POLISH ACADEMY OF SCIENCES
Systems Research Institute

ECO – INFO AND SYSTEMS RESEARCH

Editors:
Jan Studzinski
Olgierd Hryniewicz

ECO – INFO AND SYSTEMS RESEARCH

Polish Academy of Sciences • Systems Research Institute
Series: SYSTEMS RESEARCH
Vol. 52

Series Editor:
Prof. Jakub Gutenbaum

Warsaw 2006

ECO – INFO AND SYSTEMS RESEARCH

Editors:

Jan Studzinski
Olgierd Hryniewicz

The purpose of this publication is to present the information technology (IT) tools and techniques that have been developed at the Systems Research Institute of Polish Academy of Sciences in Warsaw (IBS PAN) and at the German Institute for Landscape System Analysis in Müncheberg (ZALF) in the area of applications of informatics in environmental engineering and environment protection. The papers published in this book were presented in the form of extended summaries during a special workshop organized by IBS PAN in Szczecin in September 2006 together with the conference BOS'2006 organized jointly by IBS PAN, University of Szczecin, and the Polish Society of Operational and Systems Research. In the papers the problems of mathematical modeling, approximation and visualization of environmental variables are described. Moreover, some questions concerning the environmental economy are also presented.

Papers Reviewers:
Prof. Andrzej Straszak
Dr. Lucyna Bogdan

Text Editor: Anna Gostynska

Systems Research Institute of Polish Academy of Science
Newelska 6, PL 01-447 Warsaw

Section of Scientific Information and Publications
e-mail: biblioteka@ibspan.waw.pl

ISBN 83-894-7509-X
9788389475091
ISSN 0208-8029

CHAPTER 3

Environmental Economy

FINANCIAL AND ECONOMIC ANALYSIS OF ENVIRONMENTAL PROJECTS FOR APPLICATION OF EU FUNDS

Krzysztof S. CICHOCKI
Systems Research Institute, Polish Academy of Sciences
<kcichocki@inspan.waw.pl>

Abstract: The paper presents financial and economic analysis (including cost and benefits approach) of environmental, infrastructure projects. These analyses are the major part of feasibility study, required as compulsory attachment in applications for European Union funds designated to co-finance infrastructure projects. The projects include: waste water treatment plants and sewerage systems, storm water filtration, water production and water supply networks, potable water processing, sludge treatment and solid waste treatment, including landfills construction and revitalization, as well as land protection at construction of gasoline stations.
In the paper a methodology is presented which shows when EU regulations regard co-financing as necessary to implement an infrastructure project, and how a co-financing rate is calculated. There is also a method for determination of acceptable tariffs for water supply and sewerage services, described and various categories of risk associated with project implementation are discussed. Calculation examples for real life environmental project are presented.

Keywords: Cost and benefits analysis, efficiency, feasibility study, EU co-financing rate, revenue, risk, tariffs.

1. Introduction

The objective of financial analysis is to prove technical feasibility (implementability) and financial efficiency of a project (without and with EU co-financing). This is done with a help of financial investment efficiency measures which include product and result measures and financial indicators: for example *Net* Present Value (FNPV) and Internal Rate of Return (FIRR), as well as other categories of cost efficiency and unit cost measures. The indicators refer to either investment expenditure over a construction period, or to maintenance costs over the life period of a project (typically 30 years for environmental projects).

Financial Analysis includes determination of how much financial resources, including eventual loans, are necessary to implement and maintain the project? and what is the EU contribution (co-financing rate) in financing the project construction? It also includes calculation of disposable income *per capita* and socially acceptable tariffs for water supply and sewerage services.

Economic analysis presents social costs and benefits resulting from the project implementation and social investment efficiency measures (economic values of financial indicators): ENPV, EIRR, which must be positive. This analysis also includes the project implementation impact on environment.

The objective of the feasibility study and cost and benefit analysis is to demonstrate capability to deliver quality infrastructure product and service that will serve local communities in accordance with predictable schedule and costs, and in addition - to present a well defined, repeatable processes to systemically improve product and service delivery.

Topics of analysis and discussion regarding implementation of an environmental project include project formulation and description of its location, high-level scoping of the project, identification of the project objectives and requirements, included in the feasibility study, technical analysis and selection of the best alternative, financial and cost and benefit analysis, which includes economic and efficiency analysis, the process of price determination over the lifecycle of the project and acquisition strategy. Long–term capital investment and financial planning, as well as strategic planning by an investor, is of vital importance in the analysis of a project (or a group of projects.

The financial and economic analyses not only help acquire EU funds, but they intends also to translate customer (user) needs into requirements and then transform those requirements into products and services (investment and project management system processes). This transformation may occur through building a new facility, the development of a new technology, or enhancements to an existing infrastructure system, which supports and improves current local services.

