclusive" in the opportunity that it brings for well being • Horizontal property division will create more opportunity if publicly owned properties are divided differently legally • Will create a greater night time economy for local businesses to enjoy and indeed in darkest winter months when tourist trade is slower • Health and well being promoted through walkable city, community sports areas			

Table 20 uses the same scoring and colour coding system for the subdimension 'employment generation' as that used in Table 18 for the social dimension. In Table 20, the score is very low, as only one of the programme's priority actions addresses employment generation in the example.

Table 20. PLMCA low-score illustration

(7) Priority Action 1	(8)	(9) Priority Action 3	(10) Priority Action 4	(11) Priority Action 5	(12) Priority actions 1-5 Aggregated project evidence	(15) Weight	(16) Score	(17) Weighted score
					One package fully focused on skills, others are very indirectly so	2	1	2 * 1 = 2

green = maximum score; orange = medium; red = lowest

The final scores for each dimension and the whole programme under analysis are reached by adding up the individual weighted scores of each subdimension and comparing them with the maximum possible score for the whole dimension; the outcome is usually presented in percentage terms. In the example, the whole programme had a score of 71.4 % and none of the dimensions had a score below 60 %. In this case, it was decided that the scores obtained render the programme positive for the objectives and policy context under which it was proposed.

The weighted scores for each dimension provided guidance for the prioritisation of the priority actions and their corresponding investment proposals. In addition, by including the priority actions and colour coding them, it was clear to see how each subdimension performed against the objectives and therefore which aspects to emphasise. For example, in the subdimension 'culture and heritage' (within the environmental dimension), the objective 'to seek to conserve, protect, promote and develop the natural and cultural heritage' was not achieved by the transport or skills priority actions (colour coded red). This objective was, however, well achieved by the culture and business priority actions (colour coded green), while the housing priority action moderately achieved the objective (colour coded orange). Therefore, the proposals of the red-coded actions might need a greater focus on the preservation and promotion of the natural and cultural environments. Alternatively, the decision-makers might choose to focus on the dimensions and corresponding objectives that have the highest number of 'green boxes' (high scores for the priority actions).

X.4. Other relevant information

The MCA methodology described can also be used as a system to monitor progress during later stages of the project cycle (e.g. implementation and/or operation), providing an audit trail. It can be used as a risk register to highlight trade-offs that may be required as the implementation evolves and to incorporate feedback loops from the stakeholders. Down the line, the methodology can also be used in the evaluation of urban programmes. **The use of MCA involves a number of challenges, which are listed in Table 21 together with suggestions for their mitigation.**

Table 21. Challenges and mitigation measures

Challenges	Mitigation
Urban projects (especially housing) require clear criteria/indicators. In urban programmes, criteria/ indicators need to be multisectoral. It is not always a straightforward matter or practical to apply indicators that have been generated for other sectors	Policy leadership of the appraisal is essential (to provide legitimised guidance). There must be national, regional and/or local 'urban policies' with clear guidance on objectives and appraisal eligibility indicators. Key to urban development is place-based, integrated planning to carry out the policy. The criteria/indicators need to be clearly derived from a sensible combination of existing sectoral and spatial plans. These then need to inform the action measures or the investments
It is important to establish some quality standards for the MCAs, as they are frequently superficial and of poor quality	It is highly desirable that the formation of objectives be guided by reference to international, national and local policy statements alongside secondary information sources, including best practice. Use an existing model, such as the one in the example, which exists as a toolkit containing prepared Excel sheets and a guide. The subdimensions, objectives, criteria/indicators, scoring and weighting are to be decided by consensus on a case-by-case basis
Managing Authorities (MAs)/ beneficiaries may be unfamiliar with how to perform a proper MCA	Assistance and capacity-building actions for MAs and beneficiaries to learn how to use any type of MCA tool is available (including from JASPERS). The first time a PLMCA is used, expert support may be needed. After a municipality or other decision-making body has benefited from expert advice in the use of the tool once, the experience gained should be sufficient to use it again without external support
As they are easy to manipulate (e.g. based on preferences), a beneficiary might set the criteria unilaterally and use the tool to justify a predetermined decision	The preparation of an MCA must include the main stakeholders. Whether it is used for the selection/prioritisation of projects, for the appraisal of a programme or even for a stand-alone project, a multi-stakeholder team should identify all of the steps in the process, in particular the objectives, the criteria/ indicators and the weights, and decide the scores. While the seven standard dimensions can be used in most cases, the decision-makers may choose to replace some or all of them. Whether the seven standard dimensions are chosen or not, the content of each of the following steps of the process (or columns in terms of the PLMCA matrix) must be consensually agreed upon by a team of people (the decision-makers) who together combine the necessary technical expertise and provide legitimate representation for all of the stakeholders. This is the best way to avoid using the PLMCA tool as a means of rubber stamping a decision that has been taken previously without the full analysis that the PLMCA requires

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