

# Guide to **cost-benefit analysis of investment projects**

**(Structural  
Fund-ERDF,  
Cohesion Fund  
and ISPA).**

Prepared for:  
**Evaluation Unit  
DG Regional Policy  
European Commission**

Within the framework of the programme of studies and technical assistance in the field of Regional Policies implemented by the Commission, a working team was given the task to prepare a new edition of the previous *Guide to Cost Benefit Analysis of Major Projects*, published in 1997.

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# Guide to **cost-benefit analysis** **of investment projects**

## Acronyms

<b>AEI</b>	Analysis of Environmental Impact	<b>FNPV</b>	Financial Net Present Value
<b>B/C</b>	Benefit/cost	<b>FRR</b>	Financial (Internal) Rate of Return
<b>CBA</b>	Cost and Benefit Analysis	<b>FRR/C</b>	Financial Rate of Return on Investment
<b>CF</b>	Cohesion Fund	<b>FRR/K</b>	Financial Rate of Return on Equity
<b>cf</b>	Conversion Factor	<b>ISPA</b>	Instrument For Structural Policies in Pre-Accession Countries
<b>DCF</b>	Discounted Cash Flow	<b>IWS</b>	Integrated Water Supply Services
<b>EIB</b>	European Investment Bank	<b>PPP</b>	Polluter Pays Principle
<b>ENPV</b>	Economic Net Present Value	<b>SCF</b>	Standard Conversion Factor
<b>ERDF</b>	European Regional Development Fund	<b>SF</b>	Structural Funds
<b>ERR</b>	Economic Rate of Return	<b>VAT</b>	Value Added Tax

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# Foreword

Cost-benefit analysis (CBA) of investment projects is explicitly required by the new EU Regulations for Structural Funds (SF), Cohesion Fund (CF) and Instrument for Pre-Accession countries (ISPA), for projects with a budget upper than to, respectively, 50 Meuro, 10 Meuro and 5 Meuro.

While Member States are responsible for the prior appraisal, the EU Commission has to evaluate the quality of this appraisal in order to admit the project proposal to co-financing and to determine the co-financing rate.

Many differences occur between infrastructure and productive investments; many differences also occur between regions and countries, between different theories and methodologies of evaluation and moreover between different administrative procedures between the three Funds.

Despite these differences most of the projects have some aspect in common and their appraisal should be expressed in a common language.

Beside general methodological aspects, this verification of costs and benefits is a useful tool to stimulate dialogue between partners, Member States and Commission, project proposers, officials and consultants: a supporting tool for collective decision pro-

cess. It is also a tool to make more transparent procedures for project selection and financing decision

Within the framework of its obligations as regards appraisal of projects which are submitted to it by the Member States in the context of regional policy, the Commission (DG Regio) uses a Guide to cost benefit analysis of major projects. Three years since the last updating, the political, legal and technical context has developed considerably and requires a new update of the guide.

The present guide offers to EU officials, external consultants, and all the parties concerned an agenda for the evaluation process. The text is specifically addressed to the EU officials but at the same time it offers helpful indications to the project proposer about the specific information needs by the Commission.

The specific tasks of this updated version are:

- To incorporate into the document the development of Community policies, financial instruments and cost benefit analysis;
- To feed into the Commission's reflection on the modulation of rates of co-financing for projects;
- To provide technical support to the reader.

# Outline of the new edition of the Guide

The Guide is structured in the following chapters:

- Chapter One. Project appraisal in the framework of Structural Funds, Cohesion Fund and ISPA.
- Chapter Two. An agenda for the project examiner.
- Chapter Three. Outline of project analysis by sectors.
- Annexes
- Glossary
- Bibliography

Each chapter comprises:

- A) main text;
- B) tables and figures;
- C) boxes.

Boxes are of two different kinds:

- Regulation boxes, where the most important statements of SF, CF and ISPA regulations are reminded;
- Example boxes, where some examples, both qualitative and quantitative, are given about a specific issue illustrated in the main text.

In some cases key information is reported in boxes and tables, and we suggest the reader invests some time studying them.

## **Chapter One. Project appraisal in the framework of Structural Funds, Cohesion Fund and ISPA.**

This chapter is an introduction to the objectives, scope and uses of the Guide and the main subjects it addresses. Starting from the ERDF, CF and the ISPA

Regulations the chapter focuses on the legal requirements for the co-financing decision and the related project appraisal process. The main point of the chapter is that despite the differences of procedures and methods among the three funds the economic logic of analysis and the methodology should be homogeneous.

**1.1. Scope and Objectives.** This section stresses the objectives and instruments of the ERDF, CF and ISPA. Starting from the Regulations this section focuses on the main scopes of the Funds.

**1.2. Definition of the projects.** This section defines the projects to which the appraisal process is applicable for the ERDF, the CF and ISPA instruments. It illustrates the principal sectors of application of the Funds, the financial thresholds for project appraisal and the differences between the co-financing rates.

**1.3. Responsibility for prior appraisal.** The section illustrates, for each of the three funds, the responsibility for prior appraisal of projects. This section focuses also on the main differences introduced by the new regulations on this issue.

**1.4. Information required.** A list of the information required for project preparation and appraisal is provided.

## **Chapter Two. An agenda for the project examiner.**

This chapter provides operational tools for both the preparation and the appraisal of

the projects: each section will consider the proposer's and the evaluator's points of view. The structure will be strongly operative and information will be also provided in the form of checklists, frequently asked questions, common mistakes to be avoided.

The paragraphs are the following:

**2.1. Objectives definition.** This section focuses on clearly defining the main objectives and expected results of the project. It explains how to stress the socio-economic variables that the project can influence, how to measure them in order to assess the expected socio-economic impact and the degree of consistency of the specific objectives of the project with EU development policies.

**2.2. Project identification.** This section contains indications about how to start defining the general design and the logical framework of the project, consistently with the most common recommendations of CBA analysis, financial thresholds, and the project definition stated in the regulations.

**2.3. Feasibility and options analysis.** Practical recommendations are illustrated by simple concrete examples especially for the option analysis, distinguishing modal, technological, geographical and chronological options. A typical index for a feasibility study is given in appendix G.

**2.4. Financial analysis.** Information about how to conduct a financial analysis will be given. Starting from the basic tables this section explains how to conduct the study, from the definition of the main items to include in the tables to the calculation of the FRR and FNPV (both of the investment and of the equity). The approach is strictly operative and some examples will be given in the form of case studies (boxes).

The main technical issues to be solved when implementing the analysis are:

- the choice of time horizon;
- the determination of the total cost;

- the determination of the total revenues;
- the determination of the residual value at end year;
- the treatment of inflation;
- the financial sustainability;
- the choice of an appropriate discount rate (see also annex B);
- how to calculate the financial and economic rate of return and use it for the appraisal (see also annex A).

**2.5. Economic analysis.** Starting from the financial analysis and the table of financial flows, the aim is to assess a standard methodology for the three steps for the definition of the final table for the economic analysis:

- correction for fiscal aspects;
- correction for externalities;
- the determination of the conversion factors.

The section focuses on how to calculate the social costs and benefits of a project and how they can influence the final result. This section provides guidance on how to calculate the economic rate of return and to understand its economic meaning for project appraisal.

**2.6. Multicriteria analysis.** This section will cover situations in which the rate of return is insufficient as an impact indicator and complementary analysis is needed.

**2.7. Sensitivity and risk analysis.** The section gives a broad outline on the treatment of uncertainty in investment projects. Annex D is an operative instrument for implementing the technique.

### Chapter Three. Outline of project analysis by sectors.

This chapter offers a more in-depth discussion of the CBA techniques for specific sectors. These comprise the following:

1. Waste treatment;
2. Water supply and depuration;
3. Transport.

A less detailed outline of the CBA approach is proposed for the following other sectors:

4. Energy transport and distribution
5. Energy production
6. Ports, airports and infrastructure networks
7. Training infrastructures
8. Museums and archaeological parks
9. Hospitals
10. Forests and parks
11. Telecommunications infrastructure
12. Industrial estates and technological parks
13. Industries and other productive investments.

### Annexes

This section discusses some technical issues and gives some recommendations to improve the effectiveness of the appraisal methodology.

More specifically the annexes deal with:

- A Project performance indicators;
- B The choice of the discount rate;
- C The determination of the co-financing rate;
- D Sensitivity and risk analysis;
- E Monetary evaluation of environmental services;

- F The evaluation of distributive impacts;
- G Table of contents of a feasibility study.

### Glossary

The glossary contains key words for project analysis. It includes a list of the most commonly used technical terms for the CBA of investment projects.

### Bibliography

In this section selected references are given for a more in-depth study of the most common techniques for CBA analysis.

The bibliography is structured as follows:

- General;
- Energy;
- Transport;
- Water;
- Environment;
- Education;
- Tourism and entertainment;
- Health;
- Agriculture;
- Industrial projects.



## Chapter One

# Project appraisal in the framework of the Structural Funds, Cohesion Fund and ISPA

### Overview

This chapter is an introduction to the objectives, scope and uses of the Guide and the main subjects it addresses. Starting from the ERDF, CF and the ISPA Regulations the chapter focuses on the regulatory requirements for the co-financing decision and the related project appraisal process.

The chapter illustrates the regulatory framework, which rules the preparation, appraisal and co-financing process of an investment project. More precisely it describes:

- Scope and objectives of the Fund;
- project definition for the appraisal process;
- responsibility of the prior appraisal;
- information required for the ex-ante evaluation.

The main point of the chapter is that despite the differences of procedures and me-

thods among the three funds the economic logic of analysis and the methodology should be homogeneous.

### 1.1 Scope and objectives

Investment projects co-financed by the SF, the CF and ISPA constitute the implementation tools for EU regional policies.

This Guide refers to the Structural Funds for the major projects, especially the ERDF (reg. 1260/1999), to the Cohesion fund (reg. 1264/1999 and 1164/94) and to the ISPA (reg. 1267/1999).

According to these regulations both infrastructural and productive investments may be financed by one or more of the Community's financial tools: mainly grants without security (SF, CF, but also repayable aid for the ISPA), loans and other financial tools (European Investment Bank, Investment Fund).

#### BOX 1.1. Scope and objectives of the Funds

**SF: Art. 1 reg. 1260/1999 (definition and objectives):** The Structural Funds, the EIB and the other existing financial instruments shall each contribute in appropriate fashion to the attainment of the following three priority objectives: 1) promoting the development and structural adjustment of regions whose development is lagging behind, hereinafter referred to as: "objective 1"; 2) supporting the economic and social conversion of areas facing structural difficulties, hereinafter referred to as "objective 2"; 3) supporting the adaptation and modernisation of policies and systems of education, training

and employment, hereinafter referred to as "objective 3".

**CF: finances projects in the environmental field (aqueducts, dams and irrigation; purifiers, waste treatment plants and other environmental works, including those related to reforestation, to checking erosion, safeguarding the natural environment, protecting beaches) and infrastructural networks for trans-European transport (railways, airports, roads, motorways, ports) in the Member States with a per capita income of less than 90% of the EU average who adopt a programme whose target is to achieve conditions of economic con-**

vergence as laid down in art. 104c of the EU treaty (Greece, Ireland, Portugal and Spain).

**ISPA: Art. 1 reg. 1267/1999 (definition and objectives):** ISPA shall provide assistance to contribute to the preparation for accession to the European Union of the following applicant countries: Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia, hereinafter referred to as the "beneficiary countries", in the areas of economic and social cohesion, concerning environment and transport policies in accordance with the provisions of this Regulation.

The European Union SF can finance a wide variety of projects, from the point of view of both the sector involved and the financial size of the investment.

While the CF and the ISPA exclusively finance projects in the transport and environment sectors, the SF, and the ERDF in particular, may also finance projects in the energy, industrial and service sectors.

### 1.2 Definition of the projects

In the Regulations for the Structural Funds the financial size of the projects appraised by the Commission is defined: it must not be less than Euro 50 million.

In the regulations for the Cohesion fund and the ISPA, on the other hand, in addition to the financial threshold (Euro 10 million for the Cohesion fund and Euro 5 million for the ISPA) in order to avoid excessive fragmentation of the projects and to ensure the utilisation of the Funds in an integrated and systematic manner, the terms 'project' and 'project phase' are defined in detail. They establish that the following types of measures are financeable by the Cohesion fund and by the ISPA:

- A **project**, that is an economically indivisible series of tasks related to a specific technical function and with identifiable objectives;
- A **project phase** that is technically and financially independent and has its own effectiveness;
- A **group of projects**, that is projects that satisfy the following three conditions:
  - they are **located** in the same area or along the same transport corridor;
  - they belong to a **general plan** for that area or corridor;

- they are **supervised** by the same agency that is responsible for co-ordination and monitoring.

For these projects, whatever their financial size, the proposer must prepare a Cost-Benefit Analysis that takes into account the direct and indirect effects on employment, possibly integrated with other evaluation methods in the case of projects in the environmental field.

Some specifications for financial thresholds are the following:

a) the key economic variable is the total cost of the investment. To evaluate that figure one must not consider the sources of financing (for example only public financing or only Community co-financing), but the overall economic value of the infrastructural or productive investment proposed;

#### BOX 1.2 Financial thresholds.

**SF: Art. 25 Reg.1260/1999:** As part of any assistance, the Funds may finance expenditure in respect of major projects, i.e. those: a) which comprise an economically indivisible series of works fulfilling a precise technical function and which have clearly identified aims and b) whose total cost taken into account in determining the contribution of the funds exceeds EUR 50 million.

**FC: Art. 10(3) cons. Reg.1164/94:** Applications for assistance for projects under Article 3 (1) shall be submitted by the beneficiary Member State. Projects, including groups of related projects, shall be of a sufficient scale to have a significant impact in the field of environmental protection or in the improvement of trans-European transport infrastructure networks. In any event, the total cost of projects or groups of projects may in principle not be less than ECU 10 million. Projects or groups of projects costing less than this may be approved in duly justified cases.

**ISPA: Art.2/4 Reg.1267/1999:** Measures shall be of a sufficient scale to have a significant impact in the field of environmental protection or in the improvement of transport infrastructure networks. The total cost of each measure shall in principle not be less than EUR 5 million. In duly justified cases, taking into account the specific circumstances concerned, the total cost of a measure may be less than EUR 5 million.

b) if one assumes that the investment costs will be spread over a number of years, then one must consider the sum of all the annual costs;

c) while one needs to consider only the cost of the investment, without the running costs, it is advisable also to include any one-off expenses incurred in the start-up phases, such as hiring and training expenses, licences, preliminary studies, planning and other technical studies, price revision, appropriation of operating capital, etc., in the calculation of the total cost;

d) sometimes the interrelation among different smaller projects is such that it is better to consider them as one large project (for example five stretches of the same motorway, each costing Euro 6 million, can be considered one large project of Euro 30 million).

## 1.3 Responsibility for prior appraisal

According to the SF reg. 1260/1999, art. 26, the Commission is responsible for the prior appraisal of major projects on the basis of information given by the proposer.

The regulation for the Cohesion fund (Reg. 1265/1999, art. 1), states that:

*The beneficiary Member States shall provide all necessary information, as set out in Article 10 (4), including the results of feasibility studies and ex-ante appraisals.*

The regulation for the ISPA (reg. 1267/1999, annex II (C)):

*The beneficiary countries are to provide all necessary information, as set out in annex I, including the results of their feasibility studies and appraisals, an indication of alternatives not pursued and the co-ordination of measures of common interest situated on the same transport route, to make this appraisal as effective as possible.*

The Commission's decisions about co-financed projects must be based on an in-depth evaluation, carried out in the first instance by whoever proposes the project. When the evaluation presented by the candidate is declared to be insufficient and not convincing, the Commission may ask for a revision or a more thorough elaboration of the analysis, or it may conduct its own evaluation, if necessary, availing itself of an independent evaluation (art. 40 reg. 1260/99):

*On the initiative of the Member States or the Commission, after informing the Member State concerned, supplementary evaluations if appropriate on a specific topic may be launched, with a view to identifying transferable experience.*

In the case in point, with specific reference to the Cohesion fund and the ISPA, the

regulations stipulate that for the evaluation of projects the Commission may avail itself of the assistance of the European Investment Bank, whenever appropriate. In practice, recourse to the experience of the EIB is very common in the case of projects, both when the Bank itself is financing the project and when it is not.

In any case, the Commission's decision will be the result of a dialogue and a common commitment with the proposer, in order to obtain the best results from the investment. The Member States often have structures and internal procedures for evaluating projects of a certain size, but sometimes difficulties may emerge in carrying out a quality evaluation. The Commission can help to overcome these difficulties in different ways. Technical assistance for the preparation of the evaluation of a project may be co-financed by the Community Support Framework or in other appropriate ways.

## 1.4 Information required

Community regulations indicate which information must be contained in the application form for the purposes of an effective evaluation on the part of the Commission. Article 26 of reg. 1260/99 stipulates its own rules for the submission of the request for co-financing of major projects. It asks for a cost-benefit analysis, a risk analysis, an evaluation of the environmental impact (and the application of the Polluter Pays Principle) as well as the impact on equal opportunities and on employment.

Regulations for the Cohesion Fund and the ISPA, in addition to stating that the proposals for co-financing must contain a cost-benefit analysis, a risk analysis and a detailed indication of the alternatives rejected, also provide some indications of the criteria to be applied in order to ensure the quality of the evaluation: in the case of environmental projects, a cost-benefit analysis

### BOX 1.4 Role of the EIB and the World Bank.

**CF con e 1164/94, article 13 (Appraisal, monitoring and evaluation).** In order to ensure the effectiveness of Community assistance, the Commission and the beneficiary Member States shall, in co-operation with the EIB where appropriate, carry out a systematic appraisal and evaluation of projects.

**ISPA: Reg. 1267/1999, Enclosure II (B)** The Commission may invite the EIB, EBRD or World Bank to contribute to the appraisal of measures as necessary. The Commission is to examine applications for assistance to verify in particular that the administrative and financial mechanisms are adequate for the effective implementation of the measure.

supplemented by other evaluation methods, possibly of a quantitative nature such as the multicriteria analysis and respect for Polluter pays principle (see art. 10 (5), Reg. 1164/94 and the Council's amendments). Other information that should be provided in the request for financing from the CF are: an evaluation of the direct and indirect effects on employment; an indication of the contribution of the project to European policies related to the environment and to trans-European transport networks; a "financial plan that includes, wherever possible, information about the economic viability of the project" (see art. 10 (4), reg. 1164/94).

A project examiner should consider these and other similar lists of regulatory norms more as a general indication of the minimum information required rather than as a rigid set of criteria. The applicant has the responsibility to supply the required information but the Commission should verify that the information provided are consistent, complete and of a sufficient quality to assess the appraisal; otherwise the Commission should ask for additional information.

In general, for any type of investment a financial analysis is always advisable. As we shall explain in the second part of the Guide, it is particularly important to

### BOX 1.3 Definition of the project.

**SF: Art. 5, Reg. 2081/93 (SF Framework Regulation).**

Forms of assistance

"1. Financial assistance under the Structural Funds, from the EIB and the other existing Community financial instruments shall be provided in a variety of forms that reflect the nature of the operations.

2. In the case of the Structural Funds and the FIG, financial assistance may be provided principally in one of the following forms: (a) part-financing of operational programmes; ... (d) part-financing of suitable projects; (...)"

This Guide concerns both major individual projects and those which are a part of an operational programme.

**CF: Art. 1, Reg. 1265/1999.**

1. The Commission may, in agreement with the beneficiary member State, group projects together and designate technically and financially separate stages of a project for the purpose of granting assistance.

2. For the purpose of this Regulation, the following definitions shall apply: a) a "project" shall be an economically indivisible series of works fulfilling a precise technical function and with clearly identified aims from which to judge whether the project complies with the criterion laid down in the first indent of article 10, (5); b) a "technically and financially independent stage", shall be a stage which can be identified as ope-

rationally in its own right.

3. A stage may also cover preliminary, feasibility and technical studies needed for carrying out a project.

4. To comply with the criterion in the third indent of article 1 (3), projects meeting the following three conditions may be grouped: a) they must be located in the same area or situated along the same transport corridor; b) they must be carried out under an overall plan for the area or corridor, with clearly identified goals, as provided for in article 1 (3); c) they must be supervised by a body responsible for co-ordinating and monitoring the group of projects, in cases where the projects are carried out by different competent authorities.

**BOX 1.5 Information required by the ISPA.**

**ISPA:** Reg. 1267/1999, annex I : Contents of the application [article 7, section 3, letter a)] Applications are to contain the following information: 1. the name of the body responsible for implementation, the nature of the measure and a description thereof; 2. the cost and location of the measure, including, where applicable, an indication of the inter-connection and interoperability of measures situated on the same transport axis; 3. the timetable for implementation of the work; 4. a cost-benefit analysis, including the direct and indirect effects on employment to be quantified where they lend themselves to be quantified;

5. assessment of the environmental impact similar to the assessment provided for in Council Directive 85/337/EEC of 27 June on the assessment of the effects of certain public and private projects on the environment (1); 6. information on compliance with competition law and public contract rules; 7. the financing plan including, where possible, information on the economic viability of the measure, and the total financing the beneficiary country is seeking from ISPA, the EIB including its pre-accession facility and any other Community or Member State source, the EBRD and the World Bank; 8. the compatibility of mea-

asures with Community policies; 9. information on the arrangements for ensuring the efficient use and maintenance of facilities; 10. (environmental measures) information on the place and priority of the measure within the national environmental strategy as laid down in the national programme for the adoption of the *acquis communautaire*; 11. (transport measures) information on the national transport development strategy and the place and priority of the measures within that strategy, including the degree of coherence with the guidelines for the trans-European networks and the pan-European transport policy.

understand the extent to which the capital invested in the project may be at least partially recouped over the years. This may come about, for example, via the sale of services, if this is contemplated, or through other means of non-transitory financing that may generate inflows of cash sufficient to cover expenditure for the whole period of implementation of the project.

Another reason why a suitable financial analysis is important for any project, regardless of whether it produces a positive financial return, is that this analysis is the basis for the CBA and its existence improves the quality of the project evaluation.

Reading this Guide will help to better understand what information is required by the Commission for the questions mentioned previously in the articles of the regulations of the FS, the CF, the ISPA and elsewhere, on how to evaluate the socio-economic benefits and costs; how to consider the impact on regional development and on the environment; how to weight the direct and indirect effects on employment, both immediate and permanent; how to evaluate the economic and financial profitability, etc. There are different ways of responding to these requests for information: the Guide stresses some fundamental questions, methods and criteria.

**BOX 1.6 Information required by the SF and CF.**

**SF: Art. 26 reg. 1260/99:** "During the implementation of assistance, where a Member State or managing authority envisages the Funds contributing to a major project, it shall inform the Commission in advance, and provide the following information: a) the body to be responsible for implementation; b) the nature of the investment and a description of it, its financial volume and location; c) the timetable for implementing the project; d) cost-benefit analysis including financial costs and benefit, a risk assessment and informations on the economic viability of the project; e) plus: - in the case of investments in infrastructure: the analysis of the costs and the socio-economic benefits of the project, including an indication of the anticipated rate of use, the foreseeable impact on the development or conversion of the region concerned, and the application of Community rules on public contracting; - in the case of investment in production facilities: the analysis of the market prospects in the

sector concerned and the anticipated return on the project; f) the direct and indirect effects on the employment situation, as far as possible in the Community; g) information allowing an evaluation to be made of the environmental impact and the implementation of the precautionary principles and the principle that preventive action should be taken, that environmental damage should as a priority be rectified at source and that the polluter should pay and compliance with the Community rules on the environment; h) information needed to assess compliance with competition rules, *inter alia* rules on State aids; i) an indication of the influence of the contribution of the Funds on whether the project will be implemented; j) the financing plan and the total financial resources expected from the contribution of the Funds and any other sources of Community finance.

**CF: Art. 26 reg. 1260/99:** Applications shall contain the following information: the body

responsible for implementation, the nature of the investment and a description thereof, its costs and location, including, where applicable, an indication of projects of common interest situated on the same transport axis, the timetable for implementation of the work, a cost-benefit analysis, including the direct and indirect effects on employment, information enabling impact on the environment to be assessed, information on public contracts, the financing plan including, where possible, information on the economic viability of the project, and the total financing the Member State is seeking from the Fund and any other Community source. They shall also contain all relevant information providing the required proof that the projects comply with the Regulation and with the criteria set out in section 5, and particularly that there are medium-term economic and social benefits commensurate with the resources deployed.

## Chapter 2

# An agenda for the project examiner

## Overview

This chapter offers a quick overview of the essential information that the proposer of a project to be co-financed is advised to include in the application dossier. It also provides a reading grid for the Commission officials or external consultants to be used in their assessment of the cost-benefit analysis of investment projects.

Each section will take a strictly operational perspective and each problem will be analysed both from the standpoint of the proposer and that of the project examiner.

## 2.1 Objectives definition

Definition of the project's objectives and the object of the study is essential in order to identify the project, which represents the starting point for the appraisal. Generally speaking, the question the application dossier should be able to answer is the following one:

**What are the socio-economic benefits that can be attained with the project implementation?**

The analysis of the objectives lies in verifying that:

1. The application dossier or the appraisal report should set forth which **socio-economic variables** the project is liable to influence.

2. The proposer should indicate which of the **specific objectives of EU regional and cohesion policies** could be achieved by the project and, in particular, how the project, if successful, will influence the attainment of these objectives.

The objectives considered should be **socio-economic variables** and not just physical indicators. They should be logi-

### Frequent Errors

**Socio-economic variables should be measurable, such as per capita income, rate of employment, consumption value per capita, etc.**

**It is important to avoid some frequent errors:**

- a vague statement that the project will promote economic development or social welfare is not a measurable objective;
- hectares of new forest are easily measurable, but they are not themselves a social objective: they are project outputs, not outcomes.
- per-capita GDP within a given region is a measurable social objective, but only very large projects, probably those of inter-regional or national scale may have a measurable impact on it; only in such cases may it be worthwhile to try to forecast how aggregate regional GDP will change in the long term with and without the project.

The agenda is structured in **seven steps**.

Some of these steps are preliminary but necessary requirements for cost-benefit analysis.

- Objectives definition
- Project identification
- Feasibility and options analysis
- Financial analysis
- Economic analysis
- Multicriteria analysis
- Sensitivity and risk analysis



### Check list for objectives definition

- Does the project have a clearly defined objective in terms of socio-economic variables?
- Are these socio-economic benefits attainable with implementation of the project?
- Are the objectives connected logically?
- Are the overall welfare gains arising from the project worth its cost?
- Have all the most important direct and indirect socio-economic effects of the project been considered?
- If it is not possible to measure all direct and indirect social effects, have all proxies related to the objective been identified?
- Are the means of measuring the attainment of objectives indicated?
- Is the project coherent with the EU objectives of the funds? (pursuant to Art. 25 Reg. 1260/1999, Art. 1, Reg. 1164/1994, Art. 2 Reg. 1267/1999)
- Is the project coherent with the EU objectives specific to the sector of assistance?

cally connected with the project and there should be some indications on how to measure their level of attainment.

With regard to the definition of socio-economic objectives, the proposer must be able to answer the following key questions.

**First** and foremost: can we say that the overall welfare gains arising from the project are worth its cost?

**Secondly:** have all the most important direct and indirect socio-economic effects of the project been considered?

**Thirdly:** if it is not possible to measure all direct and indirect social effects for lack of data, have some proxies related to the objective been identified?

Clear and complete definition of the socio-economic objectives is necessary to determine the impact of the project. However, it may often be difficult to forecast all the impacts of a given project. Welfare changes have also a number of components. For example, regional data do not usually allow us to make reliable estimates of the overall impact of individual projects on trade with other regions; indirect employment effects are difficult to quantify; competitiveness may depend on external trade conditions, exchange rates, changes in relative prices; all variables for which it may be too expensive to

make project-specific analysis.

However, variables correlated to the socio-economic objectives may often be found in these cases. For example, if it is difficult to determine the increase in productivity and competitiveness of a region, it may be possible to measure the change in exports.

However the approach of the present Guide is not to consider always all the indirect and maybe far-off effects of a project (which could be a large number and very difficult to consider and quantify). The procedure the Guide suggests focuses only on cost-benefit analysis of microeconomic variables.

Whilst the assessment of social benefits of each project depends on the economic policy objectives of the partners involved, the essential requisite from the Commission's perspective is that the project be logically related to the **main objectives of the funds involved**: SF, CF and ISPA. The project promoter must be certain that the assistance proposed is coherent with these objectives and the examiner must ascertain that this coherence effectively exists and that it is well justified. Specifically, the projects are part of, for SF, CF and ISPA, programmes formulated at the national or regional level (SPD, Operational Programmes and Programme Complements for objective 1, SPD for objectives 2 and 3 of the SF's, the programme plan and national plan for CF and ISPA).

In addition to the general objectives of the individual funds, the project must be coherent with EU legislation in the specific sector of assistance, mainly transport, environment and with regulation in terms of competition.

## 2.2 Project Identification

In order to identify the project, the following must be verified:

1. that the object is a **clearly identified** unit of analysis, according to general CBA principles;
2. that the object of assessment reflects the **definition of the project** provided by regulations;
3. that the **financial thresholds** set forth by regulations are respected (see box 1.2, chapter one, *Financial Thresholds*).

### 2.2.1 Clear identification

The project must be **clearly identified** as a self-sufficient unit of analysis. Specifically, the activities included in the project must lead back to a unique objective as well as to a coherent and co-ordinated entity of actions and roles.

Obviously, the above also applies to the case in which the analysis report presents only some initial phases of the investment, whose success hinges on the completion of the project as a whole. It is particularly impor-

tant to stress this point because in practice, the administrative decision-making process may entail the need to break the project down into various tranches.

In some cases, another risk may arise: a comprehensive project is presented but co-financing is requested only for one of the parts and it is not clear whether the other fundamental parts will or will not be carried out.

The identification of projects necessitating a better appraisal may in some cases entail requesting Member States to reconsider some sub-projects as one large project and provide additional related information, such as the CBA, as required by the regulations mentioned above.

The proposer has the task of providing the justification for the choice of identification of the subject of analysis and the examiner has the task of judging the quality of this choice. In the event that the object of analysis is not clearly identified, the examiner may request that the proposer integrate the presentation dossier with a clarification of its identification.

### Examples of Identification of a Project

- A highway project connecting town A with town B, which is justified only by the expectation that an airport will be located in the vicinity of town B and that most of the traffic will take place between the airport and town A: the project should be analysed in the context of the airport-highway system as a whole;
- A hydroelectric power station, located in X and supposed to serve a new energy-intensive plant: again, if the two works are mutually dependent for the assessment of costs and benefits, the analysis should be integrated, even if the EU assistance is requested only for the energy supply part of the project;
- A large-scale productive forestation project, financed with public funds and justified by the opportunity to supply a privately owned cellulose company: the analysis should consider both costs and benefits of both components, that is the forestation project and the industrial plant;
- The construction of a water purification plant justified by expectations of the development of a tourist destination, including hotel complexes, is justified only if the site is developed;
- A waste treatment plant linked to urban planning that provides for the expansion of a given area justifies the assistance only in the context of new settlements of people. In many cases, the most appropriate unit of analysis may be more than its parts. Clearly, the CBA of only one of its parts would give false results. Should the examiner receive an incomplete appraisal dossier, s/he should request a broader analysis.

In this regard, please also see the project identification sub-paragraphs in the third chapter.

### 2.2.2 Financial threshold

The Regulations presented in Chapter 1 show a financial threshold of acceptable projects that must be respected. In fact, the total cost (eligible cost for ERDF) of proposed investments must be higher than the values shown in Fig. 2.1 (for the distinction between eligible and total cost of the investment, see the section on financial analysis).

Fig. 2.1 Financial threshold for acceptable projects

Fund	Threshold in millions of euro
ERDF	50
CF	10
ISPA	5

### 2.2.3 Project definition

For project definition the reader is referred to paragraph 1.2.

As regards the assessment of a series of projects grouped together according to the principles outlined above, generally, the analysis is not carried out on each individual project, but rather through sample checks or on the major components.

On this point, the examiner's check consists in reconstructing the technical-economic context that justifies the identification of the subject of the appraisal as the key point for project evaluation. However, sometimes the CBA requires going beyond the administrative definitions.

For instance, in order to assess the quality of a given project, the proposer must produce an adequate ex ante evaluation, not only for the part of the project to be financed with the assistance of SF or CF or ISPA, but for the parts that are closely connected to it as well.

## 2.3 Feasibility and options analysis

Feasibility does not relate only to engineering aspects, but in many cases, it also concerns aspects of marketing, management, analysis of the implementation, etc. We may often adopt various project options in order to achieve a socio-economic objective. The proposer should give evidence that his project choice is the best option of all feasible alternatives. In some cases, a project may be considered valid from the CBA standpoint, but inferior to other alternative options. In order to check that project is the best of all alternative options, the following questions should be answered:

**Firstly**, has the application dossier given sufficient evidence of the project's feasibility?

**Secondly**, has the applicant demonstrated that alternative options have been adequately considered?

The project examiner should be certain that the applicant has carried out an appropriate feasibility study as well as an analysis of alternative options. If there is not sufficient evidence to support this, the examiner may recommend that this be done and that the project be consequently revised.

Typical feasibility reports for major infrastructures may include information on the economic and institutional context, forecasted demand (either market or non-market), available technology, the production plan (including the utilisation rate of the infrastructure), personnel requirements,

the scale of the project, its location, physical inputs, timing and implementation, phases of expansion, financial planning, environmental aspects. In many cases, the analysis of large projects entails detailed support studies (engineering, marketing, etc; see annex G, *Table of Contents of a Feasibility Study*, showing a typical table of contents of a feasibility study).

In some cases a project may pass a CBA test, despite being socially inferior to alternatives.

Typical examples are transport projects where different routes or different construction timing or different technologies may be considered; large hospital structures rather than a more widespread offer of health services; the location of a plant in area A versus area B; different peak-load arrangements for energy supply; energy efficiency improvements rather than (or in addition to) the construction of new power plants; etc.

For each project at least three alternatives could be considered:

- the **do nothing** alternative;
- the **do minimum** alternative;
- the **do something** alternative (or reasonable alternative, a project based on an alternative technology or concept).

The do nothing alternative is the basic approach of the project analysis that aims

### Example of options

In order to link town A and town B, there are three feasible alternatives:

1. build a new railway
2. lay a new road
3. strengthen the existing road ("do minimum" option)

If a project providing for the laying of a new road is proposed, evidence must be given to show that it is better than the alternatives of the railway and the developing of the existing road, despite their feasibility.

at least to compare the situations with and without the project. The do nothing alternative is also called the inertial scenario.

For example in order to link two areas the do nothing alternative is to use the old ferry service, the do minimum alternative could be to renew/improve ferry service and the project could be to construct a bridge.

The calculation of the financial and economic performance indicators must be performed on the basis of the difference between the do-something alternative and the do-nothing alternative or the do-minimum alternative.

## 2.4 Financial Analysis

The purpose of the financial analysis is to use the project's cash flow forecasts in order to calculate suitable return rates, specifically the financial internal rate of return (FRR) on investment (FRR/C) and own capital (FRR/K) and the corresponding financial net present value (FNPV).

While the CBA encompasses more than just the consideration of the financial returns of a project, most of project data on costs and benefits is provided by financial analysis. This analysis provides the examiner with essential information on inputs and outputs, their prices and the overall timing structure of revenues and expenditures.

The financial analysis is made up of a series of tables that collect the financial flows of the investment, broken down by total investment (Tab. 2.1), operating costs and revenue (Tab. 2.2), sources of financing (Tab. 2.3) and cash flow analysis for financial sustainability (Tab. 2.4).

### Checklist for project identification

- Does the project constitute a clearly identified unit of analysis?
- Is it a project, a phase of a project or a series of projects? (pursuant to Art. 25 Reg. 1260/1999, Art. 1, Reg. 1265/1999, Art. 2 Reg. 1267/1999)
- Is it a series of projects that satisfy the conditions with regard to location, part of a global plan, responsibility of the supervisory board?
- Does the project satisfy the financial thresholds established in by the Regulations?

### BOX 2.1 Options Analysis

CF: Art 1(2) Reg 1265/1999: Beneficiary Member States shall provide all necessary information as set out in article 10 (4), including the results of feasibility studies and ex ante appraisals. (...) Member States shall also provide, (...) where appropriate, an indication of the possible alternatives that were not chosen.

**Checklist for feasibility study and option analysis:**

- Has the application dossier given sufficient evidence of the project's feasibility (from an engineering, marketing, management, implementation, environmental...points of view)?
- Has the applicant demonstrated that alternative options have been adequately considered (at least in terms of do nothing or do-minimum alternatives?).

The financial analysis should finally result in two tables summarising the cash flows:

- one for investment returns (capacity of operating net revenues to sustain the investment costs, Tab. 2.5) regardless of the way in which they are financed;
- the other for the calculation of the returns on equity capital where in the outflows there are the own equity of the private investor (when it is paid up), the national contribution at three levels (local, regional and central), the financial loans at the time they are paid back, in addition to operating costs and related interest, and revenues for the inflows. It does not consider the EU grant. It gives the rate of return of the

project considering its financial burden, regardless its investment costs (Tab. 2.6).

In order to correctly draw up the tables above, careful attention must be paid to the following elements:

- **time horizon;**
- the **determination of total costs (total investments costs, row 1.21, and total operating costs, row 2.9);**
- **revenues** generated by the project (sales, row 2.13);
- the **residual value** of the investment (row 1.19);
- adjustment for **inflation;**
- verification of **financial sustainability (Tab. 2.4);**
- selection of the appropriate **discount rate;**
- determination of the main performance **indicators** (Tables 2.5 and 2.6, FRR and FNPV of the investment and capital, row 5.4, 5.5, 6.4, 6.5);
- determination of the **co-financing rate.**

**2.4.1 The time horizon**

By time horizon, we mean the maximum number of years for which forecasts are provided. Forecasts regarding the future

**Tab. 2.1 Total Investments - Thousands of Euro**

	Years									
	1	2	3	4	5	6	7	8	9	10
1.1 Land	400									
1.2 Buildings	700	600	150							
1.3 New equipment		155	74	80			91			
1.4 Used equipment		283	281							
1.5 Extraordinary Maintenance					200					
<b>1.6 Fixed assets</b>	<b>1100</b>	<b>1038</b>	<b>505</b>	<b>80</b>	<b>200</b>	<b>0</b>	<b>91</b>	<b>0</b>	<b>0</b>	<b>0</b>
1.7 Licences			500							
1.8 Patents			500							
1.9 Other pre-production expenses		60								
<b>1.10 Pre-production expenses</b>	<b>0</b>	<b>60</b>	<b>1000</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>1.11 Investment costs (A)</b>	<b>1100</b>	<b>1098</b>	<b>1505</b>	<b>80</b>	<b>200</b>	<b>0</b>	<b>91</b>	<b>0</b>	<b>0</b>	<b>0</b>
1.12 Cash	26	129	148	148	148	148	148	148	148	148
1.13 Clients	67	802	827	827	827	827	827	827	827	827
1.14 Stock	501	878	880	880	880	880	880	880	880	880
1.15 Current Liabilities	508	1733	1694	1694	1694	1694	1694	1694	1694	1694
1.16 Net working capital (=1.12+1.13+1.14-1.15)	86	76	161	161	161	161	161	161	161	161
<b>1.17 Variations in working capital (B)</b>	<b>86</b>	<b>-10</b>	<b>85</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
1.18 Replacement of short life equipment					200					
1.19 Residual value										-1500
<b>1.20 Other investment items (C)</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>200</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>-1500</b>
<b>1.21 Total investment costs (A)+(B)+(C)</b>	<b>1186</b>	<b>1088</b>	<b>1590</b>	<b>80</b>	<b>400</b>	<b>0</b>	<b>91</b>	<b>0</b>	<b>0</b>	<b>-1500</b>

Row numbers identify items. They should be used to fill in the next tables.

Residual value should always be included at end year (see also below). It is an inflow. It is considered with a 'minus' in this table because all the other items are outflows.

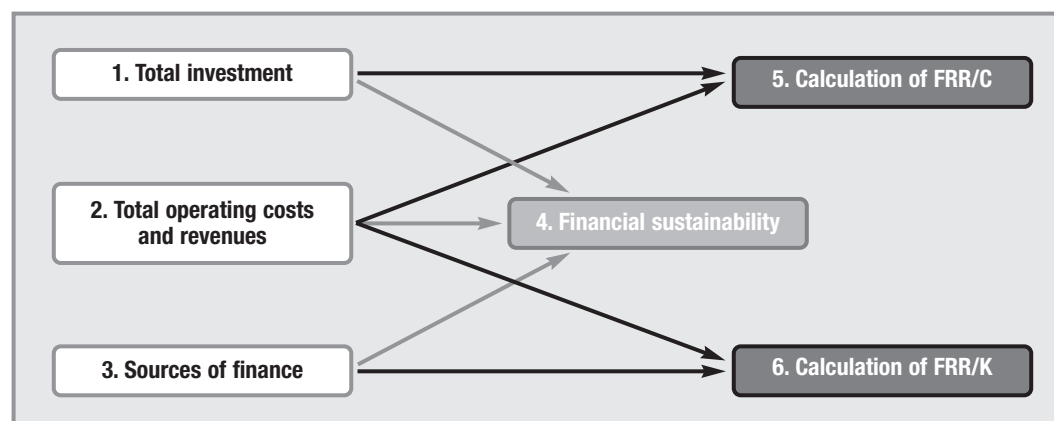


Fig. 2.2 Structure of financial analysis

**BOX 2.2 Time Horizon**

**CF Guidelines:** "The lifetime varies according to the nature of the investments: it is longer for civil engineering works (30-40 years) than for technical installations (10-15 years). In the case of a mixed investment comprising civil engineering works and installations, the lifetime of the investment may be fixed on the basis of the lifetime of the principal infrastructure (in this case investment in

the renewal of infrastructure with a shorter lifetime must be included in the analysis). The lifetime may also be determined by considerations of a legal or administrative nature: for example the duration of the concession where a concession has been granted".  
**ISPA Guidelines:** "infrastructure projects are generally appraised over a period of 20-30 years, which

represents a rough estimate of their economic life span. Although the physical assets may last significantly longer than this – e.g. a bridge may last for 100 years - it is not generally worthwhile trying to forecast over longer periods. In the case of assets with a very long life, a residual value may be added at the end of the appraisal period to reflect their potential resale value or continuing use value".

**Tab. 2.2 Operating Revenues and Costs - Thousands of Euro**

	Years									
	1	2	3	4	5	6	7	8	9	10
2.1 Raw materials		1564	5212	5212	5212	5212	5212	5212	5212	0
2.2 Labour		132	421	421	421	421	421	421	421	0
2.3 Electric power		15	51	51	51	51	51	51	51	0
2.4 Combustible		5	18	18	18	18	18	18	18	0
2.5 Maintenance		20	65	70	70	70	70	70	70	0
2.6 General industrial costs		18	75	80	80	80	80	80	80	0
2.7 Administrative costs		48	210	224	224	224	224	224	224	0
2.8 Sales expenditures		220	1200	1400	1400	1400	1400	1400	1400	0
<b>2.9 Total operating costs</b>	<b>2022</b>	<b>7252</b>	<b>7476</b>	<b>7476</b>	<b>7476</b>	<b>7476</b>	<b>7476</b>	<b>7476</b>	<b>7476</b>	<b>0</b>
2.10 Product A		400	1958	2458	2458	2458	2458	2458	2458	0
2.11 Product B		197	840	1140	1140	1640	1640	1640	1640	0
2.12 Product C		904	2903	3903	3903	4403	4403	4403	4403	0
<b>2.13 Sales</b>	<b>1501</b>	<b>5701</b>	<b>7501</b>	<b>7501</b>	<b>8501</b>	<b>8501</b>	<b>8501</b>	<b>8501</b>	<b>8501</b>	<b>0</b>
<b>2.14 Net operating revenue</b>	<b>-521</b>	<b>-1551</b>	<b>25</b>	<b>25</b>	<b>1025</b>	<b>1025</b>	<b>1025</b>	<b>1025</b>	<b>1025</b>	<b>0</b>

During the first year no operating revenues and costs occurs, but only investment costs (see tab.1).



Private equity is the contribution of a private investor.

Tab. 2.3 Sources of Financing Table - Thousands of Euro										
	Years									
	1	2	3	4	5	6	7	8	9	10
3.1 Private equity	100	200	100	0	0	0	0	0	0	0
3.2 Local level										
3.3 Regional level	200									
3.4 Central level	200	200	100							
<b>3.5 Total national public contribution</b>	<b>400</b>	<b>200</b>	<b>100</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
3.6 EU grant	1132	1056	1013	532	496					
3.7 Bonds and other financial resources										
3.8 EIB Loans		0	1822							
3.9 Other Loans										
<b>3.10 Total financial resources</b>	<b>1632</b>	<b>1456</b>	<b>3035</b>	<b>532</b>	<b>496</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>

Loan is here an inflow and it is accounted as a financial resource coming from third parties.

The EU grant should be included in this table. It is also included in the financial sustainability table below.

Interest are paid on EIB loans (see row 3.8) starting from year 3 in which loan is registered as an inflow.