2. Financial and capital investment long-term planning

The implementation of an environmental project is a part of effective and repeatable *Capital Investment Plan* (CIP). CIP is usually required by law (public finance law in Poland) and is essential to ensure sound infrastructure investment decisions. The CIP usually details the approach the local government (JST) uses to identify, prioritize, justify, fund, and manage investment opportunities. The process applies to the project selection, design and evaluation of alternative solutions, as well as to financing the construction and maintenance of infrastructure-related initiatives.

Projects involve the disciplines of project management, environmental systems engineering, quality assurance and financial management. A methodology for managing the project and the resulting product (system, infrastructure facility) should be instituted at the inception of the project and throughout the product lifecycle. When a new system, or modification to the existing system, has been completed and implemented, operation and maintenance is entered, by the managing institution. In environmental projects like in business, technical requirements of a routine maintenance nature are addressed. Requirements for changes or enhancements are generated by service provider (JST, or a private company), and the users of the system (customer).

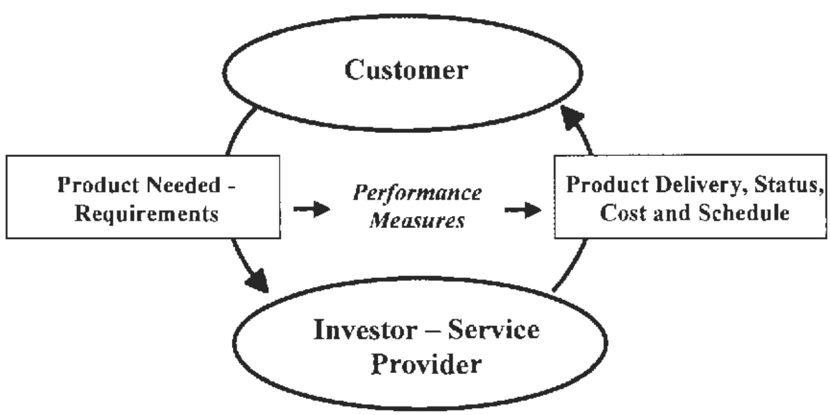

Figure 1. Customer and Service Provider Interaction.

The relationship between the customer (JST inhabitant) and the service provider (local government or other investor) is shown in Figure 1.

The customers, based on quality of service or delivered product and the cost of service, identify degree of satisfaction of the needs, and with the help of performance measures can assess if the objectives of the project are satisfied. This information is input to the process of developing improved productivity and service quality.

A project's levels of funding require long-term planning and additional operational management regarding monitoring of costs and results. Therefore, to ensure achievement of project results, cost effectiveness and feasibility throughout the project's lifecycle, in addition to project design, a Long-term Capital Investment Plan and long-term Financial Plan of an investing JST is needed, as well as the complete and sound feasibility study with financial analysis of the project over its life time (30 years).

The duration and level of funding can directly affect the project's viability and outcome. If a project's duration spans more than one fiscal year, the project could be in jeopardy of budget cuts (victim of inadequate funding, e.g. no EU sources of funding), or a change in the JST mission or strategic goals.

All projects, corporate and in public sector (non-corporate), should participate in the CIP process which ensures sufficient resources for their successful completion and operation.

3. Feasibility study and cost benefit analysis

3.1. Feasibility Study

A *Feasibility Study (FS)* provides technical, financial and economic analysis of project implementation. A formal feasibility study should be performed to obtain the necessary information for making an informed decision about project feasibility, and consistently with EU recommendations. The following are select examples of cases when a feasibility study provides answers which help in assessing the project implementation:

- there is uncertainty over the cost justification, technical feasibility or selection of an option of a project,
- there is a lack of agreement about the goals or approach for implementing the project,
- the proposed size or complexity of the project indicates a high degree of risk,
- the product will implement functions (provide services) that currently are not being performed in a given JST or in the country.

The project *FS* usually includes:

- **technical option and feasibility analysis,** which provides answers to the questions:
  How can we achieve project objectives?
  Which are the feasible alternatives?
  Is the EU co-funding of the project justified and rational?
- **financial analysis,** which provides answers to the questions:
  How much financial resources are necessary to implement the project option selected?
  What is the EU co-funding rate (the EU contribution)?
  Will the maintenance of the project be secured?
  What will be the JST budget contribution and the loans needed to implement the project?
  What are the effective prices, which result from total cost of the project (a sum of investment costs and operating costs - capital depreciation), and what are the socially acceptable prices?

- **economic analysis,** provides answers to the questions:
  What is the impact of the project on the area where the project will be implemented?
  These analyses identify and assess the project impacts on the overall society. The cost and benefit approach is used, which balances social costs and benefits (welfare), and also takes into account uncertainties regarding project maintenance. *Cost and Benefit Analysis* (CBA) *is* an evaluation methodology to assess public projects.
  Social welfare analysed may be expressed by the money value of consumption goods of all individuals belonging to a society. The project economic value is given by the impact over consumption goods of all society's individuals by a variety of the project effects and results.

