EVATREN

IMPROVED DECISION-AID METHODS AND TOOLS TO SUPPORT EVALUATION OF INVESTMENT FOR TRANSPORT AND ENERGY NETWORKS IN EUROPE

SIXTH FRAMEWORK PROGRAMME
PRIORITY 8.1Policy-oriented research

Deliverable 1

Evaluating the State-of-the-Art in Investment for Transport and Energy Networks

Final version

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0. Executive summary and conclusion

The primary objective of EVA-TREN is to further develop appraisal methods for large infrastructure projects. The project takes into account the decision-making process in the Transport and Energy sector where the European Union in strong collaboration with its Member States aims at implementing sustainable policies.

The Deliverable at hand presents the results of Workpackage 1. It contributes to the aims of EVA-TREN by collecting, analysing and comparing currently applied methodologies in a number of EU Member States and Switzerland as well as for international bodies and three Non-European countries. Workpackage 1 has the task to provide knowledge about assessment methodology which will be used for analysing the case-studies of Workpackage 2 and enhance the currently applied methodology.

This report presents the overall findings of the evaluation process and outlines a brief direction for the future. Theoretical approaches for transport infrastructure assessment are manifold. Cost-Benefit-Analysis[1] (CBA) and Multi-Criteria-Analysis (MCA) are most common and well established within the scientific community. The theoretical basis of CBA lays in the assumption that benefits increase whereas costs reduce well-being of society. Following this approach, an investment is worthwhile if its benefits exceed its investment costs. Contrary to this approach MCA uses the way of thinking of decision makers, represented by pre-defined criteria and weights. Different from CBA, that represents the single welfare maximisation criterion, MCA is an approach for multiple criteria rationalisation. Another way of thinking in assessment methodology are macroeconomic approaches, like Input/Output and simulation models. Their main objective is to forecast regional as well as national impacts (e.g. GDP, income) induced by the infrastructure investment.

Assessment approaches for energy infrastructure investments differ significantly from transport investments. Main theoretical approaches are load flow based investigation and locational marginal pricing. Low flow based investigation can be used to analyse network density on the borders and within the national energy system. The approach evaluates the maximum capacity of the network in case that one line fails to operate. Locational marginal pricing is a market-pricing methodology for energy sector projects. It is aimed at assigning a price to electricity at specific locations on the transmission grid. Differences in prices between nodes reflect the costs of transmission and can be used as an indicator for future investments.

Most of the country specific guidelines are presented in Chapter 4 and 5. The findings of existing practice of project assessment in the Energy and Transport sector has emphasised a number of similarities but also differences across the countries under consideration. It can be assumed that

1 The abbreviation CBA has only been used in the following chapters for socio-economic Cost-Benefit-Analyses. If financial CBA is meant it is specified directly in the text.

national guidelines have been developed over a long time span and that differences nowadays results from different development pathways. The authors ascertain that for the transport sector even within Europe no single national methodology is equal to another. Data shows that most countries use Cost-Benefit-Analysis in some form for decision making. In the analysed New Member States CBA has been used most commonly for projects funded by the EU. Based on these EU guidelines national guidelines have been developed (e.g. Czech Republic) or are under developing (e.g. Poland). The majority of countries in the North/West of Europe (e.g. Germany, United Kingdom) have detailed guidelines for project assessment, whereas most countries in the Southern parts of Europe have only few national standards for assessment (e.g. Portugal, Italy). Decisions are mostly based on case-to-case comparisons with a changing assessment framework.

Concerning the main methodology for transport infrastructure investments Switzerland and the United Kingdom show differences to most other countries. It has been found out that Switzerland's guidelines are in-line with EU legislation by requiring an environmental impacts analysis for every infrastructure investment. Further assessments are not required by law in Switzerland (e.g. CBA). The United Kingdom has changed its assessment methodology during the last decade basically. The New Approach to Appraisal (NATA) is mainly based on Multi-Criteria Analysis and results are summarised in an Appraisal Summary Table which includes mainly quantified parameters instead of monetizing the impacts. A contrary approach to most other analysed countries where decision making is mainly based on Cost-Benefit-Ratio or Net-present value.

The analysis of Workpackage 1 shows that there are differences between the surveyed countries concerning fundamental input parameters in assessment. Two of these parameters are the Discount Rate and the Appraisal Period which are illustrated in Figure 0.1 and Figure 0.2.

Fig. 0.1 Discount rate (real terms) used for transport infrastructure investments[2]

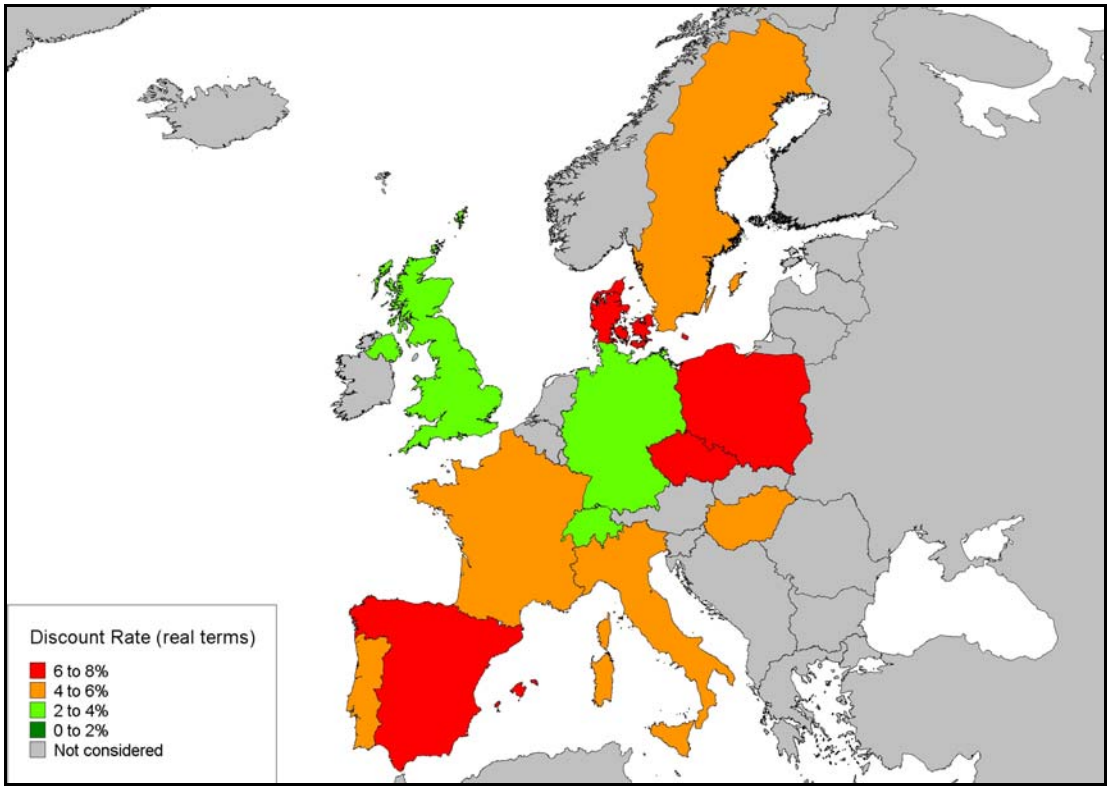
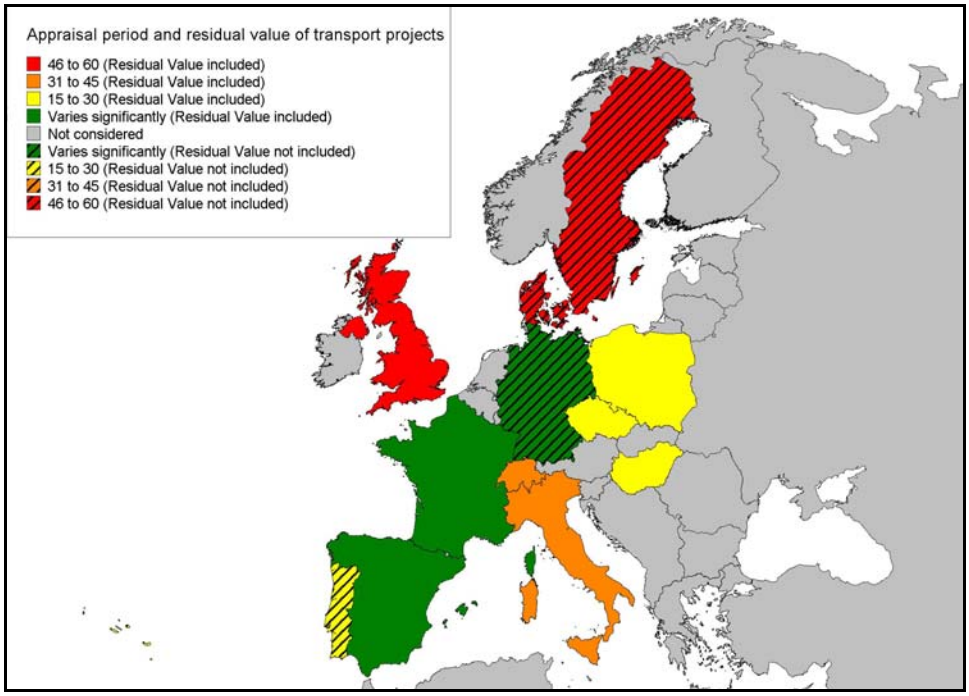


Figure 0.1 shows that significant differences in the discount rates are used in the countries under consideration. It is not possible to derive any general conclusions neither for geographical classification nor for average values from the figure above. Especially for projects where benefits occur during the following decades the discount rate plays a crucial role. The former EU project UNITE recommended a real discount rate of 3% as standard value. It can be noticed that most countries use higher rates. More important than the discount rate itself is the correlation to the appraisal period as well as to the residual value of the project.

2 The figure is based on results of Workpackage 1 supplemented by data coming from Odgaard et al., 2005

Fig. 0.2 Appraisal period and residual value of transport infrastructure investments[3]



In the North of Europe a longer time period is assessed than in the New Member States of the EU. Also the South European countries use in average a longer appraisal period than the Northern parts. For a fourth of the analysed countries significant changes in the appraisal period exist for different modes of transport. This is the reason why the authors have abdicated of illustrating averages value for these countries (green colour).

Figure 0.2 shows that there is no correlation between the appraisal period and the integration of a residual value for investment projects. More than half of the assessed countries include the residual value whereas none of the new member states do so.

EVA-TREN also evaluated national guidelines for ex-post analyses of infrastructure investments. In only two of the twelve countries under consideration an appraisal to verifying the results of the investment is compulsory (France and United Kingdom). France has defined the principle of ex-post analysis within the LOTI law (Loi d'Orientation sur les transports intérieurs) in 1982. The general guideline includes a physical description of the project as well as a direct comparison between expectations and observed figures (e.g. costs, demand, environmental impacts). Nevertheless, it is not enforced for each project so far.

In a few countries (e.g. Denmark) ex-post evaluations are carried out at times but neither national guidelines nor official recommendations exist. However, most countries do not analyse the impacts of the transport infrastructure investment comprehensively on a national level (e.g.

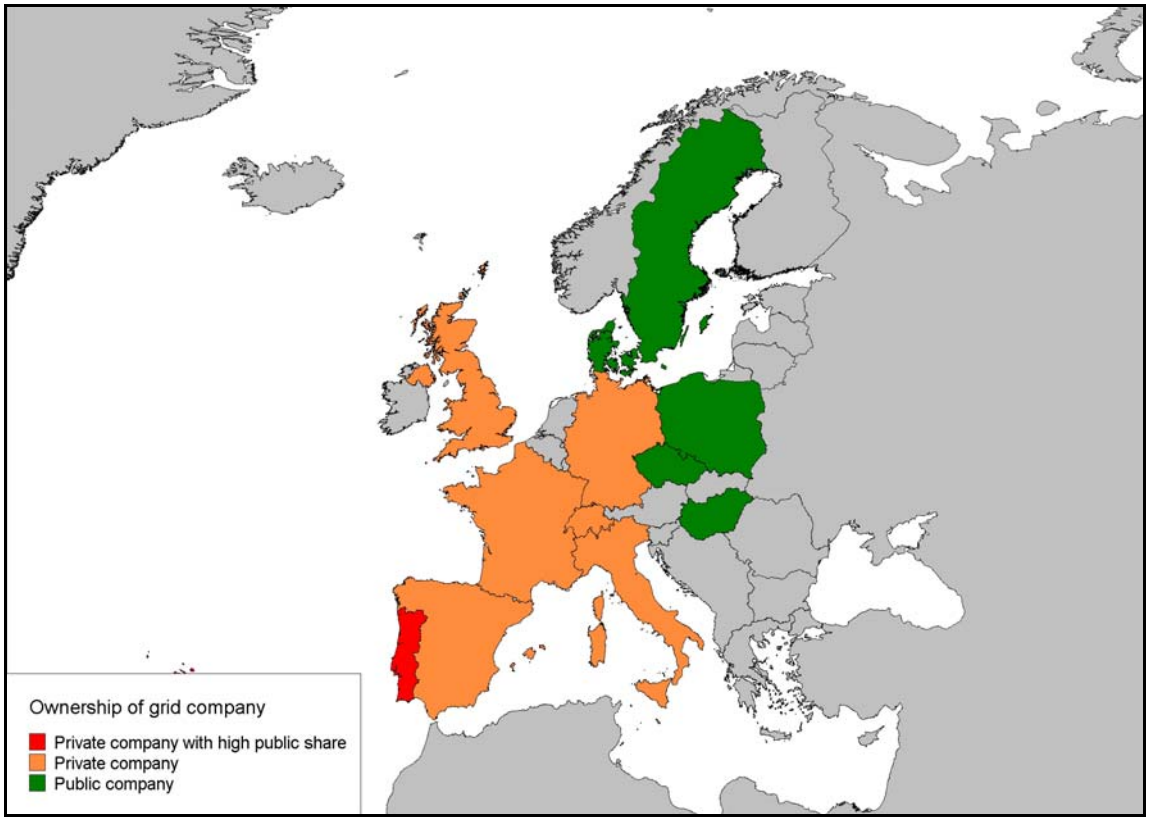
3 The figure is based on results of Workpackage 1 supplemented by data coming from Odgaard et al., 2005

Germany). In some cases regional or local authorities verify the (mostly positive) impacts for publicity reasons.

The results of the Energy sector show a different picture than for transport investments. EVA-TREN has been focussed on evaluating transmission grid investments because all Energy case-studies of Workpackage 2 deal with transmission grid investments. Furthermore, the Energy sector is very heterogeneous concerning infrastructure investments (e.g. power plants, transmission grids, renewable energy sources) that a focus has to be placed on one subsystem.

The first impression when comparing both sectors is that transport investments are mostly financed by public bodies whereas most transmission grid companies are in private hands (see Figure 03).

Fig. 0.3 Ownership of the transmission grid companies



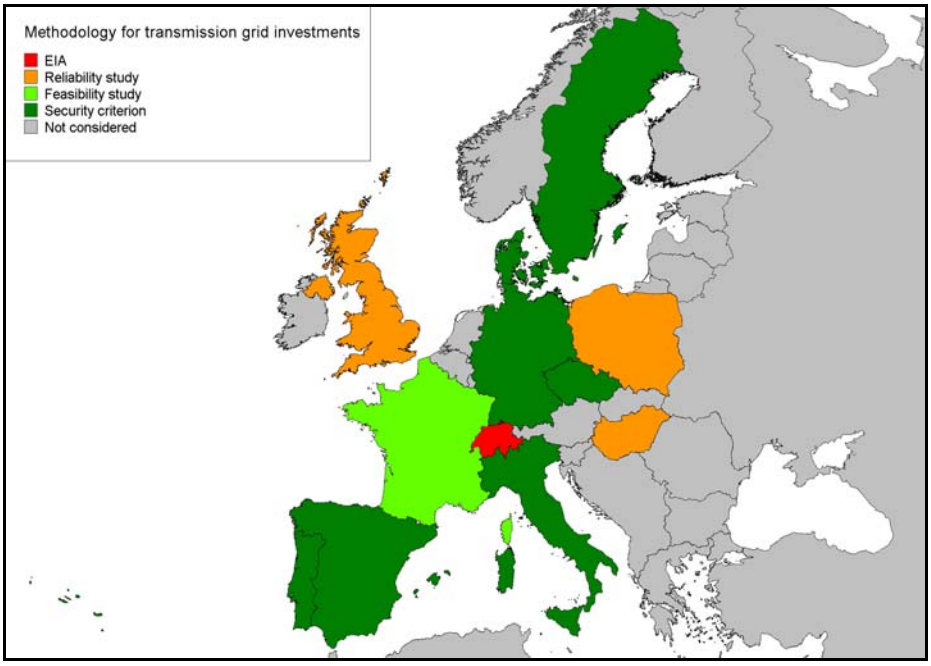
The above figure shows that only five national transmission grid companies are in public hands. In these countries companies exist which are responsible for transmission but they are completely in the scope of the public body. In Denmark, for example, Energinet.dk is the state-owned transmission system operator which owns the national electricity transmission systems. Investments in the national grids are financed by Energinet.dk and the Ministry for Transport and Energy has to agree on the planned investments. In Hungary the transmission grid company (MAVIR) has been set up for liberalising the electricity trade. MAVIR took over the functions

and assets of the former power generation and grid company (MVM). The owner of MAVIR is the Hungarian State, the ownership rights are exercised by the Ministry of Economy and Transport. Revenues coming from transmission fees have to cover only the operational costs of the company whereas investments are financed by the owner of MAVIR, the Hungarian State.

The majority of assessed countries do have private transmission grid companies. Private company has been defined in this context that shares of the company are traded and can be purchased directly. In Spain, as an example for this sample, transmission grids are owned by REE (Red Eléctrica de Espana). Shareholders are private companies which are related to the Energy sector (10%), the government via the State Industrial Ownership Cooperation (20%) and free floats (70%). Other countries have similar structures with (minor) shares in public hands (e.g. Portugal, Germany).

Concerning the methodology used for assessing infrastructure investments different results have been evaluated then for transport investments. Most transmission grid companies use the (n-1) security criterion for security of supply investigations as well as for future investment planning (see Figure 0.4).

Fig. 0.4 Methodology for assessing transmission grid investments



These results are in-line with recommendations of the Union for the Co-ordination of Transmission of Electricity (UCTE). They recommend using the security criterion for daily supply analyses whereas EVA-TREN found out that the criterion is also exercised for long-term investment planning.

Ex-post analyses for transmission grid infrastructure investments are not compulsory by law in any country. No differences have been found for private as well as for public owned companies.

However, several companies (e.g. Danish Energinet.dk) have stated that audits are carried out to learn from past experiences. Guidelines are not published and results are only used internally. Comparing to the transport sector the ex-post evaluation process in the Energy sector seems to be further developed and more frequently undertaken even though they are not open for the public.

In general it can be concluded that both networks uses different assessment approaches. The transport sector is still mainly focused on CBA whereas the Energy sector uses security or pricing criterions for decision making.

Comparing the national findings in Europe with international countries and bodies the results are similar. In Canada general guidelines for investments exist from the Canadian Treasury Board which have been modified by the Department of Transport and are applied for every transport infrastructure project. Differences between the EU and Canada exist in the value of the discount rate. In Canada a real discount rate of 10% is applied which is much higher than the European average (around 5%) or the recommendation of the European Commission (3%). The US Department of Transportation provides a single guidebook for CBA of transport infrastructure projects. Net present value, internal rate of return as well as benefit-cost ratio are compulsory for decision making. A discount rate of 7% is recommended by the department. Japan uses a mixture of CBA and MCA for infrastructure assessment. Thereby, CBA serves to judge which project should be chosen among the available options and MCA is used for project ranking. The key indicator for project selection is the benefit-cost-ratio. Appraisal period is assumed to be 40 years, while the discount rate is fixed at 4%. Investments with a benefit-cost-ratio of higher than 1.2 are admitted in the list of feasible options. These options are further assessed especially concerning intangible impacts.

In none of these three countries (Canada, US, Japan) ex-post analyses for transport investments are compulsory. No specific guidelines exist on how to undertake the evaluation process. However, in all of the three countries a growing demand for measuring results after construction has been found out by the authors.

Regarding the Energy sectors in Canada, the United States and Japan, no specific guidelines for ex-ante nor ex-post analysis exist.

The World Bank evaluates investment projects in every sector before (ex-ante) and after (ex-post) implementation. The same approach is applied for each sector. Every project undergoes the general methodological approach which is strongly based on CBA. Generally, no projects are accepted with an internal rate of return less than 10%.

The Directorate General (DG) Transport and Energy of the European Union has not defined specific procedures for project appraisal because transport as well as energy projects are mainly funded by resources of other DGs. DG REGIO, for example, is able to support transport as well as energy infrastructure projects to achieve its objectives of regional development. Submissions to DG REGIO should contain results of a feasibility study, a timetable for project implementation, CBA, an environmental impact analysis, a justification for the public contribution and a financial plan showing total planned resources. Based on these information decision for financial support is made.

Art. 49 of Reg. 1083/2006 states that ex-post evaluations of all programmes, which have been implemented under each objective should be carried out. It is aimed at identifying the factors contributing to the success or failure of programme's implementation and at identifying good practices. Nevertheless, DG REGIO does not provide any guidance on how to carry out ex-post evaluation.

Looking for improvements of the existing approaches various controversies are discussed within the scientific community. The deliverable at hand raises some open issues and analysed them into detail. Besides, are the following:

- risks and uncertainties: A very crucial point for every project assessment is how to deal with future scenarios. Assumptions on costs, benefits and impacts have to be made before they are realized. This means introducing uncertainties and risks and dealing with them;

- marginal opportunity costs of public funds: If a state uses money of public funds to finance an investment project it causes a loss in collective richness, due to alternative use of that money;

- equity and distributive issues: Most conventional approaches produce a single indicator as their output (CBA uses NPV or B/C-ratio). These indicators are aggregate measures, supposing that benefits (and costs) will be redistributed to all individuals of society. It does not state who will profit and who will loose;

- option value theory: Option values are based on the consideration that for those projects, which have a long-term time horizon and imply a large investment in a quite uncertain context, the gain and loss opportunity should be taken into account instead of including the values only.