In this table residual value is included only if the investment is really liquidated at end year. In this case there is no residual value as there is no liquidation and consequently no real inflow of money.

Interest, retirement bonus, loans reimbursement and taxes are the only items not already included in the previous tables. All the other items should be taken by the previous tables looking at the row number.

Tab. 2.4 Financial Sustainability Table - Thousands of Euro										
	Years									
	1	2	3	4	5	6	7	8	9	10
3.10 Total financial resources	1632	1456	3035	532	496	0	0	0	0	0
2.13 Sales	0	1501	5701	7501	7501	8501	8501	8501	8501	0
<b>4.1 Total inflows</b>	<b>1632</b>	<b>2957</b>	<b>8736</b>	<b>8033</b>	<b>7997</b>	<b>8501</b>	<b>8501</b>	<b>8501</b>	<b>8501</b>	<b>0</b>
2.9 Total operating costs	0	2022	7252	7476	7476	7476	7476	7476	7476	0
1.21 Total investment costs	1186	1088	1590	80	400	0	91	0	0	0
4.2 Interest	0	0	8	8	8	8	8	8	8	0
4.3 Retirement bonus	0	0	0	0	0	0	0	0	0	197
4.4 Loans reimbursement	0	0	0	168	189	211	237	265	300	451
4.5 Taxes	0	62	78	83	95	95	95	95	95	0
<b>4.6 Total outflows</b>	<b>1186</b>	<b>3172</b>	<b>8928</b>	<b>7815</b>	<b>8168</b>	<b>7790</b>	<b>7907</b>	<b>7844</b>	<b>7879</b>	<b>648</b>
<b>4.7 Total cash flow</b>	<b>446</b>	<b>-215</b>	<b>-192</b>	<b>218</b>	<b>-171</b>	<b>711</b>	<b>594</b>	<b>657</b>	<b>622</b>	<b>-648</b>
<b>4.8 Cumulated total cash flow</b>	<b>700</b>	<b>485</b>	<b>293</b>	<b>511</b>	<b>340</b>	<b>1051</b>	<b>1645</b>	<b>2302</b>	<b>2924</b>	<b>2276</b>

Loan here is considered at the moment it is reimbursed as an outflow. The inflow item of loan is included in the financial resources (row 3.8).

Financial sustainability is verified if this row is more than or equal to zero for all the years considered.

As can be seen from the row numbers, all the items of this table have already been calculated in the previous table. To draw up this table and the next one it is necessary to include all the requested items and calculate the rates.

Financial internal rate of return on investment is calculated considering total investment costs as an outflow (together with operating costs) and revenues as an inflow. It measures the capacity of operating revenues to sustain the investment costs.

Tab. 2.5 Calculation of the Financial Internal Rate of Return of the Investment -Thousands of Euro										
	Years									
	1	2	3	4	5	6	7	8	9	10
2.13 Sales	0	1501	5701	7501	7501	8501	8501	8501	8501	0
<b>5.1 Total revenues</b>	<b>0</b>	<b>1501</b>	<b>5701</b>	<b>7501</b>	<b>7501</b>	<b>8501</b>	<b>8501</b>	<b>8501</b>	<b>8501</b>	<b>0</b>
2.9 Total operating costs	0	2022	7252	7476	7476	7476	7476	7476	7476	0
4.3 Retirement bonus	0	0	0	0	0	0	0	0	0	197
1.21 Total investment costs	1186	1088	1590	80	400	0	91	0	0	-1500
<b>5.2 Total expenditures</b>	<b>1186</b>	<b>3110</b>	<b>8842</b>	<b>7556</b>	<b>7876</b>	<b>7476</b>	<b>7567</b>	<b>7476</b>	<b>7476</b>	<b>-1303</b>
<b>5.3 Net cash flow</b>	<b>-1186</b>	<b>-1609</b>	<b>-3141</b>	<b>-55</b>	<b>-375</b>	<b>1025</b>	<b>934</b>	<b>1025</b>	<b>1025</b>	<b>1303</b>
<b>5.4 Financial internal rate of return (FRR/C) of the investment</b>	<b>-3.16%</b>									
<b>5.5 Financial net present value (FNPV/C) of the investment</b>	<b>-2058</b>									

Often for EU co-financed projects FNPV/C is a negative value. This is due to the negative net cash flow during the first years which, for the discounting procedure, weights more than the last positive years.

A discount rate of 5% has been applied to calculate these values

Tab. 2.6 Table for the Calculation of the Financial Internal Rate of Return of Capital -Thousands of Euro										
	Years									
	1	2	3	4	5	6	7	8	9	10
2.13 Sales	0	1501	5701	7501	7501	8501	8501	8501	8501	0
1.19 Residual value	0	0	0	0	0	0	0	0	0	1500
<b>6.1 Total revenues</b>	<b>0</b>	<b>1501</b>	<b>5701</b>	<b>7501</b>	<b>7501</b>	<b>8501</b>	<b>8501</b>	<b>8501</b>	<b>8501</b>	<b>1500</b>
2.9 Total operating costs	0	2022	7252	7476	7476	7476	7476	7476	7476	0
4.2 Interests	0	0	8	8	8	8	8	8	8	0
4.3 Retirement bonus	0	0	0	0	0	0	0	0	0	197
4.4 Loans reimbursement	0	62	78	83	95	95	95	95	95	0
3.1 Private equity	100	200	100	0	0	0	0	0	0	0
3.5 Total national public contribution	400	200	100	0	0	0	0	0	0	0
<b>6.2 Total expenditures</b>	<b>500</b>	<b>2574</b>	<b>7538</b>	<b>7567</b>	<b>7579</b>	<b>7579</b>	<b>7579</b>	<b>7579</b>	<b>7579</b>	<b>197</b>
<b>6.3 Net cash flow</b>	<b>-500</b>	<b>-1073</b>	<b>-1837</b>	<b>-66</b>	<b>-78</b>	<b>922</b>	<b>922</b>	<b>922</b>	<b>922</b>	<b>1303</b>
<b>6.4 Financial internal rate of return (FRR/K) of capital</b>	<b>6.22%</b>									
<b>6.5 Financial net present value (FNPV/K) of capital</b>	<b>209</b>									

Financial internal rate of return on invested capital (shareholders' equity) is calculated with the shareholder's equity of the member state (public and private) when it is paid up, the financial loans at the time they are paid back, in addition to operating costs and related interest, and revenues for the inflows. It does not consider the EU grant.



**Tab. 2.7 Time horizon (years) in the appraisal of a sample of 400 large projects '92-'94 and '94-'99 combined**

	Average time horizon	Number* of projects
Energy	24.7	9
Water and environment	29.1	47
Transport	26.6	127
Industry	8.8	96
Other services	14.2	10
Average total	20.1	289

The table is based on an ad hoc survey carried out in 1994 by a working team of the Evaluation Unit, DG XVI Regional Policy. It is not necessarily representative of the composition of the larger number of major projects co-financed by SF in the period 1989-93.

In 1996, the Evaluation Unit carried out a new survey of a sample of 200 major projects. In addition to the second generation of projects co-financed by the ERDF (1994-99), the analysis was extended to projects co-financed by the CF since its temporary establishment in 1993 (as the "Cohesion Financial Instrument"). Although CF projects generally carry an investment cost of at least 10 million ECU, for ease of comparison with projects co-financed by ERDF, only CF projects with a minimum investment cost of 25 million ECU were considered in the survey. Once again the new sample is not necessarily representative of the composition of the larger number of major projects co-financed by SF and CF in the period concerned.

(\*) Projects for which comparable data are available

trend of the project should be formulated for a period appropriate to its economically useful life and long enough to encompass its likely mid/long term impact.

The choice of time horizon may have an extremely important effect on the results of the appraisal process. More concretely, the choice of time horizon affects the calculation of the main indicators of the cost-benefit analysis, and may also affect the determination of the co-financing rate.

The maximum numbers of years for which forecasts are provided determine the time span of a project and are tied to the sector of the investment. For the majority of infrastructures, for example, this time horizon (indicatively) is at least 20 years; for productive investments, and again indicatively, it is about 10 years.

Nevertheless, the time horizon should not be so long as to exceed the economically useful life of the project.

This problem may be resolved by using a standard grid, differentiated by sector and based on some internationally accepted

practices, in which reference time horizons are provided, which can be applied to the type of investment being examined. An example is that provided in Tab. 2.8.

#### 2.4.2 Determining Total Costs

The data for the cost of a project are provided by the sum of costs of investment (land, buildings, licences, patents, Tab. 2.1) and operating costs (personnel, raw materials, supply of energy, Tab. 2.2).

The Application Forms for the Cohesion Fund and ISPA require the specification of the amounts of eligible costs and total costs. The difference between the two cost items derives mainly from:

1. land purchase expenditure
2. payment of VAT
3. expenses borne before the presentation of the application
4. related work or connected expenses.

The international methodology of financial analysis of the project on a cash flow basis suggests conducting the financial analysis and the calculation of investment returns using the total costs of the investment (Tab. 2.1) borne beginning on the date the application was presented (in other words, normally no cost borne before may be considered to determine the FRR or other indicators).

Nevertheless, in some cases, the Commission may allow for the inclusion of some expenses borne before the application in the total costs (see annex C on determining the co-financing rate).

In the calculation of operating costs (Tab. 2.2) in order to determine the financial

**Tab. 2.8 Average time horizon (years) recommended for the 2000-2006 period.**

Projects by sector	Average time horizon
Energy	25
Water and environment	30
Railways	30
Roads	25
Ports and airports	25
Telecommunications	15
Industry	10
Other services	15

Source: our elaboration of OECD and project data.

internal rate of return, all items that do not give rise to an effective monetary expenditure must be excluded, even if they are items normally included in company accounting (Balance Sheet and Profit and Loss Account). In particular, the following items are to be excluded, as they are not coherent with the DCF method:

- depreciation and amortisation, as they are not effective cash payments;
- any reserves for future replacement costs, in this case as well, they do not correspond to a real consumption of goods or services;
- any contingency reserves, because the uncertainty of future flows is taken into consideration in the risk analysis<sup>1</sup> and not through figurative costs (see further).

#### 2.4.3 Revenue Generated by the Project

Some projects may generate their own revenue from the sale of goods and services. This revenue will be determined by the forecasts of the quantities of services provided and by the relative prices and are entered in Tab. 2.2 for the financial analysis with operating revenue.

### BOX 2.3 Projects generating income

**Structural Funds Regulation, Art. 29 1260/99:** "Where the assistance concerned entails the financing of revenue-generating investments, the contribution from the Funds to these investments shall be determined in the light of their intrinsic characteristics, including the size of the gross self-financing margin which would normally be expected for the class of investments concerned in the light of the macro-economic circumstances in which the investments are to be implemented, and without there being any increase in the national budget effort as a result of the contribution by the Funds."

**Cohesion Fund Regulation, art.1 Reg. 1264/1999:** "this rate may be reduced to take account, in co-operation with the Member State concerned, of the estimated revenue generated by projects and of any application of the polluter-pays principle".

**ISPA Regulation, art. 6 Reg. 1267/1999:** "Save in the case of repayable assistance or when there is a substantial Community interest, the rate of assistance shall be reduced to take into account;

- the availability of co-financing
- the measure's capacity to generate revenues, and
- an appropriate application of the polluter-pays principle".

The following items are usually not to be included in the calculation of future revenues:

- Costs and benefits should be net of VAT. Other indirect taxes should be included only if they are charged to the investor.
- any other subsidies (transfers from other authorities, etc.);

In some cases (for example, for railways or aqueducts) the investor may be different than the body that will operate the infrastructure and may the latter pays a tariff (or similar) to the former. This tariff may not reflect full costs, contributing to the creation of a financing gap.

The revenues to consider for the financial analysis are usually those that accrue to the owner of the infrastructure.

Nevertheless, on a case by case basis, the Commission may also ask for a consolidated financial analysis for both parties.

#### 2.4.4 Residual Value of the Investment

Among the revenue items at the final year considered, there is the residual value of the investment (e.g., standing debt, standing assets, such as buildings and machinery, etc.), which represents the residual value item in Tab. 2.1, taking into account investment items. In this table all items are investment costs (outflows) and the residual value must be included with the opposite sign (negative if the others are positive) because it is an inflow. In the next table (financial sustainability or calculation of FRR/K) it is considered with a positive sign because it is included in the revenues.

The residual value is considered in the sustainability table only if it corresponds to a real inflow for the investor.

It is always considered for the calculation of FRR/C and FRR/K.

<sup>1</sup>In fact risk analysis (as shown in section 2.7 and annex D) considers probability distribution of uncertain variables and deals with their expected values. Obviously there may be some variables for which no probability distribution is available: this will be the case for untreatable uncertainty that cannot be included in any reserve. A small flow of expenditure for unexpected events could be however treated as a flow of maintenance cost.

Residual value may be calculated in two ways:

- by considering the residual market value of fixed capital, as if it were to be sold at the end of the time horizon considered;
- the residual value of all assets and liabilities.

The discounted value of every net future receipt after the time horizon should be included in the residual value. In other words, the residual value is the liquidation value.

### 2.4.5 Adjusting for inflation

In project analysis, it is customary to use constant prices, that is to say prices adjusted for inflation and fixed at a base-year. However, in the analysis of financial flows, current prices may be more appropriate; these are nominal prices effectively observed year by year. The effect of inflation, or rather the general increase in the price index, or oscillations in relative prices, may impact on the calculation of the financial return of the investment. Therefore, the use of current prices is in general recommended.

On the contrary, if constant prices are used, corrections must be entered for changes in the relative prices when these changes are significant.

### 2.4.6 Financial Sustainability (Tab. 2.4)

The financial plan should demonstrate **financial sustainability**, which is that the project does not run the risk of running out of money; the timing of fund receipts and payments may be crucial in implementing the project. Applicants should show how in the project time horizon, sources of financing (including receipts and any kind of cash transfers) will consistently match disbursements year by year. Sustainability occurs if the net flow of cumulated generated cash flow row is positive for all the years considered.

### 2.4.7 Determining the Discount Rate

To discount financial flows to the present and to calculate of net present value (NPV, Tab.s 2.5 and 2.6), the suitable **discount rate** must be defined.

There are many theoretical and practical ways of estimating the reference rate to use to discount of the financial analysis. See annex B for an in-depth analysis.

#### Discount Rate

**Discount rate.** The rate at which future values are discounted to the present. Usually considered roughly equal to the opportunity cost of capital.

1 euro invested at an annual discount rate of 5% will be 1+ 5%=1.05 after one year; (1.05)x(1.05)=1.1025 after two years; (1.05)x(1.05)x(1.05)=1.157625 after three years, etc. The discounted economic value of an euro that will be spent or earned in two years is 1/1.1025= 0.907029; in three years 1/1.157625=0.863838. The latter is the inverse operation of that shown above.

The key concept is that of the opportunity cost of capital. In this regard, we recommend determining the discount rate by applying a standard criterion, taking accounts of some benchmarks. Indicatively, for the period 2000-2006, a 6% real rate may be considered the reference parameter for the opportunity cost of capital in the long term (see annex A).

### 2.4.8 Determination of performance indicators.

The indicators used for financial analysis (Tables 2.5 and 2.6) are:

- the financial internal rate of return;
- the financial net present value of the project.

Both of these indicators are to be calculated both for the investment (Tab. 2.5) and for the invested capital (Tab. 2.6).

**Tab. 2.9. Expected financial internal rates of return of a sample of 400 major projects of the 'first generation' and 'second generation' combined.**

	Average	Number* of projects
Energy	7.0	6
Water and environment	-0.1	15
Transport	6.5	55
Industry	19.0	68
Other services	4.2	5
Total	11.5	149

Source: see Tab. 2.7  
 (\*) Projects for which data were available  
 The financial rate of return here considered is FRR/C.

value of these indicators by applying the appropriate financial function.

For productive investments, such as industrial plants, financial rates of return before the EU grant are usually well over 10% (real). For infrastructure, financial rates of return are usually lower or even negative, partly because of the tariff structure of these sectors.

Usually the examiner uses the financial rate of return in order to judge the future performance of the investment. It could also contribute to deciding the co-financing rate (see also annex C).

In any case the Commission should be aware of the net financial burden of the project and should be sure that the project, even if assisted by co-financing, does not risk being stopped by lack of cash.

A very low or even negative financial rate of return does not necessarily mean that the project is not in keeping with the objectives of the Funds.

Nevertheless, the rate of returns value lets it be known that the investment may not ever be profitable from the financial standpoint. In this case, the proposer should specify what, if any, resources the project will draw on when the EU subsidy diminishes.

The financial net present value is defined as:

$$NPV(S) = \sum_{t=0}^n a_t S_t = \frac{S_0}{(1+i)^0} + \frac{S_1}{(1+i)^1} + \frac{S_n}{(1+i)^n}$$

where  $S_n$  is the balance of cash flow funds at time n (net cash flow, row 5.3 and 6.3 of Tables 2.5 and 2.6) and  $a_t$  is the financial discount factor chosen for discounting (see also point 6 and the discount factors table).

The financial internal rate of return is defined as the interest rate that zeros out the net present value of the investment:

$$NPV(S) = \sum_{t=0}^n S_t / (1+FRR)^t = 0$$

All the most commonly used data management software automatically calculates the

## BOX 2.4 Co-financing Rate

• Art. 29.3 Structural Funds Regulation 1260/99. A maximum of 75% of the total eligible cost and, as a general rule, at least 50% of eligible public expenditure in the case of measures carried out in the regions covered by Objective 1. Where the regions are located in a Member State covered by the Cohesion Fund, the Community contribution may rise, in exceptional and duly justified cases, to a maximum of 80% of the total eligible cost and to a maximum of 85% of the total eligible cost for the outermost regions and for the outlying Greek islands which are under a handicap due to their distant location; (b) a maximum of 50% of the total eligible cost and, as a general rule, at least 25% of eligible public expenditure in the case of measures carried out in areas covered

by Objective 2 or 3. In the case of investment in firms, the contribution of the Funds shall comply with the ceilings on the rate of aid and on combinations of aid set in the field of State aids";

• Cohesion Fund Reg., art.1 §7 Reg. 1264/1999 and art. 7 reg. 1164/94. "The rate of Community assistance granted by the Fund shall be 80 % to 85 % of public or equivalent expenditure, including expenditure by bodies whose activities are undertaken within an administrative or legal framework by virtue of which they may be deemed to be equivalent to public bodies. However from 1 January 2000 this rate may be reduced to take account, in co-operation with the Member State concerned, of the estimated

revenue generated by projects and of any application of the polluter-pays principle".

• ISPA Regulation, art. 6 Reg. 1267/1999. "The rate of community assistance granted under ISPA may be up to 75% of public or equivalent expenditure, including expenditure by bodies whose activities are undertaken within an administrative or legal framework by virtue of which they are regarded as equivalent to public bodies. The Commission may decide, in accordance with the procedure laid down in Article 14, to increase this rate to up to 85%, in particular where it considers that a rate higher than 75% is required for realising projects essential for achieving the general objectives of ISPA".

**Discount Factors Table**

Years	1	2	3	4	5	6	7	8	9	10
(1+5%) <sup>-n</sup>	.952 381	.907 029	.863 838	.822 702	.783 526	.746 215	.710 681	.676 839	.644 609	.613 913
(1+10%) <sup>-n</sup>	.909 091	.826 446	.751 315	.683 013	.620 921	.564 474	.513 158	.466 507	.424 098	.385 543

n: number of years

**2.4.9 Determination of the co-financing Rate**

The co-financing rate (see also annex C) is the percentage that defines how much of the eligible costs are covered by EU financing by grants.

Regulations define the maximum ceiling to apply for each Fund and establish the general principles for the formulation of the percentage. Generally by area of implementation (higher percentages in more disadvantaged areas) and, more specifically, by the co-existence of more funds in the same area. See also box 2.4, *Co-financing Rate*.

Currently, the procedure set forth by the Commission provides for the calculation of the financing gap, through which the co-financing rate to apply to eligible costs is determined. For details on the recommendations proposed for the co-financing rate calculation, refer to annex C.

**2.5 Economic Analysis**

The economic analysis appraises the project contribution to the economic welfare of the region or country. It is made on behalf of the whole society (region or country) instead of just the owner of the infrastructure like in the financial analysis.

Moving on from Tab. 2.5 of the financial analysis (the performance of the investment regardless of its financial sources), the economic analysis, by mean of the definition of appropriate conversion factors for each of the inflow or outflow items, outlines a table (Tab. 2.10) which includes benefits and social costs not considered by the financial analysis. The logic of methodology allowing the transfer from financial to economic analysis is summarised in fig. 2.3 It consists of the transformation of market prices used in the financial analysis into accounting prices (that amend prices distorted by market imperfections) and of the consideration of externalities leading to benefits and social

costs unconsidered by the financial analysis as they do not generate actual money expenditures or income (for example environmental impacts or redistributive effects). This becomes possible by attribution to each of the inflow or outflow items of an *ad-hoc* conversion factor (see below) to change market prices into accounting prices.

International practice has assumed standardised factors for some input/output classes, others require specific factors to be defined case by case.

The economic analysis, therefore, is represented by:

Phase 1: **taxes/subsidies and other transfers** corrections;

Phase 2: **externalities** corrections;

Phase 3: **conversion** of market prices into accounting prices to include also social costs and benefits (determination of conversion factors).

Once the table for the economic analysis is ready, like in the financial analysis the first step is the **discounting** made by the selection of a correct social discount rate and the calculation of the **internal economic rate of return** of the investment.

**2.5.1 Phase 1 - Fiscal corrections**

This phase leads to the determination of two new elements for the economic analysis: the value of the row 'fiscal correction' (Tab. 2.10) and the value of the conversion factor for market prices affected by fiscal aspects.

Market prices include taxes and subsidies, and some transfer payments, which may affect relative prices. While in some cases it would be difficult to estimate net-of-tax prices, some rough, general rules can be laid down to correct such distortions:

- prices of inputs and outputs to be considered for CBA should be net of VAT and of other indirect taxes;

**Tab. 2.5 Calculation of the Financial Internal Rate of Return of the Investment -Thousands of Euro**

	Years									
	1	2	3	4	5	6	7	8	9	10
2.13 Sales	0	1501	5701	7501	7501	8501	8501	8501	8501	0
<b>5.1 Total revenues</b>	<b>0</b>	<b>1501</b>	<b>5701</b>	<b>7501</b>	<b>7501</b>	<b>8501</b>	<b>8501</b>	<b>8501</b>	<b>8501</b>	<b>0</b>
2.9 Total operating costs	0	2022	7252	7476	7476	7476	7476	7476	7476	0
4.3 Retirement bonus	0	0	0	0	0	0	0	0	0	197
1.21 Total investment costs	1186	1088	1590	80	400	0	91	0	0	-1500
<b>5.2 Total expenditures</b>	<b>1186</b>	<b>3110</b>	<b>8842</b>	<b>7556</b>	<b>7876</b>	<b>7476</b>	<b>7567</b>	<b>7476</b>	<b>7476</b>	<b>-1303</b>
<b>5.3 Net cash flow</b>	<b>-1186</b>	<b>-1609</b>	<b>-3141</b>	<b>-55</b>	<b>-375</b>	<b>1025</b>	<b>934</b>	<b>1025</b>	<b>1025</b>	<b>1303</b>
<b>5.4 Financial internal rate of return (FRR/C) of the investment</b>	<b>-3.16%</b>									
<b>5.5 Financial net present value (FNPV/C) of the investment</b>	<b>-2058</b>									

(1) Phase 1. Fiscal correction. It is necessary to deduct from the flows of financial analysis, payments that have no real resources counterpart, as for subsidies and indirect taxes on input and output. For direct public transfers they are already not included in the starting table for financial analysis which considers investment costs and not financial resources (Tab. 2.5).

In the present example there are no fiscal corrections. It means that no transfers, subsidies or any other fiscal correction have been included in the financial analysis.

**Tab. 2.10 Calculation of the Economic Internal Rate of Return of the Investment -Thousands of Euro**

	cf (3)	Years									
		1	2	3	4	5	6	7	8	9	10
<b>(1) Fiscal correction</b>											
Time saving		42	42	42	42	42	42	42	42	42	
Income from increased tourist flow		78	78	78	78	78	78	78	78	78	
<b>(2) Total external benefits</b>	<b>0</b>	<b>120</b>	<b>120</b>	<b>120</b>	<b>120</b>	<b>120</b>	<b>120</b>	<b>120</b>	<b>120</b>	<b>120</b>	<b>0</b>
2.13 Sales	1.1	0	1651	6271	8251	8251	9351	9351	9351	9351	0
<b>10.1 Total revenues</b>	<b>0</b>	<b>1651</b>	<b>6271</b>	<b>8251</b>	<b>8251</b>	<b>9351</b>	<b>9351</b>	<b>9351</b>	<b>9351</b>	<b>9351</b>	<b>0</b>
Increased pollution		572	572	632	632	632	632	632	632	632	
<b>(2) External costs</b>	<b>0</b>	<b>572</b>	<b>572</b>	<b>632</b>	<b>632</b>	<b>632</b>	<b>632</b>	<b>632</b>	<b>632</b>	<b>632</b>	<b>0</b>
2.9 Total operating costs	0.9	0	1820	6527	6728	6728	6728	6728	6728	6728	0
4.2 Retirement bonus	1.2	0	0	0	0	0	0	0	0	0	236
1.21 Total investment costs	0.9	1067	979	1431	72	180	0	89	0	0	-1350
<b>10.2 Total expenditures</b>	<b>1067</b>	<b>2799</b>	<b>7958</b>	<b>6800</b>	<b>6908</b>	<b>6728</b>	<b>6810</b>	<b>6728</b>	<b>6728</b>	<b>6728</b>	<b>-1114</b>
<b>10.3 Net cash flow</b>	<b>-1067</b>	<b>-1600</b>	<b>-2139</b>	<b>938</b>	<b>830</b>	<b>2111</b>	<b>2029</b>	<b>2111</b>	<b>2111</b>	<b>2111</b>	<b>1114</b>
<b>10.4 Economic internal rate of return (ERR) of investment</b>	<b>19.20%</b>										
<b>10.5 Economic net present value (ENPV) of investment</b>	<b>3598</b>										

(2) Phase 2. Externalities correction. It is necessary to include in outflows and inflows also external costs and benefits for which there is no cash flow. Some examples could be costs for health services or losses in fisheries due to increased pollution, time saved by investment in transports, specific infrastructures supplied by public sector for the project (a road built specifically for the project...) increased touristic flows, increased accessibility of the region...

(3) Phase 3. From market to accounting prices. It is necessary to determine a vector of conversion factors.



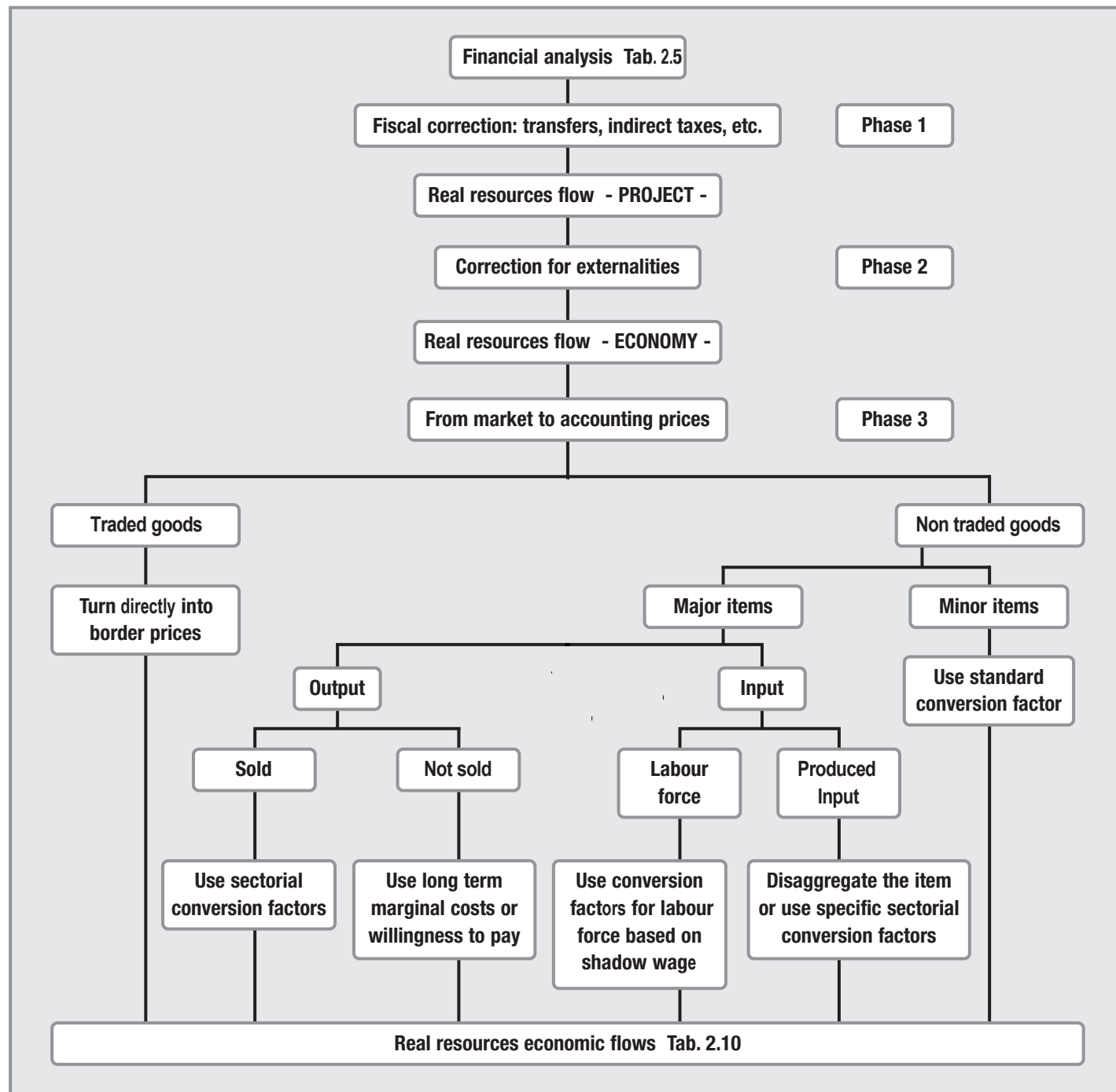


Fig. 2.3 Structure of economic analysis. Source: our adaptation from: Saerbeck, Economic appraisal of projects. Guidelines for a simplified cost benefit analysis. [1990].

- prices of inputs to be considered in the CBA should be gross of direct taxes;
- pure transfer payments to individuals, such as social security payments, should be omitted;
- in some cases indirect taxes/subsidies are intended as correction of externalities. Typical examples are taxes on energy prices to discourage negative environmental

externalities. In this case, and in similar ones, the inclusion of these taxes in project costs may be justified, but the appraisal should avoid double counting (e.g. including both energy taxation and estimates of external environmental costs in the appraisal). Obviously, the treatment of taxation should be less accurate whenever it has minor

**Examples of social external benefits**

- advantages in terms of reduction of risk of accidents in a congested area;
- savings in transport time in an interconnected network;
- increase of life expectancy from better health facilities or from reduction of pollutants.

**Examples of social external costs**

- loss of agricultural product because of different use of land;
- additional net costs for local authorities to connect a new plant to existing transport infrastructure;
- increase in sewage costs.

compensation, should be accounted for in CBA in addition to its financial costs.

The project examiner should check that these kinds of costs have been identified, quantified and given a realistic monetary value, if possible. If this is difficult or impossible this costs and benefits should be quantified at least in physical terms for a qualitative appraisal.

Many large projects, particularly in infrastructure, may be beneficial to subjects outside those appropriating directly the social income generated by the project.

importance in project appraisal, but overall consistency is required.

**2.5.2 Phase 2 - Externalities corrections**

The objective of this phase is to determine external benefits or external costs as one or more rows in Tab. 2.10, not considered in the financial analysis. Examples are costs and benefits coming from environmental impacts, the time saved by projects in the transport sector, human lives saved by projects in the health sector and so on.

These benefits may accrue not only to the direct users of the product but also to third parties for whom they were not intended. In this case, they must also be accounted for by appropriate evaluation. Examples of such positive externalities or beneficial spillovers towards other consumers are the following:

- a railway may reduce traffic congestion on a highway;
- a new university may sustain applied research and the future income of employers will be increased by a better-educated work force, etc.

Sometimes valuing external costs and benefits will be difficult, even though they may be easily identified. A project may cause some ecological damage, whose effects, combined with other factors, will take place in the long run, and are difficult to quantify and value.

Externalities should be given a monetary value, if possible. If not, they should be quantified by non-monetary indicators.

It is worthwhile to at least list the unquantifiable externalities, in order to give the decision-maker more elements to make a decision, by weighing up the quantifiable aspects, as expressed in the economic rate of return, against the unquantifiable ones (see multicriteria analysis below).

As a general rule any social cost or benefit that spills over from the project towards other subjects without

**Examples of environmental impacts**

- the environmental costs of a highway may be approximated by the potential loss of value of properties near it because of increased noise and emissions, worsened landscape;
- the environmental costs of a large polluting plant, e.g. an oil refinery, may be estimated by the potential increase in health expenditure among the residents and workers.

**Environmental impacts**

In the context of project analysis, the environmental impact should be properly described and appraised, possibly with recourse to state of the art qualitative-quantitative methods. Multicriteria analysis is often useful in this framework. A discussion of the assessment of environmental impact goes beyond the scope of this Guide, but CBA and environmental impact analysis



raise similar issues. They should be considered in parallel and, whenever possible should be integrated: this would imply giving, if possible, a conventional accounting value to environmental costs. These may be very crude estimates: however they may capture at least the most relevant environmental costs.

For a more detailed discussion on methodologies for the monetisation of environmental impacts see annex E.

### Accounting value of public sector owned capital assets

Many projects in the public sector use capital assets and land, which may be state-owned or purchased from the general Government budget.

Capital assets, including land, buildings, machinery and natural resources should be valued at their opportunity cost and not at their historical or official accounting value. This has to be done whenever there are alternative options in the use of an asset, and even if it is already owned by the public sector.

If there is no related option value<sup>4</sup>, past expenditures or irrevocable commitments of public funds are not social costs to be considered in the appraisal of new projects.

### 2.5.3 Phase 3 - From market to accounting prices.

The objective of this phase is to determine the column of conversion factors for the transformation of market prices into accounting prices.

Project examiners should check if the projects proposer has considered **social costs and benefits** of the project in addition to financial costs and benefits.

This could happen besides the fiscal or externality influence when:

- real **prices** of inputs and outputs are distorted because of an imperfect market;
- **wages** are not related to labour productivity.

### Price distortion of inputs and outputs.

Current prices of inputs and outputs cannot reflect their social value because of market distortions, such as monopoly regime, trade barriers, etc. Current prices as they emerge from imperfect markets and from public sector pricing policies, may fail to reflect the opportunity cost of inputs. In some cases this may be important for the appraisal of projects, and financial data may thus be misleading as welfare indicators.

In some cases prices are regulated by States so as to compensate for perceived market failures and in ways that are consistent with their own policy objectives; e.g., when indirect taxation is used to correct externalities. But in other cases, actual prices are distorted because of legal constraints, historical reasons, incomplete information, or other market imperfections (for example tariffs for inputs such as energy, fuel).

Whenever some inputs are affected by strong price distortions, the proposer should consider the issue in the project appraisal and use accounting prices that may better reflect the social opportunity costs of the resources. The project examiner needs to carefully assess and consider how the social costs are affected by departures from the following price structures:

- **marginal cost** for internationally non-tradable goods, such as local transport services;

### Examples of price distortion

- a land intensive project, e.g. an industrial site, where land is made available free of charge by a public body, while it may otherwise earn a rent;
- an agricultural project that depends upon water supply at a very low tariff, heavily subsidised by the public sector;
- an energy intensive project which depends upon the supply of electricity under a regime of regulated tariffs, when these tariffs are different from long run marginal costs.
- a power plant under monopoly regime, which determines a substantial price divergence of electricity prices from long-term marginal costs: in this case economic benefit could be less than financial benefit.

### Example for the calculation of the standard conversion factor for price distortion of inputs and outputs.

a) For every traded item border prices are easily available (there are international prices, CIF for imports and FOB for exports, expressed in the local currency).

b) For non-traded items, equivalent international prices should be determined. The standard conversion factor is used for minor non-traded items, while for major non-traded items specific conversion factors are used.

For an example of data for the estimate of the standard conversion factor (millions euro):

1) total imports (M)	M = 2000
2) total exports (X)	X = 1500
3) import taxes (Tm)	Tm = 900
4) export taxes (Tx)	Tx = 25

The formula to be used for the calculation of the Standard Conversion Factor is (SCF):

$$SCF = (M + X) / (M + Tm) + (X - Tx)$$

$$SCF = 0,8.$$

c) Land: government provides the land at a reduced price of 50% compared with market prices. So the market price is double the current one. The selling price should be doubled to reflect the domestic market, and, as there is no specific conversion factor the conversion factor to turn market price into border price is the standard conversion factor. Conversion factor for land is: Conversion Factor =  $2 * 0,8 = 1,60$ .

d) Building: the total cost is made by 30% of non-skilled workforce (cf of non-skilled workforce is 0,48), 40% of imported material cost with import tariffs of 23% and selling taxes of 10% (cf 0,75), 20% of local materials (SCF =

0,8), 10% of profits (cf=0). Conversion factor is:  $(0,3*0,48)+(0,4*0,75)+(0,2*0,8)+(0,1*0)=0,60$ .

e) Machinery: imported without taxes and tariffs (cf=1).

f) Stock of raw material: only one traded material is supposed to be used; the item is not subject to taxes and the market price is equal to the FOB price. cf=1.

g) Output: the project produces two outputs: A, imported and B, a non-traded intermediate item. To protect domestic firms the government has imposed an import tax of 33% on item A. The CF for A is  $100/133=0,75$ . For item B, as there is no specific conversion factor, SCF=0,8.

h) raw materials = cf=1.

i) intermediate inputs are imported without tariffs and taxes. cf=1.

j) Electricity: there is a tariff that covers only 40% of the marginal supply cost of electricity. There is no disaggregation of cost components and it is assumed that the difference between international and domestic prices for each cost component used to produce a marginal unit of electricity is equal to the difference between all traded items considered in the SCF.  $cf = 1/0,4 * 0,8 = 2$ .

k) Skilled labour force: the market is not distorted. Market wage reflects the opportunity cost for the economy.

l) Unskilled labour force: supply exceeds demand but there is a minimum wage of 5 euro per hour. Nevertheless in the sector the last employed workers come from, the rural sector, the wage is only 3 euro per hour. Only 60% of unskilled labour force reflect its opportunity costs.

- **border price** for internationally tradable goods, such as agricultural or manufactured goods.

In fact, there are often good economic arguments for using border prices and/or marginal costs as accounting prices, when actual prices are deemed to diverge widely from social opportunity costs. However this general rule may be checked under the circumstances of the specific project under examination.

### Wage distortion

In some cases, a crucial input of investment projects, particularly of infrastructure, is labour. Current wages may be a distorted social indicator of the opportunity cost of labour because labour markets are imperfect.

The proposer, in such cases, may resort to a correction of nominal wages and to the use of an accounting wage (shadow wages).

While the Commission does not recommend a specific accounting wage formula, the proposer needs to be prudent and consistent in his own appraisal of labour social costs. Additional employment is, in the first instance, a social cost. It is the use by the project of labour resources that become thus unavailable for alternative social purposes. The relevant benefit is the additional income generated by job creation, and this is accounted for by the valuation of direct and indirect net output resulting from the project.

<sup>4</sup>Option value for public goods is the possibility to use that good for an alternative use. Nevertheless for some goods there may be no alternative use (a building used for a museum which is not usable for anything else...). In that case money spent for it is not social costs.

It is important to understand that there may be two different, mutually exclusive ways to estimate the social benefit of additional employment:

- as already said, one can use an accounting wage inferior to the actual wage paid by the project. This is one way to take into account the fact that, under conditions of unemployment, actual wages are higher than the opportunity cost of labour. By reducing labour costs, this accounting procedure increases the social net present value of the project income in comparison with its private value;
- alternatively, one can try to estimate the income multiplier of output, and the social income of the project will again be more than its private income because of this positive external impact.

Both methods, either subtracting a fraction of labour costs, or adding up some addi-

### Wage distortion

- some people, particularly in public sector employment, may receive wages above or below their counterparts in the private sector for similar work;
- in the private sector, costs of labour for the private company may be less than the social opportunity cost because the State gives special subsidies to employment in some areas;
- there may be legislation fixing a minimum legal wage, even if under heavy unemployment there may be people willing to work for less.

tional output, have their drawbacks and limitations, but under appropriate conditions they are equivalent.

The income multiplier method is best applied at macro-economic level or for very big investment program. Usually it is advisable to use shadow wages where effective wages are cut proportionally to the extent of unemployment. In any case:

- the two methodologies cannot be used simultaneously (double counting!)
- if an investment project already has a satisfactory internal rate of return before corrections for employment, it is not necessary to spend much time and effort on this kind of calculation.

However, it is important to consider that in some cases the employment impact of a project may need a vary careful consideration:

- it is sometimes important to check for employment losses in other sectors as a consequence of the project: gross employment benefits may overestimate the net impact
- sometimes the project is said to maintain jobs that otherwise would be lost: this may be particularly relevant for renovation and modernisation of existing plants: this kind of argument should be supported by an analysis of cost structure and competitiveness with and without the project

### Accounting wage or shadow wage.

The highest possible remuneration the labour employed in the project could have earned elsewhere. Because of minimum wage laws, regulations and other rigidities, wages actually paid may not be a correct measure of the real opportunity cost of labour. In an economy marked by extensive unemployment or underemployment, the opportunity cost of labour used in the project may be less than actual wage rates.

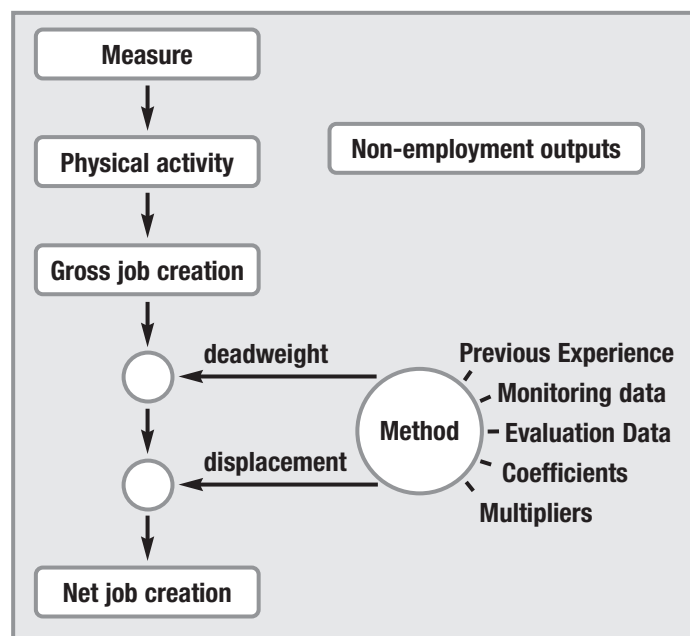


Fig. 2.4 Employment effects.

Source: "Counting the jobs. How to evaluate the employment effects of Structural Funds Interventions", European Commission, Directorate General XVI Regional Policy and Cohesion, Co-ordination and evaluation of operations.

Tab. 2.11 Expected economic internal rates of return of a sample of 400 major projects of the 'first generation' and 'second generation' combined

	Average rate	Number of projects*
Energy	12.9	6
Water and environment	15.8	51
Transport	17.1	152
Industry	18.4	14
Other services	16.3	10
Total	16.8	233

(\*) Projects for which data was available.

- some objectives of the Structural Funds are concerned with particular employment targets (e.g. youth, long term unemployed) and it may be important to consider the different impacts by target groups.

### 2.5.4 Discounting

Costs and benefits occurring at different time must be discounted. The discounting process is undertaken, as for the financial analysis, after the determination of the table for the economic analysis.

The discount rate in the economic analysis of investment projects – the social discount rate - attempts to reflect the social view on how future benefits and cost should be valued against present ones. It may differ from the financial discount rate when the capital market is imperfect (which is always the case in reality).

Theoretical literature and international practice shows a wide range of approaches in interpreting and choosing the value of the social discount rate to be adopted. The international experience is very wide and has involved different countries as well as international organisations. However a 5% European social discount rate may have different justifications, and may provide a standard benchmark for EU co-financed projects. But project proposers may wish to justify a different value.

For a more detailed discussion about the social discount rate see annex B.

### 2.5.5 The calculation of the economic rate of return

After the correction of price distortion it is possible to calculate the economic internal rate of return (ERR).

After the choice of an appropriate social discount rate it is possible to calculate the economic net present value (ENPV) and the B/C ratio.

The difference between ERR and FRR is that the former uses accounting prices or the opportunity cost of goods and services instead of imperfect market prices, and it includes as far as possible any social and environmental externalities. Because externalities and shadow prices are now considered, most projects with low or negative FRR/C will now show positive ERR.

Every project with an ERR less than 5% or a negative ENPV after the actualisation and with a discount rate of 5% should be carefully appraised or even rejected. The same applies with a B/C ratio less than 1.