- **Risk Analysis** provides answers to the questions:
  How can we make reliable forecasts of project results over the project time horizon?
  Is it possible to make the project more financially robust and economically desirable?
  Finally,

- **Project Environment Impact Report** discusses the project implementation impact on environment.
  The above analyses base on sound principles of economics and corporate finance, and on standard accounting models. However, they are arbitrarily recommended by the European Union.

A *Feasibility Study* is required as a compulsory attachment to the application for EU funds.

Thus, the FS and CBA identify:

- the best implementable (feasible) technical alternative;
- the financial resources needed to implement and maintain the project;
- effective and socially acceptable prices (of services)
- the project impact on environment (area where it will be implemented);
- project risks and its financial and economic implications.

Sometimes a feasibility study for a similar project has already been conducted. An existing feasibility study can be a guidance, if the information is current, relevant to the new project, and technically correct, but only to a limited extent. The results of the select project feasibility study should be unique, well documented with a description of the process that was used to determine feasibility, the alternatives that were considered, and the results of the CBA.

4. Financial analysis

The objective of financial analysis is to prove financial implementability and efficiency of a project (without and with EU co-financing) with a help of financial investment efficiency, cost efficiency and unit cost measures. The analysis will provide answers to questions regarding a level of necessary resources to implement the project, the JST budget and the EU contribution, and the level of loans needed. It will also determine the level of funds needed to maintain the project.

Detailed Financial Analysis includes:

- *Basic assumptions*, including determination of time horizon, prices, and real financial discount rate,
- *Total investment expenditure*, including investment expenditure in fixed assets and turnover capital,
- *Operating costs,*
- *Sources of project financing,*
- *Financial and physical schedule (monthly and quarterly),*
- *Financial balance and revenue and costs table.*

- *Net cash flows*, and the key financial indicators:
- Rate of return on investment,
- Rate of return on public and private capital,

- *The Net Present Value – NPV,*
- *The Internal Rate of Return – IRR.*

The Financial *Net* Present Value **(FNPV/C)** expresses the additional (revenues minus costs) discounted resources generated by the investment, without capital depreciation;

The Financial Internal Rate of Return **(FIRR/C)** expresses the additional discounted resources generated by the investment, in percentage terms.

These values are calculated over the lifetime of the project, which equals 30 years for environmental projects.

Below, in Table 1, we present an example of revenues, costs, and cash flow over a 10 year period. We have also calculated the values of **FNPV/C and FIRR/C**.

Table 1. Revenues, costs, and cash flow.

Year	1	2	3	4	5	6	7	8	9	10
Operating Revenues	0	1501	5701	7501	7501	8501	8501	8501	8501	0
Residual value	0	0	0	0	0	0	0	0	0	1500
Total Revenues		1501	5701	7501	7501	8501	8501	8501	8501	1500
Operating Costs	0	1400	4500	7445	7445	7445	7445	7445	7445	0
Investment Costs	2372	2092	1889	700	500	0	0	0	0	0
Total Costs	2372	3492	6389	8145	7945	7445	7445	7445	7445	0
Net Cash Flow	-2372	-1991	-688	-644	-444	1056	1056	1056	1056	1500
FIRR/C	-1%									
FNPV/C	-1.857,34									

Based on a similar table, designed for the select environmental project 30 year life time, we can assess financial viability of the project – its capability of success.

Financial viability is usually measured by financial profitability and financial sustainability.

Financial Viability is described by:

- Financial Profitability - assesses the capacity of the project to generate additional financial resources compared to those invested.
- Financial Sustainability - assesses if there is enough cash for each year of the project lifetime.

Table 2. Financial Sustainability.

Years	1	2	3	4	5	6	7	8	9	10
Total Inflow	2.372,00	3.492,00	6.389,00	8.145,00	7.945,00	7.445,00	7.445,00	7.445,0	7.445,0	
National Contribution	400	200	100							
EU Contribution	1968,76									
Private Equity	100	200	100							
Operating Revenues	0	1501	5701	7501	7501	8501	8501	8501	8501	0
Residual Value	0	0	0	0	0	0	0	0	0	1500
Total Outflow	2.469	1.901	5.901	7.501	7.501	8.501	8.501	8.501	8.501	1.500,00
Operating Costs	0	1400	4500	7445	7445	7445	7445	7445	7445	0
Investment Costs	2372	2092	1889	700	500	0	0	0	0	0
Net Cash-Flow	96,76	-1.591,00	-488,00	-644,00	-444,00	1.056,00	1.056,00	1.056,00	1.056,00	1.500,00
Cumulated Net Cash-Flow	96,76	-1.494,24	-1.982,24	-2.626,24	-3.070,24	-2.014,24	-958,24	97,76	1.153,76	2.653,76

It may happen that a project is profitable, but it is not sustainable. This is verified through an analysis, presented below in Table 2, whose goal is to assess if there is enough cash for each year of the 10 year project lifetime (we usually assume 30 years).