Another aspect in this context is the representation of the complex and dynamic reality in a formalised assessment framework. High-capacity models have been developed and applied to support decision-making in infrastructure planning. The report at hand analyses the implications of models in general and gives some theoretical recommendations for the future. The following modelling implications have been discussed in detail:

- current CBA methods: Core elements of traditional CBA are for transport infrastructure the development of user times and operating costs. Therefore, different future scenarios for transport demand are used. This leads to the classical four stage procedure of transport modelling with its existing uncertainties;

- complexity of networks: Transport plans mostly disregard inter-relationships between different investments. These mutual inter-relations might be positive in the case of supplementary projects, but might also be negative in case of competing investments;

- dynamics of Systems: System dynamics model, such as ASTRA, have been introduced to study dynamic development and feedbacks between sectors of the economy and the society. The various cost and benefit categories analysed in CBA develop over time which is not considered in static tools;

- dynamics and spatial complexity: Macroeconomic models do not suffice to simulate local impacts and related small-scale policies. To overcome this gap the EC has launched the TRANS TOOLS project. The model shall enable to analyse new infrastructure investments and fiscal instruments. Among others, the TRANS-TOOLS model shall overcome a number of shortcomings of prior European models, such as limited geographical detail, weak consideration of intermodal logistics chains or missing links to the economic sector;

- technical progress and innovation: Technical progress might be triggered by policy decisions. In most cases technological progress and innovation happens outside the sector under consideration. Existing models do not answer this question as they consider technical progress as an exogenous variable;

- new approach for assessment: Differences between forecasts and reality have been observed for many projects during the last decades. Therefore, the concept of "Reference Class Forecasting" has been developed. It relies rather on the outcomes of similar projects than on a single CBA.

The results of the present deliverable show that complex models and methodologies already exist. As it is very complicated to model the real world, existing approaches have to be further developed and expanded. The study at hand gives some recommendations for the future which will be analysed in detail in the following workpackages of EVA-TREN. These general recommendations deal with:

- develop linkages between existing models;

- the compulsory application of ex post analysis;

- technical improvements: Introducing marginal opportunity cost of public funds, means filling the gap between financial and economic analysis which is missing in existing models;

- basic recommendations: Assessment independent from decision making, transparent evaluation tools, analysing alternatives (technical as well as modal alternatives), reference to similar projects.

1. Introduction

EVA-TREN is aimed to further develop appraisal methodology for infrastructure investments in Transportation as well as Energy networks. The project objectives are derived in accordance with the Terms of reference for Task 4 "Decision-aid methods and tools for policy-makers" as part of the development of indicators, methods and operational parameters for assessing sustainable transport and energy systems. These objectives are:

- examine various ex-ante evaluation approaches used for large infrastructure projects appraisal from various countries;
- select best practice approaches and check for critical problems and pitfalls and recommended indicators and valuation on the basis of the experience in Europe and outside;
- further develop appraisal methods and related decision-aid tools regarding transport and energy projects and policies in support of ex-ante and ex-post analyses of large infrastructure projects and
- among assessment criteria, address the EU added value criterion on the relative contribution of a project to a core trans-European network.

Based on these general objectives EVA-TREN supports these goals by:

- analysing a limited number of case-studies by comparing the results from the ex-ante assessment of the project with the ex-post impacts and
- setting up ex-ante as well as ex-post guidelines based on the case-studies analysed, concerning criteria, indicators and "good practice" in the appraisal of complex projects that are considered strategic in the development of Trans-European-Networks (TEN).

To fulfil its objectives EVA-TREN is organised into three core sections: evaluating the state-of-the-art in infrastructure assessment, analysing case studies in both sectors and improving assessment methodology. The Deliverable at hand presents the results of the first core section of EVA-TREN. It provides the theoretical basis of currently applied methodologies in the Energy and Transport sector and serves as the fundament for the coming sections, including the assessment of the case studies.

This report commences with the theoretical basis of infrastructure project assessment (Chapter 3). The main evaluation methods are explained and key aspects outlined. It has been distinguished between methods which are used for decision making (ex-ante) and for verifying the outcomes (ex-post).

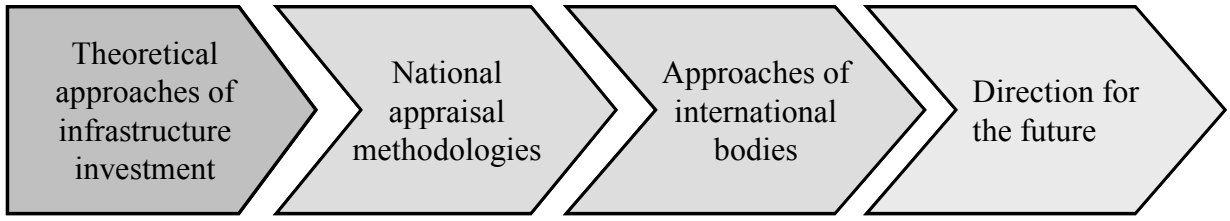
Chapter 4 contains the core of the first workpackage by describing national appraisal methodologies for transport and energy infrastructure investments for a number of chosen countries. In countries where information are available, guidelines for both assessment methods

(ex-ante and ex-post) have been analysed in detail. The chosen countries are the ones which are related to the case studies plus a limited number of new member states (NMS). Therefore, varieties between three different country-clusters can be analysed: NMS (Czech Republic, Hungary and Poland), core member states (Denmark, France, Germany, Italy, Portugal, Spain, Sweden and United Kingdom) and neutral country (Switzerland).

Following the national methodologies, appraisal approaches of international bodies and countries will be described in Chapter 5. The sample includes World Bank, the European Union on the one hand (international bodies) and Canada, Japan and the United States on the other hand (country approaches). Based on the findings of the foregoing sections Chapter 6 illustrates appraisal directions for the future while analysing modelling implications. Existing models and assessment approaches in relation to transport and energy will be identified and discussed. Learning from past experiences of real case studies is the objective of workpackage 3.

Figure 5 visualises the core structure of EVA-TREN's first Deliverable.

Fig. 1.1 *Structure of Deliverable 1*



2. Main methods of infrastructure projects assessment

The following paragraphs describe briefly the main theoretical concepts of the most used approaches to project evaluation. Among the many microeconomic approaches, the well-known Cost Benefit Analysis in its classical definition is presented. Other techniques, such as Cost Effectiveness Analysis or Cost Analysis, are not described. The multi-criteria evaluation explained is treated in general and some algorithms are quoted and briefly discussed. Finally, the macroeconomic approaches considered are the Value Added methods and other economic models. They do not produce performance indicators as the previous mentioned methods, but provide a picture of relevant indicators. Paragraphs 3.5 and 3.6 contain a brief introduction to two approaches, the "Load flow based investigation" and the "Locational Marginal Pricing" specific of electric investments. It has been found out that the two approaches are used for daily capacity as well as for strategic bottleneck review. Therefore both approaches can be seen as investment methodologies for energy projects.

The last paragraph deals with the ex-post assessment. Since it does not exist a codified methodology, the chapter presents the general objectives of this analysis, the main theoretical issues and a review of practical applications of ex-post in international practice.

The following chapter presents a methodological review of main techniques used to evaluate transport and energy infrastructure projects. The first three techniques are general and allow evaluating every kind of project. The two techniques of "Load flow based investigation" and "Locational Marginal Pricing" are specific approaches for electric investments only. It has been found out that the two approaches are used for daily capacity as well as for strategic bottleneck review. Therefore both approaches can be seen as investment methodologies for energy projects. The last paragraph focuses on the ex-post evaluation issues.

2.1 Introduction

Why it is necessary to assess public projects? It is well known that the political decisions are driven by a large and complex set of factors (electoral consensus, financial constraints, vested interests, geo-strategic "visions", regulatory settings, national and international "log-rolling" practices, etc.).The traditional "academic" approaches to evaluation are just one of the many possible factors, and often not the more decisive one.

A first distinction therefore is to be made between who, assumes that project selection is only a political issue, and who assumes that the decision process has to be based on some explicit and contestable priority-setting mechanism, based on measurements as far as possible "exogenous" from the value judgements of the policy makers.

The staring point of this second point of view is that even in a fully democratic context, decision makers are not always benevolent nor all-knowing, and this for specific procedural, not moral,

reasons: they have to be re-elected, are biased by their electoral district are short sighted by consensus aims, etc.

The ideological divide is sharp, since the above-mentioned "exogenous" factors are generally derived from the only arena, alternative to the political one, were public preferences are expressed, i.e. the market. And in fact, is the market that often drives the main factors at play in the economic analysis: the demand function, and the main shadow prices used (for example, the value of time, or the opportunity cost of labour and of capital).

Between these two approaches it is located a set of "intermediate" methodologies, that are known as the "multicriteria" approach, that try to formalize a mix of "exogenous" indexes with "weights" (i.e. value judgements) given by the decision maker. The wide number of possible multicriteria methods, and the wide number of possible alternative outcomes make this approach less transparent and to some extent more controversial.

A different approach (Added Value analysis) has a well-defined theoretical content, since it assumes a strict Keynesian setting and consistently measures as benefits the remuneration of labour and capital. For this reasons the outputs tend to be favourable by definition.

A more sophisticated set of tools is based on simulation models. They tend to relax some assumptions of standard CBA: labour, land use, fiscal linkages, production costs in the different sectors etc. are explicitly simulated in their operating way, setting aside any hypothesis of market clearing equilibrium.

They have also different theoretical complexity: from static equilibrium approaches, to semi-dynamic ones, to non-converging, dynamic disequilibrium ones. Some have a fully explicit financial dimension, others limit themselves to economic aspects. The problems here are mainly consistency and transparency. Also the quality of input data can sometime become an issue: sophisticated models with poor quality data can give a misleading impression of the level of accuracy.

2.2 Microeconomic evaluation

CBA could be viewed as an investment appraisal with a social focus. It aims at identify, measuring and comparing the social benefits and costs of an investment project or program.

The essential theoretical basis of the CBA lay on the assumption that benefits are increases in human well-being (utility) and costs are a reduction in human well-being (disutility). Following this approach, a policy/project will be positively assessed if its social benefits exceed its social costs, where society is defined as a sum of individuals.

Methods and analytical details of CBA differ from those of other project evaluation tools, in particular from financial analysis. The latter is used primarily by private sector to determine which outcome are the best from the perspective of private interest. CBA, on the other hand is designed for the evaluation of optimal public project with regards to a society standpoint. While financial analysis measures the benefits and cost in terms of observed market prices, valuation in

CBA is based on opportunity costs, i.e. prices are corrected for possible market distortions and reflect the social utility gains or losses.

2.2.1 Historical background

The beginning of Cost-Benefit Analysis (CBA) dates back to 1844, when Jules Dupuit was concerned with the benefits and costs of building a bridge and published "On the measure of Utility of Public Works" (Dupuit, 1844). He introduced the concept of consumer surplus.

The idea of economic efficiency was central to welfare economics to justify a social change, therefore, the Pareto principle was introduced in the 1930's. This principle underlines the idea that a change is desirable if someone(s) gains and no one loss. Some years later, Hicks and Kaldor set the body of modern welfare economics, which is the theoretical basis of the CBA. Moving from the *strict Pareto principle* - according to which a project/policy is optimal if at least some people actually gain and no one actually loose, Kaldor (1939) and Hicks (1940) introduced the *compensation principle*. Being less strict than the one elaborated by Pareto, this principle established the idea of a hypothetical compensation as a practical rule for deciding on policies and project. All that is required is the possibility that the gainers could compensate losers to achieve a potential Pareto improvement.

The first empirical attempt to put CBA into practice was made through the United States Flood Control Act of 1936, which in essence stated that a project is desired if its aggregated benefits are higher than its costs. Later on a vast literature that influences the pragmatism of CBA was developed.

2.2.2 The consumers' surplus

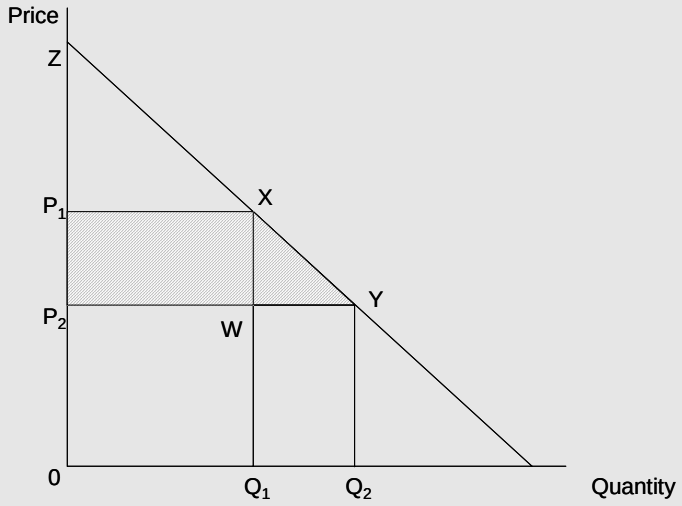
Consumers' surplus is the most crucial concept in the measurement of social benefit in any social cost-benefit analysis.

A surplus is generated when a consumer is able to buy a unit of a good at a price lower than his willingness to pay for that unit, or when a producer is able to sell a unit of a good or production factor at a price higher than that at which he would willingly part with that unit. For willingness to Pay we refer to the maximum amount that a buyer is willing to pay for a particular unit of a good - the marginal value of the good to the buyer.

An investment, which allows a reduction in the cost of a product or of a service, is viewed as a benefit for the community. Such a benefit is usually referred to as "cost difference" or a "cost saving". In the case of transport project investment (e.g. a new motorway) the cost savings are derived by expected savings in time and operating costs by all users of the new infrastructure.

Consumers' Surplus

The concept of cost saving is derived directly by the concept of the ***consumers surplus*** which could be easier understood looking at the following figure.



Consumers' surplus

Referring to the Figure 1 suppose that it describes a situation before and after the construction of a new motorway. Before the project implementation, with a quantity (i.e. traffic flow) equal to Q_1 and a price equal to P_1 (i.e. travel cost), the consumers' surplus from using this particular route (i.e. the maximum sum motorists are willing to pay above the amount the currently spend on the journey) corresponds to the area P_1XZ. The construction of the new motorways will lead to an increase of the quantity to Q_2 and to a reduction of the price (travel cost) to P_2. The consumers' surplus associated to this new situation is represented by the triangular area P_2YZ. Since the area of the triangle P_2YZ is bigger than the one of the triangle P_1XZ, it could be deduced that the projects has increased the consumers' surplus. Such an increase is made up of two parts. The rectangular area P_2P_1XW which represents the cost saving component associated to the new project, and calculated as the saving per journey, P_2P_1, multiplied by the original number of journeys made OQ_1. The second component is represented by the triangular area WXY, which is the consumers' surplus made on the additional journey undertaken, Q_1Q_2, either by the same motorists or by additional motorists. The cost savings item, included in a cost benefit calculation, is just a portion of the consumers' surplus from a fall in the travel cost. It doesn't include the additional journey that will be taken in response to a travel cost decrease. According to this the cost savings rectangle could be considered as a minimum estimate of benefits. It should be keep in mind that we are no operating a translation of money magnitude in utility terms, since the area under the market demand curve is not translate into a sum of individual utilities, but it simply represents a sum of their valuations. The extent of the aggregate improvements derived from the new infrastructure is expressed as a sum of money which is measured by a triangle consumers' surplus such as P_1ZX. Its interpretation is simply the maximum amount of money which a group of individual is willing to pay in order to have the quantity $0Q_1$ at the price P_1. The collective improvement derived from a reduction in price, however, is expressed as an increment in consumers' surplus, as for example the strip P_1P_2XY in figure 1. Such an area can be interpreted as the maximum amount of money that a group would offer in order to have a price reduction form $0P_1$ to $0P_2$.

Some problems could rise in proceeding with a simple surplus comparison. First, the demand curve may not be linear, meaning that we could have just a rough measure of WTP.

Secondly we have considered a Marshallian demand curve[4]. As the price falls, the real incomes of the consumers increase. That means measuring utility, namely income, with a money indicator which itself change as the price falls. What is needed is a demand curve in which this problem is removed. Such a demand curve, introduced by Hicks (1943) is called compensated demand curve[5].

Another problem rises from the fact that, when a price of a good falls, it may well alter demand curve for other products. According to that we need to know whether calculating the change in surplus for a good is enough as a measure of the benefit of the project that make price falling. Such an issue is known as the problem of estimating consumers' surplus when other prices change.

It appears clear that there are problems in actually estimating the consumers' surplus relevant to any project. According to Willig (1976) the use of a Marshallian demand curve won't lead to large margins of errors. Partially due to empirical difficulties the area under such a curve is usually considered in the consumers' surplus calculating even if a theoretical rigour would claims for the use of the compensate demand curve.

2.2.3 Key aspects: shadow pricing and intertemporal discount

Two are the main issues when a CBA is carried out:

- CBA looks at the costs and benefits from the society's point of view, in others word the resource opportunity costs. According to this market prices, which reflect market distortion, couldn't be used, but appropriate "shadow price" should be used and
- An appropriate discount rate should be selected since costs and benefits measured for each year of the project life rises from the different timing in their occurrence.

Shadow prices

When prices are explicitly used to exchange items freely, they are called market price. If prices are implicit in the exchanges that should be made to maximize a particular objective function (or to minimize a cost function), they are called shadow price. As already mentioned, CBA looks at the costs and benefits from the society's point of view, in others word the resource opportunity costs.

Under the perfect competition hypothesis, the market price of the inputs matches their opportunity cost. Since market distortions usually occur in the real word, such correspondence is usually not respected. In these cases, market price cannot be used for the economic analysis, and shadow prices should be estimated.

4 It simply shows demanded quantity against price

5 *Compensated Demand Curve* shows how the number of units of a good purchased at a given price changes as the price changes, assuming the consumer's income is changed enough to offset the income effect

One of the most commonly used shadow price is for labour. In principle, wages should reflect workers marginal productivity, but in real cases wage distortions occur if (Florio, 2003):

- some people, for instance 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, may be less for the private company than the social opportunity cost because the State gives special subsidies to employment in some areas and
- there may be a legislation fixing a minimum legal wage, even if under heavy unemployment there may be people willing to work for less.

Since current wages fail to reflect the labour productivity, a shadow price should be used. In order to appraisal the labour social cost, two mutually exclusive approaches can be applied: the first one very simplified and the second one more sophisticated (Florio, 2003).

1. Set the shadow wage below the current one by a certain percentage. Such an approach is based on the consideration that, under unemployment condition, actual wages are higher than the opportunity cost of labour. Try to estimate the income multiplier of the output.
2. Also other inputs market prices might be distorted by market imperfection, for instance it happens for energy. For all such inputs, shadow prices should be estimated in order to correctly reflect their long-term opportunity cost.

When a market does not exist (like for human health, environment or time), analysts try to obtain estimates of what the market price would be if the relevant good were traded in an ideal market, where the demand curve measured marginal social benefits and the supply curve measured marginal social costs. The estimation of what are called shadow prices for non-traded goods/effects is an important theme of the present scientific debate and, during the last years, several approach and methods have been proposed in order to estimate these values (OECD,2005) The approaches that are usually adopted are the revealed preference approach, which values the non-market impacts by observing the actual behaviour, and the stated preference approach, which is a survey-based methodology (for more details see Box 2.1).

Discount rate

The main difficulty to compare costs and benefits measured for each year of the project life rises from the different timing in their occurrence: for example, costs normally occur during the first years of the project, while benefits will incur later. In order to compare costs and benefits, they should be translated into present, i.e. they should be discounted by using an appropriate discounting rate. The selection of the appropriate discount rate is a quite controversial issue on the economic literature: economist are not in full agreement on which discount rate should be used, since it should reflect not only the resources used in the project (e.g. opportunity cost), but also the value of intertemporal preferences, which may differs between individuals, society and, above all, between generations. There are basically two approaches that are mainly used to determine the discount rate (Pearce, 1971):

- the first approach consists in the adoption of a direct estimate of an opportunity cost rate that reflects the resources sacrificed by project. This social opportunity cost (*SOC)* rate is a measure of the value to society of the next best alternative use of the funds employed in the project. In a perfectly competitive world, the *SOC* should equal the market interest rate. In a not perfect economy, where more than one interest rate are adopted, it is frequently argued that the *SOC* should equal the highest private actuarial rate of return (corresponding to the riskiest private investment). Such a choice is sustained according to the assumption that investors are risk adverse, and as a consequence when the expected risk is high there is a tendency - for private investors - to apply a high actuarial rate of return. Since funds can be used for either public or private investments and public investments are supposed to be more risky, this is considered a fair discount rate;

- the second approach asserts that the discount rate should be a direct estimate of the society intertemporal preference (STP; social time preference), which is the rate at which the society is prepared to trade present for future consumption. The problem with this approach is that intertemporal preference rate couldn't be derived from the exiting market rates, but it should be determined according to public policy objectives and

2.2.4 The four CBA steps

A CBA can be divided into four separate stages:

The problem to be addressed

The evaluation process of a policy/project by a social standpoint usually starts with the definition of the set of goals to be achieved (i.e. pollution reduction, health improvement, etc..) and of the technical available options to pursue these goals. The analysis is carried out confronting the selected available options with the do nothing option.

Identification of gains and losses

Once one or more options have been selected, the second step of a CBA consists in the identification of whose benefits and whose costs count (the so called *standing issue*). These involve the problem of identifying the area of influence of the project; and when such an area covers more than a single country it might become important to consider non-national impacts. Other issues concern the different subjects affected by the project, whether they are the decision taker or are suffering from decision taking by others.

The effects of the project under analysis are divided into:

- direct effects: i.e. those originated by the project/policy and falling on the subject directing addressed by the project/policy and

- indirect effects: i.e. the secondary consequences of the project/policy which could be further categorized into induced effect and derived effect.

Furthermore, these effects could be also classified as:

- technological, affecting the firms production function of the consumers utility function and
- pecuniary, which are generated by change in the relative prices.

The identification of all the main gains and losses generated by a project/policy to be valuated is a fundamental steps of the CBA, since the lack of identification and/or the non-inclusion of some them could seriously affect the final result of the analysis.

The question concerning the *time horizon* of the project/policy is addressed in this step and there are no fast rules in setting how far in the future the impacts should be estimated. As long as the CBA is used to assess infrastructure projects, the time horizon - the point beyond which costs and benefits are not considered relevant and therefore not estimated - normally corresponds to the economic life of the investment. For infrastructure such as roads, ports, rail, etc., this is usually set between a minimum of 30 years and a maximum of 50 years. This rule appears to be inadequate when CBA is adopted to assess policies, since it results quite unclear how long the effects of policies last. Furthermore, some policies could have a quite long-term goal (e.g. environmental policies). In these cases, the suggested rule is to set the time horizon according to the uncertainty of future estimate or the extent to which discounting makes future cost and benefits insignificant.

Conversion in monetary value

After having identified and measured the effects due the project/policy, these should be expressed as changes in monetary values compared to a baseline situation, usually defined as "Do nothing scenario" or "Reference solution". The assignment of monetary values to all the benefits and costs identified of the project policy is an indispensable step in order to be able to compare them. As stated before, for benefits and costs that are traded in a perfectly competitive market, the market prices could be used, but for all items for which the market price does not express the resource opportunity cost, the adoption of the so called shadow price is needed.

Costs and benefits that are not traded in any market are valuated using different economical techniques in order to assign them a money value. By assessing the monetary value of all these costs and benefits it is possible to determine a system of unitary prices that allow for their comparison and make it possible to capture their opportunity cost by a society standpoint.