In some exceptional cases a negative ENPV could be accepted if there are important non-monetized benefits, but these must be presented in detail because such a project will contribute only marginally to the objectives of EU regional development policy.

In any case the appraisal report should specify in a convincing way, through a structured argument supported by adequate data, that social benefits exceed social costs.

## 2.6 Multicriteria analysis

Multicriteria analysis considers simultaneously a variety of objectives in relation to the evaluated intervention. It facilitates consideration in the investment appraisal of policy maker's objectives that in some cases

could not be included in the financial and economic analysis eg. social equity, environmental protection, equal opportunities.

For many regional development projects equity is a relevant objective. If the project proposer wishes to assign a specific weight to equity objectives, the main information should be a forecast of distributive effects due to the project implementation and a discussion of the desirability of such effects in the context of regional policy. For example, if the project needs to modify tariffs in a public service it is probable that it will have some effect in terms of equity, the level of which should be analysed and appraised (i.e. through a presentation of the social categories that will pay some costs and the ones who will gain some benefits; 'winners and losers table'). See also annex F for the evaluation of distributional impact.

Another fundamental principle for the evaluation of EU projects is the Polluter Pays Principle which, according to regulations should be used for the modulation of the cofinancing rate. See the box 2.5, *Application of the polluter-pays principle*.

In these cases it is necessary to identify the effects of the investments on social objectives, assign a weight to each objective and calculate the final impact. For example let us consider three objectives such as consumption incentive, social equity and energy self-sufficiency. If a project causes a variation of 2% in consumption, of 1% in the equality index, of 3% in the energy self-sufficiency index, three weights to evaluate the relative importance of each objective

for the planning process need to be defined. For example let us suppose that the weights are chosen as to have the total amount of 1 (normalisation): 0.70 for consumption, 0.2 for redistribution, 0.1 for energy self-sufficiency. The total impact on the three objectives, given the public decision-maker, is easily measured (see for example tab. 2.12).

In general multicriteria analysis should be organised as follows:

1. Objectives should be expressed in measurable variables. They should not be redundant but could be alternative (the achievement of a bit more of one objective could partly preclude the achievement of the other);
2. Once the 'objectives vector' is built a technique should be found to aggregate information and to make a choice; the objectives should have a weight assigned reflecting the relative importance given to them by the Commission;
3. Definition of the appraisal criteria; these criteria could refer to the priorities pursued by the different subjects involved or they could refer to particular evaluation aspects (synergy degree with other interventions, using up of reserves capacity, implementing difficulties etc.);
4. Impact analysis; this activity consists in analysing, for each of the chosen criteria, the effects it produces. Results could be quantitative or qualitative (merit judgement);

5. Estimate of the effects of the intervention in terms of selected criteria; from the results coming from the previous stage (both in qualitative and in quantitative terms) a score is assigned;

6. Identification of the typology of subjects involved in the intervention and collection of respective preference function (weight) accorded to different criteria.

7. Scores aggregation of different criteria on the basis of revealed preferences. Single scores could be aggregated giving a numerical evaluation of the intervention comparable with other similar interventions.

In any case, the project examiner should verify if:

- forecasts for non-monetary aspects have been quantified in a realistic way in the ex-ante evaluation;
- there is an accurate non-monetary costs and benefits analysis if it is the case;
- additional criteria have a reasonable political weight as to determine significant changes in the financial and economic results.

Such a methodology is particularly effective when the monetisation of costs and benefits is difficult or even impossible. Let us suppose that a certain project shows, at a discount rate of 5%, a negative economic net present value of one million Euro. This means that the project examiner foresees a net social loss of the project in monetary terms. The project proposer could assess that, despite this, the project should be financed by the Funds because it has a 'very positive' environmental impact that it is not possible to monetize. The Commission could consider the environmental protection a merit good.

Therefore the project proposer should be asked to make an estimate of environmental benefits in physical terms. Let us suppose that this has been made and that the pro-

Tab. 2.12 Multicriteria analysis for two projects.

Project A	Scores*	Weight	Impact
Equity	2	0.6	1.2
Equal opportunity	1	0.2	0.2
Environmental protection	4	0.2	0.8
<b>Total</b>			<b>2.2: moderate impact</b>

Project B	Scores*	Weight	Impact
Equity	4	0.6	2.4
Equal opportunity	1	0.2	0.2
Environmental protection	2	0.2	0.2
<b>Total</b>			<b>2.8: relevant impact *</b>

(\*) 0: zero impact 1: scarce impact 2: moderate impact 3: relevant impact 4: very high impact

ject is supposed to cut the polluter Z emissions by 10% per year.

Now one should ask:

- a) is the forecast of the emission cut in physical terms reliable?
- b) is one million Euro an acceptable "price" for the reduction of 10% in the emission (how much is the implicit unitary cost of the reduction of emission)?
- c) is there any evidence that such a "price" of reduced emission is consistent with the weight that the government of the Member State or the Commission attaches to similar projects?

For instance, one may see whether -regularly or even occasionally- Member States have funded similar projects in order to obtain a similar cost/effectiveness ratio. Otherwise, if there is no evidence of consistency, one should enquire why this is proposed for the project under EU assistance.

One can substitute reduced emissions with many kinds of other non-monetary benefits and repeat the check, when appropriate. If the benefits are not just non-monetary, but also physically unmeasurable, there is no way of appraising the project.

One should be very careful with proposals where the analysis of non-monetary benefits is vague and merely qualitative.

## BOX 2.5 Application of the polluter-pays principle.

SF: Art. 29, par. 1 Reg. 1260/1999. "The contribution of the Funds shall be differentiated in the light of the following: (...) c) within the framework of the objectives of the Funds set out in Article 1, the importance attaching to the assistance and the priorities from the Community viewpoint, where appropriate, for the elimination of inequalities and the promotion of equality between men and women and for the protection and

improvement of the environment, principally through the application of the precautionary principle, of the principle of preventive action, and the polluter-pays principle".  
CF: Art. 7, par. 1 Reg. 1264/1999 "However, from 1 January 2000 this rate may be reduced to take account, in co-operation with the Member State concerned, of the estimated revenue generated by projects and of any application of the polluter-

pays principle".  
ISPA: Art. 6, par.2, Reg. 1267/1999: "Save in the case of repayable assistance or when there is a substantial Community interest, the rate of assistance shall be reduced to take into account: (a) the availability of co-financing; (b) the measure's capacity to generate revenues, and (c) an appropriate application of the polluter-pays principle".



For unquantifiable (or difficult to quantify) a qualitative analysis should be done as follows. A set of criteria relevant for the project appraisal (equity, environmental impact, equal opportunity) is collected in a matrix together with the impacts (measured with scores or percentage) of the project on the relevant criteria. An other matrix should collect the relative importance given to the considered criteria. Multiplying scores and weight the total impact of the project is given. In the example given in Tab. 2.12 project B has greater social impact, given preferences for the chosen social criteria.

- a second step will be the study of probability distributions of selected variables and the calculation of the expected value of the project performance indicators.

**2.7.2 Sensitivity analysis**

The purpose of the sensitivity analysis is to select the “critical” variables and parameters of the model, that is those whose variations, positive or negative, compared to the value used as the best estimate in the base case, have the greatest effect on the IRR or the NPV, that is they cause the most significant changes in these parameters. The criteria to be adopted for the choice of the critical variables vary according to the specific project and must be accurately evaluated case by case. As a general criterion we recommend considering those parameters for which a variation (positive or negative) of 1% gives rise to a corresponding variation of 1% (one percentage point) in IRR or 5% in the base value of the NPV.

The following points illustrate schematically the procedure that should be followed to conduct a sensitivity analysis.

**2.7 Sensitivity and risk**

**2.7.1 Forecasting uncertainties**

Risk analysis consists of studying the probability that a project will achieve a satisfying performance (in terms of IRR or NPV), as well as the variability of the result compared to the best estimate previously made.

The recommended procedure for assessing risks is based on:

- as a first step a sensitivity analysis, that is the impact that assumed changes in the variables determining costs and benefits are seen to have on the financial and economic indices calculated (IRR or NPV);
- a) Identify all the variables used to calculate the output and input of the financial and economic analyses, grouping them together in homogeneous categories. Table 2.13 may be of help.

Categories	Examples of variables
Parameters of the model	Discount rate
Price dynamics	Rate of inflation, growth rate of real salaries, energy prices, changes in prices of goods and services
Demand data	Population, demographic growth rate, specific consumption, sick rate, demand formation, volume of traffic, size of the area to be irrigated, market volumes of a given commodity
Investment costs	Duration of the building site (delays in realisation), hourly labour cost, hourly productivity, cost of land, cost of transport, cost of concrete aggregate, distance from the quarry, cost of rentals, depth of the wells, useful life of the equipment and manufactured goods
Operating prices	Prices of the goods and services used, hourly cost of personnel, price of electricity, gas, and other fuels
Quantitative parameters for the operating costs	Specific consumption of energy and other goods and services, number of people employed
Prices of revenues	Tariffs, sale prices of products, prices of semi-finished goods
Quantitative parameters for the revenues	Hourly (or other period) production of goods sold, volume of services provided, productivity, number of users, percentage of penetration of the area served, market penetration
Accounting prices (costs and benefits)	Coefficients for converting market prices, value of time, cost of hospitalisation, cost of deaths avoided, shadow prices of goods and services, valorisation of externalities
Quantitative parameters for costs and benefits	Sick rate avoided, size of area used, added value per hectare irrigated, incidence of energy produced or secondary raw materials used

Categories and parameters	Elasticity		
	High	Doubtful	Low
Model parameters	discount rate		
Price dynamics	rate of inflation	X	
	real rate of salaries		X
	change in energy prices		
	change in prices of goods and services		X
Demand data	specific consumption	X	
	rate of demographic growth		X
	volume of traffic	X	
Investment costs	hourly labour cost	X	

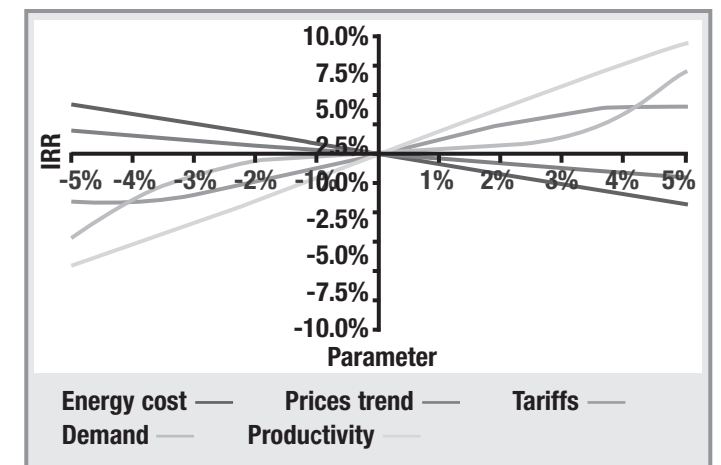
- b) Identify possible deterministically dependent variables, which would give rise to distortions in the results and double counts. If, for example, labour productivity and general productivity appear in the model, then the latter obviously includes the former. In this case it is necessary to eliminate the redundant variables, choosing the most significant, or to modify the model to eliminate internal dependencies. In conclusion the variables considered must be as far as possible independent variables.
- c) It is advisable to carry out a qualitative analysis of the impact of the variables in order to select those that have little or marginal elasticity. The subsequent quantitative analysis can be limited to the more significant variables, verifying them if doubts exist. By way of an example one can use Tab. 2.14. Furthermore the most important parameters for the risk analysis of each type of investment are indicated in the sector profiles.
- d) Having chosen the significant variables, one can then evaluate their elasticity by making the calculations, which are easier if one has a simple computer programme to calculate the IRR and/or NPV indices. Each time it is necessary to assign a new value (higher or lower) to each variable and recalculate the IRR or NPV, thus noting the differences (absolute and percentage) compared to the base case.

rantee that the elasticity of the variables will always be a linear function, it is advisable to verify this, repeating the calculations for different arbitrary deviations. In the example in the figure, the elasticity of the productivity parameter increases with the increase in absolute value of the deviation compared to the best estimate, while the demand value decreases; the elasticity of other variables is a linear function, at least in the range of changes explored.

- e) Identify the critical variables, applying the chosen criterion. Again with reference to the example in figure 2.5, according to the aforementioned general criterion, the critical variables are tariffs, demand and productivity.

**2.7.3 Scenario analysis**

The combined consideration of certain “optimistic” and “pessimistic” values of a group of variables could be useful to demonstrate different scenarios, within certain hypotheses. In order to define the optimistic and pessimistic scenarios it is necessary to choose for each critical variable



A possible result is shown in figure 2.5. Since, generally speaking, there is no gua-

Fig. 2.5 Sensitivity analysis



Tab. 2.15 Example of scenario analysis.

		Optimistic scenario	Baseline case	Pessimistic scenario
Inv. cost	Euro	125000	130000	150000
Traffic	%var	+2%	+5%	+9%
Tolls	Euro/unit	5	2	1
FRR/C		2%	-2%	-8%
FRR/K		12%	7%	2%
ERR		23%	15%	6%

the extreme values among the range defined by the probability distribution. Project performance indicators are then calculated for each hypothesis. In this case an exactly specified probability distribution is not needed.

Scenario analysis is not a substitute for sensitivity analysis or risk analysis, it is only a shortcut procedure.

**2.7.4 Risk probability analysis**

Once the critical variables have been identified, in order to conduct the risk analysis it is necessary to associate a probability distribution to each of them, defined in a precise range of values around the best estimate, used in the base case, in order to calculate the evaluation indices.

The probability distribution for each variable may be derived from different sources (see also annex D).

Having established the probability distribution of the critical variables, it is possible to proceed with the calculation of the probability distribution of the IRR or NPV of the project. Only in the simplest cases is it possible to calculate this by using analytical methods for calculating the probabilities composed of a number of independent events.

With the increasing complexity of the CBA model, even for few variables, very soon the number of combinations becomes too high for direct treatment. By way of an example, it should be noted that if there are only four variables, for each of which three values are considered (the best estimate and two deviations, one positive and one negative), then there are 81 possible combinations to be analysed.

Having said that, for investment projects it is possible to use the Montecarlo method, which can be applied using an appropriate calculation software. The method consists of the repeated random extraction of a set of values for the critical variables, taken within the respective defined intervals, and in calculating the performance indices for the project (IRR or NPV) resulting from each group of extracted values. Obviously care should be taken to ensure that the frequency the values of the variables conforms to the predetermined probability distribution. By repeating this procedure for a large enough number of extractions (generally not more than a few hundred) one can obtain a convergence of the calculation with the probability distribution of the IRR or NPV.

The most helpful way of presenting the result is to express it in terms of the probability distribution or cumulated probability of the IRR or the NPV in the resulting interval of values. Figures 2.6 and 2.7 provide graphic examples.

The cumulated probability curve (or a table of values) allows one to assign a degree of

risk to the project, for example verifying whether the cumulated probability is higher or lower than a reference value that is considered to be critical. One can also assess what the probabilities are that the IRR (or NPV) will be lower than a certain value which, also in this case, is adopted as the limit. In the case in the figure, for example, there is a probability of about 53% that the IRR will be less than 5%.

**It should be clear that a risky project is a project where the probability is high that it will not overcome a certain threshold of IRR. It is not a project where the IRR probability distribution has a great standard error.**

made between high risk projects with high social benefits, on the one hand, and low risk projects with low social benefits, on the other.

In order to evaluate the result one very important aspect is the compromise to be

There is sometime a priori reason to prefer neutrality to risk. However in some cases the evaluator or the proposer can deviate from neutrality and prefer to risk more or less for the expected rate of return: there must however be a clear definition of this choice.

**The operational role of sensitivity analysis is to identify critical variables, for which it is important to obtain further information. The operational role of risk analysis is to generate expected values of financial and economic performance indicators (e.g. FRR and ERR). For instance if a project has a FRR/K of 10% but also the probability analysis tells us that the FRR/K has a value between 4 and 10 with a probability of 70% and a value between 10 and 13 with a probability of 30%, then the expected value of FRR/K for that project is only 8.35 ((average (4;10)\*0.7)+(average(10;13)\*0.3)).**

To illustrate this concept one can consider innovative projects, which may be more risky than traditional ones. If, for example, these have only a 50% probability of achieving the expected results, then their net social value, for an investor who is neutral to risk, should therefore be halved. However innovation itself is an additional criterion of preference: in that case innovative projects must be evaluated by awarding a prize to well-deserving “innovation” and by not overlooking the risk.

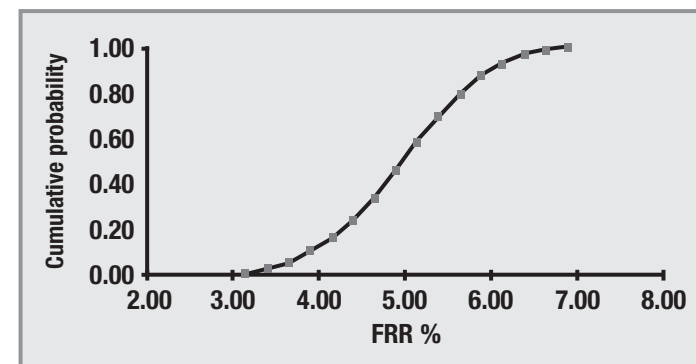
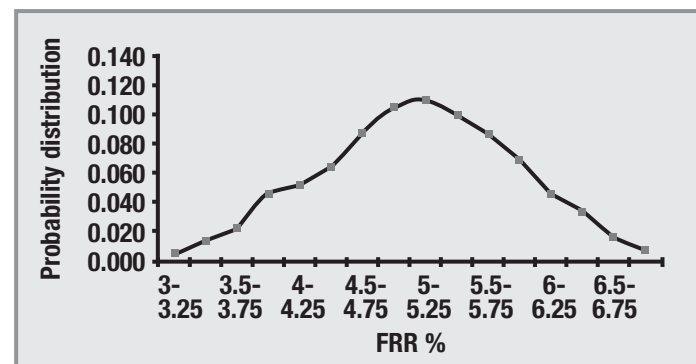


Fig. 2.6 Probability distribution for FRR.

Fig. 2.7 Cumulative probability distribution for FRR.

## Chapter Three

# Outlines of project analysis by sector

### Overview

This chapter extends the concepts expressed in the preceding sections, with reference to the main sectors supported by EU funds.

The outlines are of a schematic nature and not comprehensive. Their main purpose is to act as a guide for readers and writers of project proposals, showing, on the one hand, the established methods which should be the basis of a good appraisal and, on the other, areas of uncertainty that merit particular attention.

Obviously, all the general methodological elements mentioned in the previous chapter should also be taken into consideration. The following outline is valid for all sectors:

**Objectives definition:** it is necessary to consider the local nature of the objectives as well as the more general significance and impact;

**Project identification:** the functional and physical links of the project to the existing infrastructure system should always be clearly explained;

**Feasibility and options analysis:** comparison with the previous situation (without the project) and possible alternatives for satisfying the same demand should always be included;

**Financial analysis:** it should be conducted even if the services are totally free of charge and the financial rate of return is therefore negative. The analysis should measure the net cost to public finances and provide a significant comparison with similar investments;

**Economic analysis:** in addition to the ele-

ments derived from the financial analysis the evaluation of the main social costs and benefits should be included. Both for financial and economic analysis a comparison between the two situations with and without the investment should be conducted;

**Multicriteria and other evaluation criteria:** some indications on other evaluation criteria should be discussed, particularly in relation to on environmental impacts;

**Sensitivity and risk analysis:** uncertainty and risk about variables' trends are important points to be considered when appraising investment projects.

The outlines follow a common structure to facilitate the task of the user, and also to encourage standardisation in the procedures for analysis and reporting and to make communications smoother between proposers and appraisers.

In some cases, where possible, value ranges are given for the essential analysis variables, which have been taken from previous experience. These value ranges should be considered only a reference for the analyst and not as target values.

A more in-depth discussion is proposed for the following sectors:

1. Waste treatment;
2. Water supply, transport, distribution and treatment;
3. Transport.

In addition, a less detailed discussion is proposed for the following sectors:

4. Energy transport and distribution

5. Energy production
6. Ports, airports and infrastructure networks
7. Training infrastructure
8. Museums and archaeological parks
9. Hospitals
10. Forests and parks
11. Telecommunications infrastructure
12. Industrial estates and technological parks
13. Industries and other productive investments

## 3.1 Waste treatment

### Introduction

This section is focussed both on new investments and investment in renovation, modernisation or normalisation of waste management plants. Projects may refer to solid waste collecting and solid waste sorting plants, incinerators (with or without energy recovery), landfill or other waste disposal and waste removal plants.

Solid waste involved are:

- waste listed in the apposite directives (see Box 3.1, *Legislative framework*);
- waste enumerated in the European Catalogue of Waste (published in January 1994);
- other available national typologies of waste.

### 3.1.1 Objectives definition

Objectives are related to general criteria, as local and regional development and environmental management, but also involve specific aims in the short and long term, such as:

- the development of modern local and regional waste management sectors;
- the reduction of health risks linked to an uncontrolled management of municipal and industrial waste;
- the settle down in raw materials consumption and the closure of material production and consumption cycles;
- the reduction in pollutant emissions such as water and air pollutants;
- innovation in new technologies for collection and waste treatments.

### Main typologies of waste

- **Municipal Solid Waste** is waste collected by or on behalf of the Municipalities
- **Packaging Waste**
- **Hazardous waste** including industrial hazardous waste and household hazardous waste (batteries, oils, paints and out-of-date medicines)
- **Specific waste** such as oil waste, batteries and accumulators, end-of-life vehicles, electrical and electronic waste
- **Garden and Bulky Waste** from municipalities
- **Healthcare waste** mainly produced by hospitals
- **Ash and Slag from Combustion Processes and Fly ash** produced by waste treatment facilities
- **Mining waste**
- **Agricultural waste** included sludge

To highlight the general and specific objectives, the project should define carefully the following characteristics:

- population concerned by the project, tons of waste collected and treated by type of waste (hazardous waste, municipal waste, packaging waste...)
- type of technologies implemented (methods of treatment),
- economic impact on the local economy (in terms of employment and revenues),
- risks decrease due to the implementation of the waste management strategy,
- saving in raw material consumption, type of materials recovered and recycled,
- reduction in air, water and soil pollutants and type of environmental damages on soil and groundwater avoided, for example.

### 3.1.2 Project identification

#### Typology of the investment

The main types of waste management facilities are:

- investment in collecting and recycling waste facilities (with separate collection or not), such as municipal separate collection centre;
- compost production facilities;
- investment in facilities for physical and chemical treatment, such as oil waste treatment facilities;

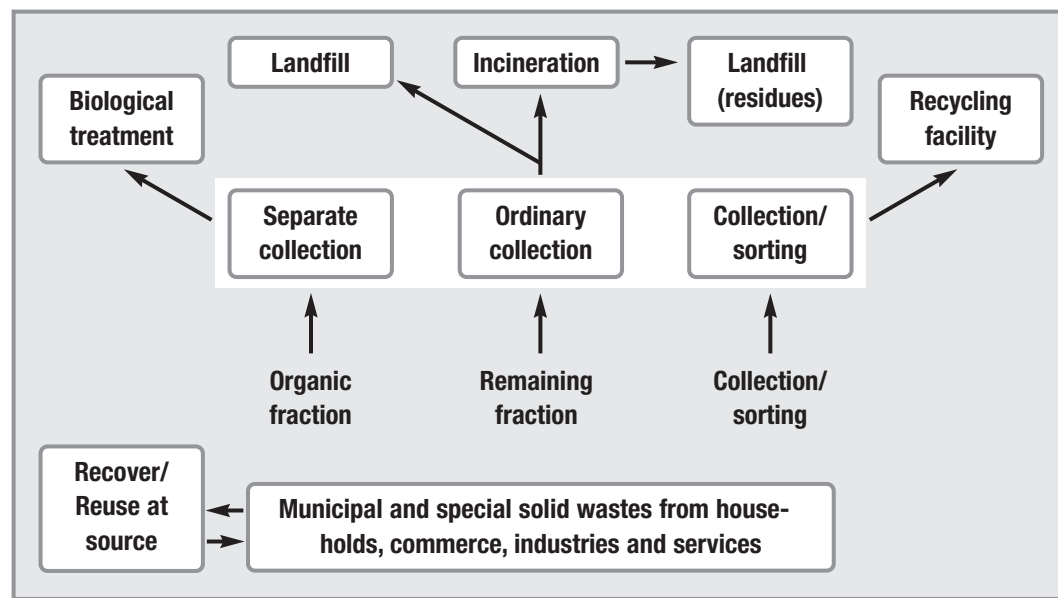


Fig. 3.1 Waste management systems from waste source to final disposal or removal

- household and industrial waste incineration plants and incinerators (with or without combined heat and power);
- landfill sites.

A map of the plant proposed should be attached to the project for a better comprehension of local economic and environmental impacts. Some information on the area concerned by the waste collection should also be included. In addition, details are needed on the origins of the waste: local, regional, national or country of origin (for waste imported from another European or non-European country).

#### Regulative framework

The selection of projects should pay attention to compliance with the general and specific legislation on waste management and with the principles which guide the EU's policy in the sector.

The European legislation and policy on waste are set out in some key directives, such as the Waste Framework Directive (75/442/EEC), the Hazardous Waste Directive (91/689/EEC) and the Regulation on waste shipments (259/93). Other numerous directives allow for management of particular waste and waste treatment methods.

The main principles are:

- The Polluter Pays Principle (PPP)<sup>6</sup>: The Polluter Pays Principle implies that those who cause environmental damage should bear the costs of avoiding it or compensating for it. Attention should be paid to the part of the total cost which is recovered through charges paid by polluters (the holder of waste).
- Waste Management Hierarchy: Waste management strategies must aim primarily to prevent the generation of waste and to reduce its harmfulness. Where this is not possible, waste materials should be reused, recycled, or used as a source of energy. As a final resort, waste should be disposed of safely (by incineration or in authorized landfill sites). In project analysis an option to prevent the generation of waste or to reuse and recycle should be systematically presented to compare the difference in costs between prevention, recycling and final disposal waste facilities. In any case, the choice of an incinerator or a landfill should be justified by the existence of very large costs occurring in waste prevention and recycling options.
- Proximity principle: Waste should be disposed of as close to the source as possible, at least with the objective

of self-sufficiency at Community level and if possible at Member State level. The project should detail the distance between the area of production of the waste and the localization of the plant and the related costs of transport. High transport costs or high distances should be justified by specifically, for example, on the basis of the nature of the waste or the type of technology used.

#### 3.1.3 Feasibility and options analysis

Some scenarios have to be set up to make possible the choice of the best option between different available alternatives. The potential scenarios are the following:

- a do-nothing scenario ("business as usual"), without investments;

- some available alternatives inside the present proposal;
- global alternatives to the project (for example the study of an incinerator as an alternative to a landfill, or a separate collection centre for recycling in the place of a final disposal plant).

In the "business as usual" scenario, the project will give the reasons for the choice of "doing something" instead of maintaining the status quo option. The arguments will focus on the economic, social and environmental benefits of the project and should emphasize the cost occurring for the status quo option in terms of economic costs, environmental and human health impacts.

In the second case, the project will expose the technical alternatives to the option selected. It could be for an incinerator, for example, the type of the furnace or the addition of a steam boiler for energy recovery.

Finally, for the global scenario the study will focus on the different methods for waste management in the context of the project. The project should distinguish one alternative focusing on the prevention, the reuse, the recycling or the recovery to be compared with the option chosen. The aim is to fulfill the hierarchy principles and initiate its concrete integration in waste management project analysis.

#### Analysis of the demand

The demand for waste recovery and disposal is a key element in the decision to build a waste treatment facility.

The estimation should be based on the following elements:

- the evaluation of the production by type of waste and by type of producer, in the geographical area of the project;
- present and expected changes in national and European norms in waste management.

The evaluation of the future demand for municipal waste management should take

### BOX 3.1 Legislative framework

#### Waste framework

- Framework Directive on Waste (Council Directive 75/422/EEC as amended by Council Directive 91/156/EEC)
- Hazardous Waste Directive (Council Directive 91/689/EEC as amended by Council Directive 94/31/EC)

#### Specific Waste

- Disposal of waste oils (Council Directive 75/439/EEC)
- Directives on waste from the titanium dioxide industry (Council Directive 94/62/EC)
- Batteries and accumulators containing certain dangerous substances (Council Directive 91/157/EEC)
- Packaging and packaging waste (Council Directive 94/62/EC)
- The disposal of PCB/PCV (Council Directive 96/59/EC)
- Protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture (Council Directive 86/278/EEC)

#### Processes and facilities

- Reduction of air pollution from existing municipal waste-incineration plants (Council Directive 89/429/EEC)
- Reduction of air pollution from new municipal waste-incineration plants (Council Directive 89/369/EEC)
- Incineration of hazardous waste (Council Directive 94/67/EC)
- Directive on the Landfill Waste (Council Directive 99/31/EC)

#### Transport, Import and Export

- The supervision and control of shipments of certain types of waste to non-OECD countries (Council Regulation 259/93)
- Rules and procedures applying to shipments of certain types of waste to non-OECD countries (Council Regulation 1420/1999 and Commission regulation 1547/99)

<sup>6</sup> "In accordance with the polluter pays principle, the cost of disposing of waste must be borne by: - the holder who has the waste handled by a waste collector or by an undertaking as referred to in Article 9 and/or the previous holders or producer of the product from which the waste came" art.15. (Directive 75/442/CEE).



into account the demographic growth and the migratory flows. For industrial waste, the key parameter will be the expected industrial growth in relevant economic sectors. In any case, it is important to bear in mind the possible evolution in waste producer behaviors\*, such as the increase of the recycling activities or the adoption of clean products and clean technologies, with their potential consequences on waste streams: variation in the type of waste produced, decrease or increase in waste production.

Norm compliance must also be considered for the demand evaluation. According to the waste management hierarchy and the considerations included in the applied directives (for example the Packaging Directive), needs for waste management treatment are expected to be increasingly satisfied by prevention, recycling, composting and energy recovery (heat or power). Consequently the sizes of an incinerator or a landfill should be calibrated in relation to these future trends.

The steps of the demand evaluation are:

- the forecast demand, derived from the current demand and demographic and industrial growth predictions,
- the adjusted demand, according to the potential changes in waste producer behaviour and according to compliance with current and expected policies and legislation.

### Cycle and phases of the project

The following different phases of the project must be specified:

- conception and financial plan;
- technical studies;
- investigation phase to find an appropriate site;
- building phase;
- management phase.

Delays occurring during of some phases could be important, especially the time required for the research of an appropriate site. For hazardous treatment plants, for example, local hostility can feature, which as a result can disturb the building and the normal managing phases of the plant with negative consequences on financial and economic flows.

### The technical features

The description of the technical characteristics of the plant are crucial for comprehension of the local economic and social impacts of the project, its environmental impacts and the total financial and economic costs and benefits involved. In addition, technical detailed information is required for the monitoring and evaluation activities asked for the structural funds.

This section should at least give the following engineering data:

- basic socio-economic data: the number of inhabitants served; the number

and the type of productive structures served;

- basic data on waste: the type (municipal waste, hazardous waste, packaging waste...) and quantity (t/d, t/y, t/h, t/€...) of product to be treated; secondary raw material recovered; energy produced (Mega joules of heat or Mwh of power);
- physical features: area occupied by the plant (thousand of m<sup>2</sup>), covered and uncovered storage areas (in thousands m<sup>2</sup>), the position and discharge systems for effluent water;
- information on building techniques and building phases;
- processing techniques for the treatment plant: technology used, energy and material consumed and others goods and services consumed;
- other useful information: number of people employed during the building and the management phase, existence of remote control or computerized equipment, etc.

This information could be relevant to highlight the socio-economic impacts of the project, in terms of employment and income distribution for example, as an input for the environmental impact analysis (see below) and the financial and economic calculations.

### 3.1.4 Financial analysis

The financial revenue (inflow) is usually given by the price for treatment, paid by private or public users, and the sales of products recovered (secondary materials and compost) or energy production (heat and power) if any. Financial outflows are:

- Investment costs (land, buildings, equipment), including feasibility investment studies;
- Net residual values (residual value minus costs of site remediation and decontamination if any);
- Stocks in raw materials or final products;
- Replacement costs for the components with a short life compared to the time horizon of the project (machinery, etc.);
- Maintenance costs:

- √ Purchases in energy, commodities, goods and services used as inputs and needed for the day to day working of the plants;
- √ Management and administrative costs, including the insurance cost;
- √ Technical and administrative personnel costs.

The choice of a financial discount rate follows the same guidelines as those applied for public investments in infrastructures. A time horizon of 30 years is advisable here, but this depends on the type of waste treatment facility used and the type of waste collected.

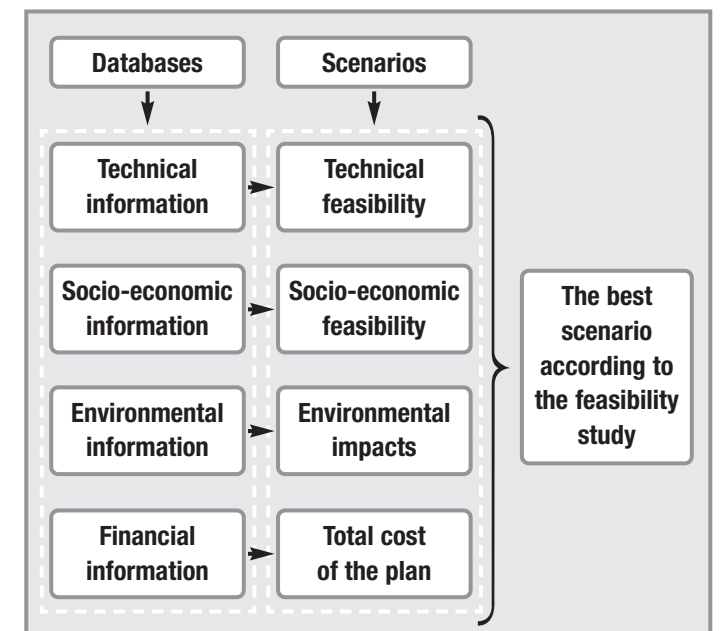


Fig. 3.3 The different elements of a feasibility analysis

### 3.1.5. Economic analysis

Economic analysis is concerned with the social benefits of the project and requires the integration of externalities and the correction of market failures in the calculation of the ENPV or the EIRR.

The main stages of economic analysis are the following:

- The financial analysis, which estimate the relevant financial flows calculated according to current market prices;
- The integration of externalities;
- The definition of conversion factors;

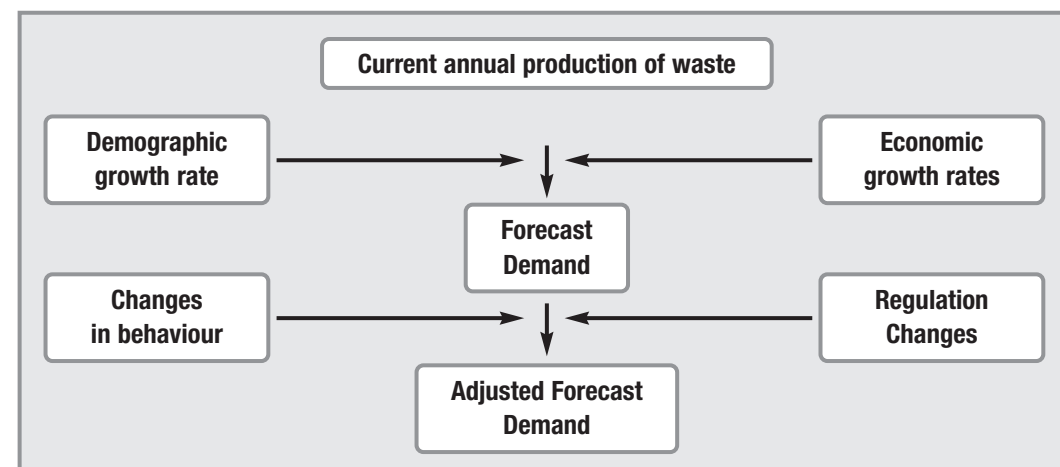


Fig 3.2 The different steps of demand evaluation

\* Such as the increase of the consumption correlated to the standard of living

- The calculation of economic benefits and costs.

Externalities generated by waste treatment facilities are mainly described by project's impacts on human health (morbidity or mortality due to air, water or soil pollution), the environmental damages induced such as water and soil contamination, the aesthetic and landscape impacts and the economic impacts, such as changes in land prices or economic development induced by the project.

Evaluation of external environmental costs and benefits can be based on the estimation of morbidity and mortality costs, the averting costs and remediation costs. Some contingent markets can also be set up for the evaluation of the impacts on landscape and an "hedonic price" can be calculated where the plant induces market price changes in lands or buildings.

For landfills and incinerators, the major positive and negative externalities are associated with:

- Air emissions,
- Waste water emissions,
- Residual solid waste production,
- Energy recovery,
- Disamenity, such as noise and odour,
- Risk of accidents.

When methodologies proposed are controversial or data are lacking, the analysis of the externalities can be performed in a qualitative way (see for example Tab. 3.1 and Tab. 3.2 for qualitative analysis of external effects in incineration and land filling). However, in such cases, results cannot be used in the monetary analysis and must be inserted in a larger multicriteria analysis.

#### The conversion factors

The items to be considered for the calculation of the conversion factors for the waste treatment facilities are the investment costs, the intermediate stocks, the products sold on the market (secondary materials, gas, heat or power), operational costs (including labour costs) and decontamination and dismantlement costs.

The estimate will be different when considering traded items (raw materials, energy, commodities and other capital goods or services) or non-traded items (electricity and gas recovery, land, some raw materials or unskilled labour).

Externalities should be considered as special non-marketed goods or services.

For waste treatment plants conversion factors will be calculated as follows:

#### For traded items:

- Equipment

Equipment for waste management is frequently traded. This is the case for incineration equipment, such as furnaces, filters and boilers, but also for collection and recovery equipment. CIF (cost, insurance and freights) and FOB (free on board) prices can be applied.

### Adjustment of market prices

The economic analysis of the project requires adjustments of market prices used in the financial analysis. Market prices are considered to be far from their long-term equilibrium because of numerous distortions such as those due to taxes, subsidies, import duties and other financial transfers. To reflect opportunity costs, economic figures must take into account externalities and remove all types of financial transfers.

A standard conversion factor is applied to internationally traded items to adjust market price and to calculate accounting prices reflecting opportunity costs. Prices on world markets represent the country's actual trading opportunities and are thus an appropriate measure of opportunity costs. The SCF conventionally reflects the weighted average divergence between border prices and domestic market prices for all traded goods and services in the economy and may be estimated based on foreign trade statistics using the following formula:

$$\frac{M + X}{(M+T_M) + (X-T_X)}$$

Where: **M** = CIF value of total imports  
**X** = FOB value of total exports  
**T<sub>M</sub>** = taxes on imports  
**T<sub>X</sub>** = taxes on exports

The standard conversion factor should be used by default, when specific sectoral conversion factors are unavailable.

Tab. 3.1 Overview of damages caused by emissions from incineration, illustrated as dose-response relations

Damage (response) Emission (doses)	Medium	Health effects mortality	morbidity	Lower agricultural yield	Forest Dis-back	Damage to buildings	Climate effects	Ecosystem
Particulates (PM10)	Air	+	+	0	0	+	0	0
No. (and O <sub>3</sub> )	Air	+	+	(-)	+	+	0	(-)
SO <sub>2</sub>	Air	(+)	(+)	+	+	+	0	-
CO	Air	(+)	(+)	0	0	0	+	0
VOC	Air	(+)	0	0	0	0	0	0
CO <sub>2</sub>	Air	0	0	0	0	0	+	0
HCl, HF	Air	?	0	(-)	(-)	(-)	0	?
Dioxins	Air	(+)	-	0	0	0	0	-
Heavy metals	Air	(+)	-	0	0	0	0	-
Dioxins	Water	?	?	0	0	0	0	?
Heavy metals	Water	?	?	0	0	0	0	(-)
Salts	Water	0	0	0	0	0	0	?

+ Measurable effect (+) Partly measurable effect - Non-measurable effect (-) Non-measurable but minor effects ? Non-measurable uncertain effects  
 0 no Known effect

Tab. 3.2 Overview of damages caused by emissions from landfills, illustrates as dose-response relations

Damage (response) Emission (doses)	Medium	Health effects mortality	morbidity	Lower agricultural yield	Forest Die-back	Damage to buildings	Climate effects	Ecosystem
CH <sub>4</sub>	Air	0	0	0	0	0	+	(-)
CO <sub>2</sub>	Air	0	0	0	0	0	+	(-)
VOCs	Air	(+)	0	(-)	0	0	0	0
dioxins	Air	(+)	-	0	0	0	0	-
Dust	Air	?	?	0	0	?	0	0
Leach ate	Soil and water	?	?	0	0	0	0	?

+ Measurable effect (+) Partly measurable effect - Non-measurable effect (-) Non-measurable but minor effects ? Non-measurable uncertain effects  
 0 no Known effect

\* Source: COWI Consulting Engineers and Planners AS., "A Study on the Economic Valuation Externalities from Landfill Disposal and Incineration of Waste", Final main report, European Commission DG Environment, October 2000.

- Recycled materials

Many recycled materials are traded, such as metallic materials, paper or glass. Prices are strongly correlated to international market prices of raw materials and energy. Information required for the calculation of conversion factors for traded items could be obtained from eco-industries, national and international statistical offices or Customs.

#### For non-traded items:

- Buildings

The conversion factors are estimated according to a process analysis which differentiates traded items from non-traded items. Information required for the calculation of conversion factors can be in some cases found in official statistical compendia published regularly.

- Electricity produced, gas and heat recovery

The conversion factor for electricity, considered as an input, can be estimated as follows: (1) a macroeconomic study which try to estimate the opportunity costs of the electricity production ("top down" approach), (2) a process evaluation which proceeds by breaking down the marginal cost structure of the production process ("bottom up" approach); (3) the application of the standard conversion factor where electricity is a minor input.

If electricity is sold at prices below the long run marginal cost (or, if not available, the consumers' willingness to pay), this latter information should be used to calculate the correction for actual tariffs. In a final step,

the domestic market price has to be converted into a border price by an adequate conversion factor (the SCF may be used).

Gas and heat are products usually sold on local markets. If they are at the origin of a minor financial flow, as usually occurs, the SCF could be applied to convert local to border prices. Otherwise (for example in the case of methane), international price to direct substitute could be used as adjusted price.

- Land

Land is generally of minor importance for industrial projects, and may be converted from market into border prices by the SCF. When land is important, for example in the case of a landfill, its economic value is determined by the valuation – at border prices – of the net output that would have been produced on the land if it had not been used by the project.

- Skilled and non-skilled labour

Labour involved in waste management facilities is mainly non-skilled.

The valuation of a price for skilled labour could be done at the market prices, skilled labour market is in fact reasonably competitive and market wage rates may reflect marginal productivity.

For non-skilled labour, some distortion may occur, due for example to a sectoral minimum salary. The output that unskilled labour would have produced in its previous occupation should be quantified. The obtained value represents the economic opportunity cost of unskilled labour.

### 3.1.6 Other evaluation criteria

#### Environmental analysis

For a large number of waste treatment projects, an environmental impact analysis (EIA) is required by regulatory texts<sup>7</sup>, especially in the case of hazardous waste deposits or removal plants or for some types of

waste treatment plants such as authorized landfills. Furthermore many plants, as landfills or incinerators, require permits for prescribed activities which set conditions to risk management, dangerous substance management and pollution control<sup>8</sup>. In any case it is advisable to insert a short environmental impact analysis even without specific legal requirement.

The main elements of an environmental impact analysis are the following:

- Emissions in the atmosphere, specially greenhouse gas emissions (impacts relevant for incineration);
- Waste water discharges and soil contamination (impacts relevant for incineration and land filling);
- Impacts on biodiversity (impact relevant for major projects built near protected area);
- Impacts on human health, linked to pollutant emissions and contamination of the environment (impacts relevant for any waste treatment facility);
- Noises and odours (impacts relevant for many waste treatment plants);
- Aesthetic impacts on landscape (impact relevant for incineration and land filling);
- Risk management of the site such as fire and explosions (impacts relevant for some specific waste treatment plants such as oil waste treatment plant and incineration).

In urban area, disturbances can also be registered during the building phase of the plants while in management phase perturbations, in addition to those listed above, are likely to be linked to the collection of waste.

A qualitative approach of environmental impacts could always be used in order to rank the potential environmental impacts according to the type of damage it induced or its dangerousness. For example the major impacts of a landfill are likely to be soil and water contamination, while, for incineration, impacts on air quality will be more relevant.

Tab. 3.3 Effects on the total cost of a 10% change in the main variable influencing the cost of incineration

Variables (inputs)	Var.	Effects on total cost of incineration
Volume of waste	+10%	-7,5%
Energy price	+10%	-2,5% -3,5 %
Ash and Slag from combustion Processes	+10%	+0,1%
Transport cost of waste from combustion processes	+10%	+0,3%

Source IFEN (France), 2000

### 3.1.7 Sensitivity and risk analysis

Critical factors influencing the success of an investment in this sector are potentially numerous, such as: investment costs, key input dynamic costs (energy, raw materials...), recovery product prices, costs of remediation and other environmental costs.