In Table 2, we also present sources of financing our hypothetical project.

From financial analysis we obtain:

- Discounted Investment Costs 6613,74 Euro (at 6% discount rate, measured in nominal values)
- Discounted Net Operating Revenues 4756,40 Euro (at 6% discount rate).

Financing Plan could look as follows:

Discounted National Capital, including private equity:

995,62 Euro (at 6% discount rate, and measured in nominal values)
EU Grant 1857,34Euro (28% of Investment Costs)
Capital Needed 3760,78 Euro.

The rationale of the EU co-funding is to guarantee the project financial profitability, that is, the FNPV should be approximately equal to zero. The method of determination of the EU co-financing rate is described in point 5.

This implies that if the financial discount rate is equal to 6% (in real terms), the EU grants result in an FIRR (or FIRR/C) equal to 6%. This in turn means that the maximum sustainable cost of borrowing money (i.e. the interest rates charged on loans) is equal to 6%. Thus, there is a need to consider in the financial analysis also the possibility of loans.

Setting Tariffs For Environmental Projects

We briefly discuss two principles:

1. *Polluter Pays Principle*: apply tariffs consistently adequate with the source of pollution generated,
2. *Affordability*: calculate tariffs, which are socially acceptable.

In a community where the project is implemented, one should consider an average income per capita without tax (disposable income) and take into account income inequality, e.g. all members of a given society (e.g. town) including unemployed. First, in a given community we calculate total disposable income of all tax payers, and divided it by the number of inhabitants of the society, which will benefit from the project implementation. Then, we calculate tariffs, which are socially acceptable. For example a socially acceptable tariff for water supply and water purification in Poland equals 4% of the disposable income (in the EU "old" countries this tariff is kept within the range of 3% to 5% of the disposable income).

The result of a financial analysis is to help determine the financial feasibility of a project and the return on investment in a short and long run.

For example, we want to know (1) if environment protection and increased welfare justify the cost of the project and EU funding, and (2) the expectation, in money terms, for realizing return on the investment is satisfactory.

The financial analysis results in determination of financial efficiency of a project (without and with EU co-financing) with a help of financial investment efficiency indicators: FNPV, FIRR, and other financial indicators, which include product and result measures, cost efficiency and unit cost measures. The indicators refer to either investment expenditure, over a construction period, or to maintenance costs over the life period of a project (EU recommends 30 years).

A detailed analysis will help establish the type of funds and the time to request these funds (i.e. investment capital and operating funds). These analyses also address the method of acquisition (i.e., purchase, lease, lease-to-ownership, lease-with-option-to-purchase, etc.).

After a project has been funded, a decision needs to be made as to who the solution provider will be; i.e., in-house, for example local government, or contracted out. If in-house, the acquisition of services may be the issuance of a statement of work and the receipt of a financial plan for the accomplishment of the operational management of the project. If the project is contracted out, then an acquisition strategy will need to be developed.

5. The rationale of the EU co-funding

The Financing Gap Rationale is consistent with the EU intervention by regional policies in Member States, based on project investments (including in-kind transfers), and financial analysis. The rationale for the EU co-funding is to guarantee that the project financial profitability is approximately equal to zero, that is the value of FNPV (without the EU contribution) < 0, and the value of FNPV (with the EU grant) $\cong 0$. This is made in three main steps.

The three Steps to Determine the EU Co-Funding Rate

STEP 1°: ***Identify the Project Financing Gap Rate*, R.** Based on the project financial analysis (total investment costs) calculate the financing gap rate.

$$R = \frac{DIC - DNOR}{DIC}$$

where:

DIC denotes discounted investment costs;
DNOR is discounted net operating costs.

STEP 2°: Identify the EU Co-Funding Rate, *CR*; This is a general method for all EU funds.
In practice: upper limits are given. See Art. 7 Reg. 1164/94, amended by Reg. 1264/99, and Art. 29, Reg. 1260/99.
The co-funding rate is the minimum value of the
(a) maximum co-funding rate established by the regulations**, *max CR,*** and
(b) financing gap rate**, *R*,** that is,
when R > max CR, then CR= max CR
when R < max CR then, CR= R.

EXAMPLES for the *Cohesion Fund*

EXAMPLE 1: R=100%; max CR = 85%: CR=85%
EXAMPLE 2: R=80%; max CR = 85%: CR=80%.