Approaches and methods for shadow price evaluation

A. Revealed preference approach

The unifying characteristic of revealed preference methods is the valuation of non-market impacts by observing actual behaviour and, in particular, purchases made in actual markets.

1. *Hedonic pricing*

The hedonic price method (HPM) estimates the value of a non-market good by observing behaviour in the market for a related good. Specifically, the HPM uses a market good via which the non-market good is implicitly traded. The starting point for the HPM is the observation that the price of a large number of market goods is a function of several characteristics. The HPM uses statistical techniques to isolate the implicit "price" of each of these characteristics.

2. *Travel cost*

TCM is based on the assumption that detailed sample survey of travellers to a site determines how they value the characteristics of the site and the time spent travelling to the site (e.g. visiting a nature area)

3. *Averting behaviour/defensive expenditures*

Based on the notion that individuals and households can insulate themselves from a non-market bad by selecting more costly types of behaviour. Alternatively, individuals might be able to avoid exposure to non-market bads via the purchase of a market good. These financial expenditures are known as defensive expenditures. The value of each of these purchases represents an implicit price for the non-market good or bad in question.

4. *Costs of illness*

Similar to the defensive expenditures method since it focuses on expenditure of medical services and products made in response to health effects of non-market impacts. The difference between this methods and defensive expenditure approaches is that often the decision to incur these health care expenditures is not made by the individual alone, but by social administrators and ultimately the taxpayer.

B. Stated Preference Approach

Stated preference approaches are survey-based and obtain people's intended future behaviour in constructed markets. By means of an appropriately designed questionnaire, a hypothetical market is described where the good in question can be traded

1. *Contingent valuation*

The contingent valuation method is perhaps the dominant stated preference method or survey-based technique. By means of an appropriately designed questionnaire, a hypothetical market is described where the good in question can be traded .A random sample of people is asked to express its maximum willingness to pay (or willingness to accept) for a hypothetical change in the level of provision of the good. Respondents are assumed to behave as though they were in a real market.

2. *Choice Modelling*

It's a survey-based methodology for modelling preferences for goods, where goods are described in terms of their attributes and of the levels that these attributes take. Respondents are presented with various alternative descriptions of a good, differentiated by their attributes and levels, and are asked to rank the various alternatives. By including price/cost as one of the attributes of the good, willingness to pay can be deduced.

Alternatives comparison and solution selection: project performance indicators

A brief description of the main methods to compare the available alternatives is reported below, pinpointing their limits.

Benefit cost ratio. It's simply the ratio between the total discounted benefits and the total discounted costs.

$$\left(\sum B_i /(1+r)^i\right)/\left(\sum C_i /(1+r)^i\right) \qquad i = 0 \text{ to } n$$

A value greater than one means that project benefits exceed the project costs. The higher the ratio is, the greater are the benefits relative to the costs. The main limit of this rule is that it does not consider the magnitude of the net benefits: rule, project with low cost and benefits may be favoured over those with higher net benefits. A way to overcome this limit is using the incremental cost benefit ratio or the Net Present Value (NPV).

Net Present Value (NPV). With the Net Present Value rule the total discounted costs are subtracted from the total discounted benefits. A positive NPV indicated that a project should be positively considered since the benefits are greater than the costs. Formally

$$\sum B_i /(1+r)^i - \sum C_i /(1+r)^i = 0$$

There two particular cases where the NPV rule can't be used in this simple form but should be modified in order to be a useful indicator for the project selection. Namely:

- under capital rationing situation in which the goal is to finance a combination of project from a given, constrained budget, in such a way as to get the high level of aggregate NPV and
- when investment projects with a different lifetime are compared.

In such cases two different version of the original NPV should be adopted. In cases of capital rationing the profitability ratio, most commonly NBIR (Net Benefit Investment Ratio) should be adopted. The NBIR is calculated as the ratio between the present value of each project's net cash inflow (NPV(B)) and the initial investment necessary to fund the project (NPV(K)). In other words it represents the net benefit derived from a unit of invested capital.

When investment projects characterized by a different lifetime are compared, the Annual Equivalent Cost method should be adopted. This method allows converting the actual stream of cost/benefit of a project into an equivalent stream of constant cost/benefit. Two steps are needed to obtain this indicator: first it should be calculated the PV of the flow of costs generated by each project along its lifetime, then the PVs of the cost of each project is converted into an annuity by dividing the total PV by the numbers of years of lifetime.

Internal Rate of Return (IRR). The internal rate of return is the discount rate at which the net present value of a project becomes zero; in other words, it's the discount rate for which all discounted costs are equal to all discounted benefits. Formally:

$$\sum B_i /(1+IRR)^i = \sum C_i /(1+IRR)^i$$

The IRR represent the average return of the investment during its lifetime and is expressed in percentage terms. A project should be selected when its IRR is higher than the one used for discounting the costs and the benefits. This method is particularly useful when there is only one alternative to the reference scenario. Two problems may occur using IRR: there might be more than one discount rate for which discounted costs equal discounted benefits and; in case of mutually exclusive project selection, when there project ranking according to the NPV and IRR criteria diverges. This case is known as *switching phenomenon*, and the NPV curves of the projects intersect one another.

2.3 Multi-criteria evaluation

According to the multi criteria methodology, the traditional microeconomic approach to evaluation based on one single criterion, the welfare maximisation, can be extended to cover more dimensions. There is a multiplicity of techniques that for simplicity's sake can be grouped into the broad family of Multi Criteria Analysis.

2.3.1 The basis of MCA: contemporary use of different criteria

The so-called *Multi Criteria Analysis* (MCA) is a family of algorithms used to perform the selection of alternatives according to a set of criteria and relative weights. The criteria and their weights are systematised by the analyst and are derived, with different techniques, from preferences and objectives expressed by the decision maker. The use of non-monetary utility functions overcomes two important issues, considered as limits of the CBA approach:

- MCA can consider also non-economic criteria in a much more straightforward way and
- MCA does not assume (necessarily) the monetary one as a common numerary.

The point of view of the MCA analysis is the one of the political decision maker, represented by its own criteria and weights. Differently from the CBA, that represent *one* criterion (the welfare maximisation), the Multi Criteria Analysis is, as the name suggests, a tool for multiple criteria rationalisation and clarification (which must be made explicit and well-defined). In other words, these algorithms are ways to simulate logical processes to treat complex systems of preferences instead of one single aggregated index. As the analysis is not based on microeconomic theory, the MCA method doesn't make any use of shadow prices to assess the value of goods prices or whose prices are distorted or not existing, and the issue is solved by utility functions and criteria weights.

The output of the basic MCA algorithms is, similarly to the CBA, a synthetic indicator and a subsequent ranking of considered alternatives. In other cases, the output is the ranking of the alternatives without any synthetic index. The MCA method might be subjected to problems intrinsic in the algorithm (like the rank-reversal problem[6]) and in the case of investment selection under budget constraints.

2.3.2 Key aspects: the criteria, the values, the weights

The MCA allows the use of any kind of criterion and any kind of ordinal or cardinal values to describe the single alternatives according to the criteria. The criteria generally used for infrastructure projects are those referring to the:

- strictly financial aspects (building, operation and revenues);
- non-financial aspects (time, accessibility, frequency, comfort, reliability, robustness, etc.);
- issues related to public goods (environment, health, other externalities) and
- other indirect impacts (income distribution, cohesion, ethics, coherence with political objectives, etc).

Nevertheless, although the number of criteria to be considered is open, some basic rules must be *a priori* established in the definition of relevant criteria such as: distinguish between tools and goals, check for consistency and avoidance of overlaps. Moreover, it must be possible to define the relative weights among criteria, as described later.

Appropriate values to measure performances and/or impacts of an investment or a policy according to every single criterion, have to be defined and measured to enter in the analysis. The nature of such performances/impact can be, in general, very wide, being possible to manage cardinal, ordinal or even qualitative indications. Some techniques allows to translate also "lexicographic" indications, like "A is better than B" into values for the analysis. The measure and its value is generally a proxy of both the criterion and the impact. For instance, the objective of pollution reduction can be described as the reduction of some pollutants' concentration, with the consciousness that the selected pollutants are not "the pollution" as a whole, but that the average concentration is a simplification of the problem[7]

6 Some algorithms, including the classical one, suffer of the rank reversal problem. In such cases the introduction of an irrelevant alternative might cause the change of the previously calculated rank. In other words: if the order of three alternatives is A-B-C, the introduction of a surely losing alternative D may not drive to the obvious A-B-C-D rank, but, for example, to A-C-B-D.

7 Many more examples can be done: the "accessibility" can be described with travel time, frequencies, hedonic prices, etc. The "increase of national richness" with the increase of GNP, and so on. It's evident that these indicators are a simplified representation and measure of the objective.

Were the dialogue with the decision maker perfect, it would be possible to translate the values into utility functions, linking the revealed value of criterion to an utility value. Since only in very limited cases there is a perfect knowledge of the utility function of the decision maker, there are different approaches that try to solve this problem (see next paragraph)

The weights attached to the different criteria are a key part of the description of the policy makers' objectives. The weights given by the political body and translated by the analyst represent the shadow prices of the objectives (Florio, 2003). The most straightforward system is to define a set of weights **W** such as the sum equal one. Exactly as the utility function expresses the internal utility of a single criterion, the weights represent the relative utilities of the defined criteria. Also in this case the perfect expression of weights is often an abstraction and alternative techniques exist.

The action of making the criteria, the weights and the values explicit (and then treatable) is the most delicate and conceptually the most controversial step of the procedure and it is managed in different ways according to the different MCA algorithms. In general, it consists in a translation of decision maker's opinions and objectives, into cardinal rankings or logical dependencies. The techniques capable of doing this are manifold: interviews, experimental methods, statistical approaches or a mix of them. All these techniques require a strict dialogue between the analyst and the policy maker or the stakeholders.

2.3.3 The most common algorithms

MCA algorithms are methods for *multi objective optimisation.* Some of them will be briefly described:

- methods based on the maximisation of weighted sum of measures of objectives. The values given to the criterion for each alternative are weighted according to a set of weights with unit sum;

- if the utilities cannot be determined, one can use an approach of minimisation of the weighted sum of variations from declared standards or methods based on the minimisation of highest deviation of an indicator from a declared standard and

- if the objectives are even less defined, in particular the weights coherence is not granted or the weights cannot be valued, one can use methods based on minimisation of ordered vector of deviations. This consists in the search for the subset of solutions maximising the first objective of the ordering. Starting from this set, the choice is reduced by applying the second more important objective and so on up to the selection of a single solution.

Another problem is that of revealing the decision maker's preferences. As said before, this can be done through direct interviews to the decision maker, or can be derived from official documents' objectives lists, interviews based on statistical approaches, revealed preferences based on past choices, etc.

2.4 Macroeconomic evaluation

2.4.1 Value added measure of economic benefits

It is part of conventional wisdom that in general public investment project are intended to have an income effect and are crucial factor in growth development. The most common measure adopted to catch this effect is the change in *value added* (also referred to as Gross Domestic Product or Gross Regional Product). This indicator simply reflects the sum of the wages income and corporate profits realized in the study area.

In today's increasingly global economy, value added is an *overestimate* of the true income impact on a region insofar, as it includes all business profits generated there including that paid out as dividends to business owners who do not reside in the study area and that which are reinvested in corporate facilities outside of the study area (region). Thus, while value added is the most appropriate measure of impact on overall economic activity in a geographic area, the personal income (wage) measure is often preferred as a more conservative measure of income benefit to the residents of the area.

2.4.2 Economic models

Economic models can be used to forecast personal income, employment, business sales, or value added impacts. Two major families of models are commonly used: the Input/Output models and the macroeconomic simulation models.

Input/Output models

Input/Output (IO) models are a family of analytical formulations that represent the inter-linkages among economic sectors as a function of the amount of inputs, in economic terms, required to produce a given output. More simply, Input/Output models express the economic output of an economy as a function of the inputs utilized in the production process. This mathematical relationship enables the estimation, for each economic sector, of the inputs that are required to achieve a given level of output. Four are the main assumptions of the IO models:

- in a given sector, the products are homogeneous;
- production technologies within a sector can be represented by the average technology;
- the technology of production can be assumed to be constant and
- there is an equilibrium between total supply and total demand.

These models are essentially accounting tables that trace the interactions of inter-industry purchases and sales within a given region, state, or country. Such interactions are expressed in

terms of *technological coefficients,* which represent the relative importance of each sector as a supplier and demander of each other sector.

The I/O models use some "multipliers" that allow to calculate the full (direct, indirect, and induced) jobs, income, and output generated per unit of spending on various types of goods and services in the study area. Furthermore, I/O models can be calibrated for specific countries or aggregations of countries and can be used to estimate the full income and job effects of construction and maintenance spending.

The advantage of using Input/Output models is that they enable to trace the impact of a change in the final demand for one sector on the demand and output of each other sector, or the impact of a change in the cost of one input on all the sectors that are using such an input.

The limits of this type of models are twofold. Normally they are based on fixed technical coefficients and therefore they don't allow for changing technology and secondly they request a large number of information and data.

Fig. 2.1 Example of a single region Input/Output model table

				Purchasing sectors								
				Intermediate demand		Final demand					Total Production	
				Sectors		Inv I	Cons C	Exp E	Gov G	Tota l Y		
				1 2 3 4 .....j.....M	W						X	
Producing sectors	Produced inputs	Sectors	M .....i... 4 3 2 1	xij	Wi	Yi					Xi	
			U									
	Primary inputs											
	Total con-sumption			Xj								

Source: UTRC, 2001

Macroeconomic simulation models

Macroeconomic simulation models, either *econometric* or *general equilibrium*, are based on complex computer programs that trace the total effects over time of changing economic conditions in a study area. In addition to the functions of the I/O models, they include additional functions that allow forecasting the effects of future changes in business costs, prices, wages,

taxes, productivity, and other aspects of business competitiveness as well as shifts in population, employment, and housing values.

The computable general equilibrium (CGE) models use the building block of microeconomics - utility function, which in turn determine the demand functions, and production/cost functions – together with computational algorithms to determine equilibrium. For example, given an investment in transport infrastructure which reduces transport costs, these models compute the new equilibrium reached by the economy including output levels, input levels, incomes, etc. These models are in general quite stylised and are based on simple utility and production functions, implying that some results might be partially pre- determinate.

A class of macro-econometric models, whose starting point is the Aschauer's paper *Is Public Expenditure Productive? (*Aschauer, 1989*),* attempt to find causality relationship between longitudinal changes in the total amount of production inputs, including public capital (like transport infrastructure stock) and annual changes in the performance of the entire economy or a subset (e.g. states or particular sectors). Using the subscript *t* to denote a time period (e.g. a quarter), the general structure of these models has the form:

$$Aggregate\ output_t = f(technology_t, labour_t, private\ capital_t, public\ capital_t)$$

Models based on the above expression basically conjecture that public capital positively affects the rate of return of private capital and, hence, private capital accumulation. Given the technical substitution between private capital and labour inputs, labour productivity rate improves as a function on of the growth rate of the stock of private capital.

2.5 Load flow based investigation

Energy networks are assessed supplementary with different theoretical methodologies for infrastructure investments. Based on data provided by ETSO (European Transmission System Operators Association), load flow based investigation aims at quantifying the additional transmission capacity resulting from the measure considered. In particular, this methodology can be used to analyse network density on borders and within the national energy system, as well as to evaluate the amount of additional cross-border transmission capacities resulting from a selection of "soft-measures". Load flow based investigation aims at determining the average lowest admissible power flow of each subsection. It is based on a network bottom-up approach at the level of each line. The considered grid line is switched off in the simulation and the (n-1) security criterion is applied to evaluate the maximum power which can flow between the two substations at the ends of the line with respect to the other line's limits. Future investments are reasonable on the sections with the minimal possible capacity and therefore with the highest possibility of a shortfall which can be defined as bottlenecks within the existing network. Based on these considerations load flow based investigation can also be used for analysing future investments.

2.6 Locational marginal pricing

Locational marginal pricing (LMP) which is also called nodal pricing is a market-pricing methodology for energy sector projects. It is aimed at assigning a price to electricity at specific locations on the transmission grid network. This methodology takes into account the ability of the grid to carry the electricity particularly when congestion occurs on the power grid. The price is based on the marginal cost to deliver the next increment of electricity at a specific location. The LMP method allows estimating the price of electricity at many different locations on the system. The local prices are determined by calculating the incremental cost of serving one additional MW of load at each respective location subject to system constraints (e.g. transmission limits, maximal generation capacity). Differences of prices between nodes reflect the costs of transmission.

2.7 Methodologies for the ex post analysis

The concept of "*ex-post* evaluation" does not refer to a precise technique but rather to some forms of re-appraisal of a completed investment. The *ex-post* evaluation is in general independent from what has been previously evaluated according to an *ex-ante* perspective, and is also carried out on projects that have never undergone a formal assessment. Box 3 reports some examples of the possible definitions of project re-appraisal activities.

Ex -post evaluation definitions

"Green Book" of UK Treasury (HM, 1997):

Appraisal is ex-ante analysis and in this sense can be seen as the comparison of a potentially wide range of options, all of which are hypothetical. Evaluation is ex-post analysis which compares a likely narrower range of options, one of which will be real. However, as part of the management process, planning of the evaluation should be considered at the time of appraisal.

EU Guide to Structural Funds (Florio, 2003), the ex-post evaluation has mainly a verification purpose:

[…] 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.

For many agencies, the ex-post evaluations are used to provide experience to improve the appraisals in the decision and design phase:

The wider objective of the ex post evaluation is not only to fulfil the regulatory requirements, but also to learn from the experiences gained. (ECORYS, 2005)

We will refer to "*ex-post*" evaluation as an activity that carries out a new or revised appraisal in a moment subsequent to the starting of the operational phase of a project. In other words, we will use the term "*ex-post*" in a wider sense, including year-zero re-appraisals, independent appraisals, appraisals done for monitoring purposes, and evaluations carried out years after the completion. The purposes of such reappraisal are various and will be described later in the text.

In spite of its vague definition, it is possible to identify some patterns common to all types of *ex-post* evaluation, as well as to point out the most widely used techniques/approaches and clarify the feedbacks with the projects evaluation and design. The purposes of these different re-appraisal techniques are various and will be described below. The analysis will rely mainly on common practice in national and international contexts, being the theory not really developed.

2.7.1 Objectives and approaches of ex-post evaluation

The general objectives of an *ex-post* evaluation, which can be very different, are grouped as follows:

- establish the impact of an intervention: measure the impacts of an investment some time after its completion;
- measure the effectiveness: the actual impacts are compared with the forecasted ones or the achievements are compared with initial objectives. The verification of their conformity gives a measure both of the utility of the project and of the quality of ex-ante evaluation/forecast;
- measure the efficiency: considers the costs of the intervention together with the reached objectives and
- provide elements to improve the ex-ante assessments of future interventions: one useful purpose of re-appraisal of the projects is to provide feedbacks to the ex-ante techniques used, in order to improve their performance (for example, including aspects previously not considered or taking more attention to the forecasts soundness).

According to the scope of the *ex post* study, the approaches can be then very different. The concept of "*ex-post*" includes simple measures of impacts, update of already performed studies or totally new independent analysis.

- Monitor the implementation: In this case the study considers *ex-post* the extent of the actions planned, in terms of conformity between planned and realised.
- Assess the impacts: Once the project is completed, its real impacts are measured. This approach is quite common, but as far as it does not compare the ex post with the ex ante, and therefore does not check the quality and the reliability of the forecasted impacts, it cannot be considered a real re-appraisal of the project.
- Repeating the ex-ante: This is the approach used by major agencies that have a clearly standardised approach to evaluation. The existence of commonly used guidelines and databases of past evaluations, allows to measure the quality and the utility of ex-ante repeating the previously done assessment with updated real figures (like for instance real costs or the real construction time) or even including some non-forecasted impacts. The results of the comparison are treated statistically and are particularly significant if the sample of re appraised projects is large and homogeneous. When new unforeseen impacts

are included, the results are of course not comparable but can produce interesting suggestions on the importance of the newly introduced elements and

- Performing an independent analysis: Finally, the *ex-post* appraisal can be carried out by applying approaches different from the ones used in the ex ante evaluation (either in terms of techniques or points of view, etc.), beyond using the real dataset. In this case the results are expected to give hints on the ex-ante methodology.

2.7.2 Theoretical approaches

The theoretical contributions to ex-post issues and methodologies are quite rare. The most of CBA manuals do not provide any "methodology" or specific goals for the phase after-completion and "*ex-post evaluation*" can have different meanings.

The main function that the theoretical contributions consulted attribute to the *ex-post analysis* is to learn from past experience how to improve future project appraisals and design (Little and Mirrlees, 1990; Pennisi and Scandizzo, 2003). For doing this, it is suggested to perform again the analyses with updated real figures, in order to reproduce the same indicators. Recently, thanks to the theory of Option Value (see the chapter 6.1.4) the concept of ex-post analysis has been reconsidered under a different perspective.

2.7.3 Review of agencies', national and independent approaches

Guidelines, either national or intergovernmental, seldom require an *ex-post* monitoring of effects that includes also a re-appraisal of the project impacts applying the same technique used in the ex ante evaluation. Nevertheless, although not in a standardised way, it is quite common for international agencies to carry out *ex-post* assessment in order to verify the extents and the effectiveness of their funding.

This paragraph reviews the approaches suggested for *ex-post* assessment by the EU, the World Bank, the United Nations and the OECD[8]. The approaches proposed have been categorised in the following table, according to the previously identified scope.

8 National approaches - where existing - may be found in the country reports (chapter 3).

Tab. 2.1 Approaches for ex-post assessment suggested from different bodies

	Monitoring	**Assess the impacts**	**Re-appraisal w. updated figures/new impacts**	**Independent re-appraisal.**
DG BUDGET	Monitoring, control and audit. Identify factors behind success or failure (DG BUDGET 2003).	Impacts, efficiency and effectiveness of the intervention. (DG BUDGET 2003). Analysis of program impacts (DG BUDGET 1997).		
DG TREN		Assessment by interviews of relevant results (efficiency, accessibility, etc.). (COWI, 2006a). Independent appraisal of actions, but no guidelines (DG TREN, 2003)		
DG REGIO	Verify the implementation (Faber, 2000)	Assess the impacts of completed projects. CSES (2003) calculates the impacts achieved. For programmes, CBA (EVALSED, 2003).		ECORYS (2005) re-appraises some sample projects to draw independent conclusions about ex-ante quality.
World Bank			Systematic repetition of past CBAs with updated inputs only.	
UNIDO	Monitoring and formative functions	Monitoring and formative functions		
OECD			Consider new impacts and compare ex-post the evidence of the inclusion.	