According the list before, it would be advisable for the sensitivity analysis and risk analysis to consider at least the following variables (potential critical variable):

- The cost of investment;
- The change in demand of waste disposal related to the diffusion of new products or new technologies, changes in behaviour, the variation in economic or population growth;
- Variations in the sales price of recycled products;
- The dynamics of costs over time of some goods and critical services for certain projects (e.g. the cost of electricity and/or fuel or the cost of remediation and decontamination of the sites).

A variation in 10 % (or 1 %) of the input variables could be used to assess the associated changes in ENPV or ERR or in any other relevant variable (see Tab. 3.3). For critical variables a risk assessment must be carried out to calculate the probability distribution of the final results.

Another type of risk analysis could be performed regarding social risk related to the possible reject by people of the project because of its potential impacts on quality of life in the area concerned. The risk is usually called NIMBY (“Not In My Backyard”) and can be investigated by a qualitative analysis based on questionnaire or direct contacts with stakeholders involved.

### 3.1.8 Case study: Investment in an incinerator with energy recovery

#### Financial analysis

The cost of the investment is fixed at EUR 50 million:

- The capacity of the furnace is fixed at 200,000 tons of municipal waste (per year).
- In order to make it easier in this example, the time horizon is only 10 years;
- The investment is financed by a loan with a 3% interest rate, the investment cost is split between 10% for land, 35 % for buildings and 55% for equipment (furnaces, boiler...);
- A 5% financial rate of discount is chosen
- The energy recycled is sold as heat and power with a price of EUR 15 per ton (40% heat and 60% power);
- The price of treatment paid by final users is fixed at EUR 25 per ton.
- Ten skilled employments (at 12000 euro/person per year) and forty non-skilled employments (at 10000 euro/person per year) are assumed;
- Functioning costs are fixed at EUR 10 per ton;
- Elimination cost of ash and slag waste are set at EUR 10 per ton;
- Renovation costs are assumed to be 5% of the initial cost of the investment and the net residual value, over the 10 years of life of the plant, is fixed at 50% of the initial cost of the investment.

The presentation of the financial analysis can be viewed in the Tab 3.4. The numbers are expressed in 1000 of euro. The Net Present Value (FNPV) calculated is 1862 thousand euro, and the Internal Rate of Return (FRR) is approximately 6 %.

#### Economic analysis

External costs and conversion factors are calculated to adjust financials flows and are intended to reflect real opportunity costs.

<sup>7</sup> At the European level see the Environmental Impact Assessment Directive (85/337/EEC).

<sup>8</sup> European legislation on pollution control and risk management sector is set out in the IPPC Directive (96/61/EC), in the Large Combustion Plants Directive (88/609/EEC) and the Seveso II Directive (96/82EC).



- the external costs calculated in this example are connected to atmospheric pollution, especially greenhouse gas emissions, environmental impacts of ash and slag, odours, noise and aesthetic damages;
  - the external net benefits are assumed to be EUR 9 per ton (evaluated as the avoided costs for energy production by conventional technology with fuel);
  - the economic discount rate should be equal to the financial rate.
- The value of the standard conversion factor comes from the following macroeconomic data (in millions of euro):  $M = 3000$ ;  $X=3500$ ;  $T_x = 30$ ;  $TM = 600$ ; for a SCF = 0,95.
- Land** is provided by the local authorities at a concession price that is 25% below what would have to be paid on the market, consequently the price has to be increase of 25% to reflect local market prices. Because of the absence of a specific conversion factor, the SCF is used to convert the market price into border price. So, the conversion factor for land is  $1,25 \times 0,95 = 1,19$ .
  - Equipment and inputs to the production process**, such as **energy** and **raw materials**, concerning the incineration sector are supposed to be imported. Tariffs are considered to be equal to the average tariffs on national goods and services, so the SCF is used to convert market price into border prices. The conversion factor for equipment and inputs is  $cf = 0,95$
  - Buildings** constitute a non-traded item for which a specific conversion factor may be calculated. In our example building costs consist of 30% unskilled labour (see below for the conversion factor), 40% of imported building materials that face import duties 25% (therefore  $cf = 0,75$ ), 20% of local material (SCF) and 10% profits ( $cf=0$ ). So the conversion factor for building is  $(0,3 \times 0,95) + (0,4 \times 0,75) + (0,2 \times 0,95) + (0,1 \times 0) = 0,7$
  - Skilled and unskilled labour** are not differentiated and it is assumed that the labour market is competitive. The conversion factor is  $1 \times 0,95 = 0,95$
  - Heat** and **electricity** are non-traded items. Heat is sold at the marginal cost

Tab. 3.4 Table for the financial analysis

	Years										
	1	2	3	4	5	6	7	8	9	10	11
Service revenues		5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
Heat sales		1350	1350	1350	1350	1350	1350	1350	1350	1350	1350
Electricity sales		1650	1650	1650	1650	1650	1650	1650	1650	1650	1650
<b>Sales</b>	<b>0</b>	<b>8000</b>	<b>8000</b>	<b>8000</b>	<b>8000</b>	<b>8000</b>	<b>8000</b>	<b>8000</b>	<b>8000</b>	<b>8000</b>	<b>8000</b>
Residual value											22000
<b>Total revenues</b>	<b>0</b>	<b>8000</b>	<b>8000</b>	<b>8000</b>	<b>8000</b>	<b>8000</b>	<b>8000</b>	<b>8000</b>	<b>8000</b>	<b>8000</b>	<b>30000</b>
Skilled labour		120	120	120	120	120	120	120	120	120	120
Non skilled labour		400	400	400	400	400	400	400	400	400	400
Raw materials		100	100	100	100	100	100	100	100	100	100
Intermediate goods		1400	1400	1400	1400	1400	1400	1400	1400	1400	1400
Energy for plants		500	500	500	500	500	500	500	500	500	500
Other costs		500	500	500	500	500	500	500	500	500	500
<b>Total operating costs</b>	<b>0</b>	<b>3020</b>	<b>3020</b>	<b>3020</b>	<b>3020</b>	<b>3020</b>	<b>3020</b>	<b>3020</b>	<b>3020</b>	<b>3020</b>	<b>3020</b>
Land		5000									
Buildings		17500									
Equipment		27500									
<b>Total investment costs</b>	<b>50000</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>Total expenditures</b>	<b>50000</b>	<b>3020</b>	<b>3020</b>	<b>3020</b>	<b>3020</b>	<b>3020</b>	<b>3020</b>	<b>3020</b>	<b>3020</b>	<b>3020</b>	<b>3020</b>
<b>Net cash flow</b>	<b>-50000</b>	<b>4980</b>	<b>4980</b>	<b>4980</b>	<b>4980</b>	<b>4980</b>	<b>4980</b>	<b>4980</b>	<b>4980</b>	<b>4980</b>	<b>26980</b>
<b>Financial internal rate of return (FRR/C) of the investment</b>											<b>5.64%</b>
<b>Financial net present value (FNPV/C) of the investment</b>											<b>1862</b>

Tab. 3.5 Table for economic analysis

	cf (3)	Years										
		1	2	3	4	5	6	7	8	9	10	11
<b>External benefits</b>	<b>0.95</b>	<b>0</b>	<b>1710</b>	<b>1710</b>	<b>1710</b>	<b>1710</b>	<b>1710</b>	<b>1710</b>	<b>1710</b>	<b>1710</b>	<b>1710</b>	<b>1710</b>
Service revenues	1.00	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
Heat sales	0.95	1282	1282	1282	1282	1282	1282	1282	1282	1282	1282	1282
Electricity sales	0.66	1568	1568	1568	1568	1568	1568	1568	1568	1568	1568	1568
<b>Sales</b>	<b>0</b>	<b>7850</b>	<b>7850</b>	<b>7850</b>	<b>7850</b>	<b>7850</b>	<b>7850</b>	<b>7850</b>	<b>7850</b>	<b>7850</b>	<b>7850</b>	<b>7850</b>
Residual value	0.87											19163
<b>Total revenues</b>	<b>0.95</b>	<b>0</b>	<b>9560</b>	<b>9560</b>	<b>9560</b>	<b>9560</b>	<b>9560</b>	<b>9560</b>	<b>9560</b>	<b>9560</b>	<b>9560</b>	<b>28723</b>
Skilled labour	0.95	114	114	114	114	114	114	114	114	114	114	114
Non skilled labour	0.95	380	380	380	380	380	380	380	380	380	380	380
Raw materials	0.95	95	95	95	95	95	95	95	95	95	95	95
Intermediate goods	0.95	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330
Energy for plants	0.95	475	475	475	475	475	475	475	475	475	475	475
Other costs	1.00	500	500	500	500	500	500	500	500	500	500	500
<b>Total operating costs</b>	<b>0</b>	<b>2894</b>	<b>2894</b>	<b>2894</b>	<b>2894</b>	<b>2894</b>	<b>2894</b>	<b>2894</b>	<b>2894</b>	<b>2894</b>	<b>2894</b>	<b>2894</b>
Land	1.19	5950										
Buildings	0.70	12250										
Equipment	0.95	26125										
<b>Total investment costs</b>	<b>44325</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>Total expenditures</b>	<b>44325</b>	<b>2894</b>	<b>2894</b>	<b>2894</b>	<b>2894</b>	<b>2894</b>	<b>2894</b>	<b>2894</b>	<b>2894</b>	<b>2894</b>	<b>2894</b>	<b>2894</b>
<b>Net cash flow</b>	<b>-44325</b>	<b>6666</b>	<b>6666</b>	<b>6666</b>	<b>6666</b>	<b>6666</b>	<b>6666</b>	<b>6666</b>	<b>6666</b>	<b>6666</b>	<b>6666</b>	<b>25829</b>
<b>Economic internal rate of return (ERR)</b>												<b>11.77%</b>
<b>Economic net present value (ENPV)</b>												<b>17967</b>

without local taxes and the conversion factor is assumed to be equal to the SCF. The project enjoys a special tariff for industrial projects and electricity is supposed to be subsidized for 30% of its market cost. The resulting conversion factor will be:  $0.7 \times 0,95 = 0,66$

- External benefits** are estimated to be free of taxes and the conversion to border prices is achieved through the use of the standard conversion factor.

After taking into account external benefits and costs and having undertaken the appropriate adjustments to correct major market failures, the ENPV becomes positive for an amount of approximately EUR 18 million, with an ERR around 12 % (see Tab. 3.5).

## 3.2 Water supply and depuration

### Introduction

This section is focussed on the investments in the management of the integrated water

supply service (IWS) for all uses of the resource. The IWS segment includes the supply and delivery of water as well as the collection, elimination, purification and reutilization of sewage.

### 3.2.1. Objectives definition

The proposer shall place the project within a general framework which is intended to show that the planned investments will have the effect (main purpose) of improving the quality, effectiveness and efficiency of the service.

It is necessary to provide ex ante quantification of the significant parameters of such an objective, such as for example:

- the extension of the supply and delivery or sewer and purification service (number of users served);
- the volumes of water saved in civil or irrigation networks as a result of the reduction of water leaks and/or the rationalisation of delivery systems;
- the smaller quantity (m<sup>3</sup>/year) taken from polluted or injured sources (for example river or natural lakes which have been strongly impoverished by resource takings or coastal and salty strata, etc.);

- the continuity of service (frequency and duration of interruptions);
- the improvement of the water delivery system in dry weather conditions;
- the extent of the polluting load which has been removed;
- the improvement of environmental parameters;
- the reduction of operating costs.

It is necessary to establish the specific objectives. Investment in the sector may be grouped into two project categories from this point of view:

- projects intended to promote **local** development<sup>1</sup>. In this case it is necessary to

establish the specific objectives of the investment, i.e. the population to be served and the average resource availability (litres/inhabitant\*day)<sup>2</sup> or the hectares to be irrigated, the types of crops, the average expected production, the resource availability (litres/hectare\*year), the time and periodicity of irrigation, etc.

- the projects may have **non-local** objectives, for example on a regional or interregional scale. This is the case of aqueducts for long-distance transportation of water from relatively rich areas to arid zones or the construction of dams intended to supply wide regions which may be also far away from their location.

### Typology of investments and offered services

#### Type of actions:

- construction of entirely new infrastructures (aqueducts, sewer systems, purifiers), intended to meet increasing needs,
- works intended to complete aqueducts, sewers and purifiers which have been partially constructed, including the completion of water supply networks or sewer systems, the construction of trunk lines for the connection to the existing conditioning systems, the construction of conditioning systems for the existing sewer systems, the construction of purifiers with tertiary treatment plants for the reutilization of conditioned sewage,
- partial modernisation and/or replacement of existing infrastructure in compliance with the strictest rules and laws in force,
- actions intended to save water resources and/or to provide for its efficient use,
- actions intended to rationally replace the use of the resource when it is not regulated (for example irrigation with private uncontrolled wells),
- actions intended to improve management efficiency

#### Prevailing typology of investments:

- works aimed at collection, regulation or production of the resource, even on a pluriennial basis,
- works meant for water transportation,
- works meant for the local distribution of water resources

as well as for civil, industrial or irrigation purposes,

- works meant for the treatment of primary water (clarification, desalination, purification)
- works meant for the collection and elimination of sewage,
- works meant for the treatment and discharge of conditioned sewage,
- works meant for the reutilization of treated sewage.

#### Services offered:

##### Civil services

- infrastructures and/or plants serving high-density urban areas,
- infrastructures and/or plants serving the districts of towns or villages,
- infrastructures and/or plants serving small (agricultural, mining, tourist) settlements and/or isolated houses,
- infrastructures and/or plants serving high-density industrial settlements and/or industrial areas,
- rural aqueducts

##### Irrigation service

- district aqueducts for collective irrigation,
- local aqueducts for individual or small-scale (oasis-like) irrigation,

##### Mixed service

- aqueducts for irrigation and civil and/or industrial service,
- industrial and civil aqueducts

In this case, the specific objectives should also refer to the resource volumes made available (millions of cubic metres per year), the maximum flow rates (litres/second) conveyed, the overall capacity of the long-term resource regulation which will be provided by the system.

### 3.2.2 Project identification

#### Typology of the investment

A precise definition of the type of available services is the first step to be taken in developing the analysis of the investment. From this point of view, it may be useful to consider the analysis of demand, the suitability evaluation of the project also from the technological viewpoint and the study of the components of costs, revenues and benefits.

#### Territorial reference framework

If the project is placed within its territorial framework, this will provide for a precise identification of the investment.

The proposer should supply also the elements required to ascertain the project's consistency with planning for the sector, at least from the following three points of view:

- **consistency with the economic-financial planning of the water sector**, as may be inferred from the pluriennial schedules for the use of community and national financing which have been approved for the various countries or regions;
- **consistency with the national sector policies**, in particular the project should significantly foster the industrialisation objectives of the sector, for the countries where this process is under way;
- **consistency with the community, national and regional environmental policies**, mainly for the use of water for human purposes, the treatment of sewage and the protection of water bodies.

The SWOT analysis, evaluating the project potentialities and risks deriving from the

context of incorporation, and the sustainability analysis may also be of great help in many cases.

### 3.2.3 Feasibility and options analysis

#### Analysis of the demand

The demand for water may be broken down into additional components according to the use (demand for drinking water, for irrigation or industrial purposes, etc.), and the timing of demand (daily, seasonally, etc.).

The estimation of the demand curve may be based on data gained from previous experience in the area involved or from published forecasting methods, particularly those based on the concept of the consumer's willingness to pay.

In case of replacements and/or completions it is also useful to make reference to historical data of consumption, provided that these data have been measured by reliable methods (for example from the readings of meters).

Demand is made up of two fundamental elements:

- the number of users in the case of civil use, including temporary users like tourists of the surfaces to be irrigated in case of agricultural use and of production units to be served in the case of industrial use
- the quantity of water, which is being or will be delivered to users for a given period of time

It is important to note that, if the water network has been not well maintained in the past, the analysis of demand should include the problem of leakages. That is to say that the total water supply is made by the final consumption and the leakages.

An other important point is to consider the elasticity of the demand to tariffs. In some cases it will be necessary to estimate the elasticity for different income groups

<sup>1</sup> Projects of sewers and depurators are almost always related to local development and they may be considered from a dual point of view: i) these actions are aimed at "closing" the water-cycle for hygienic-sanitary reasons and, as such, may be regarded as part of the integrated water supply service, ii) they are also measures to safeguard the environment and in particular the quality of the bodies of water into which drains flow. For this reason it is necessary to take into account also the specific objectives of the environment, as for example the quantity of removed pollutants, the restoration of physical/chemical and biological quality parameters of water and soil, etc.

<sup>2</sup> If the resource is destined to the service of tourist areas, it is necessary to take into account the fluctuation of the population and the seasonality of the demand.

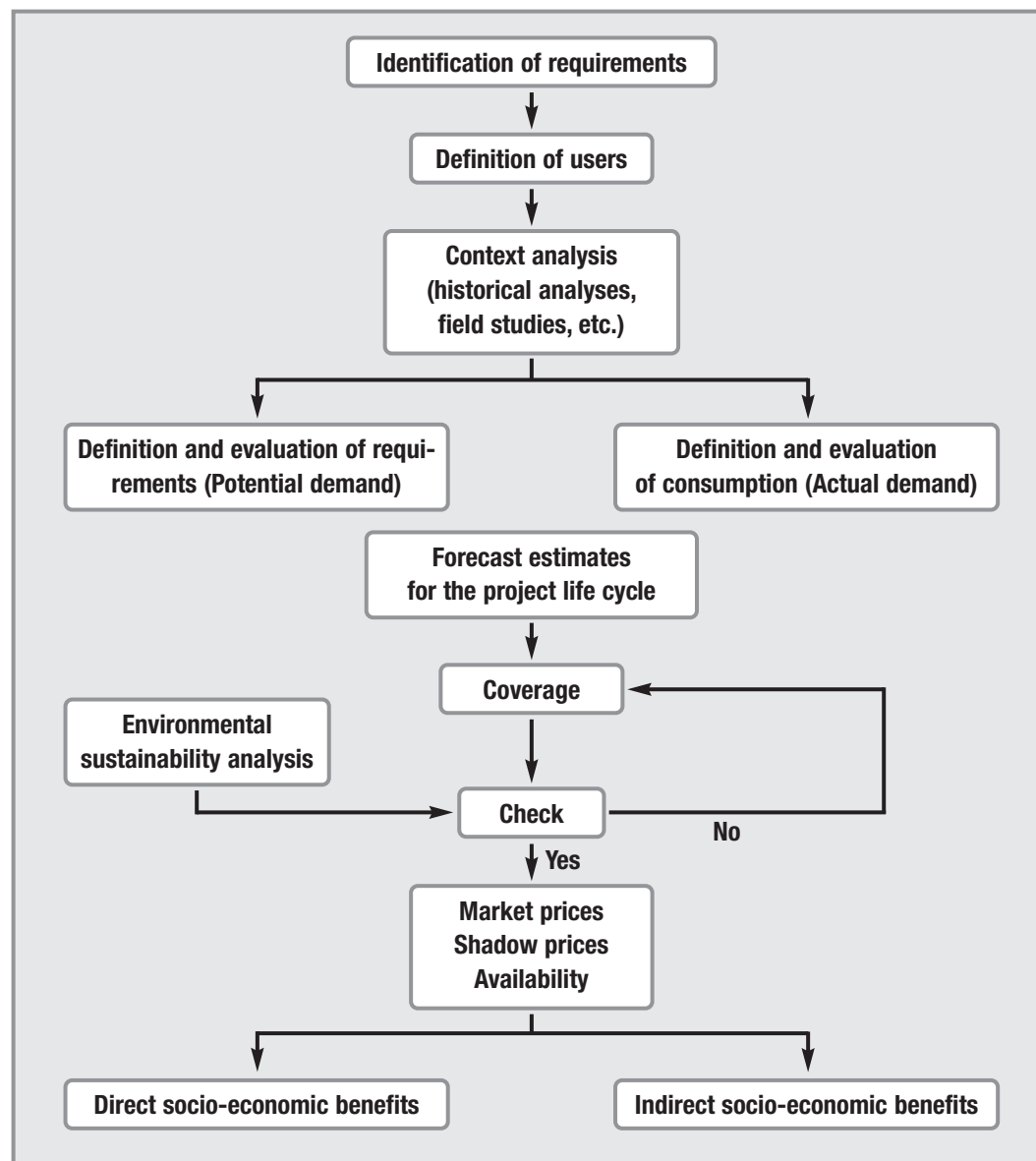


Fig.3.4 Chart for the analysis of the resource demand

and between small and big users, because this may produce quite different values and distributive impacts.

The project should focus on a demand forecast for the period corresponding to the project cycle. It should take into account demographic forecasts and migration flows for an estimate of the users and the agricultural or industrial development plans in the other cases. The time structure of the short-term demand (daily, seasonal, etc.) should be considered too.

In general, one can make a distinction between potential and actual demand. The

potential demand will correspond to the maximum requirement which should be taken into account for that investment. For example, demand may be evaluated for civil purposes on the basis of water requirements for the same use (generally expressed on a daily and seasonal basis) arising from a comparison with any situation which will be as close as possible to the project's and which has a good service level. For irrigation purposes it may be estimated on the basis of specific agronomic studies or, in this case, even by analogy. The actual demand is the demand which is actually fulfilled by the investment in question and which corresponds to the

expected consumption. The actual starting demand is represented by the actual consumption before the intervention.

A first obvious evaluation criterion for the investment depends upon the extent to which the actual demand may be close to the potential demand. It is necessary to consider other factors, first of all those related to the environmental and economic sustainability of the investment. The demand the investment can actually fulfil corresponds to the supply, net of any technical resource loss and release.

Whenever the project may imply the use of water (surface or subsurface) resources, the actual availability of the resource volumes and flows required to fulfil the assumed demand should be clearly shown by statistically studying and analysing hydrology, the down flows and regimes of strata and whatever may be of use.

If the project involves the purification and discharge of sewage, it is necessary to analyse the capacity of the body intended to receive the load of polluting and nourishing substances, in a way compatible with environmental protection.

#### Cycle and phases of the project

Great attention should be paid to the existence of propaedeutic stages playing a fundamental role for the completion of the work, such as for example the search for new subsurface resources and their qualitative and quantitative assessment by means of scout borings or hydrologic surveys and studies intended to identify the best location of dams and crosspieces, their dimensions, the size of suppliers and so on.

It is also necessary to consider the institutional and administrative aspects related to the project as well as the expected execution and building times.

The project must identify the manager(s) of any (public, private, local, national, multinational, etc) generated service, regardless of what its scale may be. The

economic, technical and entrepreneurial profile of the manager(s) should be evaluated as an integral and essential part of the investment. In particular, if the project is expected to be co-financed, with funds owned by the constructor/ manager of the infrastructure, it is necessary to ascertain the manager's capacity to support the financial and economic burden.

#### The technical features

To identify the functions of the action, it is necessary to follow the pattern of the previous point. The analysis should also be completed through the identification of technical features.

#### Options analysis

The analysis should include comparisons with:

- the previous situation (do-nothing scenario);
- the possible alternatives within the same infrastructure as for example: different locations of wells, alternative routes for aqueducts or trunk lines, different building techniques for dams, different positioning and/or process technology for plants, utilisation of different energy sources for desalination plants, etc;
- the possible alternatives of sewage drains (lagoons, different receptors, etc);
- the possible global alternatives, as for example a dam or a system of crosspieces instead of a wells field or the agricultural reutilization of properly treated sewage, a consortial depurator instead of several local depurators, etc.

#### 3.2.4 Financial analysis

The actions in the sector may fall within the category of infrastructure generating net revenues. In this case, it is necessary to guarantee a significant co-financing share through the proposer's own funds. Since most of them derive from the "advances" of the future proceeds of services which will be performed by using the infrastructures which have been built with the project, in these cases the financial analysis should show the proposer's capacity to sustain the investment from this point of view.



**Identification of basic functional data:**

- Number of served inhabitants
- Irrigated surface (hectares)
- Number and type of served production structures
- Water availability per capita (l/d\*inhabitant) or per hectare (l/d\*hectare)
- Water quality data (laboratory analysis)
- Number of equivalent inhabitants, flow rates and parameters of the polluting load of the water which should be treated (laboratory analysis) and quality constraints of the water which should be drained (defined by the law).

**Identification of the territorial construction data of the infrastructure:**

- Location of the works on the territory, shown by properly scaled topographical maps (1:10000 or 1:5000 for networks and plants; 1:100000 or 1:25000 for collection and supply works, trunk lines);
- Physical connections between the structures and the (new or existing plants); it may be useful to enclose technical drawings of a schematic kind;
- Any interference and/or interconnection with the existing infrastructures of any other type (streets, railways, electrical lines, etc).

**Identification of physical and characteristic data:**

- Total length (Km), nominal diameters (mm), nominal flow rate (l/s) and differences in height (m) of suppliers or trunk lines,
- Nominal filled volumes (millions of m<sup>3</sup>) and height (m) of dams (location plans and sections attached hereto),
- Number, length (m) and nominal flow rate (l/s) for running water taking works (location plans and sections attached hereto),
- Number, depth (m), diameter (mm), drained flow rate (l/s) for wells fields (attach properly scaled location plan),
- Linear development (Km) and characteristic diameters (mm) of aqueducts or sewers (attach properly scaled location plan),

- capacity (m<sup>3</sup>) of tanks (attach location plans and sections),
- occupied surface (m<sup>2</sup>), nominal flow rate (l/s) and difference in height (m) of any lifting apparatus (attach location plans and sections),
- Nominal flow rate (l/s), production (m<sup>3</sup>/g) and absorbed / consumed power (KW or Kcal/h) of purification or desalination plants (attach lay-out and flow pattern);
- Technical features and configuration of the main structures, for example by enclosing one or several typical sections and/or sketches (sections of ducts, layouts of control rooms, etc.) and by specifying the parts which have been recently built;
- Technical and constructive features of the main lifting apparatus, production or treatment plants, by enclosing functional layouts in details;
- Nominal flow rate (l/s), capacities (equivalent inhabitants), conditioning efficiency (at least on BOD, on COD, on phosphorous and nitrogen) of purification plants as well as the technical and constructive features of drain pipes (attach location plans, lay-outs and flow patterns);
- Technical and constructive features of the buildings or other service structures, by enclosing location plans and sections;
- Relevant technical elements, such as crossings, cave tanks, galleries, remote control plants or computerised service management plants, etc. (by enclosing data and lay-outs)
- Identification of the main components and materials proposed by the project, by specifying their availability (of local production or importation) in the investment area.
- Identification of any technology which may have been proposed for the realisation of the infrastructure, by specifying its availability and convenience (for example from the viewpoint of maintenance).
- In case of conditioners, identify the options for the disposal of treatment mud. In case of desalination plants, identify the options and infrastructures for the disposal of concentrated brine.

For the outflow, the purchasing price of the products and services, necessary both for the operation of plants and for the additional services supplied, should be considered.

The financial inflow generally derives from tariffs or fees applied for the water supply service. Possible reimbursements (or other forms of transfers) for the collection and transport of rainwater as well as possible

proceeds for the sale of water in case of reuse should also be considered, if they exist. Also in this case, the tariffs or sales prices of any additional service the manager may offer to the user (for example hooking up, periodic maintenance, etc.) should be taken into account.

Since water infrastructures are generally characterised by a long period of useful life,

the financial analysis should consider the residual value of the investment, according to the methods which have been described in the second chapter of the Guide.

A time horizon of 30 years is advisable.

**3.2.5 Economic analysis**

The main social benefits to be introduced in the economic analysis may be usefully evaluated according to estimates of expected demand for water resources that the investment will satisfy. The basis for the estimation of an accounting price for water may be the user's willingness to pay for the service. The willingness to pay can be quantified by applying the market prices of alternative services (tank trucks, bottled drinking water, distribution of drinks, purification by means of devices installed for the users, in situ sanitizing process of potentially infected waters, etc.) or by adopting other methods, which may be found in the literature (see bibliography).

For any water infrastructure meant for the service of either industrial or agricultural areas, it is possible to evaluate the added value of the additional product which has been gained through the water availability.

For any intervention which is intended to guarantee the availability of drinking water in areas with sanitary problems, where water sources are polluted, the benefit may be directly estimated by valuating the deaths and illnesses which have been avoided by means of an efficient water supply service. To make an economic valuation, it is necessary to make reference on the one hand (illnesses) to the total cost of hospital or out-patient treatments and to the income loss due to possible absence from work and on the other hand (deaths) to the human life value quantified on the basis of the average income and residual life expectancy.

The social benefits of sewers and purifiers may be also evaluated on the basis of the potential demand for sewage<sup>4</sup> which

should be fulfilled by the investment and estimated according to an adequate water accounting price.

Alternatively, if possible, direct valorisation may be applied to benefits such as:

- the value of the illnesses and deaths avoided thanks to an efficient drains service;
- the damage avoided to land, real estate and other structures due to potential flooding or unregulated rainwater (for "white" or mixed drains), valorised on the basis of the costs for recovery and maintenance;
- in the case of purified discharges into rivers, lakes and land, the value of the water resources in non-polluted collectors, to be estimated according to the method shown for aqueducts.

In any case, if no standard economic appraisal method is applicable for the specific project, it is possible to resort to any similar project which may have been developed in a context as close as possible to the one of the affected area.

For the reasons stated in the section regarding objectives, the environmental externalities should be quantified in any case, considering the following:

- the possible valorisation of the served area, quantifiable, for example, by the revaluation of real estate and building or agricultural area prices;
- the increased income due to the collateral activities (tourism, fishing, coastal agriculture, etc.) that may be settled or maintained, for example in the case of artificial lakes or projects intended to safeguard rivers, lakes, straits and other collecting bodies;
- the negative externalities due to the possible impacts on the environment (soil consumption, inert consumption, spoiling of scenery, impact on the natural context) and on any other infrastructure (e.g. roads and/or railways);
- the negative externalities during the construction phase due to the opening of

<sup>4</sup> Basically the same as the demand for water.

building sites, especially for urban networks (negative impacts on housing, production and service functions, on mobility, historical and cultural heritage, on the agricultural framework and on infrastructures, etc.).

### 3.2.6 Other evaluation criteria

In addition to what has already been stated in previous paragraphs, here it may be useful to produce a special evaluation of the effectiveness of the proposed system when the location for the project is a *sensitive area* from the environmental point of view.

### Environmental analysis

In any case, during the evaluation stage, it is necessary to analyse, even if briefly<sup>5</sup>, the environmental impact of the works to be undertaken with the project and to check any deterioration of the soil, the water bodies, the landscape, the natural environment, etc. Particular attention should be paid to the use of valuable areas, such as natural parks, protected areas, natural sanctuaries, sensitive areas, etc. In some cases, it is also necessary to take into account to which extent the wild fauna life may be disturbed by the infrastructures in course of construction and by their management activities. As to investment affecting urban centres (sewerage systems or water networks), it is necessary to consider the impacts due to the opening of yards which may negatively affect house and service functions, mobility, existing infrastructure and so on.

The analysis above falls within a more general evaluation of sustainability according to the environmental constraints and development hypotheses of the proposed investment, for which it is necessary to evaluate not only the economic and environmental benefits, but also the extent to which its development may cause such a consumption and/or a deterioration of the natural functions of the area that may compromise any potential future utilisation, in the broadest meaning of the term, i.e. including the natural use of wide areas.

Where required, such an evaluation should also consider the alternative, even future, utilisation of the same (surface, subsurface) water body which should be understood as a source of water resource or as a receiving body and, as a consequence, the impacts a decrease in the flow rate and a change in the river regimen resulting from its barrage by a dam may have on the anthropic activities performed in the same natural environment (flora, fauna, water quality, climate, etc.). For some countries it is necessary to evaluate the positive or negative investment contribution to the desertification processes underway, etc.

A quantitative approach can successfully use multi-criteria analysis methods. The results of this analysis may bring about a serious modification of the proposed investment or of its rejection. Whenever their quantification is methodologically possible, the estimated positive and negative impacts should fall within the monetary evaluation of the social benefits and costs of the investment.

### 3.2.7 Sensitivity and risk analysis

The critical factors influencing the success of an investment in this sector are:

- any unexpected occurrence in the construction of the plants, which might considerably change the cost of the investment in progress;
- the forecasts of the demand dynamics;
- the rate of change in tariffs or fees, largely depending upon the decisions taken by the national or regional regulatory bodies;
- the lack of capacity to respond to shocks in the investment (which often requires excess capacity in the first operating periods);
- the determining influence of collateral interventions (for example, the effectiveness of water supply is strictly related to the state of the distribution networks);
- the efficiency of management.

In this regard, it would be advisable for the sensitivity and risk analysis to consider at least the following variables:

- the cost of the investment;

- the rate of demographic growth (for civil use) and the forecasts of any migration flow;
- the development rate of crops and the national and/or international dynamics of the sale prices of agricultural products (for irrigation purposes);
- the variation in tariffs or fees over a period of time;
- the demand and price dynamics of the water which may be recycled in case of reutilization;
- the operating costs (maintenance, management, etc) and their time dynamics, even with reference to the evaluated suitability of management systems;
- the dynamics of costs over time of some critical goods and services for certain projects (e.g. the cost of fuels and/or electric energy for desalination plants, the cost of chemical additives and the mud disposal cost for depurators).

### 3.2.8 Case study: infrastructure sheet for the management of the IWS

The project, represented schematically in the figure below, is an investment in the field of sewerage and water purification, and the reuse of wastewater for multiple purposes through intensive tertiary treatment.

### The water supply

From the point of view of water resources, the new supply will significantly supplement the industrial area's existing supply from a small aqueduct fed by wells and springs; however only with the construction of the project under examination will the integrated water service be completed and on-going industrial installations be able to take off and be fully functional.

As regards the area irrigated, the new resource will partly (46%) substitute some of the water currently provided by the water-table and the river, both becoming impoverished because of the pressure of excessive abstraction, and will partly (54%) supplement the available volumes, allowing for the irrigation of the whole agricultural area covered by the distribution network (roughly 1,100 hectares), developed with previous public financing and at the moment only partially utilised.

This includes the construction of a new water purifier, in keeping with current regulations, to serve a medium-sized city (235,000 residents in the initial year) and an adjacent industrial area, undergoing full development. The new water purifier substitutes an existing plant, which is inadequate since it only screens and removes grit from the wastewater.

The project also includes the completion of urban sewers for 25% of the population (new settlements) and interceptor

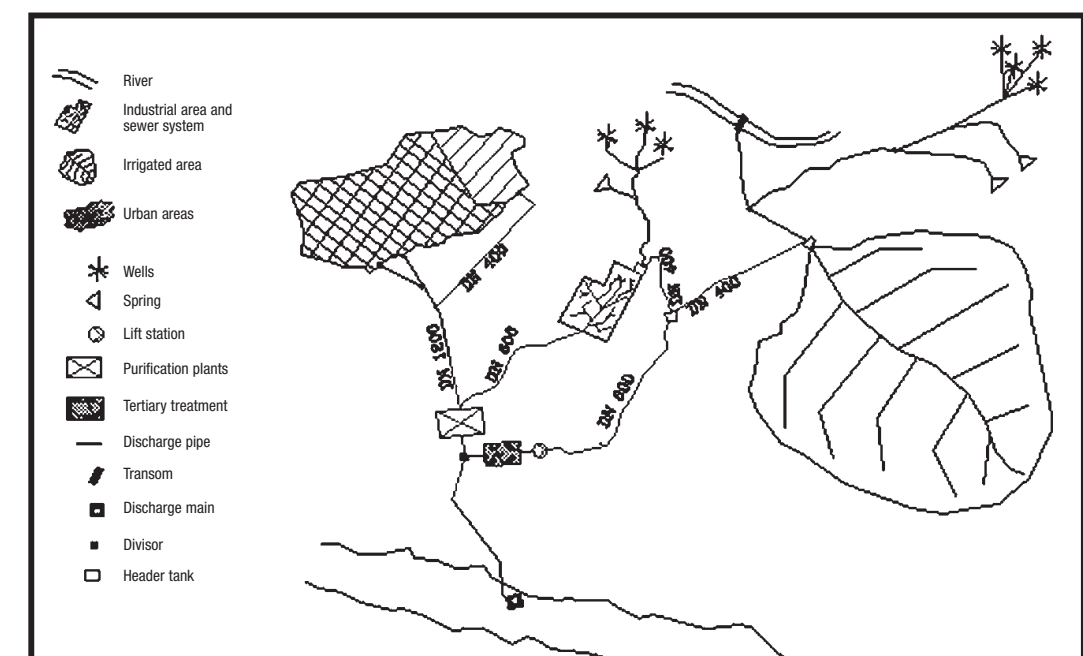


Fig. 3.5 Project map

<sup>5</sup> Legislation in the majority of member countries requires the compulsory evaluation of the environmental impact for some of these infrastructures (e.g. dams, large aqueducts, depurators, etc.), in the approval stage of projects.

**Tab. 3.6 Some hypothesis for quantification of financial costs and revenues**

	Years																								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
<b>Demographic increase</b>	235,470	235,941	236,413	236,886	237,359	237,834	238,310	238,786	239,264	239,743	240,222	240,702	241,184	241,666	242,150	242,634	243,119	243,605	244,093	244,581	245,070	245,560	246,051	246,543	247,036
<b>Migratory flow</b>																									
<b>Annual value</b>	2,900	2,900	2,900	2,900	2,900	1,933	1,933	1,933	1,933	1,933	580	580	580	580	580	580	580	580	580	580	580	580	580	580	580
<b>Incremental value</b>	2,900	5,800	8,700	11,600	14,500	16,433	18,367	20,300	22,233	24,167	24,747	25,327	25,907	26,487	27,067	27,647	28,227	28,807	29,387	29,967	30,547	31,127	31,707	32,287	32,867
<b>Residents served by the water purifier</b>	238,370	241,741	245,113	248,486	251,859	254,267	256,676	259,086	261,497	263,909	264,969	266,029	267,091	268,153	269,216	270,281	271,346	272,412	273,479	274,547	275,617	276,687	277,758	278,830	279,903
<b>Residents served by sewers</b>	59,593	60,435	61,278	62,121	62,965	63,567	64,169	64,772	65,374	65,977	66,242	66,507	66,773	67,038	67,304	67,570	67,836	68,103	68,370	68,637	68,904	69,172	69,439	69,707	69,976
<b>Annual volumes (millions of cubic metres)</b>																									
<b>New civil sewer</b>	3.95	4.00	4.06	4.12	4.17	4.21	4.25	4.29	4.33	4.37	4.39	4.41	4.42	4.44	4.46	4.48	4.49	4.51	4.53	4.55	4.56	4.58	4.60	4.62	4.64
<b>Urban purification</b>	15.79	16.01	16.24	16.46	16.69	16.84	17.00	17.16	17.32	17.48	17.55	17.62	17.69	17.76	17.83	17.91	17.98	18.05	18.12	18.19	18.26	18.33	18.40	18.47	18.54
<b>Industrial sewer and purification</b>	3.95	3.95	3.95	3.95	3.95	3.95	3.95	3.95	3.95	3.95	3.95	3.95	3.95	3.95	3.95	3.95	3.95	3.95	3.95	3.95	3.95	3.95	3.95	3.95	3.95
<b>Supplied the reservoir for the industrial area</b>	4.77	4.77	4.77	4.77	4.77	4.77	4.77	4.77	4.77	4.77	4.77	4.77	4.77	4.77	4.77	4.77	4.77	4.77	4.77	4.77	4.77	4.77	4.77	4.77	4.77
<b>Supplied to the reservoir for the irrigation area</b>	4.14	4.14	4.14	4.14	4.14	4.14	4.14	4.14	4.14	4.14	4.14	4.14	4.14	4.14	4.14	4.14	4.14	4.14	4.14	4.14	4.14	4.14	4.14	4.14	4.14
<b>Substituted to reduce the existing supply</b>	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90
<b>Additional supplying for the irrigation area</b>	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24
<b>Tariffs of services</b>																									
<b>Civil sewerage service</b>	0.09	0.10	0.10	0.11	0.12	0.12	0.12	0.13	0.13	0.13	0.14	0.14	0.14	0.15	0.15	0.16	0.16	0.16	0.17	0.17	0.18	0.18	0.18	0.19	0.19
<b>Civil purification service</b>	0.28	0.30	0.32	0.33	0.35	0.37	0.38	0.39	0.40	0.41	0.42	0.43	0.44	0.45	0.46	0.48	0.49	0.50	0.51	0.52	0.54	0.55	0.56	0.58	0.59
<b>Industrial sewer and purification service</b>	0.46	0.48	0.49	0.50	0.51	0.53	0.54	0.55	0.57	0.58	0.59	0.61	0.63	0.64	0.66	0.67	0.69	0.71	0.72	0.74	0.76	0.78	0.80	0.82	0.84
<b>Water supply to the reservoir for industrial purposes</b>	0.57	0.58	0.60	0.61	0.63	0.64	0.66	0.68	0.69	0.71	0.73	0.75	0.76	0.78	0.80	0.82	0.84	0.86	0.89	0.91	0.93	0.95	0.98	1.00	1.03
<b>Water supply to the reservoir for irrigation purposes</b>	0.15	0.16	0.16	0.17	0.17	0.18	0.18	0.18	0.19	0.19	0.20	0.20	0.21	0.21	0.22	0.22	0.23	0.24	0.24	0.25	0.25	0.26	0.27	0.27	0.28

sewers linking to the existing effluent main<sup>1</sup>, and the development of a sewer and waste collection system in the industrial area.

For reuse the project contemplates the development of three modules of intensive treatment (tertiary), which will treat an average of just over 60% of the flow of purified waste<sup>4</sup>. Both the irrigation network

and the water distribution network for the industrial installations already exist.

The project proposer is the firm which has managed the integrated water service of the area object of the investment for the past 20 years<sup>5</sup>. The proposer is prepared to co-finance the investment (the size of the co-financing rate is yet to be decided), taking into account the receipts it will gain from

### The water demand

The volume of water to be treated has been estimated on the basis of an average daily water supply of 220 litres per inhabitant and taking into account the fluctuation in the population (in the three summer months the population resident in the city shrinks by an average of 25%).

The size of the daily water supply was determined on the basis of a study of the needs of the civil population of areas similar to those of the project (similar social customs, simi-

lar consumption levels, same geographic area, etc.) and corrected in the light of data on historic consumption in the city in question, available from the service provider, who is, as we have said, also the proposer of the investment<sup>2</sup>.

For the industrial area the water demand was estimated on the basis of the specific consumption of industrial installations and taking into account a period of activity of 11 months per year<sup>3</sup>.

<sup>1</sup>The existing urban effluent trunk main and the discharge main from the water purifier will only be modified slightly (the area linking it to the new plant and tertiary treatment), and the rest of the existing system will continue to be used. The purified water is discharged into the river.

<sup>2</sup>The volumes of wastewater take into account a dispersion co-efficient of 0.88. The contamination level (BOD Biochemical Oxygen Demand, COD, Chemical Oxygen Demand) was estimated using standard environmental engineering methods.

<sup>3</sup>The volumes of waste take into account a dispersion co-efficient of 0.70 in the industrial processes and in the waste collection systems. A specific analysis of the industrial processes was carried out to determine their contamination levels.

<sup>4</sup>Below this plant a lift station and a discharge pipe carry the treated water to a separator reservoir, from which, thanks to the force of gravity, it passes down pipes to the existing header tank of the irrigated area and the new reservoir above the industrial network.

<sup>5</sup>Although the firm has no specific experience in reuse technologies, it does have solid managerial experience in the civil field and has thus far achieved good quality levels in the service offered. It is also in a healthy economic-financial position and regularly and efficiently collects the proceeds from tariffs for the service.

springs providing suitable volumes, that exist only in an area at some distance from that of use. The small existing aqueduct will still be used to supplement supply and in peak periods.

The needs to be satisfied in the case of irrigation supply are twofold:

- it is necessary to significantly increase the supply of this resource in order to fully utilise the area already equipped with the distribution network in order to encourage and accompany the cultural transformation process underway towards non-surplus and higher added value production;
- the current use of the water-table and of a small body of surface water has put excessive pressure on these natural resources, which both show tangible signs of impoverishment and vulnerability; it is therefore necessary to reduce intake.

The development of these considerations led to the solution described in the previous section.

### Financial analysis

An explanation of the financial analysis and the result are shown in Tab. 3.7.

The time horizon is 25 years.

The analysis, conducted from the point of view of the financing agency, takes into consideration the costs and differential

the new services generated by the project. The total supply is considered gross of leakages in the water network. The real consumption is calculated as follow:

$$\text{real consumption} = \text{total supply} - \text{leakages}$$

### Project analysis

In the civil segment, the demand for purification comes from both the users of the existing urban sewer network and those who will be hooked up to the part to be developed.

In the initial year, the annual volumes of civil waste amount to 15.57 million cubic metres (Mm<sup>3</sup>), and industrial waste to 3.95 Mm<sup>3</sup>, for a total of 19.52 Mm<sup>3</sup> to be collected by the effluent trunk line and treated by the water purifier.

In order to determine the demand for water for reuse a preliminary analysis of different alternatives was made and the following conclusions reached.