EXAMPLES for *Structural Funds* (method proposed by the EU commission)
The co-funding rate is the minimum value of
(a) the maximum co-funding rate established by the regulations, *max CR* and
(b) the maximum co-funding rate established by Art. 29.3, Reg. 1260/99, *max CR29.3* , times the financing gap rate, *R*, *that is*

when max CR > max CR29.3*R, then CR= max CR29.3*R
when max CR < max CR29.3*R, then CR= max CR

Examples
Projects with *no* substantial net revenues (DNOR less than 25% of investment costs)

Example 1: R=100%; max CR = max CR 29.3= 80%, then
CR is the minimum value between
CR = max CR 29.3=0.80
CR= max CR 29.3*R=1*0.80

Example 2: R=90%; max CR = max CR. 29.3= 80%, then
CR is the minimum value between
CR = max CR 29.3=0.80
CR=max CR 29.3*R=0.9*0.8=0.72

<u>Projects with substantial net revenues</u>

Example 3: R=70%; max CR = 50% (Art. 29.4); and max CR. 29.3= 80%, then
CR is the minimum value between
max CR 29.4=0.5, (the specific max CR depends on the net revenues generated by the project), and
max CR 29.3*R=0.8*0.7=0.56

Example 4: R=30%; max CR =50% (Art. 29.4), and max CR 29.3= 80%
CR is the minimum value between
max CR 29.4=0.5
max CR 29.3*R=0.8*0.3=0.24

STEP 3°: Identify the EU Grant, *GEU*

Calculation of the GEU is simple: multiply the EU Co-Funding Rate, *CR*, times the Eligible Costs, *EC*, that is,

$$GEU=CR*EC$$

Eligible costs vary from total costs for a number of reasons. For example: VAT which may be recovered is not eligible; in the case of Structural and Cohesion Funds, land costs cannot be more than 10% of eligible costs; investor's overview costs are not eligible.

Example: Calculation of the EU Grant for our standard project financed from Cohesion Fund

In section 4, presenting financial analysis of our hypothetical project, we concluded that the capital needed equal 3760,78 Euro. Thus, there is a need to consider loans as a source of financing the project. Below we present calculation for two alternative interest rates.

Loan Interest Rates equal to 6%	Loan Interest Rates less than 6%
National Capital 995,62E	National Capital 995,62E
Contribution EU 1857,34E	Contribution EU 1857,34E
Loan: 3760,78E	Loan < 3760,78
In Polish accounting interest costs add to operating costs.	

The Financing Gap is 1857,34 Euro.

Table 3. The Financing Gap.

Years	1	2	3	4	5	6	7	8	9	10
Total Revenues		1501	5701	7501	7501	8501	8501	8501	8501	1500
Total Costs	2372	3492	6389	8145	7945	7445	7445	7445	7445	0
Net Cash Flow	-2372	-1991	-688	-644	-444	1056	1056	1056	1056	1500
FRR/C	-1%									
FNPV/C	-1.857,34									
DIC	6.613,74									
DOC	35.762,31									
DRV	837,59									
DOR	39.681,11									
Financing Gap	1.857,34									
Financing Gap Rate	28%									
EU Grant	1.857,34									

Table 5. The cash-flow: FRR/K METHOD (case of loans with interest rates equal to 6%)

Years	1	2	3	4	5	6	7	8	9	10
Total Revenues	0	1501	5701	7501	7501	8501	8501	8501	8501	1500
Operating Costs	0	1400	4500	7445	7445	7445	7445	7445	7445	0
Loan Reimbursement	510,97	510,97	510,97	510,97	510,97	510,97	510,97	510,97	510,97	510,97
Private Equity	100	200	100	0	0	0	0	0	0	0
National Contribution	400	200	100							
Total Expenditure	1010,97	2310,97	5210,97	7955,97	7955,97	7955,97	7955,97	7955,97	7955,97	510,97
Net Cash Flow	-1010,97	-809,97	490,03	-454,97	-454,97	545,03	545,03	545,03	545,03	989,03
FNPV/K	0,0 E									
FRR/K	6,00%									

Below, in Table 4, we present assessment of the project profitability on the national capital (K), taking into account that the project is financed with a loan. We take into account that:

- investment costs are reduced by amount equal to the EU Grant;
- we include eventual loans and related interest rate.

ENVIRONMENTAL PROJECTS

Waste Water Treatment Plants and Solid Waste Management Projects

The EU regulations facilitate application of the "polluter pays principle", which results in application of the modified financing gap formula, which is graphically presented in Figure 1.