European Commission

The European Commission Directorates-General give advice for project evaluation in order to enable to *adjust the decisions and to assess the results and impacts of its actions*. The scope of *ex-post* analysis is *distinct from internal audit and its purpose that appraises the soundness of the internal processes through which actions are implemented* (DG TREN, 2003). The Implementation Rules of the Financial Regulation provide the minimum requirements on *interim* and *ex-post* evaluations (European Commission, 2002): Article 27 states that all programmes or activities shall be the subject of an interim and/or ex post evaluations in terms of human and financial resources allocated and the results obtained in order to verify that they were consistent with the objectives set.

DG BUDGET (2004) contains a review of EC evaluation guidelines, and concerning the *ex-post* requirements for the transport and energy sectors makes references to two general guidelines:

- evaluating EU activities: a practical guide for the Commission services (DG BUDGET, 2003). The guide outlines the functions and the forms of the evaluation in UE. It provides indications for ex-post evaluation with the aim of monitoring, control and audit the interventions and identify their successes and failures, impacts, efficiency and effectiveness and

- evaluating EU expenditure programmes: A guide: ex post and intermediate evaluation (DG BUDGET, 1997). In this case the ex-post evaluation is seen as "more likely to be summative in nature, and are often conducted with the express intention of analysing a programme's impact".

The DG for Transport and Energy (DG TREN) doesn't have specific guidelines for *ex-post* appraisal and the DG refers to DG BUDGET indications. Nevertheless some general re-appraisals have been completed not referred to single projects. The Evaluation Charter (DG TREN, 2003), which contains the key rules for evaluation, includes also some indications for the *ex-post* in terms of independent measure of results and impacts. No guidelines are provided, nor detailed indications of the procedure to be used. Starting from year 2000, DG TREN publishes the reports of all the *ex-post* evaluations[9], the most recent and involving energy and transport policies or projects, deals with sustainable mobility actions (COWI, 2006a) and energy efficiency (Joosen & Harmelink, 2005; SRC, 2001). No analyses are available concerning TEN single projects. Only COWI (2006b) deals with mid-term assessment of risk capital in TEN networks.

The DG for Regional Policy (DG REGIO) has issued the guidelines for Structural Fund, "Guide to cost-benefit analysis of investment projects" (Florio, 2003), that focuses on ex-ante evaluation of large projects. In general the funding with Structural Fund should take the benefits of a wide *ex-post* activity. The objectives of the *ex-post* evaluation of Structural Funds, as defined in the Commission's terms of reference, are to (CSES, 2003):

- establish the *impact* of the Structural Fund interventions on economic and social cohesion;

- assess the ***effectiveness*** (progress and achievements compared with initial objectives) and ***efficiency*** (cost at which the objectives were reached) of the interventions at a regional, national and European Union (EU) level as well as within key priorities;

- identify the ***Community added value*** obtained at an EU level as a result of the Structural Fund interventions and

- identify relevant elements and ***implications*** for the planning of the Structural Funds for the next period.

The relevant documents about the *ex-post* analyses carried out are available at: http://ec.europa.eu/regional_policy/sources/docgener/evaluation/rado_en.htm. In particular, the document CSES (2003) provides a detailed insight into the impact of Objective 2 interventions

9 They are all available at http://ec.europa.eu/dgs/energy_transport/evaluation/activites/index_en.htm

in terms of the efficiency, effectiveness, sustainability and value-added, by using more than 30 in-depth case studies. The "Thematic Evaluation of the Impact of Structural Funds on Transport Infrastructures" (Oscar Faber et al., 2000) evaluates the impact of Structural and Cohesion Fund interventions on transport infrastructures.

Concerning programmes, DG REGIO has an official guide[10]. The ex-post phase has a formative purpose and consists in the evaluation of impacts (also using CBA) after project completion, but not explicitly aims at verifying the correctness of the *ex-ante* phase. A sample of some Cohesion Fund projects in four EU states have been *ex-post* re-assessed and the results are available (ECORYS, 2005). The analysis evidences that the *ex-ante* analyses re-appraised were poorly founded, insufficiently documented and lacking of some impacts.

World Bank

The World Bank has been carrying on a long-lasting and complete review of its projects. In 1992 a study was published (Pohl & Mihaljek, 1991 and 1992) presenting a statistical analysis of 1.015 projects financed and selected by a CBA. The analysis used the WB database of CBAs, complete with data and results for all the projects. The re-appraisal consisted in a repetition of the CBA the first year after the completion of the project, thus using real data about investment costs, construction time and macroeconomic indicators. Numerous documents are available reporting the results of the WB monitoring and feedback activities (Pohl, Mihaljek, 1991 and 1992; WB, 1994a and 1994b; Verbeek, 1999; Grasso et al, 2003; WB, 2004; WB, 2005). A critical position about data and results can be found in Little & Mirrlees (1990).

United Nations

The United Nations Industrial Development Organization has a department of Evaluation, with monitoring and formative functions. Many project ex-post evaluations and case studies can be found on the internet (http://www.unido.org/doc/5122), but only few refer to energy and transport projects. The function of these studies is mainly a formative monitoring, collecting information for better help future projects. The guidelines, which don't deal with ex-post, focusing to ex-ante cost-benefit analysis, date back to the seventies (UNIDO, 1972 and 1978), but were reprinted.

OECD

The approach of OECD to ex-post appraisal is to provide empirical evidence of real or theoretically forecasted impacts of projects, for example the effect on regional development of transport investments (OECD, 2002). The approach to CBA used in this study is to calculate the traditional direct user benefits and to present the wider impacts as complementary analyses. The ex-post evaluation was finalised to find out evidence to support the inclusion of wider economic impacts in the evaluation of transport infrastructure proposal. The basic conclusion reached with

10 "The Guide on evaluation of socio-economic development" (EVALSED, 2003) that substitutes the previous approach, called MEANS (published in 1999).

the analysis is that "*there is a lack of information derived from* ex-post *studies which could provide a firm, quantitative basis for claims about the impact of infrastructure investment on regional economies and regeneration*. Thus, *the ability to provide guidance on improving project appraisal methodology is limited"*. (OECD, 2002)

2.7.4 Review of some relevant case studies

Numerous cases of some sort of re-appraisal of transport and energy projects are present in literature, both carried out independently by academics and professionals or by the financing agencies. Some cases are commonly analysed by scholars, like the Channel Tunnel or the Oresund Fixed Link.

An extremely relevant systematic *ex-post* analysis of transport *megaprojects* can be found in Flyvbjerg et al (2003). The book, that is completed with some papers, analyses the phenomenon of megaprojects (large infrastructure projects) using an *ex-post* approach, measuring the overrun of costs and building time, overestimation of demand, revenues and economic effects. The database is made of hundreds of analysed projects.

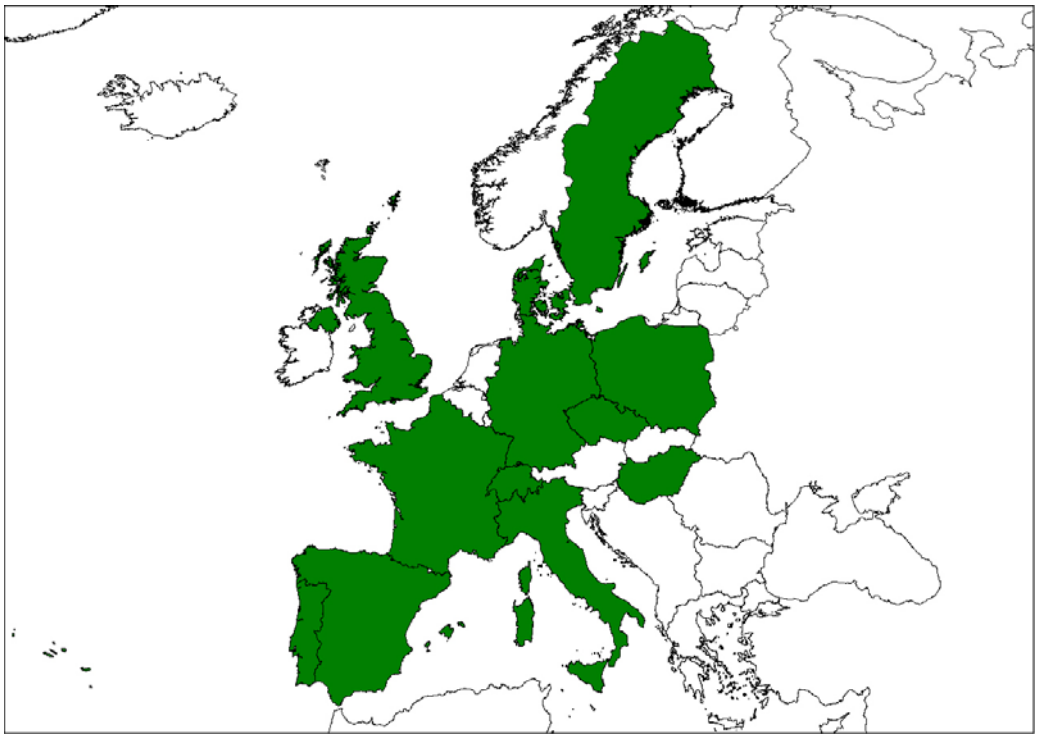
One of the recent projects that have undergone a number of ex post analysis of different types is the Channel Tunnel. Hay et al (2004a and 2004b) present the actual trends of demand, land use, jobs, employment, and firms after and before the completion of the Channel Tunnel, evidencing *ex-post* the effects on transport sector and regional economy. Anguera (2006) compares the forecasted and the actual demand and re-appraises the investment in economic and financial terms using a standard CBA with transport effects only and real data or ad-hoc hypotheses. Both the economic and financial analyses are biased in favour of Channel Tunnel that, according to the author, has a negative performance in terms of NPVe and IRRf.

Flyvbjerg deeply analysed the case study of the Oresund Fixed Link (Flyvbjerg et al, 2003), focusing on private sector involvement, transparency and participation, regulatory regime, risk analysis, environment and socio-economic effects.

3. National methodologies

Chapter 4 describes the results of the review on national methodologies. It contains the core of the first Workpackage by describing national appraisal methodologies for transport and energy infrastructure investments. The country sample includes the ones which are related to the case studies plus a limited number of new member states (NMS). Figure 3.1 illustrates the countries under consideration.

Fig. 3.1 Countries under consideration in the EVA-TREN project



The following sub-chapters are listed by the countries under consideration in alphabetical order. Each sub-chapter commences with general information about the evaluation and the decision process framework in the energy and transport sector for the country. Afterwards a detailed analysis of the transportation appraisal guidelines is done. A distinction is made between ex-ante and ex-post methodology. Following the transportation project assessment, the energy sector is analysed in detail. The focus of EVA-TREN's energy case-studies has been placed on transmission grids. Therefore, the assessment guidelines in the following chapters for the energy sector stands mainly for transmission grid infrastructure project assessment.

3.1 Czech Republic

3.1.1 General information

a) Transport investments

The Transport Policy of Czech Republic is the basic strategic document, which sets a direction of the medium-term development in the transport sector. Sectorial strategies have been derived from the national Transport Policy and assessed including their financial background. The key document is the General Development Plan of Transport Infrastructure (GEPARDI), which develops concrete measures concerning the transport infrastructure, the development thereof, including specification of financial scope and schedule of the key measures implementation.

The transport infrastructure expenditures increased to approximately 2.2% GDP (except expenditures in local roads and other public urban transport infrastructure). The majority of funds comes from the State Fund of Transport Infrastructure which participates in the above amount roughly by 60% (2005). In total the expenditures from the State Fund of Transport Infrastructure on construction, modernization and maintenance amounted almost to 47 billion CZK (2005). Such expenditures represent actual funds invested from the State Fund of Transport Infrastructure including expenditures which will be covered from appropriate EU funds.

It can be analysed that the focus of infrastructure in Czech Republic is placed on road investments. The total amount of investment increased from 2004 to 2005 by almost 30%, whereas the expenditures into railway infrastructure have increased by less than 10%. Funds expended in transport infrastructure repairs and maintenance remained more or less at the level of preceding years.

b) Energy investments

The Czech electricity transmission network is operated by the joint stock company CEPS (Česká Elektrizační Přenosová Soustava[11]). Its role is to operate the electricity transmission in the country and to ensure the maintenance and the development of the transmission network equipment.

3.1.2 Transport infrastructure projects assessment

Ex-ante analysis

In the Czech Republic, project evaluations are used for both project option selection and for project priorities within the infrastructure investment mode. Official recommendations exist for rail, road and inland waterway investments, whereas no guidelines are available for air transport.

11 http://www.ceps.cz

Normally a detailed CBA is used for appraisal supplemented in special cases by a MCA for including non-monetary impacts. Contrary to most other European countries no further EIA or socio-economic analysis is compulsory by law. The appraisal period is limited to 20 to 30 years which is much less than the lifespan of most construction facilities. Therefore the residual value is taken into consideration. It is calculated straight line with a fixed percentage of the original value per year.

Cost components are divided into construction, system operating and maintenance costs. Construction costs are calculated from material, labour, planning, land and mitigation expenditures as well as from property purchase. System operating and maintenance costs are considered over the lifespan of 20 to 30 years. For inland waterways a fixed amount of 1% of the construction costs is used per year, whereas no fixed values are applied for the other modes of transport. The Czech Republic reverts for the calculation of maintenance for road infrastructure costs to the commercial software HDM-4, which has been developed as part of the International Study of Highway Development and Management Tools (ISOHDM), sponsored by the World Bank, Asian Development Bank and the Swedish National Road Administration.

Benefits of an infrastructure project are generally calculated for time savings, user charges, vehicle operating costs, freight user benefits and reliability. For rail projects congestion and service quality is also assessed. Values of time for monetizing time savings are subdivided into trips for work (8.2 EUR/vehicle-h), non-work (2.8 EUR/vehicle-h) and trucks (6.6 EUR/vehicle-h). Furthermore, vehicle operating costs differ between cars (0.15 EUR/vehicle-km) and trucks (0.60-0.68 EUR/vehicle-km).

The calculation of safety impacts is based on average values. For road and rail material damage, personal loss of casualties and general costs to society are considered. Fatal injuries average out at 231,000 EUR and non-fatal injuries between 8.600 and 85.100 EUR per accident. These values are multiplied with the expected accident rates for the new infrastructure.

In Czech Republic environmental parameters are assessed below European average. Noise is assessed for road and rail projects, whereas CO_2, O_3 and CH_4 is only assessed for inland waterways. Further parameters like vibration, water pollution and landscape harmony are evaluated in a MCA. The same procedure is done for socio-economic impacts. Economic development, medium- as well as long-term employment impacts, land use and effects on state finance are only included in a MCA. However, it is not defined for which kind of investment project MCA is recommended by law.

Ex-post analysis

Ex-post analysis is not compulsory[12].

3.1.3 Energy infrastructure projects assessment

Ex-ante analysis

The expansion planning of the network is realized in accordance with technical and strategic standards set in the *Grid Code*, in compliance with the Czech Energy Act (2000), detailing the rules for transmission system operation. Within the whole country, the network reliability is ensured by the compliance with the *(n-1) security criterion*. For ensuring a reliable electricity transmission in the Czech Republic and also for operational planning and development purposes, the Grid Code includes a detailed overview of technical calculations to be made for verifying that the (n-1) criterion is met:

- load flow calculations, aimed at verifying that the transmission capacity of the network is not exceeded;
- reliability calculations, aimed at verifying the security of supply from transmission system users in various network configurations and
- other types of calculations aimed at evaluating the resistance of the system to short-circuiting, checking the dynamic stability of the system, etc.

As a member of the Union for the Co-ordination of Transmission of Electricity (UCTE) and CENTREL (the East European regional group of UCTE), the Czech Republic should develop its electricity transmission network in accordance with these bodies.

Ex-post analysis

Ex-post analysis is not compulsory.

3.2 Denmark

3.2.1 General information

a) Transport investments

12 "Not compulsory" has been designated if no national guidelines (e.g. laws, directives) exist. It might be the case that ex-post analyses are seldom undertaken but without lawful decrees. This understanding of "not compulsory" is used in the following chapters.

In Denmark the total road network consists of more than 72,000 km whereas less than 3% are characterised as main roads including motorways (rail network 2,785 km). As it can be noticed in most European Countries a shift from investment in new infrastructure to maintenance can also be observed in Denmark. In 2003 only 45% (4.3 billion DKK) of the total investment in the road network has been new infrastructure projects. By contrast new rail infrastructure projects are still 60% of the total investment in the rail network.

Large investments typically include the building of new roads and extending existing road stretches are financed in the annual Danish state budget as project appropriations or are financed by grants. The Danish parliament passes construction acts for the majority of large constructions. Minor constructions to improve traffic safety or environment on the trunk road network are financed from the annual state budget. This funding must be used to carry out the government's policies in areas where there is significant political interest. This funding is also used to support projects that are outside the trunk road network i.e. on County and Local Council roads. The allowance pool in 2000 covered the following themes:

- road traffic CO2 emissions (cycle traffic and combined travel);
- road accidents (black and grey spots, speed zones etc.);
- road traffic in towns (traffic calming and other environmental improvements) and
- road traffic surroundings (traffic noise, fauna and pedestrians and the visual environment).

Responsible for the construction of new rail infrastructure is Banedanmark which is a state-owned enterprise that operates the rail network under the auspices of the Danish Ministry of Transport and Energy. Just as the states-owned road directorate (Vejdirektoratet) which is responsible for the national roads.

b) Energy investments

The Energy sector situation in Denmark is similar to the transport sector. Energinet.dk is the state-owned transmission system operator and owns the national electricity and natural gas transmission network. It was found in 2005 to guarantee competition within the electricity market by separating ownership of the transmission grid and system operation on the one hand and production and trade on the other hand. Energinet.dk is in charge of the operation and maintenance of the transmission grids. Investments in the grids are financed by Energinet.dk and thereby publicly financed.

3.2.2 Transport infrastructure projects assessment

Ex-ante analysis

In Denmark proposals for new infrastructure investments can come from various sources. This includes the Danish Counties, the Municipalities as well as the Danish Road Directorate and Banedanmark. A formal appraisal methodology for road and rail investments is applied for

identifying the best alternative amongst the alternatives for the particular project and later for prioritisation. The official methodology is based on a CBA supplemented by a detailed EIA to include parameters like water, land use, vegetation and cultural assets which are not monetized in the CBA. The appraisal period for the CBA is usually 50 years but it changes if the life time of the project is less. Then the expected life time is used for the assessment.

Construction related costs are categorised into three groups: direct construction costs like material, labour, planning and land purchase, disruption from construction as well as system operating costs and maintenance over the 50 years life time. On the other hand user benefits are assessed for the following parameters: time savings, user charges and revenues, vehicle operating costs, freight user benefits, congestion, reliability and safety. For assessing time savings a distinction between the trip purposes commuting, business and others is done. Travel time by car for all three purposes consist of driving time and delays, whereas for public transport trips consist of travelling time, waiting time, changing time, frequency/hidden waiting time and delays. Values for monetizing differ strongly by purpose and mode of transport. The range is from 18 DKK per hour and person (other purpose and hidden waiting time for public transport) to 506 DKK per hour and person (e.g. travelling time for business trips done by public transport). Vehicle occupancy rates have been derived from national surveys done by Statistics Denmark (car/business=1.04, car/commuting=1.12 and car/others=1.47).

Further parameters of the CBA are user charges and revenues, vehicle operating costs and freight user benefits. Operating costs for road vehicles vary by mode of transport (passenger car, vans and truck) and are calculated on a per kilometre basis. By contrast no standard figures are available for rail infrastructure assessment but the parameter is included in the analysis. Freight user benefits for road transport are calculated per hour either for vans (<3.5t) or for trucks (>3.5t). Depreciation, salary to driver, maintenance, administration and taxes affect the monetary values. Again, no standard figures for rail are available.

Safety issues are calculated for both modes of transport, rail and road. At this, material damage, personal loss of casualties and costs to society are included in accident costs. Road accidents are calculated per accident whereas rail accidents are calculated per train-kilometre. Accident costs for rail are based on statistical data which has been arisen during 1992 and 2001. The number of casualties has been set in relation to the number of kilometres driven. The ratio is used as the general figure nowadays.

A very crucial part in every infrastructure project assessment is the evaluation of environmental impacts. As mentioned before environmental parameters are included in the CBA as well as in an quantitative assessment (EIA). For the CBA Denmark monetizes the parameters noise, air pollution (PM, NO_x, SO_2, HC and CO), CO_2 and barrier/perceived risks. Air pollution impacts are measured per kg pollutant and values are based on avoidance costs which reflect the "political willingness to pay". The monetary values differ between road and rail as well as for road between rural and urban areas. For instance NO_x emissions are calculated with 24.09 DKK/kg in rural areas, with 72.28 DKK/kg in urban areas and with 118.07 DKK/kg for rail emissions.

The official Danish CBA guideline published by the Ministry of Transport and Energy does not include socio-economic effects. Economic development, employment impacts as well as

cohesion objectives can be include in further analyses (e.g. quantitative measures) but no official recommendations are given.

Ex-post analysis

Detailed guidelines are defined in Denmark for the assessment of transport infrastructure projects. These guidelines have been published by the Ministry of Transport and Energy and are focused on the decision making process. Recommendations or official requirements for an posterior assessment do not exist.

3.2.3 Energy infrastructure projects assessment

Ex-ante analysis

In an annual transmission report Energienet.dk describes current and planned investment projects for the expansion, reconstruction and renovation of the electricity transmission grid. Projects involving investments in excess of DKK 100 million must be submitted to the Ministry of Transport and Energy for approval before work can be commence. Fixed asset investments totally less than DKK 100 million must be submitted to the Danish Energy Authority. Included in the transmission report are detailed proposals of the investment projects which are under consideration for the coming years. The proposals include a comprehensive system plan which describes the security of supply, environmental impacts and the impacts of the investment to the energy market. In the economic assessment a CBA is undertaken which compares the investment costs with the benefits of the project. Energienet.dk reverts to the national key figures (e.g. interest rate, inflation rate, price developments) published by the Danish Ministry of Finance for the socio-economic analyses.

Ex-post analysis

An ex-post evaluation of the investment projects is not compulsory by law. Neither the Ministry of Transport and Energy nor the Ministry of Finance have the rights to insistence on a measurement of results. Nevertheless Energinet.dk tries to evaluate internally every investment project in order to learn from experiences. These documents are not available to the public.

3.3 France

3.3.1 General information

a) Transport investments

The assessment procedure in France has changed progressively and deeply during the past twenty years, in two directions:

- the deepening of the evaluation methods for large projects of infrastructure with the publication, in March 2004, of a new Directive (updated in Mai 2005) and
- the development of rules for coordination, all along the decision process, and in particular for coordination with the public

in order to reach socio economic efficiency of the projects as well as the social acceptability.