Since a drastic increase in demand is expected from the industrial area, the optimum solution is to supply it entirely with treated waste water, rather than to build a new aqueduct which would need to be fed by

### The dynamics of demand

The dynamics of demand were determined bearing in mind the evolution of the population resident in the city, which has two components:

- a demographic rate of growth (the average for the region) of 0.20% per year;
- a migratory flow with a positive balance (mainly due to the growth in industrial activities) of 2,900 per year for the first 5 years, which is reduced by a third (to 1,933 per year) from the 6th to the 10th years and finally stabilises at a fifth (580 per year);
- no change in industrial demand is hypothesised.



### The tertiary treatment of waste

The plant for the intensive (tertiary) treatment of waste will be made up of three modules which, using part (520 litres per second) of the flow discharged by the water purifier, will treat 11.88 Mm<sup>3</sup> of water per year with an output of water available for reuse of 8.91 Mm<sup>3</sup>/year, which will be utilised as follows:

- 4.77 Mm<sup>3</sup>/year are destined for industry, which will be supplemented (0.87 Mm<sup>3</sup>/year) by the existing aqueduct in order to cover all needs;
- 4.14 Mm<sup>3</sup>/year are destined for agriculture, during the irrigation season of roughly seven months, which will serve to half the volumes currently abstracted from natural sources, which will thus fall from 3.80 Mm<sup>3</sup>/year to 1.90 Mm<sup>3</sup>/year and also to supply new resources; the total volume available will be 6.04 Mm<sup>3</sup>/year.

The non-treated flow from the re-use modules will still be discharged into the river.

revenue generated by the development of the proposed investment compared to those of a scenario without the investment.

Some hypothesis on the calculation of financial costs and benefits are summarized in Tab. 3.6.

Among the costs considered are those necessary for the development of the project, including expenses for studies, planning, management of the work, trials, other general expenses, and all costs related to the development and testing of the works foreseen. The total cost (Euro 89.15 million) has been subdivided into homogeneous categories, whose values have been attributed (at constant prices) to the first three years, on the basis of the schedule for the implementation of the project.

The additional running costs, that is those necessary to carry out the services generated by the investment (the new sewers for 25% of the population, the purification plant for the whole city and for the industrial area, the supply of water for industry and for agriculture), include costs for personnel (subdivided between technical and administrative staff), electricity, maintenance including spare parts, reagents and other goods for purification and tertiary treatment, for eliminating treatment sludge, for the purchase of other goods and intermediary services (technical and administrative).

Wherever possible these costs have been quantified on the basis of the technical data for the project (electricity, maintenance, reagents, eliminating sludge), or by extrapolation of the data obtained from the

management experience of the proposer (personnel, other goods and services).

The calculation of the maintenance costs was carried out on the basis of prices on the local market, or, when these were not available, on those of the region or country.

In addition to the costs above, the costs for the replacement of components with a “short” life compared to the time horizon of the project were considered: that is, basically, machines and other electromechanical equipment for the treatment and raising plants which, in accordance with the technical data from the literature, are assumed to have a useful life of 15 years.

Tab. 3.7 Table for the financial analysis - Thousands of Euro

	Years																										
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25		
New urban sewer system		140	449	480	512	529	548	567	586	603	621	639	657	677		696	716	737	759	781	803	827	850	875	900		
New urban purifying system		1711	5491	5871	6253	6471	6695	6926	7164	7373	7588	7808	8035	8269		8509	8756	9010	9272	9541	9817	10102	10394	10695	11005		
Industrial sewer and purification system		642	1975	2025	2075	2127	2180	2235	2291	2348	2407	2467	2528	2592		2656	2723	2791	2861	2932	3005	3081	3158	3237	3317		
Water supplying for industrial tank		949	2918	2991	3066	3142	3221	3302	3384	3469	3555	3644	3735	3829		3925	4023	4123	4226	4332	4440	4551	4665	4782	4901		
Water supplying for irrigation (additional)		121	374	383	393	402	412	423	433	444	455	467	478	490		502	515	528	541	555	568	583	597	612	627		
<b>Revenue from services</b>		<b>3564</b>	<b>11207</b>	<b>11750</b>	<b>12299</b>	<b>12672</b>	<b>13056</b>	<b>13451</b>	<b>13858</b>	<b>14237</b>	<b>14625</b>	<b>15025</b>	<b>15435</b>	<b>15856</b>		<b>16289</b>	<b>16733</b>	<b>17189</b>	<b>17658</b>	<b>18140</b>	<b>18635</b>	<b>19143</b>	<b>19665</b>	<b>20201</b>	<b>20751</b>		
Revenues from other services		51	156	160	164	169	173	178	183	188	193	198	203	209		215	220	226	233	239	245	252	259	266	273		
<b>Residual value of infrastructures</b>																									<b>39438</b>		
<b>Total revenues</b>		<b>3615</b>	<b>11363</b>	<b>11910</b>	<b>12463</b>	<b>12841</b>	<b>13229</b>	<b>13629</b>	<b>14041</b>	<b>14425</b>	<b>14818</b>	<b>15223</b>	<b>15638</b>	<b>16065</b>		<b>16503</b>	<b>16953</b>	<b>17416</b>	<b>17891</b>	<b>18379</b>	<b>18880</b>	<b>19395</b>	<b>19923</b>	<b>20467</b>	<b>60462</b>		
Technical personnel		259	444	1372	1414	1456	1500	1545	1591	1639	1688	1738	1791	1844	1900		1957	2015	2076	2138	2202	2268	2336	2406	2479	2553	
Administrative personnel		76	157	806	830	855	881	907	934	962	991	1021	1052	1083	1116		1149	1184	1219	1256	1293	1332	1372	1413	1456	1499	
Reagents and other specialist materials		0	0	690	707	725	743	761	780	800	820	840	861	883	905		927	951	974	999	1024	1049	1076	1103	1130	1158	
Energy for lifting		0	0	52	53	54	55	56	57	58	60	61	62	63	64		66	67	68	70	71	73	74	76	77	79	
Energy for plants		0	0	555	566	577	589	601	613	625	637	650	663	676	690		704	718	732	747	762	777	793	808	825	841	
Maintenance		119	244	1248	1279	1311	1344	1378	1412	1447	1484	1521	1559	1598	1638		1678	1720	1763	1808	1853	1899	1947	1995	2045	2096	
Cost of eliminating mud		0	0	597	612	627	643	659	675	692	710	727	745	764	783		803	823	843	865	886	908	931	954	978	1003	
Intermediate goods and technical services		25	52	266	272	279	286	293	301	308	316	324	332	340	349		358	366	376	385	395	405	415	425	436	447	
Administrative, financial, economic services		0	29	146	150	154	158	161	165	170	174	178	183	187	192		197	202	207	212	217	223	228	234	240	246	
<b>Total operating costs</b>		<b>479</b>	<b>925</b>	<b>5732</b>	<b>5883</b>	<b>6038</b>	<b>6198</b>	<b>6361</b>	<b>6529</b>	<b>6702</b>	<b>6879</b>	<b>7061</b>	<b>7248</b>	<b>7439</b>	<b>7636</b>		<b>7838</b>	<b>8046</b>	<b>8259</b>	<b>8478</b>	<b>8703</b>	<b>8934</b>	<b>9171</b>	<b>9415</b>	<b>9665</b>	<b>9921</b>	
Labour		7698	14456	7860																							
Materials		11688	21950	11934																							
Rentals		1017	1909	1038																							
Transports		895	1680	914																							
Expropriations		1063	767	299																							
Project studies, works management, trials		1796	1660	526																							
<b>Total investment costs</b>		<b>24156</b>	<b>42422</b>	<b>22571</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>		<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	
Replacement cost for “short life” components																	16109										
<b>Total expenditures</b>		<b>24156</b>	<b>42901</b>	<b>23495</b>	<b>5732</b>	<b>5883</b>	<b>6038</b>	<b>6198</b>	<b>6361</b>	<b>6529</b>	<b>6702</b>	<b>6879</b>	<b>7061</b>	<b>7248</b>	<b>7439</b>	<b>7636</b>		<b>23947</b>	<b>8046</b>	<b>8259</b>	<b>8478</b>	<b>8703</b>	<b>8934</b>	<b>9171</b>	<b>9415</b>	<b>9665</b>	<b>9921</b>
<b>Net cash flow</b>		<b>-24,156</b>	<b>-42,901</b>	<b>-19,881</b>	<b>5,631</b>	<b>6,027</b>	<b>6,425</b>	<b>6,643</b>	<b>6,868</b>	<b>7,100</b>	<b>7,340</b>	<b>7,546</b>	<b>7,758</b>	<b>7,975</b>	<b>8,199</b>	<b>8,429</b>		<b>-7,444</b>	<b>8,907</b>	<b>9,157</b>	<b>9,413</b>	<b>9,676</b>	<b>9,946</b>	<b>10,224</b>	<b>10,509</b>	<b>10,802</b>	<b>50,541</b>
<b>Financial internal rate of return (FRR/C) of the investment</b>																											<b>6.45%</b>
<b>Financial net present value (FNPV/C) of the investment</b>																											<b>15042</b>

### Inflation

- An inflationary dynamic was applied to costs (constant annual accrual of 2.5%)
- for real salaries a growth accrual of +0.5% annually (accrual of monetary wages = 3.0% annually),
- prices for energy discount a differential of -0.5% compared to inflation.

### The calculation of revenues

The revenue predicted for the initial year (Euro 9,818,000) has been calculated as follows:

- Civil sewerage service (new connections for 25% of residents): 3.89 Mm<sup>3</sup>/year x Euro 0.093 per m<sup>3</sup> = Euro 362,000;
- Civil purification service (in the current situation “without the intervention” no purification charge is applied): 15.57 Mm<sup>3</sup>/year x Euro 0.28 per m<sup>3</sup> = Euro 4,422,000;
- Industrial sewer and purification service: 3.95 Mm<sup>3</sup>/year x Euro 0.46 per m<sup>3</sup> = Euro 1,834,000;
- Industrial supply in the reservoir: 4.77 Mm<sup>3</sup>/year x Euro 0.57 per m<sup>3</sup> = Euro 2,710,000;
- Irrigation supply (additional volumes): 2.24 Mm<sup>3</sup>/year x Euro 0.15 per m<sup>3</sup> = Euro 347,000;
- Revenue from other services (3% of the first and the second): Euro 144,000.

In accordance with the regulations of the country in which the investment will be made, the tariffs are revalued according to inflation<sup>6</sup>.

To take into account the time necessary to construct the infrastructures, a receipts correction co-efficient was introduced into the calculation.

<sup>6</sup>Furthermore, when the investment is being partially co-financed by the proposer/manager – as it is in this case – an increase greater than the rate of inflation is allowed. In the analysis we assume a further increase of 3% annually for the first 6 years, applied only to the tariffs for civil sewerage and purification services.

**Tab 3.8 Conversion factors for the economic analysis**

Type of cost	cf	Notes
Labour and personnel	1.00	For simplicity and conservatism
Materials	0.83	55% machinery and manufactured goods, 45% building materials
Rentals	0.88	40% personnel, 30% energy, 20% maintenance, 10% profits (cf = 0)
Transport	0.88	40% personnel, 30% energy, 20% maintenance, 10% profits (cf = 0)
Expropriation	1.25	100% land
Project studies, works management, trials and other general expenses	1.00	Absorbed by personnel
Land	1.25	Standard co-efficient x local price (30% higher than prices paid for expropriation)
Machinery, manufactured goods, carpentry, etc...	0.82	50% local production (SCF), 40% imports (cf = 0.85), 10% profits (cf = 0)
Building materials	0.85	75% local materials (SCF), 15% imports (cf = 0.85), 10% profits (cf = 0)
Electricity, fuels, other energy prices	0.96	SCF
Maintenance	0.97	80% personnel, 20% materials
Reagents and other specialist materials	0.80	30% local production (SCF), 60% imports (cf = 0.85), 10% profits (cf = 0)
Intermediate goods and technical services	0.95	70% personnel, 30% manufactured goods
Administrative, financial and economic services	1.00	100% personnel
Resulting value of investment costs	0.91	Weighted by the types of project costs

The calculation was carried out by introducing, for simplicity's sake, the whole cost of the such equipment in the sixteenth year, revalued according to inflation.

The revenue derives from the tariff receipts for the new services provided, valued according to the respective tariffs

practised in the area of the investment applied to the volumes measured by means of the meters installed.

In the last year of calculation the residual value of the infrastructures is added to the previous financial input, which is calculated, simply, as a proportional quota

of the residual useful life of the cost of the investment, revalued according to inflation.

The following indices are obtained from the cash flows: FNPV = 15,042 thousands Euro; FRR/C = 6.45%.

**Economic analysis**

To convert the prices of the financial analysis specific conversion factors (see Tab. 3.8) and standard conversion factor (SCF) have been used.

The conversion factors allow for the correction of market prices for distortions which distance the value from that of long term equilibrium (transfers, state aid, etc.).

The calculation of the residual value of the infrastructures

The value applied (€ 39,438,000) was obtained using the following lengths of useful life:

- network and sewers: 40 years,
- reservoirs and tanks: 50 years,
- machinery: 15 years;
- carpentry: 25 years;
- building for the plant: 40 years.

The conversion factors allow for the calculation of the social costs due to the investments, the running costs and the renewal of "short" life equipment (see financial analysis).

Added to these are the negative externalities: the costs due to the opening of the site, which have an impact mainly on the urban

area, transport and other territorial functions, and the cost of using the land.

The costs due to the consumption of unused land are absorbed in the revalued investment costs.

The overall impact of the opening of the construction sites must necessarily be estimated approximately on the basis of the value of the social cost due to the prolonged opening of the construction site. This proxy is roughly EUR 6,500,000 for each year's delay in concluding the works. This amount, revalued according to inflation, was applied as a cost in the first three periods of the analysis.

The social cost due to the use of the land (about 37 ha) for constructing the new infrastructure is not completely represented by the cost of expropriation (to which its own conversion factor was applied), inasmuch as this is not representative of the value attributable to the best use of the

**Tab. 3.9 Some hypothesis for quantification of economic costs and benefits**

	Years																								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
<b>Quantities</b>																									
<b>Residents</b>																									
Demographic increase	235,470	235,941	236,413	236,886	237,359	237,834	238,310	238,786	239,264	239,743	240,222	240,702	241,184	241,666	242,150	242,634	243,119	243,605	244,093	244,581	245,070	245,560	246,051	246,543	247,036
<b>Migratory flow</b>																									
Annual value	2,900	2,900	2,900	2,900	2,900	1,933	1,933	1,933	1,933	1,933	580	580	580	580	580	580	580	580	580	580	580	580	580	580	580
Incremental value	2,900	5,800	8,700	11,600	14,500	16,433	18,367	20,300	22,233	24,167	24,747	25,327	25,907	26,487	27,067	27,647	28,227	28,807	29,387	29,967	30,547	31,127	31,707	32,287	32,867
Residents served by the water purifier	238,370	241,741	245,113	248,486	251,859	254,267	256,676	259,086	261,497	263,909	264,969	266,029	267,091	268,153	269,216	270,281	271,346	272,412	273,479	274,547	275,617	276,687	277,758	278,830	279,903
Residents served by sewers	59,593	60,435	61,278	62,121	62,965	63,567	64,169	64,772	65,374	65,977	66,242	66,507	66,773	67,038	67,304	67,570	67,836	68,103	68,370	68,637	68,904	69,172	69,439	69,707	69,976
<b>Annual volumes (millions of cubic metres)</b>																									
New civil sewer	3.948	4.004	4.060	4.115	4.171	4.211	4.251	4.291	4.331	4.371	4.388	4.406	4.424	4.441	4.459	4.476	4.494	4.512	4.529	4.547	4.565	4.582	4.600	4.618	4.636
Purification treatment for civil uses	15.791	16.015	16.238	16.462	16.685	16.845	17.004	17.164	17.324	17.483	17.554	17.624	17.694	17.764	17.835	17.905	17.976	18.047	18.117	18.188	18.259	18.330	18.401	18.472	18.543
Industrial sewer and purification	3.946	3.946	3.946	3.946	3.946	3.946	3.946	3.946	3.946	3.946	3.946	3.946	3.946	3.946	3.946	3.946	3.946	3.946	3.946	3.946	3.946	3.946	3.946	3.946	3.946
Reutilize volume for industrial and irrigation uses	8.909	8.909	8.909	8.909	8.909	8.909	8.909	8.909	8.909	8.909	8.909	8.909	8.909	8.909	8.909	8.909	8.909	8.909	8.909	8.909	8.909	8.909	8.909	8.909	8.909
Gross discharged volume	10.828	11.052	11.275	11.499	11.722	11.882	12.041	12.201	12.361	12.520	12.591	12.661	12.731	12.801	12.872	12.942	13.013	13.084	13.154	13.225	13.296	13.367	13.438	13.509	13.580
Net discharged value	8.663	8.841	9.020	9.199	9.378	9.505	9.633	9.761	9.888	10.016	10.072	10.129	10.185	10.241	10.298	10.354	10.410	10.467	10.523	10.580	10.637	10.693	10.750	10.807	10.864
<b>Wholesale industrial supply</b>																									
Supplied to the reservoir for the industrial area	4.770	4.770	4.770	4.770	4.770	4.770	4.770	4.770	4.770	4.770	4.770	4.770	4.770	4.770	4.770	4.770	4.770	4.770	4.770	4.770	4.770	4.770	4.770	4.770	4.770
<b>Irrigation</b>																									
Supplied to the reservoir for the irrigated area	4.139	4.139	4.139	4.139	4.139	4.139	4.139	4.139	4.139	4.139	4.139	4.139	4.139	4.139	4.139	4.139	4.139	4.139	4.139	4.139	4.139	4.139	4.139	4.139	4.139
Volumes previously supplied	3.800	3.800	3.800	3.800	3.800	3.800	3.800	3.800	3.800	3.800	3.800	3.800	3.800	3.800	3.800	3.800	3.800	3.800	3.800	3.800	3.800	3.800	3.800	3.800	3.800
Volumes substituted	1.900	1.900	1.900	1.900	1.900	1.900	1.900	1.900	1.900	1.900	1.900	1.900	1.900	1.900	1.900	1.900	1.900	1.900	1.900	1.900	1.900	1.900	1.900	1.900	1.900
Additional volumes	0.339	0.339	0.339	0.339	0.339	0.339	0.339	0.339	0.339	0.339	0.339	0.339	0.339	0.339	0.339	0.339	0.339	0.339	0.339	0.339	0.339	0.339	0.339	0.339	0.339
<b>Accounting prices (euro)</b>																									
Civil sewerage service (Euro per capita served)	104.80	107.60	110.48	113.44	116.47	119.59	122.79	126.08	129.45	132.92	136.48	140.14	143.89	147.75	151.71	155.78	159.96	164.25	168.66	173.18	177.83	182.61	187.51	192.55	197.72
Civil and industrial purification	0.81	0.83	0.85	0.87	0.90	0.92	0.94	0.96	0.99	1.01	1.04	1.06	1.09	1.12	1.15	1.18	1.20	1.23	1.27	1.30	1.33	1.36	1.40	1.43	1.47
Water supplied to the reservoir for industrial purposes (Euro/m3)	0.97	0.99	1.02	1.04	1.07	1.10	1.12	1.15	1.18	1.21	1.24	1.27	1.30	1.33	1.37	1.40	1.44	1.47	1.51	1.55	1.59	1.63	1.67	1.71	1.75
Accounting price for irrigation water substituted (Euro/m3)	0.17	0.17	0.17	0.18	0.18	0.19	0.19	0.20	0.20	0.21	0.21	0.22	0.22	0.23	0.23	0.24	0.25	0.25	0.26	0.26	0.27	0.28	0.28	0.29	0.30
Accounting price for additional irrigation water (Euro/m3)	0.81	0.83	0.85	0.87	0.90	0.92	0.94	0.96	0.99	1.01	1.04	1.06	1.09	1.12	1.15	1.18	1.20	1.23	1.27	1.30	1.33	1.36	1.40	1.43	1.47
New civil sewerage service		2,257	7,047	7,334	7,602	7,879	8,166	8,463	8,770	9,041	9,320	9,608	9,905	10,211	10,526	10,851	11,186	11,531	11,887	12,254	12,631	13,021	13,422	13,836	
Civil and industrial purification service		2,563	8,037	8,398	8,725	9,063	9,413	9,775	10,149	10,461	10,782	11,113	11,454	11,805	12,166	12,538	12,921	13,316	13,722	14,141	14,572	15,015	15,472	15,942	

The standard conversion factor

The SCF is defined according to the following formula and is based on the macro-economic data given below (values in EUR million):

$$SCF = \frac{M + X}{(M+TM) + (X-TX)} = 0.96$$

- where: M = value of imports = 4,000
- X = value of exports = 3,000
- TM = taxes on imports = 600
- TX = taxes on exports = 300

Tab. 3.10 Table for the economic analysis - Thousands of Euro																											
cf(3)	Years																										
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25		
New civil sewage service			2257	7047	7334	7602	7879	8166	8463	8770	9041	9320	9608	9905	10211	10526	10851	11186	11531	11887	12254	12631	13021	13422	13836		
Civil and industrial purification service			2563	8037	8398	8725	9063	9413	9775	10149	10461	10782	11113	11454	11805	12166	12538	12921	13316	13722	14141	14572	15015	15472	15942		
Water supplying for industrial tank			1618	4974	5098	5226	5356	5490	5628	5768	5913	6060	6212	6367	6526	6690	6857	7028	7204	7384	7569	7758	7952	8151	8354		
Water saved			110	338	347	355	364	373	383	392	402	412	422	433	444	455	466	478	490	502	515	527	541	554	568		
Additional water			636	1956	2005	2055	2107	2159	2213	2269	2325	2384	2443	2504	2567	2631	2697	2764	2833	2904	2977	3051	3127	3206	3286		
Revenue from services			7183	22352	23182	23963	24770	25602	26461	27348	28141	28958	29798	30663	31552	32467	33409	34378	35374	36399	37454	38539	39656	40804	41986		
Revenues from other services			48	149	153	158	162	166	171	175	180	185	190	195	200	206	211	217	223	229	235	242	248	255	262		
Residual value of infrastructures	0.91																								35885		
Total revenues			7232	22502	23335	24121	24932	25769	26632	27523	28321	29143	29988	30858	31753	32673	33620	34595	35597	36628	37689	38781	39904	41059	78132		
Opening of the building sites			6508	6671	6838																						
Consumption of land																											
Loss of agricultural production			164	168	172	176	181	185	190	195	200	205	210	215	220	226	232										
Cost of expropriation already considered			-1325	-957	-373																						
Total net cost of consumption of land			-1161	-789	-201	176	181	185	190	195	200	205	210	215	220	226	232	237	243	249	256	262	268	275	282	289	296
External costs			4187	5094	6436	353	362	371	380	390	399	409	419	430	441	452	463	475	486	499	511	524	537	550	564	578	593
Technical personnel	1.00		259	444	1372	1414	1456	1500	1545	1591	1639	1688	1738	1791	1844	1900	1957	2015	2076	2138	2202	2268	2336	2406	2479	2553	
Administrative personnel	1.00		76	157	806	830	855	881	907	934	962	991	1021	1052	1083	1116	1149	1184	1219	1256	1293	1332	1372	1413	1456	1499	
Reagents and other specialist materials	0.80				550	564	578	592	607	622	638	654	670	687	704	722	740	758	777	797	817	837	858	879	901	924	
Energy for lifting	0.96				50	51	52	53	54	55	56	57	58	59	61	62	63	64	66	67	68	70	71	72	74	75	
Energy for plants	0.96				532	543	554	565	576	587	599	611	623	636	649	662	675	688	702	716	730	745	760	775	791	807	
Maintenance	0.97		115	235	1206	1236	1267	1299	1331	1365	1399	1434	1469	1506	1544	1582	1622	1663	1704	1747	1790	1835	1881	1928	1976	2026	
Intermediate goods and technical services	0.95		24	49	251	258	264	271	278	284	292	299	306	314	322	330	338	347	355	364	373	383	392	402	412	422	
Administrative, financial, economic services	0.55		29	146	150	154	158	161	165	170	174	178	183	187	192	197	202	207	212	217	223	228	234	240	246		
Total operating costs			473	914	4914	5045	5179	5317	5459	5605	5754	5908	6066	6228	6394	6565	6740	6921	7106	7296	7492	7693	7899	8111	8328	8552	
Labour	1.00		7698	14456	7860																						
Materials	0.83		9721	18256	9925																						
Rentals	0.88		896	1682	914																						
Transports	0.88		788	1480	805																						
Expropriations	1.25		1325	957	373																						
Project studies, works, management, trials	1.00		1796	1660	526																						
Total investment costs			22223	38490	20404																						
Replacement costs	0.91																									14658	
Total expenditures			26410	44057	27753	5267	5407	5550	5697	5849	6004	6163	6327	6495	6668	6846	7028	7213	7407	7605	7807	8016	8230	8449	8675	8907	9145
Net cash flow			-26410	-44057	-20521	17235	17929	18571	19234	19920	20628	21359	21994	22648	23320	24012	24725	25458	26213	26990	27790	28613	29460	30332	31229	32152	68988
Economic internal rate of return (ERR)																											18.23%
Economic net present value (ENPV)																											185034

talisation, treatment and the lack of production (only for adults); thus a value of Euro 104.80 per year was obtained per resident served. The dynamics of this price were calculated as an average weighted between the inflationary coefficient and the salary coefficient.

Civil and industrial water purification gives rise to benefits in different sectors, first and foremost the environmental protection of water and land, but also the safeguarding of human health and the integrity of the living species. A possible conservative approximation to evaluate these positive externalities can be obtained by putting a value on the volumes of purified water discharged and susceptible for re-use for different purposes, also on other sites. In this case the volumes of purified water not used in situ and thus discharged, reduced by a dispersion coefficient (0.80), are equal to roughly 8.5 Mm<sup>3</sup>/year, hypothesising a potential irrigation re-use, at an accounting price of Euro 0.81 per m<sup>3</sup>, already used to evaluate the benefits of the additional supply of resources for irrigation purposes.

The conversion coefficients were also applied to the benefits deriving from the revenue from the other services and to the residual value of the infrastructure.

same land in the local situation. For this reason this cost was evaluated considering the added value of the additional agricultural production obtainable from well irrigated land (estimated to be Euro 4,462) – used also for the evaluation of the benefit due to the additional supply of water for irrigation purposes. Obviously the revalued cost of the expropriation must be subtracted from the value obtained.

For the evaluation of the benefits - in all cases where it was deemed applicable - the willingness to pay method was used, establishing accounting prices for the services that may have an alternative market. Since

the accounting price thus obtained refers to the service to the end-user, in order to obtain the price required for the analysis appropriate breakdown coefficients derived from literature and experience were taken into account<sup>7</sup>.

The benefits due to the new sewerage service have been assimilated into the social value of diseases avoided, without considering, conservatively, also the deaths avoided. Thus the average annual incidence of potential infections and other serious illnesses on children, adults of working age and old people was evaluated, calculating the costs of days of hospi-

Tab. 3.11 Table for sensitivity analysis		
Change in the parameter	% Change in FNPV	%Change in ENPV
<b>Price dynamics</b>		
Inflation rate of 3% and 2%	+44% / -41%	+9.6% / -9.0%
Dynamics of real salaries at +1% and at 0%	-14% / +13%	roughly constant
Dynamics of energy prices equal to inflation	-3%	roughly constant
<b>Dynamics of tariffs</b>		
Reduction to 3 years of the period of tariff increases for investments	-50%	no change
<b>Demographic dynamics</b>		
Rate of annual increase in the population (0%)	-16%	-4%
Costs of goods and services		
Cost of reagents increased by +10%	-7%	-0.4%
Cost of eliminating mud increased by +10%	-6%	roughly 0%
Cost of electricity increased by +10%	-5%	roughly 0%
<b>Revenue and benefits</b>		
Tariffs for services +10% and -10%	+116 / -116%	roughly 0%
Improvement in agricultural production increased by 10%	no change	+8%

<sup>7</sup>Accounting price for the supply of industrial water: Euro 1.29 per m<sup>3</sup> x 0.60 (breakdown coefficient only for conduction) = Euro 0.97 per m<sup>3</sup>.  
Accounting price for the supply of irrigation water: Euro 0.21 per m<sup>3</sup> x 0.80 (breakdown coefficient only for conduction) = Euro 0.17 per m<sup>3</sup>



From the cash flows shown in table 3.10, the following indices are obtained: ENPV = 185,034 thousands Euro; ERR = 18%.

#### Sensitivity analysis

The sensitivity analysis, carried out on those parameters that the proposer felt were most critical, produced the results shown in the table 3.11 in terms of change in financial and economic NPV compared to the values of the basic case.

Risk analysis was carried out on the most critical variables: inflation rate, tariffs, population (this analysis is not presented here).

## 3.3 Transport

### Introduction

This section illustrates the investments for the development of new transport infrastructures. These may include new transport lines or new transport nodes or the completion of existing networks, as well as those intended to upgrade existing lines or nodes.

The proposed methodology is mainly focussed on road and rail transport modes. However, the general principles may also be applied to other modes, for example to sea and air, whose specificity is not dealt with.

#### 3.3.1 Objectives definition

The socio-economic objectives of transport projects are generally related to the improvement of travel conditions for goods and passengers both inside the study area and to and from the study area (accessibility) as well as the improvement of the quality of the environment and the well being of the served population.

More in details, the transport problems the projects address and have as their purpose may be of the following types:

- reduction of congestion by eliminating capacity constraints on single network links and nodes or by building new and alternative links or routes;

- improvement of the performance of a network link or node, in particular by increasing travel speeds and by reducing operating costs and accident rates through the adoption of safety measures for network links;
- shift of transport demand to special transport modes (many of the investments which have been made in the past few years, where the problem of environmental externalities has arisen as a critical factor, aim at a modal shift of travel demand, from the most polluting modes to those which impact less from an environmental viewpoint);
- completion of missing links or poorly linked networks. Transport networks have often been developed on a national and/or regional basis, which may no longer meet transport demand requirements. This is above all the case of railways;
- improvement of the accessibility of peripheral areas or regions.

The first step is intended to make clear the project objectives which are strictly related to the transportation sector, (for example in terms of mode rebalance), as well as those of a more general kind (environmental protection, regional development, etc.).

After the project objectives have been made clear, the following step is intended to check whether the identification of the project is consistent with the objectives.

#### 3.3.2 Project identification

##### Typology of the investment

A good starting point for briefly, but clearly and unequivocally, identifying the infrastructure is to state its functions, which should be coherent with the objectives of the investment. This should be followed by a description of the type of action, that is whether it is a completely new road, or a link of a larger infrastructure, or part of an extension or modification of an existing road or railway (for example the construction of a third lane for a two-lane motorway, the

laying of a second track or the electrification and automation of an existing railway).

#### Territorial reference framework

Projects can be parts of national, regional or local transport plans or promoted by bodies of different natures. In both cases the functional incorporation of the planned infrastructure into the (existing or planned) transportation system (whether urban, regional, interregional or national) should be facilitate the consideration of network effects.

A second important aspect is consistency with national and European transport policy: fiscal policies (i.e. on fuel), allocative efficiency of the proposed tolling systems, environmental constraint or target, other incentive/transfer policies in the sector, technological standard.

Another element which should be considered is the degree of consistency with any other development project and/or plan which may be drawn up for the investment area both internal to transport sector and related to sectors that could have impacts on transport demand (land use, development plan).

#### Regulatory framework

Regulation of the transportation sector has significantly evolved in the past ten years. This evolution has arisen from the need to overcome the inefficiency of monopolistic systems by introducing competition for transportation services and regulation instruments for “natural monopolies”, i.e. for infrastructures.

From a community viewpoint, the European Union has gradually developed specific

#### Typology of investments

- new infrastructures (road, rail, ports, airports) to satisfy increasing transport demand
- completion of existing networks (missing links)
- extension of existing infrastructure
- renovation of existing infrastructure
- investment in safety measures on existing links or networks
- improved use of the existing networks (i.e better use of under-utilised network capacity)
- improvement in intermodality (interchange nodes, accessibility to ports and airports)
- improvement in networks interoperability
- improvement in the management of the infrastructure

#### Functional characteristics of the investments:

- increasing capacity of existing networks
- reducing congestion
- reducing externalities
- improving accessibility to peripheral regions
- reducing transport-operating costs

#### Types of services:

- infrastructures for densely populated areas
- infrastructures for long distance travel demand
- infrastructures for freight transport
- infrastructures for passenger transportation

actions and recommendations for the member countries, starting from the Nineties. As to actions, community interventions have mainly focussed on the regulation and development of the infrastructural network, on problems of tariffs of infrastructure and internalisation of external costs.

#### 3.3.3 Feasibility and options analysis

##### Analysis of demand

The estimate of the existing demand and its forecast into the future is a complex and critical task that often consumes a substantial part of the resources allocated to the feasibility study.

### BOX 3.2 Legislative framework

#### White papers

Future development of the Common Transport Policy - White Paper/COM (92) 494

Fair payment for infrastructure use: a phased approach to a common transport infrastructure charging framework in the EU - White Paper /\*

#### COM/98/0466 final

European transport policy for 2010: time to decide - White Paper/ COM/2001

Trans European Networks - Transport (TEN-T) Decision No 1692/96/EC of the European Parliament and of the Council of 23 July 1996 on

Community guidelines for the development of the trans-European transport network

Decision of the European Parliament and of the Council amending Decision No 1692/96/EC on Community guidelines for the development of the trans-European transport network COM/2001

As to the reference scenario (i.e. the do-nothing or the do-minimum scenario), it is recommended to make clear as follows:

- the area of influence of the project, this aspect is important to identify the demand without the project and the impacts of the new infrastructure as well as to identify the other transport modes which could be considered (for example in case of corridors where there are often several modes: road, rail and air transport);
- the procedure which has been applied to estimate existing demand and to estimate future demand (use of single or multi-modal models, extrapolations from past trends, fares and costs for users, pricing and regulation policies, the congestion and saturation levels of networks, the new investments which are expected within the time span of the analysis);
- the assumptions concerning the competing modes and alternative routes (fares and costs for users, pricing and regulation policies, the congestion and saturation levels of networks, the new investments which are expected within the time span of the analysis);
- any deviation from past trends and comparison with large-scale prospects (on a regional, national, European level).

In the presence of a high degree of uncertainty about future demand trends, it may be advisable to develop two or more than two scenarios, an optimistic and a pessimistic one, and to relate the two hypotheses to the trends of the GNP or of other macroeconomic variables.

As to the solution/s with a project, it should be firstly kept in mind that the transportation system is a multi-modal system. The same transport demand may be, at least partially, met by various transport modes. Transport modes may compete for the same demand.

There may be competition even inside the same transport mode (for example among ports or airports, road routes or rail passes)

for transport nodes, but also for the interventions focussing on particularly dense networks, above all long-distance traffic.

The estimates of the potential demand should make clear as follows:

- the composition of the traffic which is attracted by the new infrastructure or by the strengthened infrastructure, in terms of the existing traffic, the traffic which has been diverted from other modes and the generated or induced traffic;
- the elasticity to time and costs which is implicit in the estimates of the traffic which has diverted from other modes, properly disaggregated and compared with literature data or data taken from other projects (travel demand characteristics, structure and elasticity are particularly important in the projects which may be related to charged infrastructures since the expected volumes of traffic are determined by the level of fares);
- the sensitivity of the expected traffic flows for some critical variables: elasticity to travel times and costs, congestion levels of competing modes, strategies of competing modes, for example in terms of fare policies. This point is particularly important when it is necessary to make investments requiring long execution times. In the span of time which is required to complete the intervention, the traffic, which may be potentially acquired by the new infrastructure, may meanwhile shift to other modes and then it may be difficult to move it back.

An aspect, which may be of relevance for the financial and economic evaluation, concerns the generated traffic, i.e. the traffic which only occurs in the presence of a new infrastructure (or in case of an increase in the capacity/speed of the existing infrastructure) and which is quite different from the traffic diverted from other modes or routes.

At first instance induced traffic could be estimated on the basis of the demand ela-

sticity to generalised transport costs (times, costs, comfort..). Since nevertheless traffic is dependent upon the spatial distribution of economic activities and households, for a correct estimate, it is recommended that the changes in accessibility of the area induced by the project are analysed. This will normally require the use of integrated regional development/transport models which have limited application fields at present, but great development prospects. In the absence of these instruments, it is necessary to estimate the generated traffic with caution and to carry out sensitivity (see below) or risk analysis on this traffic component.

#### The technical features

The demand/capacity ratio of the new infrastructure will be analysed for any project alternative which is considered. This will be based on:

- the service levels of the infrastructure in terms of a traffic/capacity relationship (traffic flows on roads, passengers on public/collective transport systems, etc.). It is useful to separately analyse the different traffic components both in terms of flow types (internal, exchange or cross traffic) and on the basis of their origin (traffic diverted from other transport modes and any generated traffic);
- the travel times and costs for users (disaggregated by traffic and origin typology);
- transport indicators: passengers km and vehicles km for passengers, tons km and vehicles km for goods;
- the traffic safety levels in the new infrastructure or in the new configuration of the existing infrastructure;

In the presence of several alternatives and of congestion phenomena, it is important to establish whether the demand is not fulfilled and, if this is the case, to find out which traffic has been “rejected”. This is an important element to evaluate the economic consequences of solutions which are less rich from an infrastructural viewpoint.

At the end of the feasibility analysis, it should be necessary to define the relevant alternatives which will be evaluated from an environmental, financial and economic viewpoint. The ensemble of results will represent an input for the following environmental, financial and economic analysis.

#### Options analysis

The construction of a reference solution and the identification of promising alternatives are two aspects which will influence all the results of the following evaluations.

The reference solution will generally correspond to a do-nothing decision. However, in some cases it may involve a problem in the transportation sector. If the reference solution is “catastrophic”, i.e. if the decision of not investing would result in a traffic paralysis and, therefore, in very high social costs, any project will bring high benefits, however expensive it may be.

In the case of great congestion phenomena, whether at present or in the future, to avoid distorting the results of the analysis, it is necessary to configure a reference solution integrating do-minimum interventions (of management, technological application, etc.). This could be probably put into action to provide for a transport demand adjustment in the absence of the project and to reduce the future costs of the reference solution to an acceptable level.

The analysis of alternative project solutions is equally critical. After having defined the reference solution and analysed the critical aspects in terms of a demand/capacity ratio (see below), it is necessary to identify all promising technical alternatives on the basis of physical circumstances and available technologies.

The main risk of distorting the evaluation is the risk of neglecting relevant alternatives, in particular low-cost solutions (managing and pricing solutions, infrastructural interventions which are considered as not “decisive” by designers and promoters, etc.).

**Investment costs and operating costs**

The feasibility analysis is also intended to estimate for each alternative and reference solution the investment costs and the expenses for renewals and extraordinary maintenance operations (which will be carried out at regular intervals) for the whole analysis period. These costs should be allocated all over the time, on the analysis period. It will be also necessary to define the technical life of the work and its residual value.

It is necessary to make sure that the project includes all the works required for its functionality (for example the links to the existing networks, technological plants, etc.) as well as all the relevant costs of each alternative, that the estimates of implementation costs and times are realistic and prudent, “on the safe side”, mainly in the projects which may have a special significance for the local community.

The operating and ordinary maintenance costs of the planned works should also be described and quantified.

For collective transport modes, it is necessary to develop an operating model and to calculate its costs. A hypothesis should be put forward for example for the operation of the railway, as to the number of trains which may be provided by type of train (goods, passengers, by making a distinction between short and long-distance traffic), where each service is associated to the relating costs. The same applies for node infrastructures, such as ports and airports.

**Fares**

Just because transport demand may apply to other modes or routes, fares will influence the expected volumes of demand. It is therefore fundamentally important for the various tariff hypotheses to reconsider the estimates of demand and to associate the correct traffic volumes to each of them.

The pricing criteria for transport infrastructures are complex and they may create confusion during the financial and economic evaluation. In particular, the fares which maximise the proceeds for the managers/constructors of infrastructures and which therefore maximise the capacity of self-financing may be quite different from the efficiency fares. This because the latter fares, which take into consideration the surplus for the community consider also the external costs (congestion as well as environment and safety costs).

Efficient pricing is based on long-term marginal social costs and requires the “internalisation of external costs” (Polluter Pays Principle), including congestion and environment costs. As to congestion, this type of pricing should generally involve low tolls where or when there is no congestion so as to maximise the use of the infrastructure and high tolls where or when this phenomenon occurs. If the infrastructure is not congested, a conflict will arise between the need for self-financing and the optimal use of the work. In this case, a toll which is intended to recover a fraction of the investment costs can cause underutilisation and an inefficient use of the work.

The fares (“network access tolls”) of the railway sector represent the most innovative factor which should be analysed with great care.

There are two opposite strategies: the Anglo-German strategy (average cost tolls) featuring very high values and the French strategy (marginal cost tolls) featuring very low values. This will not completely solve either the problem of congestion tolls (when demand exceeds supply) or the problem of track allocation criteria. Special services, for example on a local level, may enjoy partial or total benefits and the allocation of tracks (i.e. of capacity) may be subject to constraints for the protection of the operator who is historically present

(“grand-fathers right”). The ensemble of tolls and regulatory constraints outlines a framework which is quite complex for the correct evaluation of the flows of future proceeds, above all if in far-off times. Tolls may have a significant feedback effect on the expected traffic, thus changing the economic profitability of the project.

Similar problems may also affect ports and airports.

It is therefore important to make clear the pricing criteria, which have been applied for rated infrastructures (in consideration of the fact that external costs vary according to traffic levels).

**3.3.4 Financial analysis**

Financial analysis should be carried out according to standard methods, as they are set forth in the second chapter of this Guide.

The analysis will be generally conducted from the viewpoint of the infrastructure owners (generally managers but not necessarily operators of the infrastructure). If required, it may be carried out for the owners and the operators, first separately and then in a consolidated way.

Financial investment costs, including the expenses for renewals and extraordinary maintenance operations as well as operating costs (including the ordinary maintenance costs of planned works and those related to tolling) are estimated during the technical analysis, disaggregated by the type of works into which the intervention may be broken down and allocated all over the time and on the basis of elementary cost components (labour force, materials, carriage and freightage) so as to enable the subsequent application of the conversion factors from financial into economic costs.

Financial inputs will be represented by the proceeds from the tolls and/or tariffs applied for the sale of well-defined services.

The estimate of proceeds should be consistent with the hypotheses which have been put forward for the evolution and elasticity of demand (see the previous section about pricing criteria). The financial analysis of non-rated infrastructures will show the net present cost at the public finance’s expense.

As to the recourse to private financing, it is necessary to pay attention to any inefficiency which may result from the adoption of pricing criteria other than those related to marginal social costs.

**3.3.5 Economic analysis**

The economic evaluation of the sector shows some specific aspects since the transportation sector is often characterised by “administered prices” (for example subsidies for collective modes) and by high “external” costs (for example environmental costs). These quantities are different from those used in the financial analysis.

For economic investment and operating costs of vehicles, if market prices are deemed to reflect the shortage of resources, it will be necessary to eliminate transfers from the financial costs by applying a conversion factor to each elementary cost component (labour force, materials, carriage and freightage) and by taking tax burdens into account. If market prices are not deemed to reflect the shortage of resources for some components, it will be necessary to apply shadow prices to correct costs (see the general methodology described in the second chapter of the Guide).

Benefits traditionally result from the variations in the area underlying the transport demand curve (Consumer Surplus, see below) as well as from the variations in economic costs (the costs of resources, including external costs).

Benefits are obtained by adding the following components:

- variations in the surplus of consumers (including the time multiplied for the



value of time value and all user charges, including fares, tariffs and tolls and changes in vehicles operating costs met by the users, i.e. for private transport);

- variations in the surplus of producers (including the profits and losses of infrastructure managers, if available, and of public transport operators as well as any variation in taxes and subsidies for the government);
- changes in unperceived costs (car drivers are in some cases assumed not to perceive non-fuel elements of costs, such as tyres, maintenance and depreciation. Changes in car travel can lead to changes in these costs, that must be added to the consume surplus calculation;
- variations in external costs.

Both the calculation of the surplus of consumers and the calculation of external costs should take into account goods which have no market (see below) and those whose estimate may require special techniques.

When calculating the benefits, it is recommended to make a distinction between the benefits for existing traffic (for example a time and cost reduction as a result of a speeding up process), the benefits of the traffic diverted from other modes (variations in costs, times and externalities as a result of the passage from a mode to another one) and the benefits of generated traffic (social surplus variation).

If the demand level is given, where time and money costs changes but demand stays the same, i.e. in the absence of generated traffic, the analysis will be restricted to the variations in the economic costs net of any transfer. In the presence of generated traffic, it is necessary to reconstruct the demand curve and to calculate the social surplus for the part of traffic which would not exist in the absence of the project.

A series of goods which have no market should be given great importance in the economic evaluation of any project which may be related to transport infrastructure, i.e. the value of time, environmental effects, the value of avoided accidents.

- The value of time: time benefits often represent the most relevant part of the benefits of transport projects. Some European countries put at the disposal of evaluators the national estimates of the time value by reason and sometimes by mode, in particular for passengers. In the absence of these reference estimates, it is possible to derive the values of time from users' actual choices or to re-adjust and to re-weight the estimates from other studies on the basis of income levels.