We can observe that the higher are tariffs the higher is the cash transfer. The modified financing gap is defined as:

$$R = \frac{DIC}{DIC + DNOR}$$

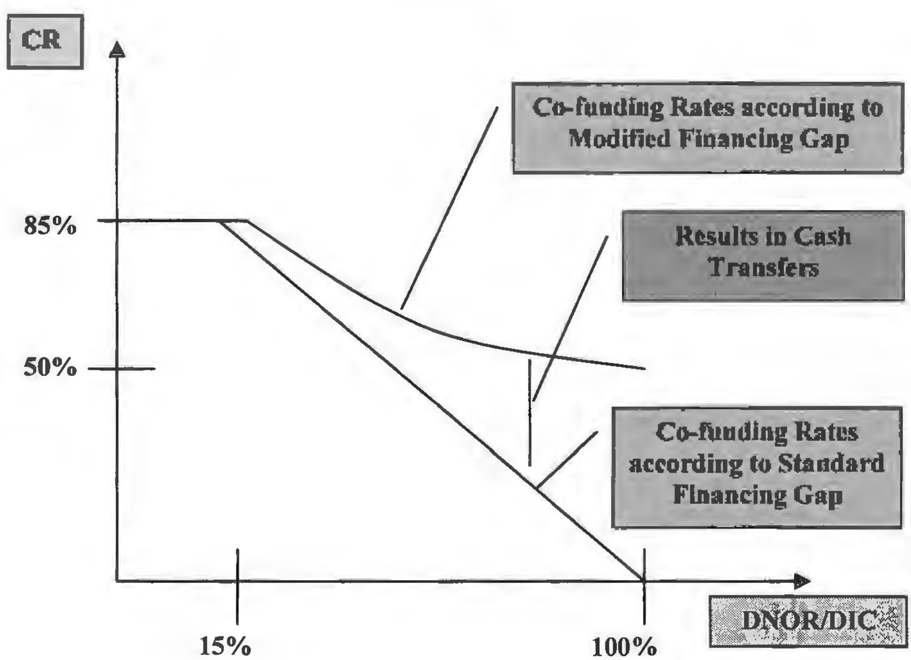

Figure 1. Co-funding Rate: modified and standard.

6. Economic analysis

Economic analysis presents the project impacts on the overall society – all social costs and benefits resulting from the project implementation, and social investment efficiency measures: ENPV, EIRR - which must be positive.

Cost and Benefit Analysis (CBA) *is* a systematic evaluation methodology to assess public projects, also for comparing alternative ways to satisfy the project objectives.

The CBA is typically performed as part of the feasibility study. It is used to identify and compare the benefits and costs associated with all the alternative activities considered in the development of an environmental infrastructure project. The results of the CBA should indicate the most cost-effective alternative.

During planning, the results of an ABC help determine the feasibility of a project and the return on investment. An ABC can be a useful tool at any stage of the environmental infrastructure engineering lifecycle and should be reviewed and updated regularly to determine if it is still valid and the cost and benefit objectives are being realized.

CBA's provide a structured framework for identifying alternatives, assessing all cost associated with implementation of the project and all benefits resulting from project implementation. The structured ABC's framework provides results affecting a decision. These results are quantified to aid decision-makers. The first decision point is whether or not any initiative should be attempted (Go or No-Go Decision). A CBA is important at this stage in determining the economic feasibility of a project. Its primary purpose is to compare the present system (status quo) to a proposed change. The second decision point is determining which alternative solution is the most desirable. While CBA's do not remove all uncertainty, they help clarify the impact of choosing among alternatives.

For all projects the major focus should be on both, the project investment costs and on defining project lifecycle operating costs as precisely as possible.

The CBA and a feasibility study process include:

- Identifying all reasonable alternatives for satisfying stated objectives. (a reasonable alternative is both technically and operationally feasible)
- Identifying benefits and costs of each alternative, over the project lifecycle

- Determining when benefits and costs will occur
- Comparing alternatives
- Identifying the best alternative – a project, which will be implemented.

Economic Analysis may be carried out through three main steps

1. *Fiscal Corrections*
2. *Corrections for Distortions*

Conversion Factors have to be used. Conversion Factors are ratios between economic and financial values.

3. *Inclusion of Externalities and monetization* of the main externalities.

Economic Analysis may be facilitated by National Guidelines on Conversion Factors and Monetization of externalities to be used by project implementers.

Direct Economic Costs and Benefits Analysis of a project include:

- *Analysis of social costs and social benefits*
  - Identification of project effects – direct and indirect (inputs and outputs), and identification of how project inputs and outputs impact upon consumption goods - directly on consumption and indirectly through production
  - Calculation of new prices
  - Calculation of new wages
  - Internal effects
  - External effects
- Calculation *of Economic Rate of Return, and Economic Net Present Value*
- *Additional criteria of project assessment*
  - Concistency with overall E U objectives and policy
  - Increase in social income (as measured by E U)
  - Decrease in discrepancy between national and EU GDP *per capita*
  - Increase in employment
  - Improvement in environment quality

Direct Effects are the impacts directly generated by the project, for example *Direct Employment* (could be increased, when a new waste water treatment plant is built, or reduced, when we produce less sludge in an old plant)

Indirect Effects are the impacts generated by the activities affected by the project - Ind*irect Employment,* for example in tourism development.

One should be careful with indirect effects as they can be a double counting. For example time savings and increase in production activities on the area where the waste water treatment plant is built.

The greater is the project impact on unemployment the greater is the project desirability (the ENPV increases since the shadow wage rates decrease).