The evaluation of the projects is indeed taking place nowadays within a large process of decision making: the infrastructure projects create most of the time debates, often controversy with participants. Therefore the assessment of a project in France is the achievement of different steps of a process which must follow a sequence of rules concerning as well computation of costs and benefits, presentation of non-monetary effects, and consultation of stakeholders and in particular the public.

It is indeed difficult to point out who is responsible for the assessment. If the ministry of transport can be considered as a very important actor, we must not forget the role of an independent "national Commission for public debate", and more and more often, intervention of local authorities who are major financial contributors. The public administrations, the elected bodies, the public do intervene in the final decision even though, at the end, ministries concerned sign for the implementation of the project. In the same time financing has become more and more often "co-financing" with contribution of national budget, local budget and eventually budget of public bodies such as RFF in charge of rail infrastructure or even with private funding.

The text which provides the legal basis for project assessment in France dates back to 1982. It is the LOTI (Loi d'Orientation des Transports Intérieurs[13]) with three important principles: the "right" for transport (which is a strong statement for "mobility right"), the intermodality in order to reinforce the global consistency of the transport sector (systemic approach) and the obligation of evaluation of public action (which is again a strong statement in favour of ex ante and ex post evaluations for investments).

Other legal texts must also be taken into consideration, prepared sometimes by other administrations in relation with the ministry of transport: these texts concern regional development and accessibility, land use policy, protection of environment, with reference to laws on noise and air (92 and 97), participation of the public which intervenes in the first stage as well as in the last stage of the assessment process.

Therefore the understanding of the assessment process in France cannot be disassociated from the overall context of decision making including consultation process as stressed in the last directive for social economic evaluation updated in 2005; this document provides elements of method for CBA but also points the efforts to be made in the presentation of the results, and practical conditions to comply with the evaluation process.

13 At that time the Ministry of the Sea was separated from the ministry of Transport which concentrated more on the internal transport : but this legal text also prevails for ports projects and can be considered as a framework for major public transport projects.

This decision process framework has already been presented as closely to the evaluation process: the idea behind is that a "decision" is not taken "once for all" at a specific time: the decision is progressively maturing starting from a general policy orientation, down to the specification of a project with a precise territorial implementation. This is why different stages must be differentiated with interference between public debate and evaluation process. In doing so national and local administration, elected people, citizens and private enterprises can participate and eventually amend the project if arguments appear relevant.

The declaration of public interest (DUP) is an important step of the final stage, made on the basis of detailed evaluation documents, so that construction can start. The general decision process can then be summarised as follow:

- a definition of a general planning infrastructure scheme with medium and long term programming: this is done in relation with Parliament, land local authorities with formalisation of contracts between state and regions and

- programming of project which include 3 major steps:

    1. preliminary studies which stress the objectives and precise the technical and financial feasibility of the project: at this stage a public debate will take place;

    2. the so-called "avant – projet sommaire" APS where socio economic evaluation is made according to the methodology described before: at this stage coordination between different administrations, elected bodies and associations concerned are deepened;

    3. the final stage decision when last technical choices are made and public inquiry is achieved with local consultation. At the end of this stage, the ministerial decision can take place;

    4. the next step will be follow up of decision and ex post analysis.

b) Energy investments

In electric energy transmission projects, social-economic feasibility study (*la justification socio-économique*) is a compulsory process that has to be conducted by the French transmission system operator (TSO) called as the RTE or *gestionnaire du Réseau de transport d'électricité*[14]. As a TSO, the RTE aims at managing the network infrastructures, managing the electric flow in the network, and maintaining the good functioning of the electric market. Transmission infrastructures (lines, posts) projects are financed by RTE.

For the electricity energy, RTE was established in July 2000 as the Transmission System Operator (TSO). They operate two sub-systems: a 400 kilo Volts (kV) main transmission and interconnection network which is used for energy exchanges between the French regions and

14 http://www.rte-france.com

other countries, and a regional sub-transmission network with three voltage levels: 225kV, 90kV, and 63kV.

The decision process is made based on the following steps:

a) Technical and economical feasibility

RTE submits a dossier containing technical and economical feasibility of the project. This dossier elaborates the benefits and drawbacks of each solution and presents the solution chosen by the RTE and the reasons behind this choice. The dossier is submitted either to the Office of energy demand and markets (DIDEME) of the Ministry of industry for the projects of lines of 400kV and 225kV, or to the Regional office of the industry, research, and environment (DRIRE) for the projects of lines of 90kV and 63 kV and for all posts projects. This dossier allows the concerned authority to verify that the project is coherence with the long term forecast of electricity consumption evolution and the data in the development scheme. If the dossier is accepted, RTE prepares a presentation dossier summarizing the technical and economical feasibility studies and proposes an area to be investigated in the form of a site (in case of posts) or in the form of an itinerary (in case of lines) called as the "aire d'étude". If accepted, this dossier will be used to support the consultation activities in the next step.

b) Consultation

Consultation aims at defining, together with the parliament members and the representative associations of the concerned public, the characteristics and the environmental and supporting measures of the project. First, the consultation activities take form of public debates between government institutions, parliament members, agricultural sector representatives, associations and economic stakeholders, as well as project engineers. Second, an impact assessment study is held to expose the envisaged solutions and to explain the choice made during the public debate. This study presents the measures to reduce the impact and to support the project itself.

c) Public utility declaration

Public utility declaration (DUP) aims at asserting the character of general interest of an electric project work, in order to apply the procedures of legal easement (in case of lines) or expropriation (in case of posts). These special procedures are used only when the concerned land owners refuse to authorize the execution of the project work in their land, despite the friendly approach of RTE. When all of the landowners give their authorization, DUP is not needed. The demand for DUP, if needed by RTE, is addressed either to the Ministry in charge of electricity, for lines of 400kV and 225kV, or to the regional government (préfet), for lines of 900kV and 63kV.

d) Project detailing

RTE puts the project into work details in coordination, especially, with the administration services, the local districts concerned, and the chamber of agriculture. For this purpose, RTE organizes dialogues with landowners and farmers aiming at achieving a consensus about the detailed trace of lines or exact positioning of the posts. A double control of the work execution is

implemented with a close coordination of the Regional Office of the Industry, Research, and Environment (DRIRE) and the Office of Infrastructure at district level (DDE).

e) Constraint and transfer of property

RTE continues the dialogue with the landowners and farmers in order to determine the exact localisation of the work while limiting the possible problems caused by the use of the land. Once the exact trace of a line is determined, the owner is invited to sign a convention with RTE concerning the compensation aim at repairing the lost caused by the project.

Installation of electrical lines on private land doesn't lead to a transfer of property in the profit of RTE. Instead of transfer, the installation can cause problems to the owner which could be compensated permanently or instantly. Installation of posts, in the contrary, leads to land acquisition obtained by friendly or legal approaches.

f) Works Execution

After all the steps are accomplished, including the achievement of the DUP, the constructing permit, the execution authorization, and agreement with the landowner, RTE could proceed with the physical works of the project. During the works, RTE keep the concerned public (majors, parliaments, agricultural actors, landowners, residents) informed of the progress of the project.

3.3.2 Transport infrastructure projects assessment

Ex-ante analysis

The ex ante analysis is composed of three main parts:

- CBA which allows comparison between different investment projects;
- presentation of "impacts" which are not or cannot be quantified in the cost benefit analysis but which play an important role; it concerns in particular the territorial and social cohesion and
- requirement for scientific rigour and clarity which means realisation of sensitivity tests as well as estimation of economic and environmental long term risks.

In the last updating of the French directive the discount rate has been brought down from 8 % to 4 % which is a considerable decrease (the rate of 8 % has been applied for 20 years): in doing so long term effects for sustainable transport could better be taken into account but this implies more development of the risk analysis, including public finance constraints, since the former 8 % rate did include, implicitly, part of these risks.

At the same time new tutelary values have been presented following the Boiteux Report, which was supposed to take into account the latest development of the research in this domain, and integrate the latest political objectives of the transport policy; This policy has focussed in

particular on the quality of services produced by the transport system (Schémas multimodaux de service of 2002).

In practise so the socio economic evaluation including the cost benefit analysis is presented at two stages:

- the first step, early in the process, where focus is more put on the debate itself and
- a second stage, where focus is more put on the socio economic evaluation and cost-benefit results, with more precise data collection and modelling.

The first stage includes the presentation of the objectives of the project, the reference situation, pointing out possible interrelations with other projects. The cost-benefit evaluation is made for different groups of stakeholders including costs of investments and operations, estimation of main benefits as regard the expected traffic. Some indications are given about financing.

At the second stage the full evaluation is achieved with the items which are going to be detailed.

a) First a method to describe the project and the reference situation

The description of the project starts with the presentation of the objectives assigned in terms of quality of service including safety, environmental impact, accessibility, performances.

A special attention is given to an accurate definition of the situation of reference which is often not an easy task:

- reference without any investments;
- reference with investments which are already decided and
- possible effects of regulatory measures which accompany the project.

Sometimes different reference scenarios are sometimes necessary. At this stage also, the presentation of the investments is not limited to infrastructures and includes rolling stocks. The competition environment is also described. A first estimation of expenses is made including possible “eluded” investments.

b) Then the presentation of a harmonised framework for socio economic environment including

   a. Macro economic parameters,

   b. Discount rate and

   c. Common value for estimation of external impact.

For the macro economic environment a study on transport projection up to 2025, published by the ministry (updated in May 2005) is taken in reference: in this study the central hypothesis for French GDP growth is 1.9% per year.

a. The analysis of the project itself includes the traffic forecast and the sensitivity of the traffic to taxes and charging policies.

The traffic forecasts start with the analysis of existing O/D flows and modal split.

b. Then the socio economic cost-benefit for the community can be achieved

This means first the identification of stakeholders groups: users, transport companies and infrastructure managers, state and local authorities.

Four indicators are computed:

- actualised benefit;
- benefit per euro invested (rates between the actualised benefit and actualised cost of the investment);
- internal socio economic rate of return and
- immediate return (benefit of first year, divided by actualised cost of investment).

Then sensitivity tests are achieved as regard GDP growth, cost of investment, traffic forecast, cost of energy, price of transport modes. The sensitivity to all the hypotheses concerning value of life and nuisance are recalled. Finally recommendations are given for presentation of the results depending upon the stage of the evaluation process: stage “amont” and “final” stage.

c. For the financial profitability, the financial risk and impact on public finances is estimated.

The former elements of the traffic forecast and price sensitivity are taken into account, considering that:

- more attention is given to operating measures, commercial strategies, competition context;
- external effects are not taken into account as long as they are not compensated by the transport operation (in monetary terms);
- financial risk analysis must be added (for the transport operation, including risk related to concession when relevant) and
- impact on public finances must be estimated.

The financial profitability is calculated in current currency (and not in constant prices as for socio economic evaluation).

Indicators provided are:

- net actualised added value (including eluded investment);

- financial internal rate of return;
- possible public subsidies (or alternative charging solution, horizon definition for concession) and
- time frame for financial return.

Ex-post analysis

The principle of ex-post analysis has been also put within the LOTI (Loi d'Orientation sur les transports intérieurs) of December 1982. Ex-post analysis is an adequate way to control the relevance of public action as well as to improve methods of ex-ante analysis, from a practical point of view: forecasts and expectations are confronted to observed data.

In the updated directive of 2005 on methods for evaluation there is a list of items to be reviewed so that follow up of the project is made possible and differences between observations and forecasts can be computed for the ex post analysis. For motorways, observatories have been implemented for the follow up of the evolution of traffic and measure of socio economic effects.

However it takes time to implement such "ex post" methodology. A large infrastructure project takes a minimum of 5 to 10 years (and very often much more), from the first stage of the definition of the project till the end of construction. In addition to this a period of five years is, in general, considered as necessary for "maturation" of the effects so that first experiences of ex-post analysis could not be realised before 1995. The experience is now considered as satisfying especially for new rail infrastructures which are often the most difficult to achieve at a time when responsibility has been shifted from SNCF to the new infrastructure manager RFF.

If we concentrate on more complex project such as "HST new lines" (as compared, for example, to motorways projects where competition is more easy to apprehend) the first experience of ex post evaluation concerned the Atlantic HST line, published only in July 2001, almost 20 years after the publication of the LOTI. Since then the methodology and the presentation has been refined with each time, methodological recommendations for the future.

The tables of content of these ex post analyses report tend to a common type of structure with the following items:

1. the history of the project;
2. the physical description of the project, the traffic forecasts, and costs as well as the cost benefit results of the ex ante evaluation;
3. the conditions of realisation of the project, once the decision has been taken to implement the project (technical changes, length of construction, …);

4. And finally the measure of differences between expectations and achievements:

From the demand point of view taking into account:

- the economic environment and
- the transport environment (competition context).

in order to make a comparison between the reference situation "a priori" and "a posteriori".

From the supply point of view with in particular review of new projects which might influence the transport situation and in order to compare traffic expected a priori and traffic observed a posterior (or at least to compare expected gain of traffic, with observed gains of traffic).

5. The impact on environment
6. The structural effects on regional economic development although, at this stage, it is always difficult to precise what is really due to the project
7. Finally a comparison is made between the socio economic rate of return a posterior and a priori for the transport company (for example SNCF) and for the community.

3.3.3 Energy infrastructure projects assessment

Ex-ante analysis

RTE elaborates the feasibility study dossier of the project (la justification socio-économique) which gives:

- the hypotheses and the reasons to conduct the project;
- the various solutions envisaged to satisfy the identified needs and
- the predicted advantages and drawbacks of the project especially in relation the economic and the environmental impacts.

In the economic impacts study of the electricity transmission, two indicators are very often used: the increase of transmission efficiency and the reduction of operating costs. These are normally obtained by model simulation of "with" and "without" scenarios. The model simulates the electric energy production, transmission and consumption.

Later on, after the dossier is accepted through public debates, the RTE might be asked to develop a more detailed and elaborated environmental impact study (*l'etude d'impact complémentaires*). If this complementary study is conducted, it will include the detailed and territory based (trajectory based for line and site based for post) study on the impacts of the project on:

- physical environment (climate, soil , underground and surface water quality);

- natural environment (wildlife: fauna, flora, birdlife);
- human environment and health (human activities, health problems);
- constraints due to the public works and water zone and
- landscape (topography, people migration, landscape of the surrounding area).

From the ICF Consulting report (2002) some costs elements on networks charges and assets values could be obtained as mentioned below.

Network charges

Network charges consist of infrastructure construction cost, network losses cost, cost of constraints, ancillary services and taxes. Since November 2002, transmission tariff in France is based on recommendations of the regulator body, the CRE (*Commission de regulation de l'énergie).* The management body of electricity network (RTE) is allowed to self-finance its investments to the extent of €76 millions per year and to cover operating expenses, depreciation, and a 6.5% return on capital.

Calculation of asset values:

Assets values are calculated on a straight-line basis which is based on the acquisition cost less depreciation. Assets acquired before 1977 were re-valued as 1 of January 1977. Transmission systems and transformers are depreciated over the declining balance method. The useful life of the transmission assets is between 30 and 50 years. Capitalised interest relating to transmission equipment under construction is deferred until the start of operations and then amortised over the useful life of the asset.

Ex-post analysis

Ex post analysis is not compulsory in France.

3.4 Germany

3.4.1 General information

a) Transport investments

In Germany transport infrastructure plans are prepared by the Federal Ministry for Transport, Building and Urban Development (BMVBS) every 10 to 15 years. The latest issues are dated 1992 and 2003. As the investment covers road, rail and waterborne transport, the responsibilities

are split between several departments, coordinated by Department A20 (Federal Investment Plan, Investment Policy)[15].

The projects to be included in the investment plan are proposed by the 16 federal states. Scenarios, transport forecasts, project assessment and the financing framework are then carried out by the Federal Ministry. The final priority ranking of the projects is finally done with consultation of the federal states. The Federal Investment Plan is not a legislation and thus is accompanied by specific investment acts for the several modes of transport.

The current investment plan contains more than 2000 projects with total costs of roughly 150 billion Euros for the period 2003 to 2015. This sum includes TEN- and EFTE funds from the EU and distributes to the means of transport as follows: Federal roads: 78 billion €, rail: 64 billion € and waterways 8 billion €. In addition, the federal government provides funds via the Community Financing Act (GVFG) and the Regional Funds for the railways (14 billion €).

According to the rule of the General Infrastructure Investment Plan, the Federal Government takes the final decision on the projects to be funded, based on the evaluation scheme described above. However, due to the strong position of the Federal States and the existence of a particular funding quota for each state the final set of projects included is the outcome of a lengthy negotiation process.

The participation of the States is justified because they should contribute profound knowledge on local conditions and demand developments. Such, it even happens that the Federal States carry out own cost-benefit analyses for desired projects to confront with the assessment of the Federal Investment Plan.

The project funding is mainly based on specific budgets of the Federal Ministry for Transport, Building and Urban Development (BMVBS), but also takes into account funds from the EC for TEN and ERDF projects, from the Community Funding Act (roughly 1.6 mill. €/a) and from other federal and state programs.

b) Energy investments

The German electricity transmission sector is composed of 4 private companies: EnBW Transportnetze AG, RWE Transportnetz Strom GmbH, E.ON AG Netz GmbH and Vattenfall Europe Transmission GmbH. For this reason the responsibility for the evaluation of new network projects devolves upon the companies themselves. For the same reason, no detailed guideline and unique methodology exist at the national level and network infrastructure projects are directly financed by the companies involved.

The German legal framework on electricity networks is described in the law on electricity and gas supply, as well as in decrees on the access to electricity supply networks and on charges for

15 Bundesministerium für Verkehr, Bau und Stadtentwicklung (BMVBS), Referat A20 (Bundesverkehrswegeplan und Investitionspolitik), Invalidenstr. 44 , D-10115 Berlin, Germany.

the access to the networks. One important objective of this framework is to ensure a non-discriminatory access to electricity networks, ruled by a regulated network access system.

A key-role of the German regulator – the Federal Network Agency ("Bundesnetzagentur") – is to ensure non-discriminatory network access and to control and homologate the network usage rates levied by the power supply companies. One future task of the Federal Network Agency will be to check power transmission fees.

The Association of Network Operators (VDN, "Verband der Netzbetreiber") is a central organisation regarding the power supply network and its operators. The role of this platform is to ensure competition and operability and to link network operators, politics and public. It provides information about the German power supply network, the legal framework, the quality of supply, the management of bottlenecks, etc.

3.4.2 Transport infrastructure projects assessment

Ex-ante analysis

The Federal Transport Infrastructure Investment Plan is carried out in five steps (FIS (2006), Schueller et al., 2003) and follows a number of general objectives:

1. Ensuring an environmentally sustainable and safe mobility
2. Fostering economic development and employment in Germany
3. Promotion of sustainable settlement structures
4. Providing fair and equitable conditions for all modes of transport
5. Promotion of the European Integration

The following section describe the German framework of transport infrastructure assessment by outlining four main pillars of the framework.

a) Policy scenarios and transport demand forecasts

The 2003 infrastructure plan distinguishes between two scenarios of transport policy: (1) the Laissez-faire scenario does not consider any new political measures and (2) the Integration scenario assumes a policy promoting modal shift by implementing road user charges and by further opening access to the rail network. In all cases an increase of passenger demand by 20% and of freight demand by 64% is projected between the base year 1997 and 2015. All other socio-economic parameters, such as GDP development, demography, etc. are dept constant across scenarios.

b) Update of CBA methodology for project assessment

Since 1985 the assessment methods have been constantly improved. Besides updates of cost factors, the most important improvements between the Investment Plans 1992 and 2003 have been (1) the joint assessment of interdependent projects, (2) improved methods for effects of infrastructure construction on nature and landscape, (3) formulation of clear objectives and

assessment criteria for regional and urban development. The components of the cost benefit analysis and their contribution to the total benefit cost ratio of all projects (results of a pre-test in brackets) are (FIS 2006):

(1) Vehicle operating costs (59%)
(2) Infrastructure maintenance costs (-2%)
(3) Transport safety (14%)
(4) Accessibility (48%)
(5) Regional Effects (4%)
(6) Environmental Effects (-7%)
(7) Induced traffic (-15%)
(8) Hinterland access (1%)
(9) Non-traffic related functions of investments
(10) Investment costs

(1) Vehicle operating costs take into account changing distances, speeds and occupancy rates. Considered are vehicle depreciation, wear & tear and personnel costs in commercial transport (goods vehicles and 31% of passenger car traffic in road transport).

Cost values:

- depreciation 1.19 €/h (cars on urban and rural roads) to 6.93 €/h (HGVs on motorways);
- labour: 21.47 €/h (LDVs and buses) to 27.92 €/h (commercial cars);
- wear & tear: 10.03 €/km (passenger car) to 66.86 (bus on urban roads) and
- fuel costs by speed-dependent consumption function.

In rail and inland navigation no values are proposed. As for all other cost components assets are depreciated over their true economic life span with a social interest rate of 3% at constant prices excluding VAT and subsidies.

(2) Infrastructure maintenance costs: Renewal and repair may be saved by investment measures. Replaced old roads are valued 150,000 €/km of motorway and 27,100 €/km of federal roads. These potential savings are consolidated with annual maintenance and operation costs between 10 mill. €/km for trunk roads and 33 mill. €/km for 4 lane motorways in road transport and in rail networks shares between 0.07% for noise protection facilities and 3.5% for telecommunications equipment at rail investment costs.

(3) The Assessment of transport safety distinguishes between pure material damages and accidents affecting human health or life. Accident rates vary by road type between 0.9 and 1.9 damages to persons and between 0.6 and 13.6 material damages per million vehicle kilometres. The applied accident cost rates for personal damages vary between 36,000 € on urban roads and 87,000 € on motorways and for material damages between 6,100 € on urban roads and 8,300 € on motorways.
In rail transport accidents are classified by severity with the following rates per million pkm /

tkm: 1.5/0.4 death casualties, 3.2/0.9 severe and 4.0/1.1 light injuries and 57/16 material damages.

(4) Improved accessibility is computed for private trips (coach and 69% of car travel) only and thus accomplishes the benefits form reduced operating costs for commercial transport. Time benefits are 3.38 €/h and traveller.

(5) Regional advantages within the CBA include employment effects during the infrastructure construction and operation phases and the development of international relations. Other effects are analysed by a separate "Spatial Development Analysis".
The benefit of new jobs created during the construction phase is estimated with 13,000 € according to the past state net expenses for employment programs. Each hob is assumed to hold for 8 years. Total additional employment is estimated by Input-output-analyses and average wage rates. Accordingly, 100 mill € of investments entail 2,350 person years, of which 40% are assumed to remain in the same region and further roughly 30% are be served by formerly unemployed persons.
Employment effects during the operation phase consider the increased economic activity induced by improved accessibility from and to national and international regions and the current level of structural unemployment in the region. The number of additional jobs per 1% accessibility improvement range between 21 (Bavarian Alps) and 2,762 (Berlin).
International integration is assessed in monetary terms via a bonus upon the time and operating cost savings on network sections of international importance. It calculates according to the share of international traffic and takes a maximum value of 10%.