With a few exceptions (the goods having a very high value), the time value of goods is generally very low and it should be calculated on the basis of the capital lock-up. In

Tab. 3.12 Estimates of average external costs of transport (EU17)

Passenger (Euro/1000 pkm)					
	Car	Motorcycle	Bus	Rail	Aviation
Accidents	36.0	250.0	3.1	0.9	0.6
Noise	5.7	17.0	1.3	3.9	3.6
Air pollution	17.3	7.9	19.6	4.9	1.6
Climate change	15.9	13.8	8.9	5.3	35.2
Freight (Euro/1000 tonkm)					
	LDV*	HDV**	Rail	Aviation	Waterborne
Accidents	100.0	6.8	11.5		
Noise	35.7	5.1	3.5	19.3	
Air pollution	131.0	32.4	4.0	2.6	9.7
Climate change	134.0	15.1	4.7	153.0	4.2

Source: INFRAS-IWW

\* = LDV Light Duty Vehicles (Vans up to 3,5 tonnes gross weight)

\*\* = HDV Heavy Duty Vehicles (Roads truck above to 3,5 tonnes gross weight)

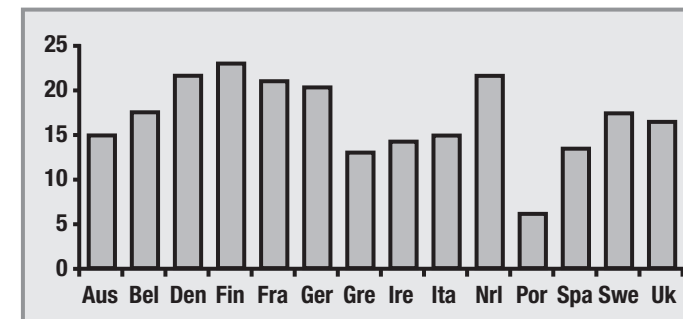


Fig. 3.6 Quantification of economic benefits.

Values of time per persons per hour business (1995 euro)

any case, since it is a quantity which can be hardly estimated, the general description of the project should make clear the values of time (which have been disaggregated by reason of the travel and flow) and used in the demand estimate and evaluation as well as the ways by which they have been obtained.

Values of non-working travel time (including homework commuting) vary, in most countries, from 10 to 42% of the working time value. Non-working travel time typically makes up a large proportion of the benefits of transport investments.

- The external costs: environmental externalities generally depend upon the travel distances and exposure degrees to polluting emissions (except for CO<sub>2</sub> representing a “global” pollutant). In order to monetise the environmental effects, in the absence of local values, it is possible to apply to the “physical” estimates of pollutants the “shadow prices” which have been inferred from the scientific literature (properly adjusted for the fractions of external costs already internalised for example by taxes on fuel).

The present methods, which are intended to evaluate the external costs related to prevented accidents, should be referred to the average dangerousness levels by transport mode. For example, for road traffic, the average cost by vehicle-km or by passenger-km is generally calculated on the basis of the costs of all road accidents (by adding all the costs of dead and injured people), net of the component which has already been internalised by insurance costs, and of the whole traffic.

Estimates of values of time per hour per person during work by car taken can be taken from the EUNET project. The range of values is largely dependent on variations in wage levels.

### 3.3.6 Other evaluation criteria

#### Environmental analysis

Community and national laws require evaluation of the environmental impact for most investments in the transportation sector, in particular for the development of new infrastructure. In these cases, reference should be made to the evaluation methods which have been recommended.

However, even if is not prescribed by the law, it is advisable to analyse the environmental impact from a general viewpoint, to identify the impact the project alternatives may have and to provide for (if possible) a quantitative evaluation on the basis of their impact and localisation in order to draw a comparison among the alternatives and to identify any mitigating and compensating measures.

#### Impact on the economic development

This is one of the most controversial aspects of the economic evaluation of transportation projects from a theoretical and an empirical viewpoint. However, it is important to keep in mind that the impacts on the economic development may be both positive and negative. It means that in the presence of market distortions, increased accessibility of a suburban area or region may result in a competitive advantage, but also in a loss of competitiveness if industry is less efficient than in the central regions. In this case, increased accessibility may force local industry out of the market. It is therefore necessary to proceed with caution when assigning the project such kinds of benefit and, in any case, it is advisable to exclude them from the calculation of profitability indicators.

The routine procedure for evaluating these benefits in terms of a income multiplier/ac-

celerator is distorting. Actually, these multipliers may be applied to public expenditure. It is therefore necessary to calculate the differential between the multiplier of the investments in the transportation sector and the multiplier of other sectors. This is a method which is not advisable, except for some special cases.

In any case if there are no major distortions in the transport-using sectors, i.e. markets are reasonably competitive, the use of transport costs and benefits (time savings, externalities...) could be considered as an acceptable approximation of the final economic impact of the transport projects.

**3.3.7 Sensitivity, scenario and risk analysis**

Sensitivity analysis consist in examining the extent to which the profitability indicators for the various alternatives vary with some key variables in order to check the soundness of the achieved results and the ranking of any tariff alternative as well as to identify the riskiest areas.

Because of their criticality it is advisable to carry out sensitivity analysis at the money values which have been assigned to the goods without any market. Other sensitivity analysis may be focussed, for example, on investment and operating costs or on the expected demand, in particular the generated traffic.

**3.3.8 Case study: investment in a motorway**

The project is intended to realise a new motorway which links two medium size urban areas and crosses a densely populated area. The local road network represents the transportation offer. The recent increase in traffic volumes, which is expected to continue in the future, is causing problems of congestion in some part of the existing network, and environmental and safety problems to the people living in the area.

The general objectives of the project are:

- to reduce congestion on the existing network;

- to face the forecasted increase in passengers and freight demand due to the rapid development of the area;
- to reduce the exposure of people living in the area to air pollution and noise;

As an accompanying measure, heavy vehicles will be banned from the most environmental sensible part of the existing link.

The whole traffic that will be attracted by the new infrastructure is the traffic diverted from the existing roads plus some newly generated traffic. The pattern of land use development of the area is car dependent, and there are no significant alternatives to road transport.

As the area is already densely populated, and congestion is highly localised, the new road is expected to have a limited impact in terms of additional traffic. The public funding of the new infrastructure cannot entirely cover the amount of the investment costs, as a consequence the new road will be tolled.

**Traffic forecast**

The following table shows the estimated traffic flows at the opening year of the new highway.

**Tab. 3.13 Traffic forecast**

Daily traffic at the opening year				
	Diverted from the existing network	Generated	Total on the highway	Staying on the existing network
<b>Tolled highway</b>				
Heavy vehicles	5 901	487	6 388	20 429
Passengers vehicles	24 228	3 720	27 948	126 331

**Financial analysis**

Financial investment costs have been disaggregated by the type of works into which the intervention may be broken down and on the basis of elementary cost components (labour force, materials, carriage and freightage) so as to enable the subsequent application of the conversion factors from financial into economic costs.

Investment costs include the expenses which will be borne to build the motorway and its crossings, the costs of the accessory network required guaranteeing the connections with the new motorway and the restoration of the ordinary network, expropriations and overheads.

An estimate has been made for the ordinary and extraordinary maintenance costs of the planned works as well as for the administrative costs, including those related to tolling costs. The personnel, materials, freightage and carriage costs have been specified in this case too.

The costs for ordinary and extraordinary maintenance have been calculated on a 90 km project length and on the basis of the average value of maintenance costs for similar roads.

It has been assumed that the residual value of the road will amount to 50% of the initial value at the end of the analysis period, except for the expropriations whose residual value will be equal to the initial value.

Proceeds will derive from the traffic using the new motorway. National fares will be applicable. The internal financial rate of return is 0.5%.

**Economic analysis**

The economic analysis will take into account any cost and benefit of relevance for society, which may be generated by the project. Financial investment costs have been adjusted for fiscal components. As to the labour force, the personnel cost has

**Tab. 3.14 Table for financial analysis**

	Years																													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Passengers vehicles				20	22	24	26	29	31	34	37	40	44	47	51	55	60	64	70	72	72	72	72	72	72	72	72	72	72	72
Heavy vehicles				12	13	14	16	17	19	20	22	24	26	28	30	33	36	38	42	45	45	45	45	45	45	45	45	45	45	45
<b>Total revenues</b>				<b>32</b>	<b>35</b>	<b>38</b>	<b>42</b>	<b>46</b>	<b>50</b>	<b>54</b>	<b>59</b>	<b>64</b>	<b>70</b>	<b>75</b>	<b>81</b>	<b>88</b>	<b>95</b>	<b>103</b>	<b>111</b>	<b>117</b>	<b>117</b>	<b>117</b>	<b>117</b>	<b>117</b>	<b>117</b>	<b>117</b>	<b>117</b>	<b>117</b>	<b>117</b>	
<b>Maintenance</b>																														
Labour				10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Raw materials				8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Freight				5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Tolls collection																														
Labour				5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Raw materials				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
<b>Total operating costs</b>				<b>28</b>	<b>28</b>	<b>28</b>	<b>28</b>	<b>28</b>	<b>28</b>	<b>28</b>	<b>28</b>	<b>28</b>	<b>28</b>	<b>28</b>	<b>28</b>	<b>28</b>	<b>28</b>	<b>28</b>	<b>28</b>	<b>28</b>	<b>28</b>	<b>28</b>	<b>28</b>	<b>28</b>	<b>28</b>	<b>28</b>	<b>28</b>	<b>28</b>	<b>28</b>	<b>28</b>
Labour	321	321	161																											
Raw materials	367	367	184																											
Freight	142	142	71																											
Carriage	88	88	88																											
Expropriations	295																													
Overheads	22	22	11																											
<b>Total investment costs</b>	<b>1236</b>	<b>941</b>	<b>514</b>																											
<b>Total expenditures</b>	<b>1236</b>	<b>941</b>	<b>514</b>	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28
<b>Net cash flow</b>	<b>-1236</b>	<b>-941</b>	<b>-514</b>	<b>4</b>	<b>7</b>	<b>10</b>	<b>14</b>	<b>17</b>	<b>21</b>	<b>26</b>	<b>31</b>	<b>36</b>	<b>41</b>	<b>47</b>	<b>53</b>	<b>60</b>	<b>67</b>	<b>74</b>	<b>83</b>	<b>88</b>	<b>88</b>	<b>88</b>	<b>88</b>	<b>88</b>	<b>88</b>	<b>88</b>	<b>88</b>	<b>88</b>	<b>88</b>	<b>1581</b>
<b>Financial internal rate of return (FRR/C) of the investment</b>																														
<b>Financial net present value (FNPV/C) of the investment</b>																														

been adjusted for national insurance contributions and taxable income shares. The conversion factor was equal to 0.56. The materials item has been deprived of the sole fiscal component, value added tax. Two items have been specified for freightage and carriage: energy and others. The share of the energy component has been reduced by the amount of the tax burden amounting to 33%. The two conversion factors have been set to 0.95 for carriage and 0.934 for freightage.

The financial cost of overheads has been assumed as an indicative value of the economic cost. As to the land, expropriation costs are reflecting market costs. The conversion factor which has been assumed is equal to 1 in this case too. Conversion fac-

tors have been applied to investment and maintenance costs as well as to tolling.

The project benefits have been subdivided into two components: the benefits for the users who will use the new tolled road and the benefits for the users who will continue to use the existing network.

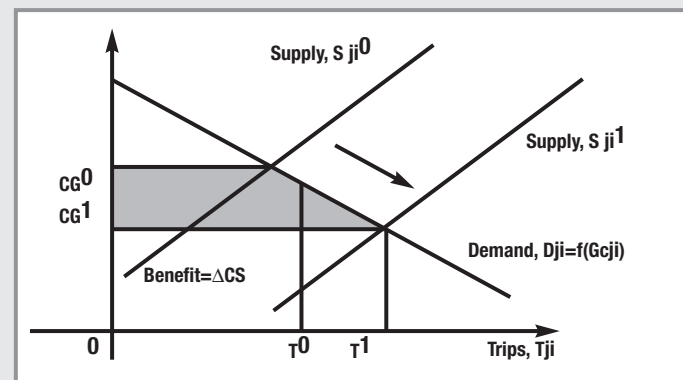
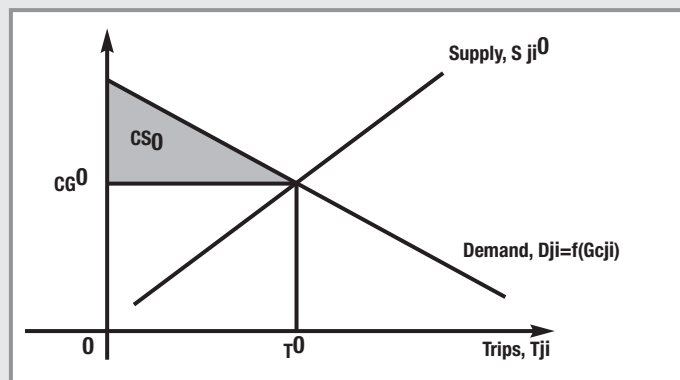
The users of the new road (the diverted traffic and the generated traffic) are due to the fact that the new route is shorter and quicker and that it is crossing areas which are less densely populated. The users who continue to use the existing network are due to the fact that the new infrastructure will reduce the traffic, increase the travel speed and improve the use of the existing network.

### BOX 3 How to calculate economic benefits by quantification of consumer surplus

User benefits for transport projects can be defined by the concept of the consumer surplus. Consumer surplus is defined as the excess of consumers willingness-to-pay<sup>17</sup> over the prevailing generalised cost of i-j travel. Total consumer

surplus (CS0) for a particular i and j in the do-something scenario is shown diagrammatically in the figures. It is represented by the area beneath the demand curve and above the equilibrium generalised cost, area CS0.

User benefit<sub>ij</sub> = Consumer surplus<sub>ij<sup>1</sup></sub> - Consumer surplus<sub>ij<sup>0</sup></sub>  
Where 1 is the do-something scenario and 0 is the do-nothing scenario.  
If there is an improvement in supply conditions



(for example for improvement in road infrastructure) consumer surplus will increase of an amount of DCS, due to a reduction in equilibrium generalised cost. Usually we do not know the real shape of the demand curve, we only know GC and T in the do-something situation and a forecast of GC and T in

the do-something situation. The demand curve is only supposed to be a straight line as shown in the figure, even it is not the case in reality. The user benefit can be approximated by the following function, known as the rule of a half<sup>18</sup>:

$$\Delta CS = \int_{CG_1}^{CG_0} D(GC) dGC \text{ Rule of a Half (RoH)} = \frac{1}{2} (CG_0 - CG_1) (T_0 + T_1)$$

When the effect of a project can be captured in the form of a reduction in generalised costs between particular origins and destinations, the rule of a half is a useful approximation to true user benefits. It is recommended to use the rule of a half to calculate user benefits in most cases.

Source: TINA Appraisal Guidance, October 1999

<sup>17</sup> Willingness-to-pay is the maximum amount of money that a consumer would be willing to pay to make a particular trip; generalised cost is an amount of money representing the overall disutility of travelling between a particular origin (i) and a destination (j) by a particular mode (m).

<sup>18</sup>  $(CG^0 - CG^1) \times T^0 + (CG^0 - CG^1) \times \frac{T^0 - T^1}{2} = (CG^0 - CG^1) \left( \frac{T^0 + T^0 - T^1}{2} \right) = (CG^0 - CG^1) \left( \frac{2T^0 + T^0 - T^1}{2} \right) = (CG^0 - CG^1) \left( \frac{T^0 + T^1}{2} \right)$

	Financial costs		Economic costs		Conversion factors
	Cost/1000km	Cost/1000h	Cost/1000km	Cost/1000h	
Gasoline, lubricants	403		177		0,44
Other costs depending on km	291		228		0,79
Labour costs		26.366		14.765	0,56
Insurance, depreciation depending on driving times		1647		1521	0,92
<b>TOTAL</b>	<b>694</b>	<b>28.013</b>	<b>405</b>	<b>16.286</b>	

The benefits are made up of three items for both categories of users: variations in operating costs, variations in times, and variations in the emissions of polluting externalities.

The variations in operating costs: only variable costs (fuel, lubricant, tyres and a fraction of maintenance and insurance costs) and travel distances have been taken into account for passengers' vehicles. The decrease of covered kms is not deemed to have an impact on the purchase of vehicles.

These variable costs have been deprived of fiscal components (fuel taxes).

No shadow price has been applied for energy. Driving costs have been considered for the costs of goods vehicles, in addition to the costs mentioned above.

Variation in travel times: the time value which has been applied for passengers will vary according to travel reasons. The value-used are EUR 10 for business trips, EUR 4.5 for any other reason. Only the main polluting emissions have been taken into account for environmental externalities.

The reference values on which the cost estimation is based derive from those explicitly recommended for the country. The internal economic rate of return is 4.4%.

#### Analysis of scenarios

Two scenario analysis have been conducted: by decreasing the benefits of the two goods without any market, i.e. time and external cost, by 50% and by removing the tolls from the new road, where the realisation of the second analysis was even more complex.

This has slightly decreased investment costs, completely removed tolling costs and provided for a much more intensive utilisation of the new road. This will considerably increase the benefits for the diverted traffic which will prove to be much heavier than in the rated hypothesis and for the traffic remaining on the existing network.

Time saving for the new road, though solid, is not enough to justify for many users, especially the relatively short runs, the extra monetary cost due to tariff. So, the with-tariff system leads to an underutilization of the new infrastructure and, consequently, a smaller flow of benefits, both of time for users than of reduction of environmental external cost.

The results of the economic evaluation show a relative fragility of the project. The ERR is slightly below the acceptability threshold. The analysis also shows the relevance of the benefits of non-market goods to the economic feasibility of the project, the evaluation of which maintains a certain degree of uncertainty.

	Financial costs	Economic costs	Taxes	Conversion factors
Perceived cost (gasoline, lubricants)	107	48	59	0,44
Overall operating cost (including maintenance, depreciation etc.)	311	209	102	0,67
Unperceived cost	205	162	43	0,79





### 3.4.5 Economic analysis

Environmental impact and risk assessment are essential aspects. Externalities to be considered are:

- the valuation of the area served, quantifiable by the revaluation of real estate and land prices,
- the negative externalities of possible impact on the environment (loss of land, spoiling of scenery, naturalistic impact) and on other infrastructure
- the negative externalities due to the opening of building sites, especially for urban networks (negative impact on housing, productive and service functions, mobility, agricultural framework and infrastructure).

Economic rate of return*	Energy transport and distribution
minimum	8.57
maximum	25.00
average	14.19
standard deviation	7.65

\* Sample data: 3 major projects out of 7 in the sector included in the sample of 400 projects combined.

### 3.4.6 Other evaluation criteria

See the corresponding section for energy.

### 3.4.7 Sensitivity and risk analysis

Critical factors: investment costs and length of the cycle.

The variables that should be considered in the sensitivity and risk analysis are:

- the cost of the investment,
- demand dynamics (i.e. forecasts of growth rates, of the elasticity of electricity consumption, etc.),
- the dynamics of the sale prices of substitutes electricity or gas.

## 3.5 Energy production

### 3.5.1 Objectives definition

Measures may include:

- construction of plants to produce electricity from any source

- prospecting and drilling natural gas or oil fields
- actions directed at energy saving

Examples of objectives are:

- increased energy production to cover growing demand
- reduction of energy imports by substitution with local or renewable sources
- modernisation of the existing plants for energy production, e.g. for reasons of environmental protection
- modification of the *mix* of energy sources, e.g. increasing the share of gas or renewable sources.

### 3.5.2 Project identification

When defining the functions of the project, it is advisable to:

- state destination, dimension and location of the potential area served (e.g. research and drilling of a new well field may have as its objective the supply of energy for more than one country, a new power station may serve an entire region, and so on).
- describe the projected positioning of the product on the market
- state the phases of the investment; e.g. for a well field the prospecting and research within the target area, initial test drilling, mining and commercial exploitation, closure.
- describe the engineering features of the infrastructure:
- basic functional data, such as: type of plant for producing electricity<sup>1</sup>, installed capacity (MWe) and energy produced (TWh/year); annual potential capacity of well fields (millions of barrels/year or millions of m<sup>3</sup>/year);
- physical characteristics<sup>2</sup>,
- building, technological and processing techniques for the production plants;
- building techniques and technical features of the plants for mining wells, e.g. off-shore platforms, attaching building and functional sketches;

- building techniques and technical features of the other service structures;
- the waste water and fumes treatment systems, with the number and the position of stuks and water discharges;
- significant technical elements, such as the constructions in caverns, dams, special technical solutions for treating refluxes, computerised control systems, telecommunications systems, etc.

### 3.5.3 Feasibility and options analysis

Key information: the demand for energy, seasonal and long-term trends and also, for electricity power stations, a typical graph of the daily demand for electricity.

The comparison in the options analysis should consider possible alternatives within the same infrastructure (e.g. different technologies for production and drilling, different technologies for treating refluxes, etc.) and possible realistic alternatives for producing the energy required (e.g. launching actions and policies aimed at energy saving instead of building a new power station).

### 3.5.4. Financial analysis

Forecast estimates are required for:

- price dynamics
- development scenarios of the other sectors (trends in energy demand are strongly linked to the dynamics in other sectors).

Time horizon: 30-35 years.

### 3.5.5 Economic analysis

The major problems to be faced are:

- the monetary value of benefits. They should be quantified as the revenue from the sale of energy (at appropriate accounting prices) and evaluated, wherever possible, by estimating the community's willingness to pay for energy, by, for example, quantifying the costs the user must incur to acquire energy (e.g. installing and using independent generators, or direct purchasing of combustibles on the market).
- the evaluation of environmental externalities:

- the cost of the measures necessary to neutralise possible negative effects on air, water, land.
- the cost of other negative externalities which cannot be avoided such as loss of land, spoiling of scenery...
- the identification of the opportunity cost of the various inputs. The economic costs of raw materials should be evaluated by considering the loss to society by the diversion of them from the best alternative use.
- the value attributed to a greater or lesser dependence on energy from abroad. The evaluation should be conducted by applying appropriate shadow prices<sup>3</sup> to the substituted imported energy (to quantify these, it would be advisable to refer to the suggested reading).

Economic rate of return*	Energy production
minimum	8.17
maximum	16.10
average	11.70
standard deviation	3.29

\* Sample data: 3 major projects out of 5 in the sector included in the sample of 400 projects combined.

### 3.5.6 Other evaluation elements

This section refers to:

- evaluation of the impact on the environment (visual, noise, pollution, and refuse) which, according to the laws of the majority of member states, must be a part of the approval procedures.
- evaluation of the indirect economic costs, for example those deriving from the use of exhaustible resources, not previously included in the estimates. They can be measured as standard physical indicators and then subject the project to a multi-criteria analysis.

### 3.5.7 Sensitivity and risk analysis

Critical factors: the high investment costs and the length of the cycle.

The sensitivity and risk analysis should consider at least the following variables:

- cost of the research phase (meaning the

<sup>1</sup> In the case of hydroelectric plants (production and/or pumping) linked to aqueducts, one must also bear in mind the observations for the aqueduct sector.

<sup>2</sup> For example: area covered by well field (Km<sup>2</sup>) and position. In the case of off-shore drilling, it would also be useful to provide local bathymetric profiles; average depth of deposits (m); area occupied (Km<sup>2</sup>) by plants (thermo-electricity) and relative storage areas, location of dams, pressure water-pipes and generators for hydro-electric production; area occupied by fields of photovoltaic generators (Km<sup>2</sup>) and their location.

<sup>3</sup> If, as often happens, there are strong distortions in the energy market (duties, internal taxes, prices levied, incentives, etc.) it would be wrong to evaluate the value of import substitution using these distorted prices.

- prospecting phase for new deposits or research into new technological processes),
- cost of the project implementation phase (site costs),
  - demand dynamics (i.e. forecasts of growth rates, of the elasticity of electricity consumption, etc.),
  - sales price dynamics for energy produced (or energy products),
  - mix and dynamics of critical input costs (fuels, etc.).

## 3.6 Ports, airports and infrastructure networks

### 3.6.1 Objectives definition

In general the aims of projects in this sector are:

- promoting local development either because it provides a direct service to productive activities or because it aims to satisfy the wider transport needs of the local population (in the case of tourist ports, these needs are by far the most important and consequently the analysis should show and quantify a positive impact locally)
- completing and permitting maximum utilisation of national/international transport networks.

### 3.6.2 Project identification

In order to correctly identify the project it is useful to:

- specify whether it is a completely new construction, extension or modification of an existing structure (e.g. the automation of traffic and the container park, the improvement of ground services at an airport).
- describe the engineering features of the infrastructure:
- type and size (range) of the means of transport (aeroplanes, ships, etc.) which will benefit from the structure;
- physical features: number and total length of airport runways, number and total

- length of piers or quays for ports, covered and uncovered storage area (in thousands of m<sup>2</sup>) for the intermodal structures.
- physical or functional links with other local transport systems e.g. motorways, roads, railways etc. (with schematic drawings); for an airport, the links with the cities it is to serve, for a tourist port the links with other tourist structures
- technical features and conformation of the major structures, including examples of one or two typical sections or sketches (sections of runways, the structural arrangement of the quays etc.) clearly showing the parts to be constructed,
- technical features of buildings and other service structures, with attached plans and sections;
- significant technical elements, such as internal transport, crane systems, equipment for computerised traffic control, automation of goods traffic, etc.

### 3.6.3 Feasibility and options analysis

Key issue: the volume of passenger and/or goods traffic, based on daily and seasonal trends.

Other essential information: the pattern of traffic flows, forecast for trends over time and technological solutions adopted.

### 3.6.4 Financial analysis

In the case of tourist ports or intermodal structures the managing body and the investors may be different.

- Financial inflows: rents, taxes and other forms of payment for the use of the structure and for any possible additional service offered (e.g. water and fuel supply, catering, maintenance and storage services).
- Financial costs: the investment costs<sup>1</sup>,

Financial rate of return*	Airports	Ports
minimum	6.19	3.66
maximum	16.02	15.49
average	10.73	8.49
standard deviation	3.22	4.47

<sup>1</sup> The investment cost includes e.g. the following: works, expropriation, indemnity and connection expenses, etc, expenses for special machinery and equipment, general expenses. In addition, the cost of extraordinary maintenance may be charged to the investor or to the licensee, according to the contract licence.

\* Sample data. Airports: 5 major projects out of 12 in the sector included in the sample of 400 projects combined.

Ports: 4 major projects out of 8 in the sector included in the sample of 400 projects combined.

depreciation, maintenance<sup>2</sup>, technical and administrative personnel costs and the purchasing price of the products and services needed for the day to day working of the structure and the additional services.

Time horizon: 30 years.

### 3.6.5 Economic analysis

The economic analysis may follow the pattern of that for roads, taking into account the following costs and benefits:

- the time saved if compared to a situation without the realisation of the project, to be quantified as suggested for roads and by dividing users into categories (e.g. passengers and goods).
- the time saved as a result of the substitution of other, less efficient transport systems (or goods handling), as an indication, the value of time considered in 27 major projects of the second generation (1994-99) was an average of 7.44 ECU/h (σ = 3.17 ECU/h) regardless of the type of user;
- possible variation in the rate of accidents<sup>3</sup>, especially in modernisation projects; considering not only the rate for users (passengers, staff, transporters, etc.) but also that for workers on the infrastructure itself;
- the reduced social income due to the decrease in traffic in other existing transport systems which may have been (partially) substituted by the new, more efficient structure.
- Negative externalities, such as: the loss of agricultural land, possible relocation of other infrastructure and/or possible relocation of residential, commercial or industrial areas, environmental pollution (acoustic, visual, etc.) and the raw material consumption<sup>4</sup>;
- positive externalities, as for example the increased value of land and real estate in the impact zone of a tourist port or the possible increase in local earnings due to the setting up of new enterprises (e.g. hotels, restaurants or shops in the new airport or port), with the warning to avoid double;
- additional income arising from trade.

<sup>2</sup> Ordinary maintenance; for extraordinary maintenance see previous note.

<sup>3</sup> The valorisation may follow the methodology described for roads.

<sup>4</sup> The impact of the latter may be valorised by referring to the loss in commercial value of real estate in that particular area.

Economic rate of return*	Airports	Ports
minimum	1.00	7.46
maximum	36.34	41.00
average	16.90	19.96
standard deviation	9.28	4.15

\* Sample data. Airports: 9 major projects out of 12 in the sector included in the sample of 400 projects combined.

Ports: 5 major projects out of 8 in the sector included in the sample of 400 projects combined.

### 3.6.6 Other evaluation elements

This section refers to:

- the impact on the environment (visual, noise, pollution etc.) which, in any case, according to the laws of the member states, must be a part of the approval procedures.
- the local impact on the territory (particularly in the case of new infrastructure or significant extensions), in terms of urban and traffic congestion, etc., showing that this has been kept to a minimum.

### 3.6.7 Sensitivity and risk analysis

Critical factors: the forecast traffic flows (demand), the lack of elasticity of the investment (excessive capacity is often required in the early stages of the exercise), the determining influence of side activities. Variables that should be taken into account:

- the rate of change of traffic over a period of time,
- the substitution rate of other existing infrastructure,
- the value of time,
- the value of life and temporary disability.

## 3.7 Training infrastructure

### 3.7.1 Objectives definition

Projects may concern:

- basic education
- vocational training
- higher levels (universities, business schools, etc.)
- particular needs for specialisation in productive areas
- improvement of the positioning of young people on the labour market



- homogenization of unequal geographic distribution of school services (projects in rural or isolated areas)
- elimination of discrimination between social classes, genders
- improvement of opportunities for the disabled.

### 3.7.2 Identification of the project

It would be advisable to:

- give the following basic data: geographic location (attaching maps), level and type of educational activity, number of pupils and geographic catchment area, associated services (libraries, sports-recreational activities, reception facilities, canteens, etc.).
- give the following engineering data for the structure:
  - covered area (m<sup>2</sup>) and uncovered equipped area (m<sup>2</sup>);
  - data and typical construction designs for buildings intended for pedagogical purposes (classrooms) and for related activities (laboratories, libraries, etc.);
- functional data and sketches for service structures (management, offices, gymnasiums, stadiums, guest-quarters, canteens, etc.);
- functional sketches and layout of the major technological equipment (internal networks, central heating, electrical and communications systems, etc.);
- internal viability systems (and possible car parks) and links with local communication routes;
- significant technical elements, such as particularly important architectonic constructions, laboratory or complex calculating equipment, etc.
- Summarize the proposed training plan over a number of years (number and type of courses, length, number and type of subjects taught, duration and timing of pedagogical and related activities, didactic methods, diplomas and other qualifications obtainable, etc.).

### 3.7.3 Feasibility and options analysis

Key issue: the demographic and labour market trends, which determine the poten-

tial number of pupils and the opportunities available to them.

The description should include:

- demographic trends disaggregated by age range and by geographic area,
- rate of enrolment, attendance and completion of studies<sup>1</sup>,
- employment forecasts for various sectors, including forecasts of the organisational changes within the various productive segments<sup>2</sup>.

### 3.7.4 Financial analysis

- Financial inflows: school fees, annual subscriptions, and prices of possible paid auxiliary services.
- Financial cost: the cost of the personnel necessary to run the structure (in the long term)
- Time horizon: 15-20 years

Financial rate of return*	Schools, universities, etc.
minimum	- 1.88
maximum	20.00
average	7.01
standard deviation	9.23

\* Sample data: 4 major projects out of 16 in the sector included in the sample of 400 projects combined.

### 3.7.5 Economic analysis

The following variables may be a starting point for the identification of the benefits:

- effective enrolment rates compared to potential ones,
- the share of students repeating the year,
- the percentage of pupils who complete the whole training course,
- the average attendance rate per pupil,
- the achievement of pre-established, measurable learning standards,
- the quality of pedagogical material,
- the suitability of equipment and its rate of use,
- the level of preparation and the commitment of the teaching staff, based on objective examination,
- the fungibility of the pedagogical content in as many and varied contexts as possible.

Economic benefits:

- the number (or percentage) of pupils who have found (or who are expected to find) productive employment and who, without this specific training, would have been unemployed or under-employed<sup>5</sup>. If the prominent objective is to improve the opportunities for potential pupils on the labour market, the benefits may be quantified and valorised by the expected increased income of the pupils due to the training received (avoided under-employment, better positioning on the market)<sup>3</sup>.
- Social costs: may be evaluated on the basis of the loss to society due to the deviation of factors from their best alternative use<sup>4</sup>.
- *Externalities*: loss of land, and other raw materials, possible mobility or construction congestion brought about by the installation of the infrastructure. If it can be predicted, the increase in incomes due to other possible induced activities, (commercial activities, restaurants, recreational activities, etc.).

Economic rate of return*	Schools, universities, etc.
minimum	3.35
maximum	47.52
average	17.53
standard deviation	14.20

\* Sample data: 6 major projects out of 16 in the sector included in the sample of 400 projects combined.

### 3.7.6 Other evaluation elements

An independent evaluation from a panel of qualified experts of the ability of the educational investment to meet the proposed objectives and social needs and of the suitability of the type of training programmes.

### 3.7.7 Sensitivity and risk analysis

The following parameters should be covered:

- rate of growth of the population (per age range) in the catchment area,

- rate of growth of salaries for teaching and non-teaching staff (see example shown in the graph below),
- the actual enrolment rate,
- the rate of employment of pupils who have completed their studies.

## 3.8 Museums and archaeological parks

### 3.8.1 Objectives definition

The investments have generally local objectives but may also have a more general value of a cultural nature.

### 3.8.2 Project identification

In keeping with the objectives, it is necessary to:

- state the type of infrastructure affected by the action (creation, renovation or extension): museums, historical monuments or buildings, archaeological parks, industrial archaeology
- list the services offered (research centres, information and catering services, internal transport..)
- include a summary of the cultural and/or artistic programmes planned for the medium term
- give the following engineering data:
  - √ basic data, primarily the number of expected users (per day, season, year, etc.) and the maximum capacity of the structure;
  - √ physical features: covered and showroom areas (m<sup>2</sup>) for museums and historical monuments or buildings, total area of parks or archaeological areas (m<sup>2</sup>), number of seats, usable area (m<sup>3</sup>) for theatres,
  - √ architectural characteristics, construction, and *layout* of museums, historical monuments or theatres,
  - √ technical features and *layout* of buildings or parts thereof dedicated to additional services

<sup>5</sup> Forecasts for this variable can be based on the long term studies carried out in other countries

<sup>3</sup> An alternative method, theoretically valid for all cases, is to refer to the willingness to pay, valuable as the average fees students would have to pay to take similar private courses. Great care should be taken when following this method due to possible distortionary effects: e.g. there may be a difference in quality between the training offered by the investment and what is already available privately, or there may be differing degrees of risk aversion according to income levels, and so forth. Wider discussion of the subject can be found in the suggested readings.

<sup>4</sup> For example, the social opportunity cost of teaching and other staff is equivalent to the product of these people in alternative occupations (quantifiable as the average market salaries for people of a similar training). That of the pupils, which should not be forgotten, is based on the estimated product of young people outside the education system, on the marginal basis that the project in question does not affect salaries.

<sup>1</sup> This information will be even more useful if broken down into sex, social class and geographic area.

<sup>2</sup> It is important to forecast the growth of new professions and the decline of others.

- √ process features and layout of the plants and of air-conditioning, lighting, communications, etc.;
- √ viability and access systems (plus possible car parks) and links with the local communications routes;
- √ significant technical elements, such as particularly exacting architectonic constructions, experimental restoration technologies, communication systems.

### 3.8.3 Feasibility and options analysis

Key issue: the potential flow of users, broken down according to type.

The comparison in the options analysis should consider:

- variations in structural arrangement or lay-out of the infrastructure,
- possible alternative technology and methods of restoration/recovery for existing buildings,
- alternative choices of infrastructure (e.g. one could consider establishing a museum of technology instead of recovering a historical industrial structure, etc.).

### 3.8.4 Financial analysis

- Financial inflows: admission fees (which cover only a fraction of the real costs), sales of collateral services and related commercial activities.
- Financial costs: personnel and maintenance (which may be predominant in the medium-long term).

Time horizon: 15-20 years.

### 3.8.5 Economic analysis

- Social benefits: evaluation may be based on the willingness to pay for the service on the part of the public<sup>1</sup>, for museums, archaeological parks etc.
- Social costs: evaluation may be based on the loss to the society due to the diversion of factors from their best alternative use. (e.g. the social opportunity cost of the staff employed is equivalent to the product of these people in alternative occupations).

- *Externalities*: loss of land and other raw materials, possible mobility or construction congestion brought about by the installation of the infrastructure and so on.
- Increases in incomes in the tourism sector (increased flow and longer average length of stay) induced
- additional increase in income due to other possible induced activities (commercial activities, restaurants, recreational activities, etc.).

### 3.8.6 Other evaluation elements

These should give a clear cultural and artistic profile of at least the medium-term programmes. The decisive element is the independent experts' opinion.

### 3.8.7 Sensitivity and risk analysis

Critical factor: the high personnel and maintenance costs and the long-term dynamics of admission fees.

Sensitivity and risk analysis should consider at least:

- the cost of the investment,
- the rate of growth of staff salaries,
- the rate of growth of effective demand (number of visitors per year),
- the admission fees
- with regard to maintenance, the risks related to possible damage, regardless of the cause.

## 3.9 Hospitals and other health infrastructure

### 3.9.1 Objectives definition

The objectives:

- may include the prevention and/or treatment of numerous pathologies.
- may refer to different ranges of the population, according to:
  - √ age (children's or geriatric hospitals, etc.);
  - √ gender (support structures for childbirth, andrology, etc.);

- √ professional conditions (traumatology centres for industrial accidents, sports or military hospitals, etc.).
- could be quantified by the increased life expectancy<sup>1</sup>.

### 3.9.2 Project identification

In order to correctly identify the project it is useful to:

- clearly define the functions of the proposed infrastructure and in particular the group of pathologies involved, the range of the population, the diagnostic functions, the short or long term treatment/recovery, reception facilities and connected services
- include the following data:
  - √ basic data, such as: the average and maximum numbers of users per day, month, year; a list of the departments for assistance and prevention, treatment and diagnosis; for a hospital the number of beds in each ward;
  - √ physical data such as the surface area and covered area (m<sup>2</sup>), usable space (m<sup>3</sup>), number of treatment rooms, wards, prevention and/or diagnostic consulting rooms, existence and size of outpatients department;
  - √ the functional arrangement of internal/external areas (lay-out), including viability between the various buildings and within them, under both normal and emergency conditions;
  - √ technical features of the principal equipment and machinery for diagnosis and/or treatment (e.g. X-ray, scans, nuclear medicine, endoscopes etc.);
  - √ Layout of the auxiliary plants and of the major systems (electricity, lighting, water, refuse and possible incinerators, fire-fighting equipment, air-conditioning, gas distribution, remote monitoring, communications, etc.);
  - √ architectural characteristics, construction, and *layout* of buildings or parts
  - √ viability and access systems (plus possible car parks) and links with the local communications routes, with possible

- privileged access for the casualty department, attaching appropriate blueprints;
- √ significant technical elements, such as particularly exacting architectonic constructions, special or experimental treatment or diagnosis machinery.

### 3.9.3 Feasibility and options analysis

Key issue: the patients flows and *trends* (determined on the basis of demographic data) and epidemiological and morbidity data for the pathologies involved<sup>2</sup>.

The comparison in the options analysis should consider possible alternative medical-technological solutions (different treatment systems, different diagnosis technologies, etc.) and possible general alternatives with the same socio-sanitary objectives (e.g. building an outpatients department instead of wards in a hospital).

### 3.9.4 Financial analysis

- Financial inflows: fees for hospital admission (e.g. the number of days the patient spends in hospital), diagnosis and treatment which are paid separately and additional services (single rooms, etc.).
- Financial costs: personnel, medicines and materials, *out-sourced* medical services necessary to run the structure.

Time horizon: at least 20 years.

### 3.9.5 Economic analysis

The key benefits are:

- the future saving in health costs, directly proportional to the decrease in the number of people affected and/or the lesser degree of gravity of the illness due to the implementation of the project (reduced outpatient and home assistance costs for those who avoided catching the illness, lower hospital and convalescence costs for those who have been treated more effectively);
- the avoided loss in production, due to the lower number of working days lost by the patient and his family;

<sup>1</sup> It does not seem correct to include the indirect costs of the visitor (journey, food, lodging etc.) to the value attributed to the willingness to pay, unless one can demonstrate that for the project in question, those expenses must be attributed exclusively to the desire to visit the structure or see the particular show and not to other recreational activities e.g. tourism.

<sup>1</sup> These are very rough indications. Obviously, in addition to the quantity there is also the quality of life: some indexes have been proposed which take this into account (Q.A.L.Y.), further details can be found in the publications suggested in the reading list.

<sup>2</sup> If no specific data is available for the catchment area in question, it would not be wrong to use data referring to socially similar areas.

- the increase in the welfare or the reduction in suffering on the part of the patients and their family, identifiable as the number of deaths avoided, the increased life expectancy of the patient and the improved quality of life for the patient and his family as a result of the illness avoided or the more effective treatment administered.

Benefits may be given a money value recurring to the market prices of the service (*willingness to pay*)<sup>3</sup> or using standard methods, as the indices for increased life expectancy, suitably adjusted by the quality (e.g. *Quality Adjusted Life Years*) which can be valorised according to the principle of lost income or to similar actuarial criteria.

Economic rate of return*	Hospitals
minimum	10.00
maximum	23.10
average	14.57
standard deviation	6.03

\* Sample data: 3 major projects out of 5 in the sector included in the sample of 400 projects combined.

### 3.9.6 Other evaluation elements

It may be helpful to evaluate the benefits in terms of simple physical indicators e.g. an analysis of the cost-effectiveness which is largely used in the health sector and offers comparable data.

A panel of independent qualified experts should also illustrate the intrinsic value of the project for the health system.

### 3.9.7 Sensitivity and risk analysis

Crucial factors:

- the availability and reliability of epidemiological data for the catchment area
- the risks incurred by administering (new) diagnostic, preventative or therapeutic treatment, etc)
- the difficulty in correctly evaluating trends in the costs of personnel, medicines etc. in the long term.

Sensitivity and risk analysis should consider at least the following variables:

- the cost of the investment,
- the percentage incidence of pertinent morbidity, disaggregated by pathological type, age range, sex, profession, etc.,
- tariffs for health services and their dynamics in time,
- dynamics in time of personnel costs,
- dynamics in time of the costs of medicines, products and critical services,
- the value and dynamics of the risks involved in carrying out diagnoses or treatment.

## 3.10 Forests and parks

### 3.10.1 Objectives definition

Forestry projects can have different primary objectives:

- projects aimed at increasing the production of wood or cork for commercial or energy purposes;
- projects aimed at increasing the production of non-wood products<sup>1</sup>;
- projects of an environmental character, such as establishing parks and protected areas, actions for the prevention of erosion, control of water, environmental protection (naturalistic, improvement of scenery, vision and noise screens, etc.);
- projects for promoting tourist-recreational activities<sup>2</sup>;

All investments in forestry bring about multiple effects (land protection, water regulation, species conservation, environmental protection).

### 3.10.2 Project identification

It would be advisable to:

- identify the project according to a scheme of typologies
- supply the following data:
  - √ geographic position, altitude (m. above s.l.) and surface area (hectares or Km<sup>2</sup>);

- √ detailed description of projected operations, the extent (number of trees to be removed or planted, etc.) and methodologies (chosen species, type of cultivation, etc.), time period (years), form of management, type of treatment and execution period;
- √ surface area (m<sup>2</sup>) and gradients (m) of the slopes to be consolidated;
- √ number and length (Km) of the water flows to put into regime;
- √ number, length (Km) or surface area (m<sup>2</sup>) and type for access routes and for parking or *picnic* areas;
- √ maps showing position and description of biotypes and other interesting natural phenomena (waterfalls, caves, springs, etc.);
- √ number, position, surface area (m<sup>2</sup>) and *lay-out* of service buildings, such as visitor centres, lodgings, canteens, observation posts, warehouses, sawmills.
- √ number, position, surface area (m<sup>2</sup>) and capacity of possible tourist reception structures, such as hotels, refuges, restaurants, etc.;
- √ access routes and links with the local and regional road networks;
- √ description of and data for important interventions, such as the re-introduction of rare or extinct species, remote fire prevention surveillance systems, communication and information networks, etc.

### 3.10.3 Feasibility and options analysis

Key issue:

- For projects for wood (or cork) arboriculture: the demand for the type of wood (or cork) to be produced, in addition, if this is the case, to the objective of substituting imports.
- For mostly tourist-recreational projects: the forecast trends for tourist flows, including their seasonal trends etc.

An impact analysis showing the sustainability of the proposed project also from an environmental point of view would be helpful. One possible method is to establish a series of physical indicators for each effect and then conduct a multi-criteria analysis.

Comparison in the options analysis should consider:

- different areas of intervention within the same forestry district,
- different methodologies for amelioration, reforestation and cultivation,
- cultivation of alternative species, compatible with the chosen area (e.g. eucalyptus plantations instead of poplars for the production of cellulose pulp),
- different perimeters and zoning of the parks,
- different routes or typologies for footpaths, tracks and equipped areas,
- different positioning of entrances, visitor centres, car parks, camp sites, etc. for projects for equipped parks and forestry areas,
- different destination (e.g. agricultural and not forestal) for the areas to be reforested, for example, within a park.