Internal Effects are those effects which are market transacted (i.e. a price is paid for these effects – for waste water treatment); they are *Project Inputs*

External Effects are those effects for which no direct monetary compensation is made - *Pollution; Health Effects; Effects on values of land and buildings.*

The project Economic NPV can be measured quantitatively, when we measure the economic effects in money values, using for example *A Study of the Benefits of Compliance with the EU Environmental Acquits,* by Peter Faircloth and Colin Barnes (2004).

EXAMPLE of WASTE WATER TREATMENT PLANT
Identification; <u>Identify project inputs and outputs:</u> e.g. treated water
<u>Identify how project inputs and outputs impact upon consumption goods</u>; directly on consumption: e.g. price for water treatment increases, we observe an increase in the values of land and buildings in the area, and an increase in tourism.
Indirectly through production: e.g. increase in fishing.
Assessment of project effects consists of determination of:

- Individual Marginal Willingness to Pay (MWTP)
- Increase in production valued at market prices

Project Economic Value equals impact on consumption goods*MWTP.

Examples of fiscal corrections include:

- *Indirect Taxes* should be eliminated
- *Direct Taxes* related to labour should be included
- *Pure Transfers* such as social security payments should be omitted
- *Taxes aiming at correcting externalities* should be omitted if the related externalities are included. An example could include the case of the VAT tax on construction material, which e.g. equals 10%. Then the related conversion factor is 1/(1+0,10)=0,9090.

One can use conversion factors for various categories of revenues and costs.

7. Risk analysis

Future is characterised by uncertainty; we do not know which values the variables, for example the operating costs, will assume in the future. We do not know either the impact of external variables on the results of our approximations. Thus, we would like to know answers to the questions: which are the likely financial and economic results? Can they be improved?

The most often effects of risk are:

- A delay in project implementation
- Exceeding the costs of project implementation (construction and maintenance)
- Unsatisfactory results of the project
- Impossibility to implement the project.

Therefore, we should identify the factors of risk, analyse the impact of each factor on expected results over the life time of the project, and elaborate a response strategy, minimizing the effects of uncertainty, to each of the risk category.

One rationale approach is to tackle uncertainty by attaching probabilities to each value: by doing this, uncertainty is transformed into risk. We could evaluate the expected values (sum of the values weighed by their own probability) as a result of a weighed average, where the weights are the probabilities.

Thus, the rationale of risk analysis in public project appraisal could look as follows:

- The project NPV depends on a set of hypotheses (e.g. demand forecasts)
- For each scenario, there may be a different NPV
- The project NPV can be assumed to be equal to sum of the NPV for each scenario weighed by their own probability. This value could be called expected NPV.

This rationale leads us to sensitivity analysis – investigation of the impact of critical variables (those whose changes result in significant changes in the financial and economic indexes). Then, one could apply a rule, for example that a variable is critical when a 1% variation results in 0,5% change of the IRR; and in 3% change of the NPV. In the Feasibility Study of construction a waste water treatment plant we can analyse the following six types of risk.

1. Institutional and political risk
2. Risk of a decrease in daily consumption of water and waste water *per person*
3. Risk of delays in payments by users
4. Risk of the interest rate change
5. Risk of an increase in other operating costs
6. Risk of a decrease in the investor's (JST) revenues

The sensitivity analysis was carried out separately for each variable (type of risk), under the assumption that other critical variables remain unchanged.

Table 6. Impact of a decrease in daily consumption of water *per person* on the FNPV and unit cost of the project.

Water[l]\Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
102	2,38	3,33	3,29	3,26	3,22	3,18	3,15	3,14	3,13	3,12
NPV = -8 756 276,69 zł										
99	2,39	3,36	3,32	3,29	3,25	3,21	3,17	3,17	3,16	3,15
NPV = -8 754 038,52 zł										
96	2,40	3,39	3,35	3,31	3,27	3,23	3,19	3,18	3,18	3,17
NPV = -8 752 407,35 zł										
93	2,40	3,41	3,37	3,33	3,29	3,25	3,21	3,20	3,20	3,19
NPV = -8 750 776,18 zł										
90	2,41	3,44	3,39	3,35	3,31	3,27	3,23	3,23	3,22	3,21
NPV = -8 749 145,02 zł										

We present results of analysis for two types of risk. In Table 6 the impact of a decrease in daily consumption of water *per person* on the FNPV (and unit cost of service) of the project is presented. This impact is rather small, because it was assumed in the policy of price determination that the price of service results from total costs of the project, and the demand for turn-over capital is modest.

In Table 7, we present the impact of a change in the credit interest rate on FNPV, as loans were utilized as a source of financing the project.

Table 7. Impact of the interest rate on the FNPV and unit cost of service of the project.