(6) Environmental effects include the assessment of noise nuisance, air pollution and greenhouse gas emissions. Noise costs are computed by a unit value of 54.71 € per affected inhabitant and decibel above the target value of 37 dB(A) (road) or 42 dB(A) (rail) during night time. Noise exposure levels are computed by dispersion and settlement structure models.
Air emissions are further subdivided into global emissions (NO_X-equivalents) deteriorating vegetation, local emissions (NO_X) causing cardiovascular diseases, carcinogenic substances (benzene, particulate matter, PAH[16]) and greenhouse gases. The respective emission factors depend on the type of road, speeds and vehicle classes. The valuation basis is 365.00 €/t NO_X equivalent for global emissions, 3.37 € per affected inhabitant and NO_X-concentration ($\mu g/m^3$) for local emissions, 0.79 € per casualty for carcinogenic substances and 205 €/t CO_2 for climate gases. In rail transport cost values between 1.28 €/train-km for electric passenger trains and 2.52 €/train-km for diesel powered freight trains are proposed for climate and vegetation damages plus a wind dependent component for health and material damages are proposed.

(7) Induced traffic describes changing demand which is generated by new or improved infrastructures. In the short run these are new or omitted trips, while in the long run effects of location changes of people or firms get apparent. The benefits for "new" users are estimated by consumer surplus considerations, making use of a linear relationship between transport cost decreases and induced demand. Finally, negative impacts due to increased congestion and

16 Plycyclic Aomatic Hdrocarbon

environmental loads outweigh the benefits. The assessment uses general cost factors of around 1.5 €/million vehicles of induced traffic.

(8) The improved access to sea- and airports results in demand changes in these facilities. For these additional flows vehicle operation, accident and environmental costs and employment effects are estimated using the respective methodologies.

(9) Non-transport related functions in first instance relate to investments in inland waterways, which may also serve hydro power generation, flood prevention, water supply and disposal and leisure purposes.

(10) Investment costs are differentiated by asset category and include all eligible compensation payments and environment protection measures. For roads average investment unit costs are used, while for rail and waterways specific analyses per project are required. If necessary, prices are transferred to the year 1998. Life expectancies are considered by detailed assed type. Examples: Rail formations, crossing and tunnels: 75 years, rail systems, road bridges and tunnels: 50 years, equipment: 10-12 years.

Although it is one of the most advanced methods in Europe, the German Federal Investment Plan consists of a series of shortcomings:

- alternative strategies for increasing the capacity and quality of transport infrastructure (e. g. applications of new technology) are not considered;
- there is no controlling instrument monitoring the achievement of original plans;
- combined freight and local rail transport are not considered adequately;
- different rail network operating strategies are disregarded and
- some conflicts could arise when larger network parts are operated privately.

c) Environmental Risk Assessment

On top of the cost benefit analysis, a detailed assessment of potential conflicts of the proposed projects with national and European nature conservation legislation is carried out for selected project. The selection is proposed by the Federal Office for Nature Conservation (BfN). The analysis goes along the following steps: (1) identification of sensitivity patterns, (2) forecast of impacts of the investment and (3) conflict analysis.

d) Spatial Development Analysis

Policy goals of spatial development are an equitable distribution of technical infrastructure across the entire country and the provision of sufficient supply with rail and waterborne infrastructures and services in agglomeration areas. For the achievement of these goals a score system is applied, which is finally consolidated with the CBA results.

Ex-post analysis

In German infrastructure planning ex post analyses are neither compulsory nor recommended by the assessment guidelines. Sporadic information is provided by the federal and the state governments for specific investment project due to parliament enquiries.

3.4.3 Energy infrastructure projects assessment

Ex-ante analysis

Due to the diversity of actors and to confidentiality reasons of the private energy sector's players, no general assessment guidelines exist and no typical methodology for energy projects evaluation can be found at the national level. However two major assessment methodologies are commonly used in the German energy sector, and particularly for electricity network interconnections:

- Load flow calculations: this methodology, based on a network bottom-up approach, consists in network capacity calculations aimed at quantifying the additional capacity resulting from a measure implemented to increase the transmission capacity and
- Economic efficiency analysis: the analysis of countries' power plant parks development (e.g. power plant capacities, energy mix) as well as electricity price differences between countries before and after the implementation of a new line provides valuable information for the assessment of an interconnection line.

Within these methodologies, the commonly used decision criteria are the technical (n-1) criterion (as widely used in the whole UCTE area) related to the security of supply, the net present value and the analysis of price differences related to the assessed project. The use of the (n-1) criterion for the expansion planning of energy networks in Germany is detailed in (VDN, 2003).

Ex-post analysis

Since standardisation for energy infrastructure project assessment hardly exists in Germany, ex-post analysis is not compulsory.

3.5 Hungary

3.5.1 General information

a) Transport investments

The Hungarian Parliament has passed the current Hungarian transport policy in 2004 for the period from 2003 to 2015. It is in-line with European Union's common transport policy and

reforms became necessary primarily as a result of Hungary's accession to the EU. The aim of this transport policy is to create a transport system which is economically efficient, modern, safe, environmental friendly and meets the requirements of society. The priorities of the Hungarian transport policy are:

- development of the missing infrastructure with a special focus to the Pan-European transport corridors which cross Hungary (e.g. Corridor V – Venice – Ljubljana – Budapest – Lvov);
- complete adoption of the transport regulations of the EU bearing in mind Hungarian peculiarities and possibilities, of which the cornerstones are reform of the railways, public transport and regulated competition and
- building of an environment-friendly transport system, and the development of and preference for environmentally friendly transport modes.

Based on these general transport policy objectives, Hungary develops regularly a national road investment plan. The last plans have been published every 10 years with the current plan came into force in 2005. The methodology behind the Hungarian road infrastructure plan will be analysed in detail.

The methodology for road infrastructure assessment has been developed over the last three decades. Official recommendations have been derived for investments in the road network whereas no official guidelines exist for other modes of transport. During the last two years the described methodology, as a combination of CBA and MCA, has been criticised fundamentally. In particular the methodological combination of CBA and MCA with no clear distinction between the monetized and the non-monetized parameters. It can be assumed that the general methodology of Hungary will be revised manifestly and expanded to the other modes of transport (e.g. rail).

b) Energy investments

Since October 2000 with regard to the liberalisation of the electricity market, the power generation and grid company MVM (Magyar Villamos Művek[17]) established the state-owned company MAVIR (Magyar Villamosenergia-ipari Átviteli Rendszerirányító Zártkörűen Működő Részvénytársaság[18]) to perform the operation of its electricity transmission system.

17 MVM: http://www.mvm.hu

18 MAVIR: http://www.mavir.hu

3.5.2 Transport infrastructure projects assessment

Ex-ante analysis

Official recommendations only exist in Hungary for road transport whereas rail, air, inland waterway and sea are assessed on a case to case basis. Road infrastructure projects are evaluated for two types of tasks: the selection of the best project alternative from a set of different possible solutions and the definition of the best project to achieve the optimal predefined network in the long term. Both choice problems are assessed by CBA and MCA to evaluate monetized as well as non-monetized parameters. The combination of both methodologies should demonstrate the social-economic viability of the projects and the influence on the (regional or national) economy. Usually net present value and benefit-cost-ratio are used as decision criteria. The time horizon is 25 years and the discount rate is fixed to 5%.

Passenger transport time savings are differentiated for light vehicles in weekday and weekend trips whereas heavy vehicles and busses are differentiated more detailed. The values are a function of GDP per capita and for light vehicles they amount to 1781 HUF/veh-h (weekday) and to 890 HUF/veh-h (weekend). User charges and revenues are only included in the assessment in cases of BOT projects (built-operate-transfer). Vehicle operating costs are considered for depreciation, repair and maintenance costs as well as for fuel and lubricants. The values are multiplied with speed-dependent multiplier for both light and heavy vehicles (e.g. 50 km/h=0.98 – 70 km/h=0.94 – 120 km/h=1.3 for light vehicles). Freight user benefits are based on time savings of the driver and savings in the operating costs of the vehicle.

Air pollution and noise emissions as negative impacts of traffic are calculated section wise. Air pollution is a result of the emissions of different vehicles. A distinction is made between different vehicle categories (e.g. light vehicles, heavy good vehicles) because the average exhaust emissions differ significantly between the categories. Emissions coming from PM, NO_x, SO_2, HC, CO and PAH (polycyclic aromatic hydrocarbons) are considered whereas no climate change parameters (e.g. CO_2, O_3) are under consideration. Noise level consumption needs the collective of all vehicles since low level sections cannot cross compensate sections of high noise levels. Hungary assesses the number of persons affected from noise and monetizes them with a fixed annoyance value of 8,000 HUF/person.

Safety issues play an important role in Hungary as it is stated in the aims of the current national transport policy. Damages are partly to the transport users, partly to the society related. Therefore material damage to the vehicle as well as costs to society, like medical treatment, legal and court costs, emergency service and net production loss are calculated. Fixed values are used for monetizing the accident numbers which grow each year by 4% (annual price increases). They amount to (2002 prices):

Tab. 3.1 Standard Values in Hungary for accident costs

Type of casualty	Monetary value
Road accident with casualties	98,000,000 HUF/casualty
Road accident with serious injury	6,800,000 HUF/injury
Road accident with slight injury	900,000 HUF/injury
Road accident	500,000 HUF/accident

Source: Odgaard, 2005

Contrary to European standards socio-economic parameters are not covered by CBA - they are included in the MCA assessment. Parameters considered are economic development, cohesion objectives on a national as well as EU level, network effects, equity of regions and impacts on tourism, flora and fauna and landscape protection.

Ex-post analysis

Ex-post analysis is not compulsory.

3.5.3 Energy infrastructure projects assessment

Ex-ante analysis

Objectives of MAVIR are to ensure a reliable, efficient and secure operation of the power network, to maintain the system balance and develop the network for a proper and reliable supply, and to harmonise the operation with neighbouring countries. Other tasks of MAVIR include the integration of short- and long-term capacity plans and of electricity trade contracts, as well as the monitoring of electricity transmission prices.

The network expansion is a major task of the Hungarian transmission operator, which therefore relies on *operational reliability indices* in accordance with its network development strategy. As a member of UCTE, CENTREL and SUDEL international organisations, Hungary should develop its electricity transmission network in accordance with the requirements of these bodies.

Ex-post analysis

Ex-post analysis is not compulsory.

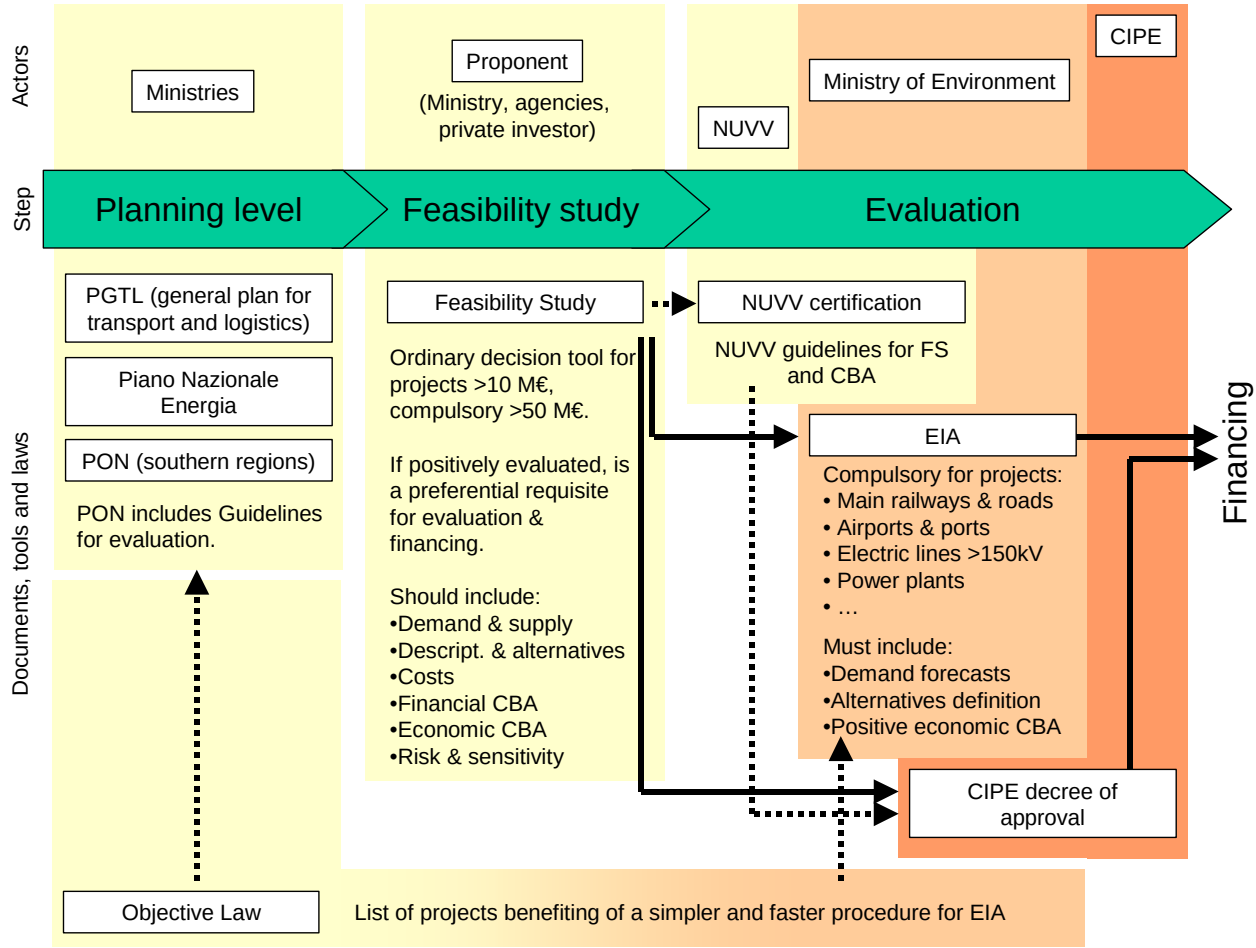
3.6 Italy

3.6.1 General information

The set up of evaluation procedures for infrastructure projects in Italy is quite recent and still not standardised. The first experiences dates back to 1982, when a procedure for evaluation accompanied the establishment of a Fund for investment and employment (FIO - Fondo Investimenti Occupazione). The proposed approach was largely derived from international experiences.

The evaluation framework in Italy at national level can be described as in the following figure.

Fig. 3.2 Evaluation framework in Italy



Source: TRT

The planning level

The first step is in the planning level, where the criteria, the objectives, and often the list of infrastructural investments, are declared.

Regarding transport sector, at national scale, the main tool is the PGTL, National Plan of Transport and Logistics. The last edition, the second, has been issued in the year 2001 (PGTL, 2001), completely revising the contents of the previous dating back to the 1986 (PGT, 1986) and introducing new elements like market regulation. Although the single projects are listed, it doesn't provide any indication for assessment or formal prioritisation.

Regarding energy sector, the infrastructural projects can deal with the national HV grid and the local distribution low-voltage grids. The focus here is on national networks and the role of TERNA company. It is also responsible, from November 1st, 2005, of planning the development of the national grid. The planning tool is yearly and it is called Development plan for the national electricity network (*Piano di sviluppo della rete elettrica di trasmissione nazionale)*. The

remuneration of investments is fixed by the Authority, based on the total amount invested and is paid directly by the consumers as a quota in the electrical bill. In this sense, being TERNA the monopolist and the financing compulsory and independent from the provider, the financing can be seen as public money. Nevertheless the company acts as a private company, as it is, and the investments are decided with non-public criteria. The development plan must only undergo the approval by a commission of experts. The commission suffers of ignorance about real costs and grid loads, data owned by TERNA itself.

Another national planning tool is the PON, National Operative Plan, focusing on the development of southern (objective 1) regions. The transport sector has its own PON ("*PON Trasporti*"). A recent document (PON, 2006) includes also a methodological note about assessment methodology of single projects.

For comments about the so called "Objective law" that partially revised this framework, please refer to the dedicated paragraph.

The feasibility study

Currently, all the public investments, whose costs exceed 10 M€, should undergo a feasibility study (Studio di Fattibilità, SdF) which is the "*ordinary tool, preliminary to assumption of investment decisions"*.

Feasibility studies are compulsory since the year 2000 and should contain all the information needed to support an investment decision, including Cost Benefit Analysis, analysis of alternatives, demand forecasts. The *SdF* should be completed by the proponent of the investment either a private investor or a public agency.

According to L.144/99, for projects whose cost is lower than 20 M€ the feasibility study is necessary only to obtain the financing of the design phase, while is the ordinary preliminary tool for decision for investments over 10M€. The same law defines that for projects with a cost higher than 50 M€ the economic analysis is compulsory.

The main contents to be included in the study are provided, but their order and their structure is only suggested (NUVV, 2001 and Dosi, 2002).

- Technical feasibility description.
- Demand and supply analyses.
- Description of project and alternatives.
- Costs.
- Financial CBA.
- Economic CBA and
- Risk & sensitivity analysis.

Evaluation

The object of evaluation is the feasibility study.

Moreover they must be submitted to the relevant Public Investments Assessment Unit (Nucleo Valutazione e Verifica Investimenti Pubblici) called NUVV. NUVVs are based both at the regional level and at the various ministries for sectorial investments of national or supranational interests. They have been designed to improve and support evaluation procedures and methodologies and they also provided guidelines (NUVV, 2001) based on a common approach, in order guarantee for consistency in the evaluations through sectors and regions. Nevertheless, NUVVs are support structures and not evaluation agencies, and for this reason, at least according to some authors, their role is quite vague and their independence from higher administrative levels is weak (Petrina et Virno, 2002).

After the possible evaluation of NUVVs, the projects are then submitted, together with the suggestions provided, to the Inter-ministerial Committee for Economic Planning CIPE[19], to ministries or to local administrations, according to the nature of the project. The approval of feasibility studies constitutes the certification of public utility and allows the financing. Each single authority will then decide whether to proceed with the financing of the project from its own budget (L.144/1999).

For major (strategic) projects the financing must undergo a double evaluation, both based on the feasibility study. CIPE and the Presidents of concerned Regions are now in charge for the assessment in economic terms of the projects presented by the Promoters, while the Ministry of Environment and Cultural Heritage are checks the impacts according to an EIA approach. In case of serious conflicts, CIPE shall act as mediator. Only some categories of projects, mainly the most impacting ones, must be assessed by an EIA (see further). At the completion of the assessment cycle, the Government is in charge for engaging funds in the yearly national budget. Each strategic project has then to be started within 13 months after CIPE approval (6 for delivering the preliminary project design and 7 for the final one).

Key tasks of CIPE, with regard to assessment themes only, are the appraisal of strategic investment schemes and programmes, their approval and the ex post assessment of policies' to achieve national objectives (Borgnolo, 2004).

The Environmental Impact Assessment is a public procedure and can undergo a public debate. Furthermore, all kinds of projects listed in the law 349/1986 must undergo an EIA. For transport and energy investments in particular, the categories of infrastructures for which the EIA is compulsory are (DPCM 377/1988 and Law 27-12-88):

- rail lines for long distance traffic;
- airports with runway longer than 1.500 m;

19 CIPE is responsible for matters involving different departments whose "medium-long term implications have significant impacts on economic and financial aspects".

- highways, freeways and roads for motorised traffic only, with multiple lanes […];
- maritime ports;
- inland waterways and ports for vessels larger than 1350 t;
- external power lines with nominal tension higher than 150 kV and longer than 15 km;
- oil pipelines longer than 40 km […] and
- thermal power plants with power capacity higher than 50 MW […] or hydro power plants with power capacity higher than 30 MW.

The EIA and its verification must take care of Cost Benefit Analysis provided in the feasibility study. According to the guidelines produced by the National Agency for Environmental Protection: *The EIA assessment must simply verify that these evaluations* (economic cost/benefit, technological feasibility) *took place to avoid that needless or technically wrong investments produce […] unnecessary impacts on environment. […]. If the project is not justified under the socio-economic profile, the produced impacts, whatever they are, must be considered unjustified* (ANPA, 2001).

The "Objective Law" (Law 443/2001)

A separate comment must be done concerning the so called "Objective law" (L. 443/2001, "*Legge Obiettivo"*). It declares coherence with the PGTL and gives the national government full powers to identify public and private projects of strategic national interest and which can be considered a national plan for major infrastructure projects. The law can then be considered together a procedural tool involving assessment criteria and a planning tool.

Apart the list of project identified, it deals with a procedural simplification. Its key provisions are conceived to improve decision-making and to significantly reduce the time span in approval and planning of projects proposed by concerned Ministries and Regions. In order to speed up high priority projects scrutiny and approval, the "Objective Law" established (Borgnolo, 2004).

- Centralised funding procedures.
- Simplified feasibility study.
- Simplified environmental rules, limited to the first stage of the project and
- removed the possibility of concerned national and local administration of exercising veto powers in the Service Conferences ("Conferenze dei Servizi"), called up to co-ordinate decisions making of concerned local authorities.

Moreover it introduces the figure of General Contractor for the managing of the entire design and construction and for a larger private participation.

3.6.2 Transport infrastructure projects assessment

Ex-ante analysis

The assessment of the transport infrastructures is a relevant application of the process framework.. As mentioned before, the ex ante evaluation is part of the feasibility study phase and is strictly integrated with it.

As the guidelines produced by the NUVVs are not compulsory, each single project follows its own CBA application. The values for the different parameters are derived from the analyst experience, calculations and assumptions. Only for a few of these parameters there are reference "standard values": the social discount rate and some shadow prices suggested by NUVV are the main ones. Scientific literature values are often used, even if not included in official documents: as an example, the estimation of external costs of INFRAS/IWW (2000) is adopted in all rail projects.

The guidelines for the Feasibility Studies developed by the NUVV (NUVV, 2001), which have tables for both financial and economic analysis, provide also some procedures and reference values for the evaluation. The guidelines distinguish between small and large projects and for the small ones suggest an aggregate analysis according to the scheme in the following table.

Tab. 3.2 Classification of costs and benefits according to NUVV guidelines

Costs	Benefits
Investment costs Exercise costs Maintenance costs Environmental costs Private external costs Enterprises external costs Others	Financial revenues Subsidies Residual values External economic benefits

For large investments, the approach is more sophisticated, including shadow pricing as well as risk and sensitivity analysis. Two other guidelines are available at the national level: the CBA approach developed by the Italian rail tracks operator RFI (Cicini et al., 2005) and the ones included in the PON (PON, 2005).