### 3.10.4 Financial analysis

- Financial costs: often the largest costs are those for personnel and maintenance (ordinary and extraordinary).

Time horizon: 25-35 years can be considered appropriate<sup>1</sup>, but in some cases of forestry interventions the horizon should be extended.

Available literature shows that interventions in this sector have rather low FRR values, which rarely exceed 5%.

### 3.10.5 Economic analysis

- The benefits arising from the utilisation and transformation of wood can be valorised using the added value of woodland companies.
- The tourist-recreational benefits can be quantified and valorised using the visitors' "willingness to pay" method or by a quantitative estimation of the tourist product realised, evaluated at market prices, net of distortions. If it can be predicted, the increased income for the tourism sector and related activities in the areas adjacent to or linked with the park or forest involved should be also added.

<sup>3</sup> This method may, for example, be applied in the case of an odontology clinic, as these services are generally offered by both the public and the private sectors.

<sup>1</sup> Such as truffles and mushrooms, fruits of the forest (strawberries, bilberries, raspberries, blackberries, aromatic and/or medicinal herbs, etc.), game, bee keeping, and others.

<sup>2</sup> Such as bird watching, photographic safaris, camping, horse riding, trekking, etc.

<sup>1</sup> The lowest values should be applied to tourist-recreational interventions and to those of a short cycle (e.g. forest fruits, etc.).



- The benefits arising from hydro-geological protection can be evaluated on the basis of the costs due to flooding, landslides etc., which will be avoided thanks to the project and, if demonstrable, the higher added value of woodland production compared to a situation without the intervention.
- The benefits arising from the improvement of the countryside and environmental protection can be evaluated on the basis of the greater “willingness to pay”<sup>2</sup> or the higher income from tourist activities compared to a situation without the intervention.

### 3.10.6 Other evaluation elements

Whenever the proposed project contains any elements, which are of naturalistic, environmental or scientific importance in themselves (e.g. the protection of threatened species), these should be confirmed by a *panel* of qualified independent sector experts.

### 3.10.7 Sensitivity and risk analysis

It is advisable to analyse the following variables:

- trend in tourist flows,
- cost trends for some critical factors, such as personnel,
- the value and the dynamics of the risks related to possible damage, regardless of the cause (natural, human error, technical).

## 3.11 Telecom infrastructures

### 3.11.1 Objectives definition

Projects with objectives of a local scale are

- local cabling or relay systems to extend services to areas not covered,
- cabling a city, metropolitan or industrial areas, etc. to provide faster, more powerful networks which will enable the development of new local services (e.g. the so-called “wide band”) networks,

- the construction or modernisation of units for band switching with wider networks (this type of project is often linked to the previous type),
- the laying of cables, construction of relay or satellite stations to link isolated areas (mountainous areas, islands, etc.).

Projects with objectives of a non-local scale are:

- the development of international communications systems, to increase capacity, power and speed (e.g. launching telecommunications satellites, building satellite radio stations, laying long distance cables underwater, etc.),
- increasing the capacity, power and speed of inter-regional communications networks,
- the technological updating of the network to enable connection with new services (e.g. multi-media services, portable telephones, cable television, civic networks, virtual museums, etc.).

### 3.11.2 Project identification

It is essential to have a clear idea of the following two aspects, which are strongly inter-related:

- the organisation of the intervention management, including any possible division into sectors,
- the implementation programme for the project itself and the proposed plan for penetrating the catchment area with the services offered by the new structure.

It is also useful to:

- Identify the potential catchment area the project is designed to serve
- provide an analysis of the potential market.
- explain the functional and physical links between the projected infrastructure and the existing telecom-munications system.
- Describe the engineering features of the infrastructure:
  - √ basic functional data, such as: type of communications infrastructure, traffic volume and type, maximum communication speed (baud), type of commutation, communication protocol,

frequency bands (GHz) and power (kW), electronic technologies for commutation/ connection, etc.;

- √ physical data such as the length of cables (Km) and area covered by the network (Km<sup>2</sup>), the number and position of commutation/connection nodes, the number and position of radio stations and the area covered (Km<sup>2</sup>);
- √ data, building techniques and technical features of networks;
- √ data, building techniques and technical features, layout of commutation/connection centres or radio stations, attaching plans;
- √ data, building techniques and technical features, layout of auxiliary plants e.g. electricity supply, lighting, and remote control;
- √ covered area (m<sup>2</sup>) and schematic layout of possible buildings and other service structures, attaching blueprints and sections;
- √ significant technical elements, such as satellite transmission/reception systems, underwater cables.

### 3.11.3 Feasibility and options analysis

Key issue: the volume of traffic, and the daily, weekly and seasonal trends (the optimum capacity must be a reasonable compromise between the highest peak levels of traffic and that which the system can handle).

In the options analysis comparison should consider possible alternatives within the same infrastructure (e.g. different types of cables, different transmission protocols, different commutation/connection technologies etc.), alternative locations or radio stations and possible global alternatives for the projected infrastructure, which can offer similar services such as a satellite transmission or mixed network (air-cable) rather than optic fibre cables.

### 3.11.4 Financial analysis

- Financial inflows: sales tariffs for services, rents for additional services.

In the case of telephony, the existence of government-controlled tariffs may help in forecasting price dynamics.

Time horizon: at least 10 years, except for cabled networks and long distance cables (20 years).

### 3.11.5 Economic analysis

It is necessary to quantify:

- the time saved for each communication (waiting time, transmission time, etc.), quantifiable by unit according to type of service (e.g. commercial telephone call, transmission of a text, transmission of a data file, transmission of graphics and so on); for valorisation purposes the users may be divided into categories, for example in the civil sector reference can be made to the average income of citizens, and in the company sector to the average added value.
- The new additional services, which would be impossible without the project. In some cases the preceding method can be applied for their quantification and valorisation (e.g. on line anagraphic services could lead to almost a 100% saving in the time taken to request and obtain certificates), in other cases one can estimate the willingness to pay for the service on the part of the public, quantifying the costs the user would incur to obtain certain types of data (e.g. purchasing specialist publications).

### 3.11.6 Other evaluation elements

Here one should refer to the development of the new telematic and multi-media services. In this respect it could be helpful to subject the project to a flexibility examination, to see how capable it is, in technological and construction terms, of satisfying the wider needs stemming from future development.

### 3.11.7 Sensitivity and risk analysis

Critical factors: forecast of future demand, high investment costs (e.g. for satellite systems) and rapid technological evolution (the investment is totally or partly obsolete long before expected ex-ante).

Sensitivity and risk analysis should consider at least the following variables:

- investment costs, including those for technological development,
- forecast for substitution cycles (ageing, technical obsolescence) of the equipment installed,
- demand dynamics (i.e. forecast growth rates for the population and businesses),
- dynamics of the sales prices for services.

## 3.12 Industrial estates and technological parks

### 3.12.1 Objectives definition

Objectives can be classified in the following categories:

- creation of basic infrastructure for establishing industrial estates, commercial and service areas;
- creation of basic infrastructure for the planned relocation of productive plants from excessively congested or polluted areas;
- creation of centres supplying real services to companies in a specific area (accounting, financial information, marketing, training..)
- creation of centres promoting the setting up of new companies and supporting existing ones (technological parks, business innovation centres, etc.);
- a mix of the above, often aimed at supporting companies in one particular industrial segment.

### 3.12.2 Project identification

It would be useful to:

- identify the catchment area, that is the geographic area, the size of target companies (e.g. craftsmen, SME's, medium and large.) and the productive segments
- give basic data, such as the number, size and type of companies involved, the type of real services and scientific/technological laboratories, if present,
- provide the following engineering data:
  - √ location and surface (Km<sup>2</sup>) of the equipped area and the breakdown into plots;

- √ number and covered area (m<sup>2</sup>) of warehouses, stores, office blocks, exhibition spaces, etc.;
- √ internal viability and mobility (roads and railways) and their links with external systems; features of possible ports, heliports, etc.;
- √ internal networks and systems, e.g. aqueducts, drains, depurators, electricity, lighting, telecommunications systems, security, etc., attaching data and layout;
- √ number of and area covered by public buildings (real services, laboratories, logistics, canteens, telecommunications centres, etc.);
- √ significant technical elements, such as specialised laboratories, multimedia services centres, etc.

### 3.12.3 Feasibility and options analysis

Key issue: estimated demand from existing companies to relocate in the catchment area and the birth rate of new companies, demand and dynamics for real services, environmental elements.

The options analysis should consider global alternatives, e.g. increased funding direct to companies for the same end (moving premises, purchase of real services, technological innovation, new production lines or newly constituted companies, etc.)

### 3.12.4 Financial analysis

- Financial inflows: rent or licensing costs of land and warehouses and the sales prices of services (water, electricity, drains and purification, storage, logistics, etc.) and of real services.
- Financial outflows: costs of goods and services necessary for the running of the infrastructure and the production of real services.

Time horizon: at least 20 years.

Financial rate of return*	Infrastructure to support production
minimum	2.30
maximum	16.87
average	10.49
standard deviation	5.28

\* Sample data: 4 major projects out of 14 in the sector included in the sample of 400 projects combined.

### 3.12.5 Economic analysis

The analysis should consider:

- Social benefits: better positioning on the market for existing companies, a diffusion of entrepreneurial knowledge and skills among the beneficiary companies, and externally, the retraining of personnel, the effects of various productive factors on employment and incomes, the birth of new productive companies, the birth of new private service companies, etc.
- Quantification of social benefits: an approach that may sometimes be adopted is that of subdividing the potential beneficiary companies of the catchment area by size and sector of activity. For each class it is then possible to evaluate the benefit, with reference, for example, to increased added value thanks to the more advantageous location (e.g. savings in transport costs, greater penetration of a previously difficult to reach market, effect of possible promotional activities in the new exhibition areas, lower costs for basic services, etc.), or the availability of real services (e.g. better positioning due to the marketing service, better penetration and cost-saving with telemarketing, technological improvements or new production technologies, improved professional level thanks to training, etc.).
- The economic costs of raw materials and the land used in the construction of the project should be evaluated according to the loss to society by the diversion of these from an alternative better use. Personnel costs should be evaluated in a similar manner.
- Environmental costs should also be quantified (land, water and air pollution, spoiling of the visual impact, noise, refuse, etc.) as should any possible urban and transport congestion caused by the realisation of the infrastructure. Note, however, that since the impacts considered will increase in the area surrounding the new infrastructure, they should decrease in the rest of the catchment area, the global effect - which is what

should be considered in the analysis - may be for the better or for the worse (e.g. systems for controlling influences may be more effective, etc.).

Financial rate of return*	Infrastructure to support production
minimum	9.10
maximum	36.00
average	18.89
standard deviation	6.91

\* Sample data: 12 major projects out of 14 in the sector included in the sample of 400 projects combined.

### 3.12.6 Other evaluation elements

Social costs may be measured by the physical indicators directly or indirectly linked to them and cost/effectiveness ratio may be computed.

### 3.12.7 Sensitivity and risk analysis

Critical factors: initial rigidity, difficulty in forecasting the real rate of penetration in the catchment area, from the point of view of both the relocation of companies<sup>2</sup> and the development of new businesses.

The sensitivity and risk analysis should consider:

- the cost of the investment,
- the rate of installations in the area,
- the cost of some critical input (labour, out-sourced goods and services for the production of real services),
- if they have been quantified, the birth and early mortality rate of new businesses.

## 3.13 Industries and other productive investments

### 3.13.1 Objectives definition

Intervention may be classified into:

- projects aimed at encouraging the industrialisation of all sectors in areas that are relatively backward,
- strategically important, capital intensive projects (e.g. certain segments of the energy sector),

<sup>2</sup> In some cases the relocation of industries has been accelerated by opportune territorial planning policies.

- projects aimed at encouraging technological development in specific sectors or at applying new, more promising technologies which require a high initial investment (e.g. applying new materials to the transport industry, developing electric superconductors, applying technologies for the use of renewable energy)
- projects aimed at creating alternative employment in areas where there has been a decline in the existing productive units,
- projects aimed at encouraging the installation and development of new companies, both craftsmen and SME's (new enterprises).

### 3.13.2 Project identification

It would be helpful to provide an accurate description of the company (or group of companies) which will benefit from the intervention:

- a list of the categories of goods or services produced by the company before the intervention and those predicted as a result;
- a list of the annual quantities of production input in terms of raw materials, semi-finished articles, services, workforce (disaggregated according to category and specialisation), etc. both before and after the intervention;
- the turnover, gross operating margin, gross and net profit, cash-flow, debt ratio and other balance sheet indicators, both before and after the intervention;
- a description of the market covered by the company and its positioning before and after the intervention (e.g. giving quotas per product and geographic area and their respective dynamics);
- company structure (functions, departments, procedures, quality systems, information systems, etc.) before and after the intervention;
- a description of the production and auxiliary machinery and equipment;
- a description of the company buildings and related areas;

- discharge points for liquid and/or gas waste and a description of treatment plants;
- waste products (type and quantity) and disposal/treatment systems;

### 3.13.3 Feasibility and options analysis

Key issue: the parameters are specific and depend on factors such as the sector in which the company operates, the type of product, the production technologies employed.

The options analysis should consider alternative methods of financing (e.g. financing the interest account instead of the capital account, financing a leasing contract, or other methods of financing), technical or technological alternatives to the proposed project and the global alternatives (e.g. supplying low-cost real services).

### 3.13.4 Financial analysis

The financial analysis can be carried out comparing the cash flows produced by the company (or group of companies) as a result of the investment, with those it would have generated without the subventions<sup>2</sup>. The various cost and revenue items should be evaluated according to market prices, and discounting the cash flows.

Time horizon: around 10 years.

Financial rate of return*	Industry
minimum	5.50
maximum	70.00
average	19.59
standard deviation	14.45

\* Sample data: 64 major projects out of 107 in the sector included in the sample of 400 projects combined.

### 3.13.5 Economic analysis

It is necessary to take into account the externalities, such as:

- the benefit due to the increased income caused by the increase in business or by the creation of new sector companies

(producing goods and services) stimulated by the beneficiary company or group of companies;

- the economic costs of raw materials and the land used in the construction of the project should be evaluated according to the loss to society by the diversion of these from the best alternative use;
- the environmental costs (land, water and air pollution, spoiling of the visual impact, noise, refuse, etc.) should for the most part be evaluated on the basis of the costs (at distortion corrected market prices) of the actions necessary to eliminate the effects of pollution or by other methods suggested in previous outline.
- the cost of any possible urban and transport congestion caused by the installation of new companies or the increased activity of existing companies, estimable in terms of longer transport times (goods and passengers) on the communications routes involved<sup>3</sup> and the possible depreciation in value of adjacent real estate and land.

### 3.13.6 Other evaluation elements

Furthermore, considering the difficulties in quantifying and valorising all of the social benefits, for the purpose of a more comple-

te evaluation of the project it would be useful to make a careful appraisal of these, even if only in terms of physical indicators, so that the direct and indirect effects may be measured.

These should include the effects on employment, bearing in mind that maintaining or developing employment is a central objective in many incentive programmes for the productive sector.

### 3.13.7 Sensitivity and risk analysis

Critical factors are specific to each type of intervention (new companies, modernisation or expansion of existing companies) for every productive segment (mature or pioneer segments, strong or weak competitiveness, processes with a considerable or negligible impact on the environment, etc.).

Sensitivity and risk analysis should consider the following variables:

- the cost of the investment, for projects with a high technological risk,
- the growth rate in demand for the goods and services produced for the specific market,
- the cost of critical input,
- the price of the output.

<sup>2</sup> The incremental cash flows coincide tout-court with total flows in the case of newly constituted companies. It should be emphasised that, in any case, it is necessary to consider two possible alternatives i.e. one where the company would have still made the investment (e.g. it would have purchased the machinery) at a higher investment cost, and the other where the company would have been unable to purchase the machinery without the financial concessions.

<sup>3</sup> For the quantification and valorisation of these effects, see the section on roads.



# Annex A

## Project performance indicators

This section explains the calculation and use of the main **performance indicators** for CBA analysis: IRR, NPV and B/C. These indicators are expressly required in the financial and economic analysis and in the Application Forms for the three Funds. IRR and NPV are included in the main tables for financial and economic analysis (see Tab. 5, 6 and 10, rows 5.4, 5.5, 6.4, 6.5, 10.4, 10.5).

These indicators should give concise information about project performance and could be the basis for ranking projects.

### A.1 The net present value (NPV)

Financial and economic tables are defined by inflows (I1, I2, I3), outflows (O1, O2, O3) and balances (S1, S2, S3 for time 1, 2, 3). The model is built in a number of years and this could generate problems if we want to sum S at time 1 and S at time 2 and so on. This is due to the fact that the marginal utility of one euro today is bigger than the marginal utility of a euro tomorrow. Some reasons justify this point, for example:

- risk aversity for future events;
- monetary income is an increasing function and marginal utility for consumption decreases over time;
- pure preference for present utility compared to future utility.

Aggregation of heterogeneous data is possible with specific weighting coefficients. These coefficients should have the following characteristics:

- decreasing during time;
- they should measure the loss of value of the *numeraire* during that time.

Such a coefficient is the financial discounting factor at:  $at = (1+i)^{-t}$  where t is the time horizon, i the interest rate and at is the coefficient for discounting a future financial value to have the actual value.

Thus the net present value of a project is defined as:

$$NPV(S) = \sum_{t=0}^n at St = \frac{S_0}{(1+i)^0} + \frac{S_1}{(1+i)^1} + \frac{S_n}{(1+i)^n}$$

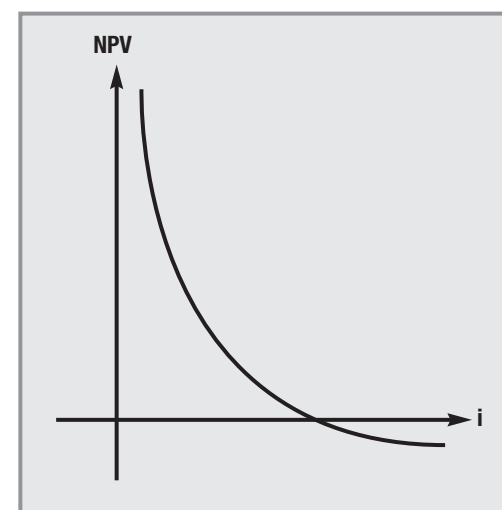
where  $S_n$  is the balance of cash flow funds at time n and at is the financial discount factor chosen for discounting.

This is a very concise performance indicator of an investment project: it is the actual amount of all the net flows generated by the investment expressed in one single value with the same unit of measurement used in the accounting tables.

It is important to note that usually the balance of the first years from the investment are negative and become positive after some years. As they decrease over time, negative values in the first years are weighted

Discount Factors Table										
Years	1	2	3	4	5	6	7	8	9	10
(1+5%)-n	.952 381	.907 029	.863 838	.822 702	.783 526	.746 215	.710 681	.676 839	.644 609	.613 913
(1+10%)-n	.909 091	.826 446	.751 315	.683 013	.620 921	.564 474	.513 158	.466 507	.424 098	.385 543

n: number of years



Graph. 1 NPV as a function of i.

more heavily than the positive ones in the last years. This means that the choice of the time horizon is crucial for the determination of the NPV. Moreover the choice of the discount factor (that means the interest rate in the at formula) influences the calculation of the NPV (see also graph.1).

This indicator could be a very simple and precise evaluation criteria for an investment:  $NPV > 0$  means that the project generates a net benefit (because the sum of the weighted  $S_n$  is still positive) and it is generally desirable. In other words it can be a good measure of the value added of a project for the society in monetary terms. It is also useful ranking projects on the basis of their NPV values and decide which is the best. As in the graph 2 project 1 is more desirable than project 2 as it has a bigger NPV value for every i value.

Sometimes NPV values could be non comparable for every value of i, as in the case of graph 3. In this case the definition of the same i for every project could lead to a clear choice between projects.

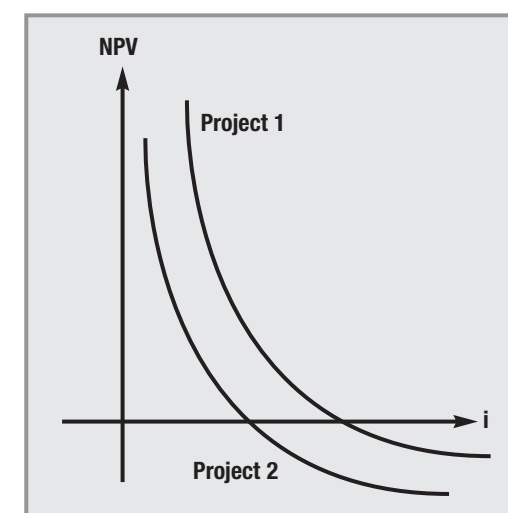
As already described in chapter 2 net present value could be financial net present value if it is calculated in the financial analysis with financial variables, and economic net present value in the case it is calculated in the economic analysis.

### A.2 The internal rate of return<sup>1</sup>

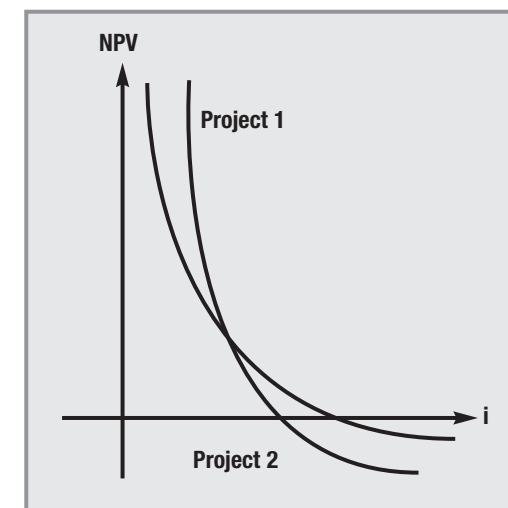
The internal rate of return is defined as the interest rate that zeroes out the net present value of the investment, that is to say the interest rate IRR of the equation below:

$$NPV(S) = \sum_{t=0}^n St / (1+IRR)^t = 0$$

All the most commonly used data management software automates the calculation of the value of these indicators by applying the appropriate financial function. The results of the calculation of the IRR are the interest rates shown in graph. A.

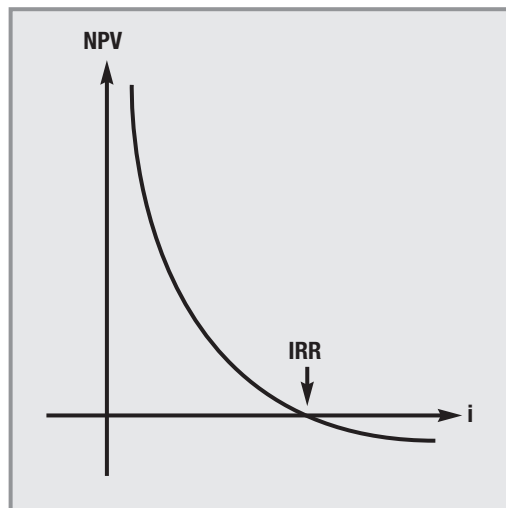


Graph. 2 Project ranking by NPV values.



Graph. 3 A case of non-comparable NPV.

<sup>1</sup> Here we do not make distinction between financial internal rate of return (both on investment and on equity) and economic rate of return. For an in-depth explanation on that point see chapter 2.



Graph. A The internal rate of return.

As it is clear from the definition of IRR and its formula, no discount rate is needed for the calculation of this indicator.

The examiner mainly uses the financial rate of return in order to judge the future performance of the investment. Infact, if  $i$  is considered the opportunity cost of equity IRR is the maximum value  $i$  could assume without making the investment a net loss compared to an alternative use of the capital.

Thus IRR could be an evaluation criterion for project appraisal: under a specific value of IRR the investment should be

considered not suitable.

Either NPV or IRR could be used as an evaluation criteria for ranking projects.

Nevertheless it is useful considering always NPV value and IRR together, as ambiguous cases could occur (see graph 5 and 6).

### A.3 B/C ratio

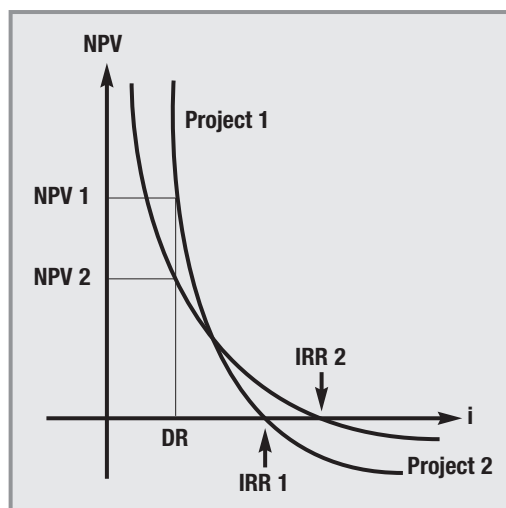
The B/C ratio is defined by:

$$B/C = NPV (I)/NPV (O)$$

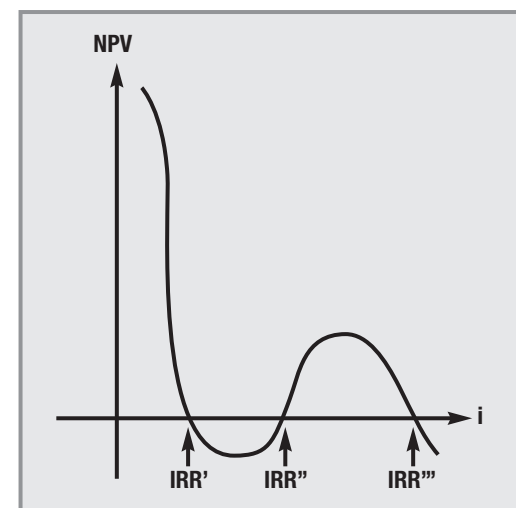
where I are the inflows and O outflows. If  $B/C > 1$  the project is suitable because benefits, measured by the present value of the total inflows, are greater than costs, measured by the present value of the total outflows.

It is a pure number, like IRR, and it is independent of the size of the investment. Moreover it is sometimes easier to use because there are no ambiguous cases like those shown for IRR.

For this reason it is in some cases very suitable to rank projects.



NPV<sub>1</sub> > NPV<sub>2</sub> but IRR<sub>2</sub> > IRR<sub>1</sub>  
DR: discount rate



Graph. 5 Ambiguous cases.

## Annex B

# The choice of the Discount Rate

### B.1 The Financial Discount Rate

In theoretical literature and in practice we can find different points of view regarding the discount rate to be considered in the financial analysis of investment projects.

There is a substantial academic literature on the definition and estimation of discount rates, and it is not necessary to summarise it here (see bibliography). Yet, project proposers and appraisers should understand the basic ideas behind the selection of one discount rate.

As a general, and quite uncontroversial, definition, the financial discount rate is the opportunity cost of capital. Opportunity cost means that when we use capital in one project we renounce to earn a return in another project. Thus we have an implicit cost when we sink capital in an investment project: the loss of income from an alternative project.

Having in mind this broad definition, we need to estimate empirically the relevant opportunity cost of capital for a given project, in a given country and time.

There are basically three approaches that may be helpful to identify the appropriate financial discount rate, and we should briefly mention them below.

The first approach estimates a *minimum* opportunity cost of capital. Sometimes this approach suggests that the real discount rate should measure the cost of the capital used for the specific investment project. As

Tab. 1. Some examples of financial discount rates in different sectors and countries*		
Sector	Country	Discount rate
Transport	Espana	5
Transport	Espana	6
Transport	Espana	6
Transport	Espana	6
Transport	France	8
Environment	Lituania	3
Environment	Poland	5
Environment	Poland	5
Industry	Portugal	10
Energy	Portugal	11

\* Data refers to ISPA, FC and ERDF projects

a consequence, the benchmark for a public project may be the real return on Government bonds (the marginal cost of public deficit), or the long term real interest rate on commercial loans (if the project needs private finance).

This approach is very simple, but it may be quite misleading. It is important to understand that under this approach we use the actual cost of capital to determine the opportunity cost of capital, and the two concepts are different. In fact the best alternative project could earn much more than the actual interest rate on public or private loans.

The second approach establishes a *maximum* limit value for the discount rate as it considers the return lost from the best investment alternative. In practice the opportunity cost of capital is estimated looking at the marginal return on a portfolio of securities in the international financial market, in the long run and with minimum risk. In other words, the alternative to the project income is not the buying back of public or private debt, but it is the return on an appropriate financial portfolio.

However, some investors, particularly in the private sector, on the basis of previous

experience in similar projects, might feel capable of achieving an even higher return on investment.

The third approach is to determine a cut-off rate. This implies avoiding the detailed examination of the specific cost of capital for a given project (under the first approach) or the consideration of specific portfolios on the international financial markets or on alternative projects for a given investor (under the second approach), and to use a simple rule-of-thumb approach.

We take a specific interest rate or rate of return from a well-established issuer in a largely traded currency, and use a multiplier on this minimum benchmark. For projects co-financed by the European Union an obvious minimum benchmark may be long term bonds denominated in Euro issued by the European Investment Bank. The real return on these bonds can be established by the consideration of the nominal return rate less the inflationary rate in the EU.

In practice we suggest that a real financial discount rate of 6% for 2001-2006 will not be very far from 2 times the value of the real return on EIB bonds. This may be a convenient financial cut off rate for public projects, except in particular circumstances that must be justified by the project proposer.

## B.2 The social discount rate

The discount rate in the economic analysis of investment projects (i.e. social discount rate) attempts to reflect the social view on how future benefits and cost should be valued against present ones. It may differ from the financial rate of return when the capital market is imperfect.

Theoretical literature and international practice show a wide range of approaches in interpreting and choosing the value of the social discount rate to be adopted.

The international experience is very wide and has involved different countries as well as international organisations.

The World Bank and, more recently, the EBRD have adopted a required economic rate of return of 10%. This is usually regarded as a quite high cut-off rate, and according to some criticisms it may reflect a kind of cream-skimming of best projects by prime lenders.

Usually national governments set the social discount rate for public projects at a lower level than international financial institutions.

In the UK the Green Book<sup>1</sup> considers the social opportunity cost of capital as the cost due to the displaced private consumption and production. Social time preference rate and private rate of return are set both at 6%, although several exceptions are allowed.

In Italy, according to the new guidelines for feasibility studies<sup>2</sup> the discount rate is currently set at 5%.

In Spain different values of the social discount rate have been set depending on the sector involved: 6% in real terms for transport<sup>3</sup> and 4% for water resource projects.

In France, the discount rate set by the Commissariat Général du Plan is equal to 8% in real terms. This rate has not been updated since 1984.

In the USA the OMB (Office of Management and Budget) proposes different discount rates. In particular, assuming that public investments (defined as those projects impacting social welfare) do displace private consumption, the discount rate to be used is set at 7% in real terms, or calcu-

lated through the shadow price capital approach which allows both consumption and production displacement. Internal government's investments (those projects impacting only the government debt) must be discounted using Treasury borrowing rates. CBO (Congressional Budget Office) and GAO (General Accounting Office) state that public investment may be discounted by using Treasury borrowing rates.

This variety of international experience reflects different theoretical and policy approaches.

The main approaches for the social discount rate estimate are the following:

- One traditional view proposes that the marginal public investment should have the same return as the private one, as the projects can be substitutes.
- An alternative approach is to use a formula based on the long-term rate of growth of the economy. An approximated formula is the following:

$$r = ng + p$$

where  $r$  is the real social discount rate of public funds and expressed in an appropriate currency (e.g. Euro);  $g$  is the growth rate of public expenditures,  $n$  is the elasticity of social welfare to public expenditures and  $p$  is a rate of pure intertemporal preference. For example, suppose that public expenditures for subsidies to the poor (i.e. the most socially valued expenditures) grow at a real annual rate equal to that of

average per capita consumption, say at 2%, and that the value of elasticity of social welfare to this kind of expenditures is between 1 and 2. So, if the pure intertemporal preference is about 1%, then the real social discount rate will be in the 3%- 5% range.

This approach leads to values of the discount rate usually lower than those of the previous approach. This is because capital markets are imperfect, and myopic, and discount the future more heavily. In fact under an extreme view, the State should have a zero value for intertemporal preference, because it has to protect the interests of all future generations.

- a third solution is to consider a standard benchmark for the discount rate, a required rate of return, reflecting a real growth objective. In fact, in long run, real interest rates and growth rates should converge.

On the basis of the first approach a 5% social discount rate for public projects will be around two times the real return on a long term EIB bond in Euro, thus not too far from a reasonable financial rate of return, perhaps on the lower end of the opportunity cost of capital for private investors.

But a 5% social discount rate will also not be too far from a value based on the second approach, perhaps on the higher end of the range of reasonable values for the different parameters.

And eventually, for European regions lagging behind, a 5% return is compatible with the third approach: it may reflect the need for these regions to invest at a higher rate of return in order to achieve a rate of growth higher than the average for the EU area (where in the last decades the real growth rate has been around 2.5-3%).

In conclusion a 5% European social discount rate may have different and convergent justifications, and may be a standard benchmark for EU co-financed projects. However, in specific cases, project proposers may wish to justify a different value.

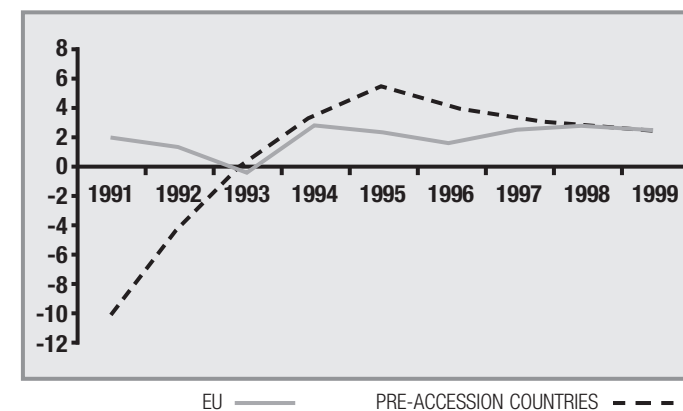


Fig.1 GDP growth, constant prices, % variation.

<sup>1</sup> HM Treasury (1997) Appraisal and Evaluation in Central Government. The Green Book

<sup>2</sup> Conferenza dei Presidenti delle Regioni e delle Province Autonome (2001) Studi di fattibilità delle opere pubbliche. Guida per la certificazione da parte dei Nuclei regionali di valutazione e verifica degli investimenti pubblici

<sup>3</sup> Ministerio de Transportes, Turismo y Comunicaciones (1991) Manual de evaluación de inversiones en ferrocarriles de vía ancha. Anexo 1



# Annex C

## The determination of the co-financing rate

This section proposes a practical approach to determine the modulation of the cofinancing rate as required by the Regulations.

### C.1 Regulatory framework

The new Regulations, while fixing maximum rates (see Tab. 1) explicitly require the Commission to determine the actual rate, taking into account various circumstances, particularly:

- the existence of project revenues;
- the polluter pays principle.

The Regulations require the Commission to state how it determines its cofinancing rate, in a transparent and verifiable way. The current approach for the Cohesion Fund (imitated by ISPA), is the “equity gap” or “financing gap” approach.

The basic idea is to fill the “financing gap” by EU grants. That means that, if C is the present value of total cost of the invest-

**Tab.2 The discount rate and the co-financing gap: an example\***

Basic project data			
Total eligible cost	€	36.000.000	
Proposed ISPA grant	€	27.000.000	
Co-financing required	€	9.000.000	
Grant rate			75%
The choice of a discount rate			
Scenario (DR)	6%	8%	11%
Co-financing gap	47%	51%	11%

\* This example is based on an ISPA project

ment, R the present value of the net revenues generated by the project, including its residual value, E the eligible cost, (C-R) is the financing gap, we have that r is the cofinancing rate and G is the EU grant defined as follows:

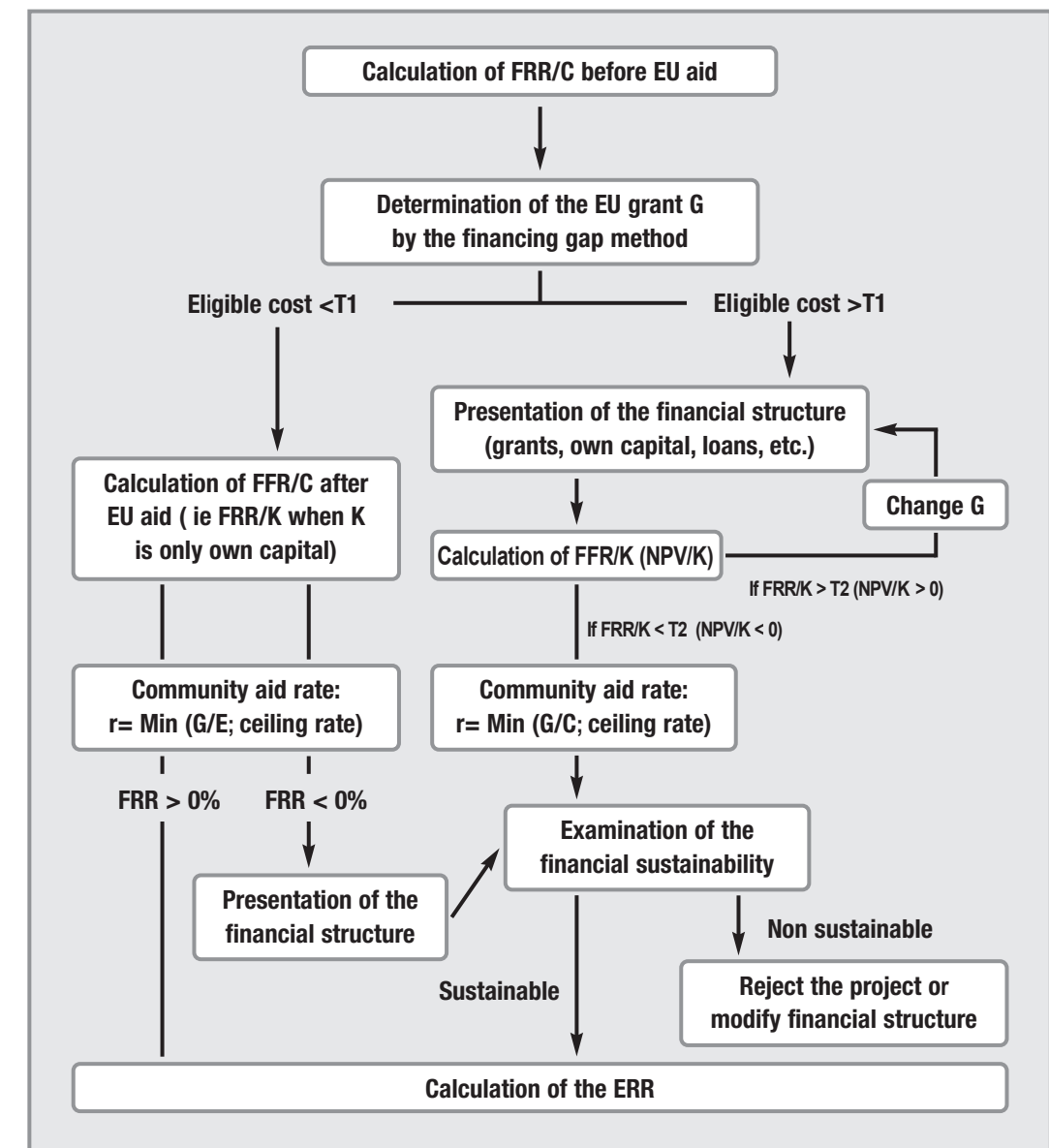
$$r = (C - R) / C \quad \text{and} \quad G = E * r$$

### C.2 Rules for modulation

The rule of the financing gap needs some recommendations to be followed in order to better accomplish Commission objectives and use cost-benefit analysis to modulate the cofinancing rate. Infact the general rule stated in the CF Guidelines states:

*The rate will be fixed in the light of the characteristics of the project and with particular attention to the results of the economic analysis.*

This should mean that rates calculated within the financial and economic analysis, such as FRR/C, FRR/K and ERR might be used to check the quality of the project before



T1=50MEUR T2=6% by way of illustration

the determination of the cofinancing rate. This would be possible through both the harmonisation of the accounting rules for financial and economic analysis (see chapter 2) and a triple checks system based on fixing benchmarks for FRR/C, FRR/K and ERR. The logic of this system is showed in the diagram.

#### C.2.1 Calculation of the financial rate of return on the total investment cost (before EU intervention).

The project proposer should present a calculation of the (real) financial rate of return on the total investment, FRR/C, id est the internal rate of return when total

investment costs, total operative costs and total revenues are considered (without considering grants, equity capital, loans and interests) in order to evaluate the overall financial profitability of the project or, as more often it will be the case, the net cost for public finance when project revenues are zero or insufficient.

If the FRR/C is less than a threshold the applicant should be asked by the Commission to give evidence on how the project will be sustainable in the long term, beyond the time horizon. This will include a complete financial plan with indication of all financial resources (national subsidies, loans, shareholder’s equity..).

**Tab. 1 Ceilings for the cofinancing rate as from the Regulations.**

Structural Funds and Cohesion Fund	
Types of region/country	Max co-financing rate % of total eligible cost
Obj. 1	75
Obj. 1-Cohesion fund region	80
Obj. 1-Cohesion fund region/ultra peripheral	85
Obj. 2 and 3	50
	Higher co-financing rate % of total eligible cost
Cohesion Fund country	80-85
ISPA	
ISPA country	75 (85 in exceptional cases)

# Annex D

## Sensitivity and risk analysis

### C.2.2 Calculation of the financial rate of return on national capital (after EU grant).

As explained in detail in the Guide, there are two ways to consider financial returns. FRR/C gives an indication of the overall financial efficiency of the project. It considers investment cost, and deliberately ignores how they are financed.

However it is important to look also at the financial return of the investor's own capital. This is done by considering, instead of total investment, the cost of capital for the investor: equity disbursed, reimbursement of loans and interest (including EIB and commercial bank loans). EU grants should not be included. This is the same as the calculation of the FRR 'without EU', when the costs of the investments not covered by the EU grant are completely covered by investor's capital (no loans and interests).

In the case FRR/K is below a given threshold the applicant should propose the financial structure he proposes for the project (by a simple table of financial planning, see financial sustainability table 2.3 in

chapter 2), on the basis of his expectations of the EU cofinancing (in other words the applicant should state how much own capital, including national public funds or private equity, and third parties loans and interests he/she will be prepared to afford). The financial internal return on national capital (FRR/K) usually should not exceed a real 6%<sup>2</sup>. For projects with a FRR/K > 6% more contribution with own capital should be asked and the FRR/K must be recalculated with this new financial structure.

### C.2.3 Calculation of the economic rate of return.

The project proposer should calculate the ERR, with the methods suggested in the present CBA guide. The difference between ERR and FRR is that the former uses accounting prices or the opportunity cost of goods and services instead of imperfect market prices, and it includes as far as possible any social and environmental externalities. Because externalities and shadow prices are now considered, most projects with low or negative FRR/C will now show positive ERR.

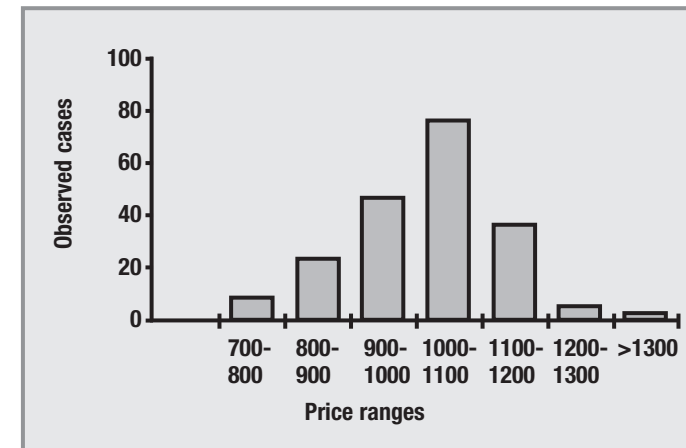


Fig. 1 Distribution commodity price-average 1.017 euro - Standard deviation 164 euro

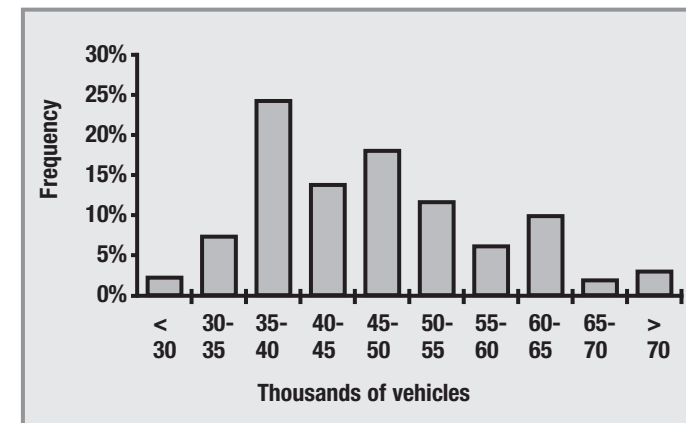


Fig. 2 Daily traffic - average 46.800 - SD 2.400

The uncertainty of the forecasts carried out in the CBA stem from different causes. As a typical example, figures 1, 2 and 3 show the results of field surveys conducted to determine which values to attribute to the three variables to be used in the analysis. As we can see, even if it is possible to determine a value as the best estimate for the data under examination (for example the mean), the parameters show a variability of values.