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
6%	2,38	3,33	3,29	3,26	3,22	3,18	3,15	3,14	3,13	3,12
NPV = -8 756 276,69 zł										
7%	2,38	3,36	3,31	3,27	3,23	3,19	3,15	3,14	3,13	3,12
NPV = -8 736 813,09 zł										
8%	2,38	3,38	3,33	3,29	3,24	3,19	3,15	3,14	3,13	3,12
NPV = -8 717 349,48 zł										
9%	2,38	3,40	3,35	3,30	3,25	3,20	3,15	3,14	3,13	3,12
NPV = -8 697 885,87 zł										
10 %	2,38	3,48	3,41	3,34	3,28	3,21	3,15	3,14	3,13	3,12
NPV = -8 639 495,05 zł										

The impact of interest rates is significant during the construction period, and until the credit is re-paid. The cost of debt (credit repayments and interest) have significantly changed the cash flows as we presented in Table 5. However, the impact interest rates change on the FNPV value is negligible.

It turned out that the most critical was the impact of a decrease in the JST (investor) revenue, specially a decrease in the funds the local government receive from the EU. It resulted in a substantial decline in the value of investment, which could be implemented.

References

Approximation of Environmental Legislation: A Study of the Benefits of Compliance with the EU Environmental Acquis for Central Europe and Cyprus, (Peter Faircloth and Colin Barnes Eds.), UE, Brussels, 2004.

Cichocki K.S. (2006) *Step by Step Training Manual for the Feasibility Study Specialist,* [Polish], RENOWATOR- Center for SME, EU Initiative – EQUAL, Warszawa.

Cichocki K.S. (2006) *Feasibility Study for Construction of Water Supply Network in* Kukawki-Adampol, Jadów, July.

Cichocki K.S., M.W. Bitner (2005) *Feasibility Study for Construction a Waste Water Treatment Plant and Sewerage Network in Łochów*, [Polish], Łochów, November.

Cichocki K. S., M.W. Bitner (2004) *Feasibility Study for Construction of a Sewerage Network in Zamość – Zawodzie*, Czarnocin, [Polish], also Report No RB/14/2004, 11. 2004, IBS PAN.

Ferrara A. (2004) (Evaluation Unit A3, DG Regional Policy Cohesion, European Commission), *COST-BENEFIT ANALYSIS in the Framework of the EU Regional Policy, presentation at the Conference*: Structural Action 2000-2006; EU Regional Policy, Prague, 07 April 2004.

Guidelines for the Development of the EURO-ISDN (Integrated Services Digital Network) as a trans-European network,1995; *Guidance for the Implementation of Regulation (EC) No 761/2001 of the European Parliament and of the Council - allowing voluntary participation by organizations in a Community; eco-management and audit scheme* (EMAS), 2001.

Guide to Cost–Benefit Analysis of Major Projects, EU, Structural Fund –ERDF, Cohesion Fund and ISPA, M. Florio and others, (2001).

Guidance for the Implementation of Regulation (EC) - Art. 7 Reg. 1164/94, amended by Reg. 1264/99, and Art. 29, Reg. 1260/99, 2001.

Kawala J. (Ed.) (2000) *Planning and Implementation of Investment in Rural Areas*, [Polish], Know-How Fund, [Polish], Warszawa.

Law on Environment Protection, [Polish], 27 April 2001 (Dz. U. No 62, p.627)

Law on water Production and Waste Water Treatment, [Polish], 07 June, 2001, (Dz.U. No 72, p.747).

Manual for Implementation of Investment Projects Financed from the E.U. Structural Funds, [Polish], Ministry of Economy, Warszawa, 2005.

Manual for Implementation of Investment Projects Financed from E.U. Cohesion Fund, [Polish], Ministry of Economy, Warszawa, 2005.

Public Finance Law, [Polish], July, 2005.

Recommendations Regarding Preparation of *Feasibility Studies for*:

A. *Waste Water Treatment Plants and Sewerage Networks*

B. *Water Supply Networks,*

Implemented in the ZPORR program, (Integrated Regional Development Program), Ministry of Economy, Warszawa, 2004.

Jan Studzinski, Olgierd Hryniewicz (Editors)

ECO – INFO AND SYSTEMS RESEARCH

This book presents the papers that describe the most interesting results of the research that have been obtained during the last few years in the area of applications of informatics in environmental engineering and environment protection at the Systems Research Institute of Polish Academy of Sciences in Warsaw (IBS PAN) and at the German Institute for Landscape System Analysis in Müncheberg (ZALF). The papers were presented in the form of extended summaries during a special workshop organized by IBS PAN in Szczecin in September 2006 together with the conference BOS'2006 dedicated to the applications of systems research in science, technology and economy and organized jointly by IBS PAN, University of Szczecin, and the Polish Society of Operational and Systems Research. They deal with mathematical modeling, approximation and visualization of environmental variables and with development of computer aided decision making systems in the area of environmental informatics.

ISBN 83-894-7509-X
9788389475091
ISSN 0208-8029