Ex-post analysis

Ex-post analysis is not a common practice in Italy and indeed neither guidelines nor laws require a systematic re-appraisal of completed projects. Nevertheless, an important action of monitoring a number of project which undergo a feasibility studies approved by the CIPE has been carried on by UVAL, the "Unità di Valutazione degli investimenti pubblici", under request of CIPE itself (Cervigni et al, 2002 and 2003). The analysis covered 393 projects, with the aim of

building up a database of studies financed by CIPE and highlight the most critical issues in the feasibility procedure. The review focused on the state of completion and the quality of the products. This last can be considered an analysis of conformity, providing evidence of possible limits of the analysis such incompleteness, quality, clarity[20].

3.6.3 Energy infrastructure projects assessment

The sector doesn't have any public guideline, since all the investments are decided by the monopolist grid company TERNA and simply approved by a ministerial commission. Only some cross-border lines (called Merchant Lines) are subjected to a particular normative (EU 1228/2003 and following ones) due to the technical problems.

Ex-ante analysis

TERNA decides investments according to internal criteria and analyses. It declares to perform Cost Benefit Analyses (TERNA, 2003), but these are not public. The criteria included in the procedure are the monetary ones (investment costs, operational and maintenance) and others out of market. These are mainly the benefits due to the removal of capacity constraints (freeing the capacity of constrained power plants) and the security of supply. This last benefit, in particular, is the most controversial since the shadow value attributed is difficult in definition and, in any case, never transparently declared in the studies and in the plan.

The problem of this assessment system is the scarce transparency and the way of remuneration of investments that can drive to distorted planning. The investments have fixed remuneration (Authority decree 5/2004 and modifications) and the incentives to clarity and efficiency of investments are very scarce. The company privileges lines with minimal acceptability problems and less costly (for example in scarcely urbanised areas) instead of difficult and fundamental missing links in high demand areas. Moreover, the capacity excess doesn't favour monopoly rents.

All investments in high-voltage lines (>150 kV) must undergo an EIA, as Italian and European laws require. The economic/social feasibility demonstration is probably based on internal CBA.

Ex-post analysis

The ex-post evaluation activity of investments is not known.

20 References can be found in: http://www.dps.mef.gov.it/uval_doc_studi.asp.

3.7 Poland

3.7.1 General information

a) Transport investments

Poland's transport policy has been revised by the "Strategy of Transport Infrastructure Development in 2004 – 2006 and the following years". It analyses the periods of planning of 2004 – 2006 as well as 2007 – 2013. The aim of this plan is to be in-line with European Union's planning and to reduce bounds which hindered the development of transport in Poland. Therefore, the strategy concerns all modes of transport whereas road and rail networks are of supreme importance.

Poland is a main transit country between East and West as well as North and South Europe. This is also recognized through the four Pan-European transport corridors crossing Poland (e.g. Corridor II: Berlin – Warsaw – Minsk – Moscow – Nizhny Novgorod). Improving the importance of the transport infrastructure the main priorities of the current transport development plan are (Krawczyk & Siwek, 2003):

- improvement of connections of Warsaw with European capitals to 2006 and with main country regions to 2013;
- effective transport system for intensified trade turnover within the Single Market and with Eastern Europe;
- improvement of accessibility of main urban areas in Poland;
- support of the regional development;
- improvement of road traffic safety;
- environmental protection and reduction of costs and
- development of the inter-modal systems.

The transport infrastructure has been financed out of the following sources: national (public) funds, EU funds and private capital (marginal role). In the coming years the sources shall not change significantly but the role of EU funds and private capital is supposed to increase (Krawczyk & Siwek, 2003).

b) Energy investments

The Polish company *PSE-Operator S.A.* (Polskie Sieci Elektroenergetyczne[21]) is the owner of Poland's high voltage electricity network. It was created in August 1990 by the Polish Ministry

21 http://www.pse-operator.pl

of Trade and Industry as a joint-stock company and is responsible for grid operations and power dispatching.

3.7.2 Transport infrastructure projects assessment

Ex-ante analysis

In the past no generally accepted appraisal methodology existed in Poland. After accession to the European Union two ways of appraisal methodology have been implemented. The first approach which is supported by the EU is used for projects co-financed by European funds. These infrastructure project assessments have to fulfil the guidelines of the EU. National projects financed by the federal budget have mostly not been assessed with this methodology. Recently the methodology which is used for EU funded projects is being extended also for national projects, even though no official recommendations exist so far. This methodology will be elucidated.

CBA is normally used for road and rail infrastructure projects. The discount is fixed at 6% and the appraisal period is limited to 20 years. For both modes of transport construction costs are measured for material, labour, energy, planning, land and property purchase as well as an add-on for bias in estimate of construction costs. Disruption from construction is not taken into account. System operating costs and maintenance are assessed for the appraisal period but no standard figures are used. Values are estimated for each project separately.

User benefits are either included in a CBA or assessed qualitatively. Passenger transport time savings, for example, are not monetized in a CBA because no standard values exist in Poland. The same procedure is applied for vehicle operating costs and freight user benefits. Contrary to other European countries these impacts are not monetized (e.g. Denmark, Germany). The income of user charges and revenues of tolled roads are calculated as benefits for the CBA.

Further assessment is done for impacts concerning safety, environment and socio-economic development. The polish policy concerning safety defines quantitative goals which should be achieved in the medium-term. Therefore new infrastructure has to support this goal without measuring the accident costs. Calculating the impacts on the environment are compulsory by law for all medium as well as large infrastructure projects. The “Natural Environment Protection Law” (Ustawa Prawo Ochrony Srodowiska) deals with project assessment. Additionally local administration has the power to enforce environmental impact studies for investments which may have adverse environmental impacts. Assessments are based on quantitative values which compare between “with” and “without-scenarios”. Nevertheless, no emissions parameters are defined which have to be assessed. In the same way vibration, severance, visual intrusion, loss of important sides, resource consumption, landscape and water pollution are evaluated without exact guidelines. Climate change (e.g. CO_2) impacts are not analysed for infrastructure projects even though Poland has signed and ratified the Kyoto-Protocol.

Socio-economic impacts are only assessed for motorway investments. Parameters considered are land use, economic development, employment, cohesion objectives, network effects and effects on state finance. They are analysed qualitatively without monetizing the results.

Ex-post analysis

Ex-post analysis is not compulsory.

3.7.3 Energy infrastructure projects assessment

Ex-ante analysis

The main tasks of PSE-Operator S.A. include the national security of supply, a cost-effective system operation with regard to cross border electricity exchanges, and the performance, the maintenance and the development of the electricity transmission system infrastructure.

Polish electricity network expansion planning is realised upon *reliability analyses of interconnected systems*. As a member of UCTE and CENTREL, Poland should develop its electricity transmission network in accordance with these bodies.

Ex-post analysis

Ex-post analysis is not compulsory.

3.8 Portugal

3.8.1 General information

a) Transport investments

For the transport infrastructures, the following institutions are responsible to conduct evaluation:

- tolled roads: Instituto das Estradas de Portugal (IEP[22]) and BRISA[23],
- rail transport: CP – Caminhos de Ferro Portugueses[24],

22 http://www.estradasdeportugal.pt

23 http://www.brisa.pt

24 http://www.cp.pt

- air transport: ANA Aeroportos de Portugal SA[25] and
- maritime transport: Ministério das Obras Publicas, Transportes e Comunicações (MOPTC) or the Ministry of Public Works[26].

All of these departments conducting evaluation belong or depend upon the Ministry of Public Works (MOPTC)

b) Energy investments

In the electric energy infrastructure, the *Rede Eléctrica Nacional, S.A.* (REN27) is the responsible body for the electric transmission in Portugal. It is an independent company since November 2000 in response to the European Directive 96/92/CE which dictates the legal separation of electricity transmission companies from those holding distribution and production of electricity. A legal framework (DL no 185/95 of July 21st and DL no 56/97 of March 14th on Concession principles of National Network of Electric Energy Transportation or RNT) confers to REN the concession of RNT and the global management of Electric System of Public Supply (SEP), including planning, construction and operation of RNT infrastructures with objective to secure the electric energy supply to SEP clients with adequate level of quality and service continuity.

In the electric energy transmission project, the decision process framework is fixed by the Regulamento de Acesso as Redes e Interligações (RARI) of the year 2005 or the regulation of access to the networks and interconnection. It is mentioned that REN has to present the scenarios of forecast used in its investment planning and to demonstrate in a good functioning of its networks from technical point of view, and to submit the technical-economic feasibility of its projects to the ERSE (entidade reguladora dos services energeticos or the energy services regulatory authority).

3.8.2 Transport infrastructure projects assessment

Ex-ante analysis

Portugal has currently neither standardisation nor recommendation of principles for transport infrastructure project appraisal. An official methodology is expected to be defined in the short/medium term. However, in current practice in road, rail, air and maritime transport modes, cost benefit analysis (CBA) method starts to be widely used. CBA is required only in the case of co-funding projects by an international body. Besides CBA, qualitative assessment (QA) method which classifies effects into one of several ranked categories (ordinal scale) based on well-

25 http://www.ana-aeroportos.pt

26 http://www.moptc.pt

27 http://www.ren.pt

defined standard criteria for each of the categories, is also commonly used. This method whose standard criteria vary between projects is less sophisticates than CBA.

In general, the following main effects are covered in the CBA:

- infrastructure costs (construction costs, system operating costs and maintenance);
- user benefits (passenger transport time savings, vehicle operating costs (VOC)) and
- externalities (safety).

Decision criteria

Net present value (NPV) and internal rate of return (IRR) are used as decision criteria in the CBA. Prices are valued at factor costs, in consequence, items are valued as if no indirect taxation or subsidy were applied. The discount rate varies from 3% to 6% which excludes risk premium. Risk is assessed by considering larger investment costs or decreases in the forecasted traffic flows. The discount rates exceed the recommendation of UNITE (FP5) of 3%. The appraisal period is 20 years and the appraisal covers only national range.

Infrastructure costs

Construction costs include several elements, such as material/labour/energy, planning costs, land and property purchase, mitigation, and add-on for bias in estimate of construction costs. Terminal/residual value is not taken into consideration. The normal lifetime for bridges and tunnels are 30 years while the life time for roads and rails are 20 years.

In operation and maintenance costs, standard figures are determined as fixed amount (in euros per km).

For roads these figures are (in 2003 euros market prices):

- maintenance costs of 3.000 – 6.000 €/km;
- costs of renewal for *Itinerarios Principales* and *Complementarios* with two lanes (IP and IC)- on 10 year basis of renewal : 350.000 €/km/year;
- costs of renewal for *estradas nacionales* and *estradas regionales* with two lanes (EN and ER) – on 10 year basis of renewal: 250.000 €/km/year and
- costs of concessions: 600.000 €/km.

Some figures for railways:

- costs of maintenance with mechanical signalling : 400 €/km/year and
- costs of maintenance with digital signalling : 1.200 €/km/year.

The changes in costs of the existing network are not taken into account and the cost function/ marginal costs are assessed based on the total average costs (long run).

User benefits

Time values for work trips are differentiated simply by mode of transport (car versus HGV). While non-work trips is group into one single category. For the work trips, the value of time is calculated based on the function of GDP per capita (gross internal product per capita and per hour for the specific region), while for the non-work trips, the value of time is a function of the work trips time savings (for commuter and others, the value is considered as 75% and 50% of business trips value). The latest value of time study was made in 2004.

Tab. 3.3 Monetized time values for Portugal

Description	Purpose	Mode/type	Value	Unit	Year
Value reported in EUNET Country Report	Business	Car	10.5	ECU per vehicle-hour	1996
Value reported in EUNET Country Report	Commuters	Car	6.2	ECU per vehicle-hour	1996
Value reported in EUNET Country Report	Others	Car	7.1	ECU per vehicle-hour	1996
Value reported in EUNET Country Report	Work	HGV	8	ECU per vehicle-hour	1996
Value used in the Extension of the Lisbon Metro asessment		Car	0.075	Ecu per minute	1994
Value used in the Extension of the Lisbon Metro asessment		Public Transport	0.025	Ecu per minute	1994
IEP (Roads)	Business	Car	24.5	€ per vehicle-hour	2004
IEP (Roads)	Commuters	Car	3.9	€ per vehicle-hour	2004
IEP (Roads)	Work	HGV	8.7	€ per vehicle-hour	2004
IEP (Roads)	Work	LGV	11.7	€ per vehicle-hour	2004

Source: Odgaard, 2005

User charges and revenues are not included in the appraisal but vehicle operation costs (VOC) are included. The VOC comprise of standing costs and operating costs components. For road transport, the standing costs components are depreciation, interest on capital, repair and maintenance costs, material costs, insurance, and overheads. The operating costs components of road transport are fuel, lubricants, and tyres costs. There are two type of VOC; one obtained from studies or "commonly used values" and the other obtained from a standard formula. For road transport, for example, the formula is sensitive to vehicle type, speed, and type of terrain/ground.

Tab. 3.4 Some "commonly used" vehicle operating costs values

Description	Mode/vehicle type	Value	Unit	Year
Value reported in EUNET Country Report	National roads-Private car	0,18	Ecu per km	1996
Value reported in EUNET Country Report	National roads-HGV	0,62	Ecu per km	1996
Value reported in EUNET Country Report	National roads-Light Vans	0,22	Ecu per km	1996
Value reported in EUNET Country Report	Motorways-Private car	0,17	Ecu per km	1996
Value reported in EUNET Country Report	Motorways-HGV	0,61	Ecu per km	1996
Value reported in EUNET Country Report	Motorways-Light Vans	0,25	Ecu per km	1996

Source: Odgaard, 2005

Tab. 3.5 Values reported by IEP for 2004

Type of Vehicle	Speed	VOCs €/100 km
Private Vehicles	20	26.81
	40	22.81
	60	21.17
	80	21.71
	90	22.51
LGV	20	46.20
	40	37.40
	60	34.28
	80	35.48
	90	37.34
HGV	20	99.80
	40	77.72
	60	73.44
	70	74.53

Source: Odgaard, 2005

Freight user benefits are not included in the appraisal.

Externalities

Safety is included in the appraisal. Personal loss for casualties and costs to society are two types of costs included in monetized accident costs. The personal loss is estimated by liability payments while the costs to society include only net production loss. The types of casualties are differentiated by fatality, serious injury, and slight injury which is consistent with EUNET definition. The unit of measurement are number of accidents (reported), number of accidents with person injuries (reported) and number of casualties.

Tab. 3.6 Key figures for safety assessment

Description (including mode)	Type of cost included	Value	Unit	Year
Value reported in the EUNETCountry Report (roads)	Value of statistical life	36.350	Ecu	1996
Value reported in the EUNETCountry Report (roads)	Serious injury	14.550	Ecu	1996
Value reported in the EUNETCountry Report (roads)	Slight injury	3.650	Ecu	1996
IEP (Roads)	Value of statistical life	320.000	€	2004
IEP (Roads)	Serious injury	15.000	€	2004
IEP (Roads)	Slight injury	1.000	€	2004

Source: Odgaard, 2005

The change of risk of accidents (before and after project) is estimated based on infrastructure type.

Finally, environmental (noise, air pollution, and climate change) and indirect socio-economic effects (employment, income, added value, business location, regional) are not systematically included in the project appraisal. However, from several transportation infrastructures projects appraisals in Portugal, it could be seen that the following indicators are captured to represent the indirect socio-economic effects:

- the effect of transportation projects on total and per-sector gross domestic product (GDP), obtained by estimating the elasticity of GDP with respect to the increase of transport use;
- the effect on total and per-sector employment;
- the effect on per-sector added values and
- the effect on direct and indirect taxes.

The EU Directive no 85/337/CEE which forces every member state to analyse environmental impacts in detail is ratified in Portugal by the Decree Law (Decreto-Lei) no 69/2000 of the Portuguese Ministry of Environment and Regional Development (Ministerio do ambiente e do ordenamento do territorio). The projects covered by the annexes I and II of the Decree Law require an environmental impact assessment (EIA) to be concluded. Mega transportation as well as energy projects are clearly covered in the two annexes.

For example, annex I includes:

Article 7: a) construction of roads, railway, and airport with runway longer or equals to 2100 meters, b) construction of separated double carriage highway construction of two lanes in each c) construction of principal or complementary road networks with segment length longer than 10 km.

Article 8: a) construction of inland waterway or inland port which allow access of ships with tonnage superior to 4000 GT, b) construction of commercial ports.

Article 19: construction of electricity transportation lines with tension equals or superior to 220 kV with length superior to 15 kilometres.

The documentation required for an EIA should be presented to the body responsible for licensing or authorizing the project, which will send it to the EIA authority which consists of Environmental Institute (IA – Instituto de Ambiente) and the Regional Coordination and Development Commission (CCDR).

In brief, the EIA is compulsory for the projects mentioned in annex I and II of the Decree Law and the current method use is the *qualitative analysis (QA)*. In annex III of the Decree Law, the minimum contents of this QA of EIA are mentioned below (rough translation from Portuguese):

1. Description and physical characterization of the project and of reasonable solution alternatives that have been studied, including the do-nothing solution, taken into account location and exigencies of the use of natural resources in function of:
   - construction, commissioning and decommissioning phases;
   - activity nature;
   - activity extension and
   - emission sources.
2. Description of the material and energy used or produced, including:
   - the nature and quantity of the primary and the secondary material;
   - the used or the produced energy and
   - the used of the produced substances.
3. Description of the local condition and the environmental factors that might be exposed or affected by the project, especially population, flora and fauna, water, atmosphere, landscape, climatic factors, patrimonies including architectural or archaeological patrimonies, and the interaction between the mentioned factors.
4. Description of type, quantity and volume of the foreseeable emissions, residues, during the construction, commissioning and decommissioning phases for the different means (water pollution, soil, atmosphere, noise, vibration, light, heat, radiation, etc.)
5. Description and hierarchy of the significant environmental impacts (direct and indirect effects, secondary and cumulative, short, medium and long term, permanent and temporary, positive and negative) produced by the project as well as the proposed solution alternatives elaborated from the project execution, the use of the natural resources, the pollutants emission, from the creation of the perturbations and from the possible measures to eliminate residues and emissions.

6. Indication of the methods used to evaluate the possible impact as well as its scientific base.
7. Description of the measures and techniques preview to:
   - avoid, mitigate, or compensate the negative impacts;
   - prevent and revalorise or to recycle the produced residues and
   - prevent accidents.
8. Description of the monitoring programme during the construction, commissioning and decommissioning phases.
9. Summary of the current difficulties, including technical or knowledge gap found during the compilation of the required information.
10. Reference of public opinion and explanation of not using these opinions.
11. Non-technical summary of all the previous items, accompanied by visual representation if possible.

Ex-post analysis

Since standardisation hardly exists in Portugal, the ex-post analysis is not compulsory.

3.8.3 Electric energy transmission grid projects assessment

Ex-ante analysis

From the ICF Consulting report (2002), some elements costs on transmission charges could be deducted below.

Network Charges

Cost of construction, cost of network losses, cost of constraints, ancillary services and taxes, are included in the capacity element of the transmission tariff. In Portugal, charges relating to the promotion of renewable energy or Combined Heat and Power (CHP) exist. Transmission charges are set to provide a 3% allowance for depreciation, the recovery of operating and maintenance costs and a 9% pre-tax return on the book value of net assets (excluding land).

Calculation of asset values

Fixed assets of REN (Rede Electrica Nacional) were re-evaluated as of 31 December 1003. Assets acquired or brought into service since then include finance charges and foreign exchange differences capitalised during the construction phase, as well as certain overheads.

Depreciation is calculated on the straight-line basis at rates agreed with the tax authorities. These rates vary between 10 years for electrical equipment to 30 years for transmission equipment.

Investment guide

Planning principles of REN investment in transmission infrastructure are determined in the Measures of Planning Safety o the electric energy transportation network (Padrões de Segurança de Planeamento da RNT). This document, in Portuguese, describes the measures and hypotheses to be used in the forecasting simulation of the integrated functioning of the National Electric Energy System (SEN) whose objective is to maintain an adequate quality of service in the energy supply for clients, within the cost minimisation constraint. The need to construct new infrastructure has to be planned in accord with the following principles:

- compliance of technical criteria in all the typical situations of the forecasted functioning of the RNT over the simulation period and
- consideration for other projects which also accomplish the previous principle. Priority might be given to other projects due to economic justification for the reason of territorial order or national or communitarian objectives in energy policy.

A part from this techno-economic feasibility, some other principles of investment planning have to be taken into consideration:

- reduction of environmental impacts;
- management of the default level of current;
- integrated optimisation taking into account production and distribution and
- interconnection capacity management.

Cost-benefit calculations

Cost and benefit calculation in Portugal might be based on the oligopoly model of conjectural variation (de Sousa, 2005). This allows a representation of different levels of competitiveness intensity between firms. These levels are parameterised in conjecture that each firm conducts based on to the variations of quantity produced by its rivals as well as to the variations of its own quantity produced.

From the supply point of view, it is assumed that each firm has a portfolio of possible production technologies which is represented by a quadratic function of costs which corresponds to the linearly increasing marginal cost with parameters estimated based on the installed potential for each technology and its marginal cost.

The demand is characterized by an inverse function with sigmoid form. An approach of conjectural variation could be used as competitive model which allow to observe different levels of competition between firms, varying from the perfect competition (with $\theta=-1$) to the collusion situation ($\theta>0$) through the Cournot's equilibrium ($\theta=0$).

It is assumed that the supply of electric energy in the market is given by the whole production firms altogether by considering their installed capacity and production costs. It is assumed that the production cost is determined by the following square function:

$C(q_i)=a_i+b_iq_i+c_iq_i^2$

Where
q_i=quantity produced by the firm i,
And a_i, b_i, c_i are non-negative coefficients of cost function.
The marginal cost function is then

$C'(q_i)=b_i+2c_iq_i$

Coefficients b_i, and c_i are estimated from the marginal cost (y_j) and from the installed capacity for each technology based on the least squares method, by the following equation:

$$\min_{(b_i,c_i)} \sum_{j=1}^{m} \int_{x_{j-1}}^{x_j} [b_i + 2c_i x - y_j]^2 \, dx$$

The marginal cost curve could be obtained from the real data of production cost, installed capacity in Portugal for each of the production technology.

This approach allow to formulate a model based on a single decision variable for each firm once the aggregate cost curve has been obtained for each firm. The disadvantage of this approach is the fact that it implies a difference between the real cost and its representation obtained from a regression of real cost which might be significant for firms with different production cost.

The demand model is obtained by the inverse demand function is represented by a sigmoid function in the equation:

$$Q_T(P) = k_2 + \ln(\frac{k_0 - P}{k_1 P})$$

This function has three parameters to be found (k_0,k_1,k_2). k_0 is determined in such a way that its maximum value is obtained by observing the maximum supply in the Portuguese market (P_{max}):

$$k_0 = P_{\max}(1 + k_1 e^{-k_2})$$

The k_1 value is determined by the least square method of non linear regression of the demand curve while k_2 is the horizontal axe intercept of the curve.