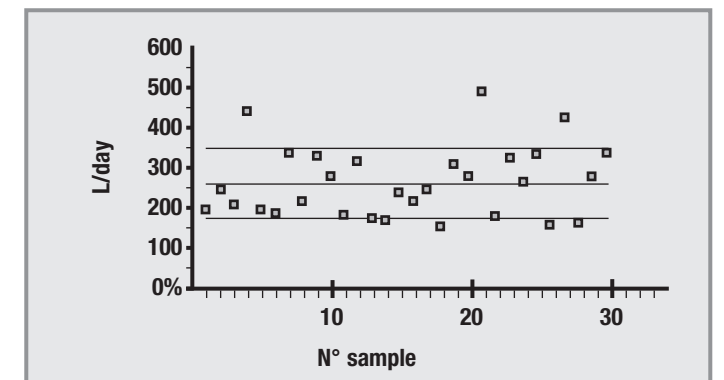


Fig. 3 Per capita consumption - (average: 230 litre/day-Standard deviation: 96 litre/day)

Once the critical variables have been identified, in order to conduct the risk analysis it is necessary to associate a probability distribution to each of them, defined in a precise range of values around the best estimate, used in the base case, in order to calculate the evaluation indices.

The probability distribution for each variable may be derived from different sources. The most common one is made up of the results of studies carried out to obtain the desired experimental values, in situations that are as similar as possible to those of the project. This is the case shown as an example in the previous figures 1, 2 and 3. It is possible in almost all cases, with various methods found in specialist literature (statistical inference), to obtain a probability distribution from the experimental data, which is expressible graphically and/or analytically. When there are no experimental data, one can use the distributions found in literature, which are valid for cases similar to the one being studied.

<sup>1</sup> "Without EU" means before EU intervention: the total cost of the project is used. "With EU" means after EU financing intervention: the total cost, minus the community aid, is used.

<sup>2</sup> This threshold value is given by way of illustration and can be modified by the Commission. Any project that earns a FRR/K of more than this value is considered as asking an excessive grant.

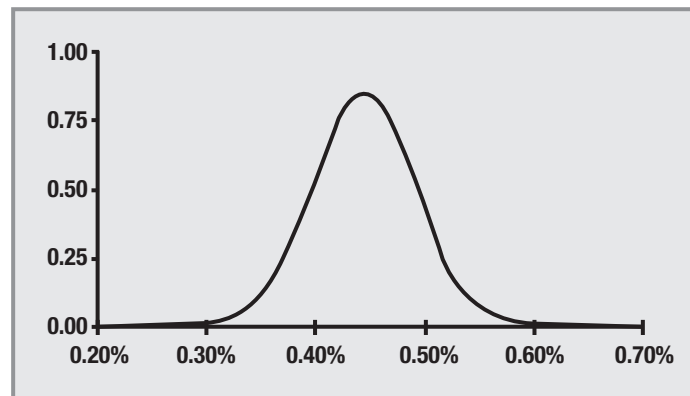


Fig. 4 Gaussian curve

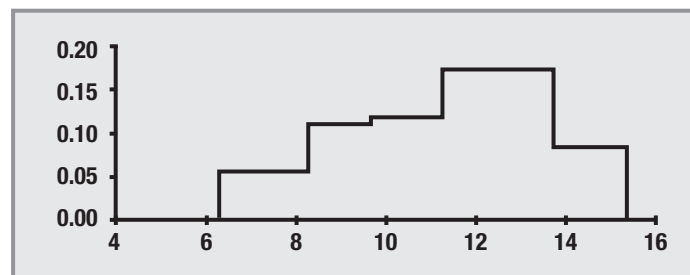


Fig. 5 Discrete probability

Another possibility (the Delphi method) is to consult a group of experts (panel), asking each of them to estimate the probability to be assigned to defined intervals of values – generally only a few - of the parameter in question, and then combine the values obtained with the rules of statistics.

Figures 4 to 8 show graphically some typical probability distributions which are commonly found in literature and espe-

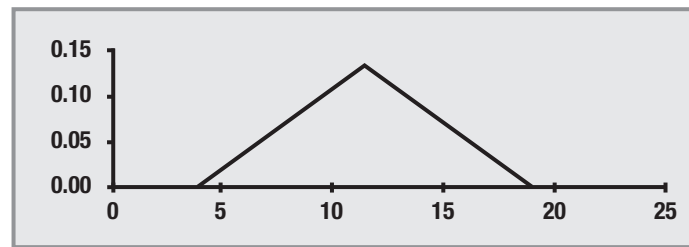


Fig. 6 Symmetric triangular distribution

cially in the analysis of the risks associated with investment projects.

Fig. 4 is a typical symmetrical bell-shaped, or Gaussian curve, while fig.5 is a discrete probability distribution in constant values for defined intervals of the variable. This simplified representation is commonly used because it is easier to calculate. For the same reason symmetrical or non-symmetrical triangular distributions are also used, shown by way of illustration in figures 6 and 7. The last figure shows a step distribution (in this case with three values), a typical result of applying the Delphi method.

Having established the probability distribution of the critical variables, it is possible to proceed with the calculation of the probability distribution of the IRR or NPV of the project. Only in the simplest cases is it possible to calculate this by using direct methods, using analytical methods of calculating the probabilities composed

of a number of independent events. The following table shows a possible calculation procedure that uses the tree development of the independent variables.

For example there is a 3% probability (0.15\*0.20) that the NPV has a value of 5.

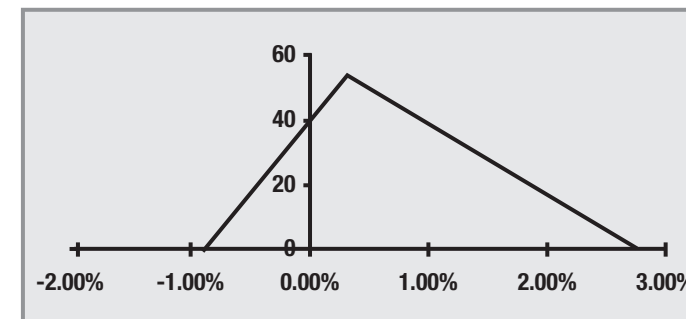


Fig. 7 Asymmetric triangular distribution

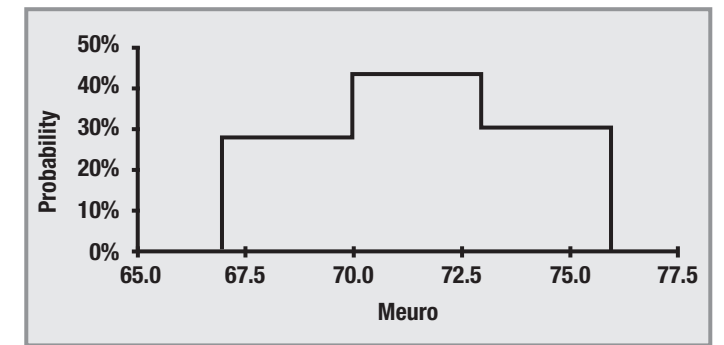


Fig. 8 Project cost

In fact if investment costs are decreasing by 56 and other costs are decreasing by 13 (with a probability of 20%), benefits will increase by 74 (with 15% probability). If these new values are included in the NPV formula, the result is 5.

Tab. 1 Probability calculation for NPV from variations of critical variables						
Critical variables Result						
Investment	Other costs		Benefit		NPV	
Value	Value	Probability	Value	Probability	Value	Probability
-56.0	-13.0	0.20	74.0	0.15	5.0	0.03
			77.7	0.30	8.7	0.06
			81.6	0.40	12.6	0.08
			85.7	0.15	16.7	0.03
	-15.6	0.50	74.0	0.15	2.4	0.08
			77.7	0.30	6.1	0.15
			81.6	0.40	10.0	0.20
			85.7	0.15	14.1	0.08
	-18.7	0.30	74.0	0.15	-0.7	0.05
			77.7	0.30	3.0	0.09
			81.6	0.40	6.9	0.12
			85.7	0.15	10.9	0.05



# Annex E

## Monetary evaluation of environmental services

### E.1 Why do we value the environment?

The economic evaluation of the environment helps decision-makers to integrate in decision-making processes the value of environmental services provided by ecosystems. Direct and external environmental effects produced by economic projects are calculated and expressed in monetary terms<sup>1</sup>. Monetary evaluation is a useful way to express in the same dimension different social and economic costs and benefits and is required to calculate a homogenous aggregate indicator of net benefits.

In the context of strong uncertainty and irreversibility in the future availability of the environmental resource or for ethical reasons, other economic evaluation methods can be applied, such as Environmental Impact Assessment, multi-criteria analysis or public referenda. These methods avoid the need to express all environmental impacts and individual's preferences in a single numeraire.

### E.2 Evaluating environmental impacts in development projects

Most public infrastructure projects have negative, or positive, impacts on the local and global environment. Typical environmental impacts are associated with local air quality, climate changes, water quality, soil and groundwater quality, biodiversity and

#### Environment impacts and environmental services in the project

Relevant environmental impacts in major projects are related with the following environmental dimensions:

- **Water:** surface water and groundwater availability and quality
- **Air pollution:** urban air pollution and greenhouse gas emissions
- **Soil pollution:** contamination by chemicals and heavy metals
- **Waste:** urban and industrial waste production and treatment
- **Biodiversity loss**
- **Landscape deterioration**
- **Natural and technological risk**
- **Noise and human health**

Environmental impacts affect the furniture in environmental goods and services consumed by consumers or used as input by producers. Example of direct and indirect environmental services provided by ecosystems:

- **Direct production** of oxygen, water, fresh food, fodder and fertilizer, genetic resources, fuel and energy, raw materials,
- **Indirect services** as regulation of hydrological cycle, water catchments and groundwater recharge, regulation of climate, storage and recycling of nutrient, biomass production, production of top soils, assimilation of waste, maintenance of biological diversity and so on.

landscape degradation, technological and natural risks. These impacts alter the normal functioning of ecosystems and reduce (or in some cases increase) the quality of ecological services provided by ecosystems. Decrease, or increase, in the quality or the quantity of environmental goods and services will produce some changes, gains or losses, in social benefits associated with their consumption.

For example, a road infrastructure will be expected to reduce the superficies of useful rural land, will change rural landscape

#### Total economic value

The monetary measure of a change in an individual's well being due to a change in environmental quality is called the total economic value of the change. Total economic value of a resource can be divided into use values and non-use values:  
 Total economic value = use values + non-use values.

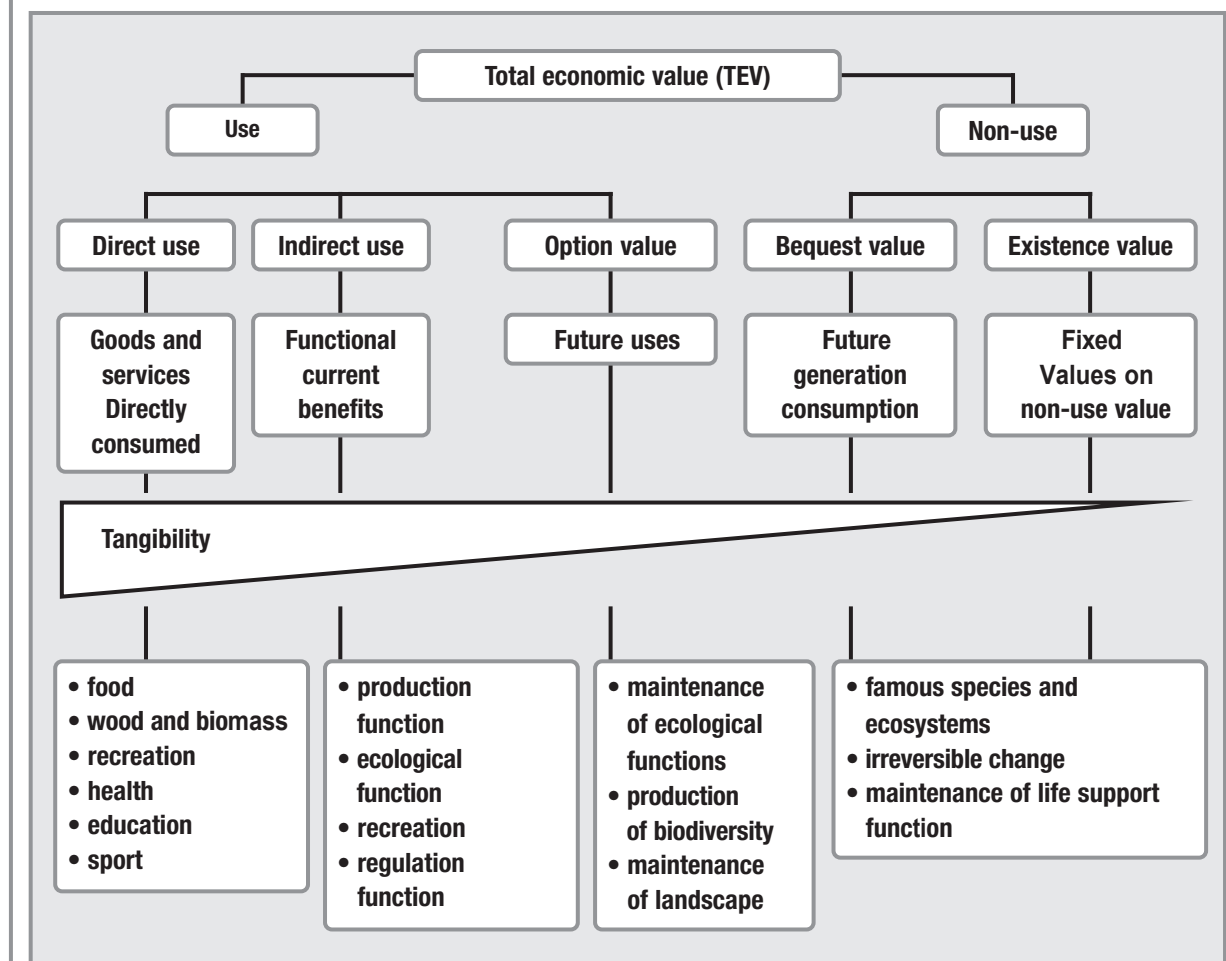
Use values include benefits from physical use of environmental resources, such as a recreational activity (sport fishing) or productive activities (agriculture and forestry). Option value takes place in this category, even if concerning only future uses. It stems from the combination of the individual's uncertainty about future demand for the resource and uncertainty about its future availability. Non-use values refer to the benefits individuals may obtain from environmental resources without directly using them. For example, many people value tropical ecological systems without directly consuming or visiting them. The components of non-use values are existence value and bequest value. Existence value measures willingness to pay for a resource for some "moral", altruistic or other reason and is unrelated to current or future uses. Bequest value is the value that the cur-

rent generation obtains from preserving the environment for future generations. Non-use values are less tangible than use values since they often do not refer to a physical consumption of goods and services.

Values are directly linked to ecological services produced by ecosystems, which support them. For example, fishery depends on ecological productivity of water ecosystem as wetlands. Water availability is linked to the entire hydro geological cycle and groundwater quality depends on the filtering capacity of soils. A reduction in the provision of ecological services (by pollution for example) will be likely to depreciate values expressed by people on environmental quality with, as a final result, a decrease of social benefits associated with.

It is important to understand that economic value does not measure environmental quality per se, rather it reflects people's preferences for that quality.

Evaluation is "anthropocentric" in that it relates preferences held by people.



<sup>1</sup> A Direct effect can be directly observed on markets (through the variation of price and quantity) or in the decision-making process, while external effects arise when the economic behaviour of an individual (or a firm) affects the behaviour of another (individual or firm), without any economic compensation or transaction from the former to the latter. In economics, pollution or resource depletions are often analysed with the help of the externality concept.

availability, will increase pressures on biodiversity and reduce the general air quality related to the traffic cars in the area. As a result, each of these impacts will reduce the provision of environmental services by ecosystems and will lower economic benefits, such as farm activity, landscape consumption and other recreational activities associated with the economic use of the area. On the other hand, investments in waste treatment facilities will decrease environmental negative impacts on soil and water and will increase economic benefits related to the furniture of high quality environmental services to economic agents (consumers and producers).

Not taking into account environmental impacts, through the calculation of associated externalities, will lead to an over or under estimation of social benefits of the project and will induce bad economic decisions.

### E.3 What do we do measuring monetary benefits?

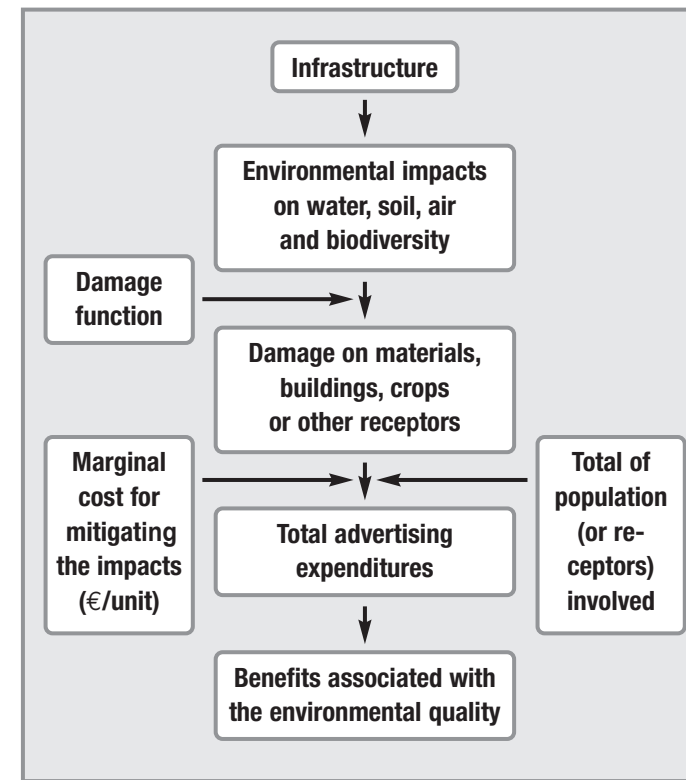
In practice, economic evaluation tries to reveal (or state) individual willingness to pay (or to receive) for benefits associated with use (consumption) of environmental goods and services. The aim of evaluation is to appraise total economic value, considering explicit use and implicit non use values. The core concept of the methodology is the concept of consumer (or producer) surplus.

When environmental service markets are available, the easiest way to measure economic value is to use the actual related market price. For example, when marine pollution reduces fish catches, market values for the lost harvest are easily observed on fish market. When there is no “market”, the price can be derived through non-market evaluation procedures. This is the case for example in measuring the social cost of urban air pollution since no market can be associated with air pollution. There are two broad approaches to evaluation, each comprising several different techniques (see figure): the indirect approach seeks to infer preferences from actual, observed market-based information, the direct approach is based on the simulation of market goods and uses survey and experimental methods.

#### 1. Averting expenditures and avoided costs

When changes in the quality of the environment occur, firms' and households' reactions can be observed through the money they spend to mitigate the impacts. For instance, expenditure on sound insulation can indicate householders' evaluation of noise reduction and expenditures in building renovation might reflect the benefits of reduced air pollution. Averting expenditures are used for evaluation of environmental degradation and avoided costs are rather used for the evaluation of environmental quality improvements. Several problems are associated with the method:

- Individuals or firms may undertake more than one form of averting behaviour in response to any environmental



change, instead of spending money in building renovation, owners would prefer sell and move away for example;

- Averting behaviour may have other beneficial effects which are not considered explicitly, sound isolation for example may also reduce heat loss from a home;
- Much defensive expenditure is often not continuous and not a reversible decision but is rather discrete and irreversible, such as double-glazing which is expensive to remove once installed. In that context, it could be difficult to measure other future variations of environmental quality.

For these reasons the method often over or under estimates benefits associated with environmental quality changes.

#### 2. Dose-response functions

The dose-response technique aims to establish a relationship between environmental impacts (the response) and physical environmental impacts as pollution (the dose). The technique is used when the dose-response relationship between the cause of environmental damage, such as air or water pollution, and the impacts, morbidity due to air pollution or water contamination by

chemical products for example, is well known. The technique takes natural science information on the physical effects of pollution and uses this in an economic model of evaluation. Economic evaluation will be performed by estimation, through a production or a utility function, of the firm profit variations or the individual revenue gains or losses.

The two steps of the method are:

- The calculation of the pollutant dose and receptor function, and
- The economic evaluation by the choice of an economic model.

To assess the monetary gain or loss of benefits due to the variation in environmental quality requires the analysis of biological and physical processes, their interactions with the economic agent decisions (consumer or producer) and the final effect on welfare.

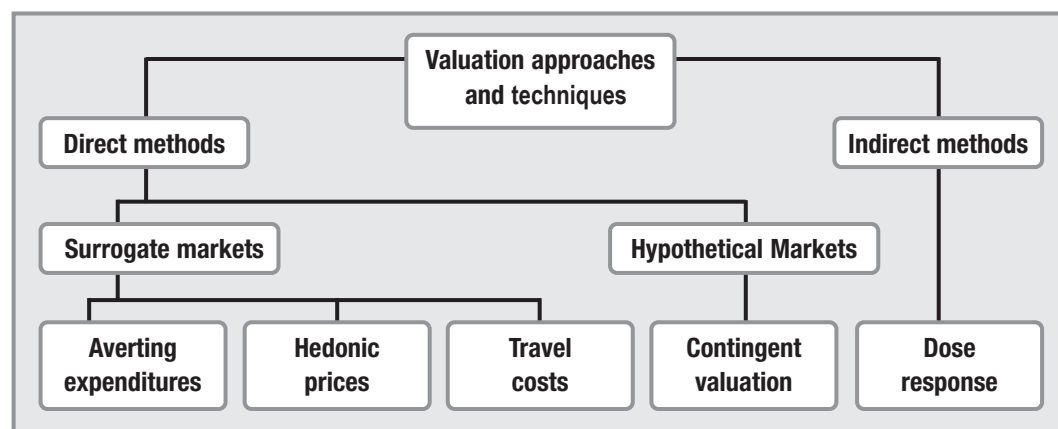
The major fields of application of the methodology are the evaluation of losses (in crops for example) due to pollution, the pollution effects on ecosystems, vegetation and soil erosion and the impacts of urban air pollution on health, materials and buildings. The approach cannot estimate non-use value.

#### 3. Hedonic price method

The hedonic price technique analyses existing markets for goods and services where environmental factors have an influence on the price. Hedonic price approach is most often used in analysing the effect of

Example of use of an hedonic price for an economic evaluation on the noise

Due to the extension of an airport, the indices of noise **B** in the neighbourhood area increase by 10 points (so  $\Delta B$  is assumed to be equal to 10). For a number **L** of 15000 houses located in this area, an average value **V** of 100000 e and for an elasticity of depreciation **e** equal to 0,5, the social cost of noise would be calculated as follow:

$$C = \Delta B \times e \times V \times L$$


environmental quality on house prices. A house near an airport, for example, can be expected to present a lower price than a house located far away because of the sound nuisance. The difference in value can be viewed as the value attached to the difference in environmental quality. Because of the large number of characteristics, which influences the price, advanced econometric techniques are usually used to hold other attributes constant and separate out the value of an individual characteristic.

The hedonic pricing approach has been applied to labour as well as to measure the benefits or cost associated with a reduction or an increase in risk accidents.

**4. Travel cost method**

The travel cost approach seeks to value the individual's willingness to pay for an environmental good and service by the costs incurred to consume it. The consumption cost will include travel costs, entry fees, on-site expenditure and expenditure on capital equipment necessary for consumption. The travel cost method is usually used to estimate the value of outdoor recreation activities, such as fishing, hunting boating and forest visits. For example, a visit to a national park will imply loss of time (to travel), entry fee, petrol and other travel costs. These elements are used to evaluate a demand curve to environmental asset based on the relationship between travel costs and the number of visitors.

Because of valuating only actual costs arising out of direct consumption of environmental services, the method does not estimate non-use values (option value and existence value). Some other limits can also be pointed out such as the evaluation of leisure time or some econometric specific difficulties.

**5. Methods based on hypothetical markets: the contingent evaluation method**

In contingent evaluation studies, people are asked directly to express their willingness to pay for a benefit or to avoid a cost

or their willingness to accept compensation for a loss. The method uses a questionnaire approach, which can be applied by mail, telephone or face to face. The respondents are requested to answer questions such as (for a questionnaire on air pollution reduction for instance):

“How much are you willing to pay for a reduction in urban air pollution or how much are you willing to accept in compensation for a low air quality standard”?

The questionnaire is structured in such a way as to assess the respondent maximum willingness to pay. In a second step, econometric techniques are applied to the survey results to derive the average value. Then, in a third step, average bid is multiplied by the number of people concerned, to find the total willingness to pay of the population for the environmental service. The market is said to be contingent because constructing a hypothetical market through scenario techniques.

Usually the questionnaire is organised in three different parts:

- An introductory part relies on the description of the environmental good and service under investigation (water quality, air pollution, soil contamination, biodiversity reduction, or other environmental problems) the general environmental context and the methodology used (specially the method of payment);
- The questioner asks about willingness to pay or to accept compensation.
- Questions on the socio-economic (revenue, position...) and demographic characteristics (age, family...) to obtain background information and make it easier to extrapolate from the sample to the relevant population.

The contingent method is likely to be the most applied among the economic evaluation techniques and is the only one to be

extensively used when calculating non-use values or option value. Potential problems with contingent evaluation originate from the construction of the questionnaire and the numerous potential biases associated, such as payment bias (when payment method affects the value calculated), starting point bias (if value are suggested to the respondent and influences his choice), mental account bias (when the respondent doesn't separate out his willingness to pay for the good under evaluation from his total willingness to pay for environment in general), and other minor biases.

**6. Benefits transfer**

When data are not available, more costly to produce, time is lacking or for other political reason, we can carry out a transfer of values from data already available in other studies (for other sites), to the new context of evaluation. This approach is called “benefit transfer”. It's unlikely to expect from benefits transfer precise estimates, but the method can help to rank various policy options for reducing environmental impacts. Benefits transfer is usually performed in three steps:

- The compilation of the existing literature on the subject under investigation (recreational activity, human health, air and water pollution...);
- The assessment of the selected studies for their comparability (similarity of the environmental services valued, difference in revenue, education, age and other

socio-economic characteristics which can affect the evaluation);

- The calculation of value and their transfer in the new context of evaluation.

When there are a number of original studies available, it is possible to perform a meta-analysis to link the value obtain to its different environmental or socio-economic characteristics.

Three possible techniques can be used for the transfer of benefits:

- Transferring average benefit estimates, when assumed that the change in well-being experienced by average individuals on an existing site is equal to that which will be experienced at the new site;
- Transferring adjusted benefit estimates, when average is adjusted according different criteria such as socio-economic characteristics of the individuals, difference in quality and availability
- Transferring benefits function: the existing relationship is transferred and data needed to apply it for the new site is collected.

Some databases have been set up in an attempt to facilitate benefits transfer. This is the case of the EVRI database developed by Environment Canada and the US Environment Protection Agency. More than

Order	Impacts	Examples	Techniques of references
1	Marketed products	• Provision of: food, fuel, timber, fish	• Market prices • Averting behaviour
2	Impacts on goods that are not marketed but whose value is indirectly captured through other goods	• Air quality or noise as reflected in house prices	• Hedonic pricing
3	Environmental services that individuals can fairly readily value in monetary terms	• Recreational amenities e .g. fishing, boating, walking. • Many national park services • Scenic viewpoints	• Hedonic pricing • Travel costs • Contingent evaluation • Averting behaviour
4	Less tangible impacts on human welfare not already covered	• Aesthetic impacts of pollution or a degraded landscape and • Impacts on ecological functions such as loss of biodiversity, climate moderation	• Protection costs • Contingent Evaluation
5	Non-use and option values	• Some ecological functions • Option value • Bequest and existence value	• Contingent evaluation



700 studies are currently available in the database, but only a minority are European in origin, this still reduce the usability of the database in a European context of evaluation.

Except perhaps transfer analysis, the use of the methodologies reviewed above, will depend on the socio-economic context, on the type of environmental impacts studied and other characteristics such as the cost and the time for carrying out a new evaluation in a new site.

The list below shows the main types of costs and benefits that a cost-benefit analysis should appraise. When you move down the list, it becomes harder to derive robust estimations of the value people place in the good and there will probably be more disagreement with the use of evaluations based on the public's preferences. Consequently, as you move down the list, other methodologies of evaluation which take into account assessed ethical considerations, such as public consultation or multi-criteria analysis, are likely to be accepted more easily by stakeholders, with a greater consensus than analysis with monetary values.

## E.4 The different steps of an environmental cost-benefit analysis

Monetary analysis is usually split in different steps, which are the following:

1. The definition and the technical description of the different options of the project. Useful information is likely to be available in the feasibility studies and should be enough to state the technical and socio-economical context of the project;

2. The assessment of environmental impacts and damages to the ecosystem and human health associated with the different scenarios available. For major projects an Environmental Impacts Analysis is usually required and will contain enough information on the most important local impacts on air, water and soil pollution.

3. The description of external effects and economic agents affected directly or indirectly by the environmental impacts of the project. The idea is to describe more accurately the relationship between the provision of environmental services by ecosystems and the social benefits derived from their consumption. A list of people involved must be set up at this stage.

4. The choice of an evaluation method and the validation of the monetary value calculated. The most satisfactory method of evaluation will be chosen, which depends on the type of project, on the environmental goods and services and on the general socio-economic and political context. In an ideal evaluation procedure, stakeholders would validate calculated values in order to assure a consensus on the methodology selected.

5. The choice of a discount rate and the estimation of the environmental net benefit of the project. The use of a low discount rate is sometimes justified by the fact that environmental impacts produce negative effects in the long term. Some people argue for a zero discount rate because of ethical considerations for future generations. In any case, where strong environmental impacts occur, a low discount rate (approximately 3 or 5 %) should be selected in order to include some ethical principles such as the precautionary principle.

## Annex F

# Affordability and evaluation of distributive impact

Affordability is an important issue in evaluating investments projects, especially in some countries. Income streams will for instance take the form of charges for environmental services, such as water supply or waste disposal. A project affordability analysis will help assess the ability of consumers to pay at least a share of the proposed charges and contribute to operating and maintenance expenditures, as well as assess the effect of the charges on demand. A Polish study has estimated that 4% of household income for water use is the upper limit of affordability for consumers. Another important issue is to take redistributive effect into account in evaluating an investment project, especially in some regions. When project evaluation is carried out from the point of view of the public sector, distributive equity could be one of the themes of the social welfare function that should influence the choice of public intervention. For example an intervention that contemplates changes in tariffs influences the distributive profiles. There are two methods for taking the distributive effects into account.

The **first** is to attribute so-called *welfare weights* (see section on multicriteria analysis). This approach allows the social objectives of the public planner to be incorporated in the shadow prices. The accounting Euro is weighted to take the distributive effects on different social groups into consideration. The correction is then included in the subsequent step for the economic analysis. Public redistributive preferences in this case are expressed by weighting<sup>1</sup> the aggregated per-capita consumption (or income) for the various consumer groups. When there is income disparity, one Euro at the margin does not have the same value for individuals with different incomes (that is it has a different weight in public evaluation). Let us con-

Tab. 1 Example of weight for distributive impact

Polation	Weight (cf)	Benefits	Distrib. impact
High income	0.5	1200	600
Medium income	0.7	1000	700
Low income	1	1500	1500
Total		3700	2800

sider a society made up of two groups of individuals, one rich group and one poor, where the income of the poor group is half that of the rich group. An increase of one Euro in the price of a consumer good (or a tariff for the use of a public service) does not have the same social effect for both groups. In fact it may have double the impact (from the welfare point of view) on the poorer group. The public planner expresses his redistributive intent if he considers the consumption of the poorer group be more important than that of the richer group. Thus, if we wish to express this effect in monetary terms, the accounting units can be weighted by distributive weights, considering 1 Euro for every Euro of the poor group and 0.5 Euro for every Euro of the rich group. At this point one can recalculate the effects of the project including these considerations in the economic analysis.

The **second** method for evaluating the redistributive impact is impact analysis: as was the case with the environmental analysis, a separate study is carried out of the redistribution of income that the project involves. One constructs an indicator of social inequality (for example a Gini index<sup>2</sup> of the consumption structure) and one calculates whether the project determines a gain or a loss in terms of equity. The result is then processed as a multicriteria analysis tool (see par. 2.6).

Tab. 2 Example distributive impact analysis with Gini index

Gini index	Without project	With project	Impact
Project A	0.6	0.7	+
Project B	0.6	0.5	-

<sup>1</sup> These weights are not comparable with weight used for multicriteria analysis expressing preferences of the public body for social objectives.

<sup>2</sup> The Gini index incorporates the more detailed shares data into a single statistic which summarizes the dispersion of the income shares across the whole income distribution. The Gini coefficient may be expressed as a proportion or as a percentage. The Gini coefficient will be equal to 0 when the distribution is completely egalitarian. If the society's total income accrues to only one person/household unit, leaving the rest with no income at all, then the Gini coefficient will be equal to 1, or 100%.

# Annex G

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## Glossary

# Some key-words for project analysis

### Basic glossary

**Accounting period:** the interval between successive entries in an account. In project analysis, the accounting period is generally a year, but it could be any other convenient time period.

**Accounting unit:** the measure that makes it possible to add and subtract unlike items. Euro may be the unit of account for the appraisal of EU financed projects.

**Appraisal:** refers to the ex-ante analysis of a proposed investment project to determine its merit and acceptability in accordance with established decision making criteria.

**Ex ante evaluation:** an evaluation carried out in order to take the financing decision. It serves to direct the project in the most coherent and relevant way possible. It provides the necessary base for the monitoring and subsequent evaluations ensuring that, wherever possible, the objectives are quantified.

**Ex post evaluation:** an evaluation carried out a certain length of time after the conclusion of the initiative. It consists of verifying the impact effectively achieved by the initiative compared to the overall objectives and project purpose.

**Feasibility study:** a study of a proposed project to indicate whether the proposal is attractive enough to justify more detailed preparation.

**Final evaluation:** an evaluation carried out immediately after the complete implementation of the initiative and whose object is

the results obtained. It serves to establish whether and to what extent the expected results have been achieved and what were the factors for its success or failure.

**Identification:** it consists of the selection of the possible intervention ideas for an instrument project that will then be the object of a specific pre-feasibility study.

**Implementation:** the intervention is carried out and the forecast activities of production or services become fully functional. During this phase it will be necessary to start the monitoring activity and, when appropriate, the in itinere evaluation.

**Independent project:** projects that in principle can all be undertaken at the same time. These should be distinguished from mutually exclusive projects.

**In itinere evaluation (on-going evaluation):** an evaluation carried out concurrently with the implementation, on a fixed date, in order to allow a re-orientation of the activity. It considers critically the first results that allow for an initial judgement to be made of the quality of the implementation.

**Long run:** the time period relating to the process of production during which there is time to vary all factors of production, but not sufficient time to change the basic technological processes being used.

**Monitoring:** the systematic examination of the state of advancement of an activity

according to a predetermined calendar and on the basis of significant and representative indicators.

**Mutually exclusive project:** projects that, by their nature, are such that if one is chosen the other one cannot be undertaken.

**Programme:** a co-ordinated series of different projects where the policy framework project purpose, the budget and the deadlines are clearly defined.

**Project:** it refers to an investment activity upon which resources (costs) are expended to create capital assets that will produce benefits over an extended period of time, and that logically lends itself to planning, financing, and implementing as a unit. A project is thus a specific activity, with a specific starting point and a specific ending point, that is intended to accomplish a specific objective. It can also be thought of as the smallest operational element prepared and implemented as a separate entity in a national plan or program. A project may produce benefits that can be valued in money terms or it may produce benefits that are intangible.

**Project analysis:** the analytical framework that compares costs with benefits to determine if, given the alternatives, a proposed project will sufficiently advance the objectives of the entity from whose standpoint the analysis is being undertaken to justify undertaking the project.

**Project cycle:** a sequence of the series of necessary and predefined activities carried out for each project. Typically it is separated into the following phases: programming, identification, formulation, financing, implementation and evaluation.

**Project evaluation:** the last phase of the project cycle. It is carried out to identify the success factors and the critical areas in order to understand and to diffuse the lessons learnt for the future.

**Short run** the time period in the production process during which the fixed factors of production cannot be changed, but the level of utilization of variable factors can be altered.

### Financial analysis

**Accrual accounting:** the method that records revenues in financial statements for the period during which the revenues are earned or realized, and expenses in the period incurred, regardless of whether the corresponding cash transactions took place previously or subsequently.

**Benefit-cost ratio:** the present value of the benefit stream divided by the present value of the cost stream. When the benefit-cost ratio is used, the selection criterion is to accept all independent projects with a benefit-cost ratio of one or greater when discounted at a suitable discount rate, most often the opportunity cost of capital. The benefit-cost ratio may give incorrect ranking among independent projects, and cannot be used for choosing among mutually exclusive alternatives.

**Cash basis accounting:** the method of recording accounting transactions only when cash receipts or expenditures occur. It should be distinguished from accrual accounting.

**Constant prices:** prices at a base year in order to exclude inflation from economic data. They may refer either to market prices or shadow prices. They should be distinguished from current prices.

**Current prices:** (Nominal prices) prices as actually observed at a given time. They refer to prices that include the effects of general price inflation and should be contrasted to constant prices.

**Cut-off rate:** the rate below which a project is considered unacceptable. It is often taken to be the opportunity cost of capital. The



cut-off rate would be the minimum acceptable internal rate of return for a project or the discount rate used to calculate the net present value, the net-benefit investment ratio, or the benefit-cost ratio.

**Discount rate:** the rate at which future values are discounted to the present. Financial discount rate and economic discount rate may differ, in the same way that market prices may differ from accounting prices, see economic analysis key-words.

**Discounting:** the process of adjusting the future value of a cost or benefit to the present by a discount rate, i.e. by multiplying the future value by a coefficient that decreases with time.

**Financial analysis:** this allows for the accurate forecasting of which resources will cover future expenses. It allows one to : 1) verify and guarantee cash equilibrium (verify the financial sustainability), 2) calculate the indices of financial return of the investment project based on the net time-discounted cash flows, related exclusively to the economic unit that activates the project (firm, managing agency).

**Financial rate of return:** the internal rate of return (see definition below) calculated using financial values and expressing financial profitability of a project.

**Internal rate of return:** the discount rate at which a stream of costs and benefits has a net present value of zero. Financial rate of return (FRR), when values are estimated at actual prices. Economic rate of return, (ERR) when values are estimated at accounting prices. The internal rate of return is compared with a benchmark in order to evaluate the performance of the proposed project.

**Market price:** the price at which a good or service is actually exchanged for another good or service or for money, in which case it is the price relevant for financial analysis.

**Net benefit:** the amount remaining after all outflows have been subtracted from all inflows. Discounting the incremental net benefit before financing gives a measure of project worth of all resources engaged; discounting the incremental net benefit after financing gives a measure of project worth of the entity's own resources or equity.

**Net present value (NPV):** the sum that results when the discounted value of the *expected* costs of an investment are deducted from the discounted value of the expected benefits. Economic net present value ENPV. Financial net present value FNPV.

**Opportunity costs:** the value of a resource in its best alternative use. For the financial analysis the opportunity cost of a purchased input is always its market price. In economic analysis the opportunity cost of a purchased input is its marginal value product in its best non project alternative use for intermediate goods and services, or its value in use (as measured by willingness to pay) if it is a final good or service.

**Real rates:** rates deflated to exclude the change in the general or consumption price level (for example real interest rates are nominal rates less inflation rate).

**Relative prices:** the exchange value of two goods, constituted by the ratio between the quantity exchanged and their absolute nominal prices.

**Residual value:** the net present value of assets at the final year of the period selected for evaluation analysis.

**With and without project scenario:** in project analysis, the relevant comparison is the net benefit with the project compared with the net benefit without the project, in order to measure the additional benefits that can be attributed to the project.

## Economic analysis

**Accounting prices:** the opportunity cost of goods, generally different from actual market prices and from regulated tariffs. They should be used in project appraisal to reflect better the real costs of inputs to society, and the real benefits of the outputs. Often used as a synonym of shadow prices.

**Border price:** the unit price of a traded good at the country's border. For exports, it is the f.o.b. (free on board) price, and for imports, it is the c.i.f. (cost, insurance and freight) price.

**Conversion factor:** a number that can be multiplied by the domestic market price or value in use of a non traded item to convert it to an accounting price. In other words, actual prices are converted in shadow prices, approximated by the use of ACB.

**Cost-Benefit analysis:** conceptual framework applied to any systematic, quantitative appraisal of a public or private project to determine whether, or to what extent, that project is worthwhile from a public or social perspective. Cost-benefit analysis differs from a straightforward financial appraisal in that it considers all gains (benefits) and losses (costs) regardless of to whom they accrue. CBA usually implies the use of accounting prices. Results may be expressed in many ways, including internal rate of return, net present value and benefit cost ratio.

**Distortion:** a state in which the market price of an item differs from the price it would bring in the absence of government policy failures or market failures. This generates a gap between the opportunity cost of a good and its actual price, e.g. monopoly pricing, externalities, indirect taxes, duties, regulated tariffs, etc.

**Economic analysis:** analysis that is undertaken using economic values, reflecting the values that society would be willing to pay

for a good or service. In general, economic analysis values all items at their value in use or their opportunity cost to society (often a border price for tradable items). It has the same meaning of cost-benefit analysis.

**Economic rate of return (ERR):** an index of the socio-economic profitability of a project. It may be different from financial rate of return (FRR), because of price distortion. ERR implies the use of accounting prices and the calculation of the discount rate that makes project benefits equal to present costs, i.e. makes economic net present value (ENPV) equal to zero.

**Externalities:** in project analysis, an externality is an effect of a project felt outside the project, and consequently not included in the valuation. In general, an externality is said to exist when the production or consumption of a good or service by one economic unit has a direct effect on the welfare of producers or consumers in another unit. Externalities may be positive or negative.

**Non-tradeable goods:** goods that cannot be exported or imported, e.g. local services, unskilled labour and land. In economic analysis, non traded items are valued at their marginal value product if they are intermediate goods or services or according to the willingness to pay criterion if they are final goods or services.

**Social discount rate:** to be contrasted to financial discount rate. It attempts to reflect the social view on how the future should be valued against the present.

**Socio-economic costs and benefits:** opportunity costs or benefits for the economy as a whole. They may differ from private costs to the extent that actual prices differ from accounting prices. (social cost = private cost + external cost).

**Tradeable goods:** goods that can be traded internationally in the absence of restrictive trade policies.

**Willingness to pay:** the amount consumers are prepared to pay for a final good or service. If a consumer willingness to pay for a good exceeds its price, the consumer enjoys a rent (consumer surplus).

**Shadow prices** see accounting prices.

## Other evaluation elements

**Cost/effectiveness analysis:** an appraisal and monitoring technique used when benefits cannot be reasonably measured in money terms. It is usually carried out by calculating the cost per unit of benefit and requires that means exist for quantifying benefits but not necessarily for attaching a monetary price or economic value to the benefits.

**Chronogramme:** a technique used to make a realistic and verifiable estimate of the times necessary, showing the critical points of the implementation of the initiative. It defines the logical-temporal links between the various activities of the initiative and estimates the time for the implementation itself.

**Environmental impact analysis:** analysis that identifies the effects on the environment of any investment project. This would include the forecasting of potential pollution emissions, loss of visual amenity, and so on.

**Impact analysis:** an evaluation of the change or the long term effect on society that can be attributed to the action of intervention, linked to the achievement of the overall objectives. It must be expressed in the unit of measurement adopted to indicate the problems it is meant to resolve.

**Multicriteria analysis:** an evaluation methodology that considers many objectives by the attribution of a weight to each measurable objective.

**Risk analysis:** a study of the odds of the project's earning a satisfactory rate of return and the most likely degree of variability from the best estimate of the rate of return. Although risk analysis provides a better basis than sensitivity analysis for judging the riskiness of an individual project or the relative riskiness of alternative projects, it does nothing to diminish the risks themselves.

**Sensitivity analysis:** the analytical technique to test systematically what happens to a project's earning capacity if events differ from the estimates made about them in planning. It is a rather crude means of dealing with uncertainty about future events and values. It is carried out by varying one element or a combination of elements and determining the effect of that change on the outcome.

**Financial sustainability analysis:** analysis carried out in order to verify that financial resources are sufficient to cover all financial outflows, year after year, for the whole time horizon of the project. Financial sustainability is verified if the cumulated net cash flow is never negative, during all the years considered.

**SWOT analysis:** briefly describes both the intrinsic characteristics of the initiative and the context in which it is realised; enabling alternative development scenarios to be analysed. It analyses the context in which one intends to intervene and shows the internal factors upon which to concentrate (strengths) or which need to be cancelled out (weaknesses), as well as the favourable (opportunities) or unfavourable (threats) external factors.

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