The demanded quantity of market m (Portugal) is then given by:

$$Q_{Tm} = \beta_m Q_T(P) = \beta_m [k_2 + \ln(\frac{k_0 - P}{k_1 P})]$$

With β_m as a factor of scale given by the relation between the consumption of market m and the observed consumption of the market (expressed by k_2) :

$$\beta_m = \frac{consumption_m}{k_2}$$

The inverse demand function of the market m is given by:

$$P_m(Q_T) = \frac{k_0}{1 + k_1 e^{\frac{Q_T}{\beta_m} - k_2}}$$

Market equilibrium is determined for an asymmetric oligopoly situation where the solution is obtained by the maximising firms' profits.

$$\max_{q_i} \pi_i(q_i) = P(Q_T)q_i - C_i(q_i) \qquad \text{with } 0 \le q_i \le K_i$$

Where
q_i = quantity produced by firm i
K_i = installed capacity of firm i
$P(Q_T)$ = inverse demand function
$C_i(q)$ = cost function of firm i

The following condition has to be fulfilled:

$$\sum_i q_i = Q_T$$

The solution of this problem refers to the application of the game theory as a representation of strategic interaction between firms which Nash equilibrium is obtained through conditions (necessary and sufficient) of Karush-Kuhn-Tucker (KKT) for all the firms, by transforming the equation of profit maximisation into a Lagrange function.

Market price and the quantity produced for each firm is determined directly by the solution of the model. Based on these results, the other indicators could be calculated: quantity produced and consumed, exported/imported quantity for each market, firms' profits, users' surplus and social welfare.

The quantity produced by market m is given by the sum of quantity produced by firms in this market:

$$Q_{Tp_m} = \sum_{i \in m} q_i$$

The quantity consumed in market m is given by the following function:

$$Q_{Tc_m} = \beta_m (K_2 + \ln \frac{K_0 - P*}{K_1 P*})$$

Where P* is the equilibrium price.

The exported quantity of market m equals the difference between the quantity produced and consumed of this market:

$$Q_{T\exp_m} = Q_{Tp_m} - Q_{Tc_m}$$

Profit of each firm is given by the difference of the revenue and cost:

$$\pi_i = P * q_i - C_i(q_i) = P * q_i - (a_i + b_i q_i + c_i q_i^2)$$

The total profit of market m is then:

$$\pi_m = \sum_{i \in m} \pi_i$$

Users' surplus is given by the zone between the inverse demand curve and the equilibrium price:

$$W_m^C = \int_0^{Q_{C_m}} [P_m(Q_T) - P*] dQ_T$$

Substituting $P(Q_T)$ by its corresponding function in each market, the following equation is obtained:

$$W_m^C = k_0 [Q_{TC_m} + \beta_m \ln(1 + k_1 e^{\frac{Q_{C_m}}{\beta_m} - k_2}) + \beta_m \ln(1 + k_1 e^{-k_2})] - P * Q_{C_m}$$

And finally the social well being for market m is obtained by adding the users' surplus and the firms' profits:

$$W_m = W_m^C + \pi_m$$

Ex-post analysis

Ex post analysis is not compulsory in Portugal.

3.9 Spain

3.9.1 General information

a) Transport investments

In transportation sector, there are four institutions conducting evaluation. They are:

- Road: Dirección General de Carreteras[28],
- Rail: Dirección General de Ferrocarriles[29],
- Air (airports): Aeropuertos Españoles y Navegación Aérea or AENA[30] and
- Sea (ports): Puertos del Estado[31].

All of these departments belong or depend upon the Department of Transport of the Ministry of Public Works (Ministerio de Fomento).

In the development of transportation projects, there are usually two main steps being taken:

- firstly, the Ministry of public works (fomento) carries out broad analysis of where the investment will deliver most value and
- second, the Ministry and the corresponding development company (*Administrador de Infraestructuras Ferroviarias* or ADIF in case of rail, for example) carry out more detailed analysis in each corridor.

b) Energy investments

In electric energy sector, the Red Eléctrica de España or REE[32] is the responsible body for the transmission network and for operation of the Spanish electricity system. Created in 1985, the REE was the first company in the world devoted to electricity transmission and operation.

Concerning the environmental impact, the Electricity sector act of 1997 (law 54/1997) made it obligatory to carry out environmental impact studies on power lines of 220 kV or higher with a

28 http://www.fomento.es/MFOM/LANG_CASTELLANO/DIRECCIONES_GENERALES/FERROCARRILES/

29 http://www.fomento.es/MFOM/LANG_CASTELLANO/DIRECCIONES_GENERALES/FERROCARRILES/

30 http://www.aena.es/csee/Satellite?pagename=Home

31 (http://www.puertos.es/index.jsp)

32 http.//www.ree.es

length greater than 15 km. REE was conducting impact studies (on socioeconomic means, on historical patrimony, on birdlife, on vegetation and on water) for all its new installation long before this act.

Before a new project investment is conducted, REE and/or project promoter (for example regional governments, etc.) conducted environmental impact studies and submit it to the General office of environmental quality and evaluation of the Ministry of Environment (Ministerio de medio ambiente). The general office examines the dossiers and publishes the *déclaracion de impacto ambiental* (environmental impacts declaration). With this declaration, the general office decides the acceptance (or non-acceptance) of the project and gives as well several remarks. The promoters might be asked to submit some additional documents concerning technical and/or security details of the work before obtaining full approval from the Ministry.

3.9.2 Transport infrastructure projects assessment

Ex-ante analysis

Spain has currently several official recommendations of standardised principles for economic appraisals in transport infrastructure projects of road, rail, air, and maritime modes. CBA is used largely in projects in those modes which is consistent with the principles established by the European Commission Directorate General for Regional Policy. In sea transport, multi-criteria analysis (MCA) is as well largely used.

- In CBA method, the following main effects are covered:
  - infrastructure costs (construction costs, system operating costs and maintenance) and
  - user benefits (passenger transport time savings, user charges and revenues (in rails mode), voc)
  - externalities (safety)
- MCA method covers the following main effects in all but sea transport:
  - infrastructure costs (construction costs, system operating costs and maintenance);
  - user benefits (passenger transport time savings, user charges and revenues (in rails mode only), voc (in rail and road only));
  - externalities (safety, noise (in rail and air), air pollution (in rail only)).

Decision criteria

In CBA method, NPV, B/C ratio, first year benefit, and IRR are used as decision criteria. Calculations are made in factor prices with various standard factors of conversion to market prices. No distortion effects from tax financing are included in the appraisal. The normally

discount rate is 6% while appraisal period varies between modes or projects. Risk is assessed by scenario analysis. Finally, the evaluation covers both national and transboundary effects. The later are included especially in projects co-funded by EU.

The construction costs of the CBA include several elements, such as material/labour/energy, planning costs, land and property purchase, mitigation, add-on for bias in estimate of construction costs. Terminal or residual value is normally taken into consideration but the depreciation method depends on case/project. Project's life time varies between modes.

Tab. 3.7 Project life time

General		Road		Rail		Ports	
Category	**Years**	**Category**	**Years**	**Category**	**Years**	**Category**	**Years**
Bridges	30	Base course	20-30	Substructures	20-75	Docks	50
Tunnels	30	Wearing course		Tracks	35	Handling areas	20
				Power supply	60	Dry docks	40

Source: Odgaard, 2005

In operation and maintenance costs, standard figures are determined both as fixed amount (euros/km) and as fixed percentage of construction costs (see table below).

Tab. 3.8 Operation and maintenance costs (in market price)

Mode	Description	Value	Unit	Year
Road	Maintenance. Amount per km increasing with lifetime (Two lanes road)	100,000 for first year	Ptas	1987
Road	Maintenance. Amount per km increasing with lifetime (One lane road)	150,000 for first year	Ptas	1987
Road	Renewal. Amount per km every eight years (Two lanes road)	20,000,000	Ptas	1987
Road	Renewal. Amount per km every eight years (One lane road)	10,000,000	Ptas	1987
Road	Maintenance and renewal. Value per year as % of construction cost	1,50%		
Rail	Amount per Train-Km (Conventional trains)	98.79	Ptas	1990
Rail	Amount per Km (HST)	9.14	Million ptas	1990

Source: Odgaard, 2005

User benefits

Passenger time savings are not disaggregated between work and non-work trips. Therefore average values based on boundary value of time method are used. This method calculates the differences in fares or in times between alternatives modes. In road transport, the time values are distinguished between private and HGV while in rail transport, time values are distinguished between types of trains. Some monetized values are presented in the following table.

Tab. 3.9 Some monetized values of time

Description	Purpose	Mode/type	Value	Unit	Year
Value reported in the official manual	Private car	Road	1415 ptas	Per vehicle-hour	1992
Value reported in the official manual	HGV	Road	2500 ptas	Per vehicle-hour	1992
Value reported in the official manual	Day time train	Rail	601 ptas	Per hour	1991
Value reported in the official manual	Intercity train	Rail	1326 ptas	Per hour	1991
Value reported in the official manual	Talgo train	Rail	1447 ptas	Per hour	1991

Source: Odgaard, 2005

The latest values of time studies were made in 1992 and 1991 for road and rail transport consecutively. Time values change over time and the rate of change depends on inflation rate.

User charges and revenues are included in the appraisal in rail transport projects (CBA and MCA methods). Vehicle operating costs (voc) are as well included (CBA: road, rail, air and sea transport, MCA: road and rail transport). In sea transport (ports), voc is calculated based on social surplus.

In road transport, the following factors compose the standing cost of voc:

- depreciation;
- repair and maintenance costs and
- material costs.

In rail transport two more factors are considered as standing costs: overhead costs and administration costs. The operating costs as components of road voc are depreciation (distance-related share), fuel and lubricants. The operating cost of railway transport are personnel cost, fuel, and lubricants. Vehicle operating costs (voc) are not differentiated between work and non-work trips.

For road transport, both standard values and standard formula are used for voc calculation. For standard values, for example, in 1988 factor prices, voc depreciation values reported in the official manual are 2.7 pesetas/km and 4.91 pesetas/km for private car and HGV respectively.

The standard formula used in road transport, the formula is sensitive to vehicle type, speed, road gradient, and zone (urban versus interurban). The formula (in 1988 pesetas) is the following:

Maintenance

Private vehicles cost/km:

$$CPK = 17.22s^{-0.44}$$

Fuel consumption in interurban areas for private vehicles:

Flat of ramp:

$$C = 117.58 - 1.76s + 1.21*10^{-2}s^2 + 24.09p - 0.47sp + 4.74*10^{-3}s^2p$$

Steep:

$$C = 213.31 - 6.15s + 7.42*10^{-2}s^2 + p[6.08 + 3.82*10^{-2}s + 7.27*10^{-4}s^2]$$

Where:
C= consumption in c.c.
s= speed in km/hour
p= slope in %

Lubricants

Private vehicles cost/km:

$$CPK = 0.012CP$$

HGV cost/km:

$$CPK = 0.08CP$$

Where
C= fuel consumption in litres according to previous formulae
P= lubricant price without taxes

Freight user benefits are included in sea transport project appraisal. The calculation of these benefits is based on time savings of driver and crew, out of pocket money, operating costs of the ship.

In road transport, service quality is also taken considered as composing user benefit. In rail transport, comfort is as well a common element to be taken explicitly as user benefit in the appraisal.

Externalities

Safety is included in the appraisal, both in CBA and in MCA methods. Material damage (composed by cost of damage to vehicle and cost of loss of damaged goods) and personal loss for casualties (estimated by liability payments method) are two types of costs included in the accident costs. The type of casualties is simply differentiated into fatalities and injuries. The measurement units are:

- number of accidents (reported);
- number of accidents with person injuries (reported) and
- number of casualties.

Two examples of key figures used in safety analysis are presented in figures below.

Tab. 3.10 Key figures (market price) in safety analysis

Description (including mode)	Type of cost included	Value	Unit	Year
Value reported in the official manuals for road and rail	Value of statistical life	25.000.000	ptas	1992
Value reported in the official manuals for road and rail	Injuries	3.300.000	ptas	1992

Source: Odgaard, 2005

Values change over time depends on inflation rate. The change of risk of accidents (before and after project) is estimated based on infrastructure type.

Noise, as one of environmental impacts element, is evaluated by MCA (in rail and air transport). Noise annoyance experienced in dwellings, is included in the evaluation. This is measured by the number of people exposed to certain levels of noise with dB is used as noise metric. The noise impact is evaluated as well in road and sea transport by using less sophisticated method, such as qualitative analysis (QA).

Air pollution, is analysed in MCA method for rail transport. In other modes (road, air, and sea), this pollution, as well as climate change impacts, is assessed merely by QA method.

For the purpose of environmental impacts assessment in general, a case specific study is carried out by the Department of Environment (Ministerio de Medio Ambiente). This study (Declaración de Impacto Medioambiental) is a compulsory requirement for a project to go ahead. It takes a general view of all environmental impacts. Several environment indicators are included in MCA method.

Finally, it is important to remarks that the use of shadow prices and conversion factors is extensive in Spain in order to deal with the indirect socio-economic effects. In the construction of AVE (high speed train) connection between Madrid to Sevilla for example, a conversion factor of 0.7 is applied to all employment related costs. This reflects the fact that social insurance contributions are a significant proportion of wages. This is quite reasonable given the fact of high unemployment rate in Spain. Special attention has to be put to in the counting of staff costs: considering staff costs as a benefit rather than a cost in the appraisal process, for example, might lead to double-counting. Another example, still in AVE Madrid-Sevilla case, 30% of all work undertaken in physical construction of the line is assumed to be performed by workers with new jobs. As a consequence, the entire salary cost of these workers is considered as benefit without adjustment by any conversion factor.

Ex-post analysis

Ex post analysis is not compulsory in the moment.

3.9.3 Electric energy transmission grid projects assessment

Ex-ante analysis

From the ICF Consulting report (2002), some elements costs on transmission charges could be deducted below.

Network charges

Cost of construction, cost of network losses, cost of constraints, ancillary services and taxes, are included in the capacity element of the transmission tariff. Transmission tariff in Spain include as well stranded costs. These are fixed and sunk costs that were imposed by the regulator (Red electrica de España or REE) in the regulated market that cannot be recovered via the market if the market is opened up for competition.

Remuneration of the transmission activity is stipulated in regulations and takes into account investment costs, operation, and maintenance of installation and other necessary costs for the performance of the activity. The assets rate of return is fixed in a four-year period. For example, the rates for the period 1999 to 2002 are:

- 1999: 5.25%;
- 2000: 3.94%;
- 2001: 5.38%;
- 2002: 5.25%.

Calculation of asset values

REE re-valued its tangible fixed assets in 1996. Since then, the gross asset value of transmission assets included directs costs related to the construction of assets including own labour and financial costs on external financing. The fixed infrastructure costs of facilities that entered into operation since 31 of December 1997 are determined from published standards.

Depreciation rates on plant and equipment acquired by the grid company vary between 7 and 20 years and between 14 and 40 years on assets brought into service by the company.

Cost-benefit calculations

Cost-benefit calculation in Spain is the same as applied to Portugal as seen before (based on de Sousa, 2005).

Ex-post analysis

Ex post analysis is not compulsory in Spain

3.10 Sweden

3.10.1 General information

a) Transport investments

In Sweden the Ministry for Industry, Employment and Communications (MIEC) in close co-operation with its associated institutions and the Swedish federal states is responsible for the national transport plan. The latest issue covers the period 2004 – 2015. Modal plans are published by the following authorities:

- Swedish national road administration (Vägverket[33]) and
- Swedish Rail Administration (Banverket[34]).

Detailed plans for the 7 regions (states) and the 21 local districts are performed and are agreed between the local governments and the federal authorities in order to comply with the overall goals of Swedish transport planning. The national road transport plan is not compulsory. As the planning monopoly is at the municipal level, indicators are assessed on a local and inter-regional dimension. The speed of project implementation is determined by the annual budget decisions of the Swedish Parliament.

In contrast inter-urban rail development plans are made for the entire country only by Banverket. But also here the consultation of local authorities is important for the realisation of the regional development goals. The project evaluation is, however, performed on a national level only.

At the moment a governmental committee has the task to review the Planning and Building Act (PBL) and propose possible changes (Nordregion 2004, consultation of Vägverket).

b) Energy investments

In Sweden the energy sector is owned by private companies. In particular the introduction of a liberalized market for electricity production and trading took place January 1st, 1996. In this context, energy infrastructure projects are evaluated and financed by energy companies themselves. Concerning transmission grids Svenska Kraftnät is the state utility responsible for the management and the operation of the Swedish national electricity grid.

The Swedish electricity network is part of the Nordel organization, aimed at ensuring co-operation between transmission system operators of Denmark, Finland, Sweden, Norway and Iceland for the development and the harmonization of the electricity market in the Nordic countries. For this purpose, Nordel's working groups focus mainly on:

33 Röda vägen 1, 781 70 Borlänge, Sweden (http://www.vv.se)

34 Jussi Björlings väg 2, 781 85 Borlänge, Sweden (http:// www.banverket.se)

- the system development and the elaboration of rules for network dimensioning;
- the system operation and the security of supply;
- the rules for transmission pricing;
- the European and international co-operation and
- the publication of information about the electricity market of Nordic countries.

In Sweden the electricity market is operated by Svenska Kraftnät[35], which is an official member operator of Nordel. Within this organization, Svenska Kraftnät participates to the determination of recommendations about the system expansion and planning criteria for the transmission system, but also about the security of supply and the pricing of transmission services. All operator members of Nordel signed in 2004 a system operation agreement including a detailed description of the members' operational collaboration.

3.10.2 Transport infrastructure projects assessment

Ex-ante analysis

In Sweden, planning is mainly decentralised and a municipal concern. The regional level (county level) is not that strong formally as regards spatial planning in Sweden. On a national level there are steering documents and guidelines, but the interpretations and decisions mainly take place on the municipal level, which holds the "planning monopoly" in Sweden (Nordregio 2004).

The "National Plan for the Road Transport System 2004 to 2015" (Vägverket 2004) was carried out individually for each federal state. It covers an investment sum of 152 billion SEK (16.5 billion EUR). The national rail transport plan (Banverket 2004) includes projects for 101.5 billion SEK (11 billion EUR) including local transport, maintenance and rolling stock investments.

The planning and assessment procedure itself is rather pragmatic. Conditions, deficiencies, roblems and possible solutions are reported by the 21 counties to Vägverket in the case of road infrastructures, which asists assessing them using several rules of thumb. These include: "First realise cheap projects addressing the problems adequately", "prefer generally agreed solutions" or "avoid hopeless or trivial projects". Formally, the procedure is expressed by a "Four State Approach" to test and identify the most efficient set of measures over time (Vägverket 2002):

1. Measures to affect the transport demand and mode choice outside the transport sector.
2. Measures improving road utilisation (controls, regulation, information, charging, ITS).
3. Improvement measures (widening or rebuilding of intersections) combined with ITS.
4. New investments

35 http://www.svk.se

Its paramount goal is to ensure long-term ecologically and economically sustainable transport for citizens and the business sector throughout the country. Under the given budget the "most beneficial" set of projects is selected and discussed with the local authorities.

The main criteria for selecting the projects have been (FIS 2006):
(1) Measures with lowest costs solving the most problems.
(2) Big projects over 10.8 million EUR must be cross checked with all partial goals.
(3) Employment effects constitute a central criterion.

Partial goals are:
1. An accessible transport system: Improved transport information services, development of combined transport facilities, development of port and own-account transport.
2. A high standard of transport quality: Increased capacity and improved punctuality.
3. Safe traffic: New control technologies and protected rail-road intersections.
4. A good environment: Environmentally friendly disposal of waste materials.
5. Positive regional development: Increase of network density, decrease of travel times and increase of frequencies of service.
6. A transport system offering equal opportunities: Development of regional networks to foster or to adopt to local employment markets.

The social and economic welfare level is the yardstick for a positive regional development. Important indicators are the regional income level the regional employment rate the available supply of private or public service and the prevailing living and housing quality. Of utmost priority is the better inter-connection of regions by a decrease of travel times.

Within this context the compulsory Strategivc Environmental Assessement (SEA) plays an important role. Although the sites of national importance are designated and strictly regulated by the "Environmental Code" the methodology applied can be decided on by local and municipal authorities. An central common element of EIA is public involvement and stakeholder consultation (Lindskog and Soneryd 2000).

The environmental impact assessment forms part of a wider social impact assessment, addressing aspects of accessibility, living quality, business climate, education or employment. However, as for other planning aspects, there are only broad guidelines and objectives formulated on the national level. Detailed methodological approaches to address these aspects have to be worked out by the municipalities.

Ex-post analysis

No information on the legal basis or the practice of ex-post evaluations in Swedish transport planning is available.

3.10.3 Energy infrastructure projects assessment

Ex-ante analysis

The fact that the energy sector is owned in Sweden by private companies implies that no national guideline can be found for energy infrastructure projects assessment. Indeed the assessment relies on the responsibility of each company, which uses its own evaluation methodology for expansion planning (e.g. load flow calculations, economic efficiency analysis). However as stated below, the Swedish electricity system operator - Svenska Kraftnät - is part of the Nordel organization. As a member of it, it has to follow a number of rules specified in the system operation agreement of this body.

For network expansion planning, the reliability criterion that must be used is clearly specified as the (n-1) criterion. This ensures that single failures in a given subsystem shall not imply serious operational disturbances in other adjacent subsystems. Another major item is the bottleneck and operational disturbance management, related to transmission limits and to the management of all transmission problem within each TSO's subsystem.

Ex-post analysis

Ex post analysis is not compulsory in Sweden.

3.11 Switzerland

3.11.1 General information

a) Transport and Energy investments

The federal offices (bureaux) which require assessments outsource the task to private consultants and use the report to make decisions. In Switzerland, a single Department (Ministry) deals with Energy, Transportation, Environment and land use issues, the DETEC (Federal Department of the Environment, Transport, Energy and Communications). Therefore, the federal offices involved in assessments very often refer to the same Minister. Environmental impact statements have to be submitted to the Federal Office for the Environment FOEN. The Environmental Protection Act (USG) is the cornerstone of fundamental acts and associated ordinances in this domain. No general values do apply in terms of cost-benefit analysis. The authors of the studies have to argue for the values they use in each specific case.

Decisions of national or county importance require popular ballot, at national level or county level. Prior to the ballot, the official body in charge of the project may require socio-economic or other forms of assessments in order to choose between variants and in for convincing voters. The promoter of a project (it can be the State, a county or a private company) is responsible to submit the assessment reports required to the federal or county government. Such documents at least

include an environmental statement (ES). The ES is to be delivered to the environmental institution, either representing the County or the Federal government (FOEN). These authorities can accept the ES or ask for changes to be made in the project. During the 1990-2000 period more than 60% of all ES produced in Switzerland and transmitted to FOEN were related to transport.

Projects that require a change in the Federal Constitution require the majority of both the citizen and the counties. This was the case for the launch of the Heavy Vehicle Fee, a levy system that taxes road freight and passes part of the income to rail transport.

3.11.2 Transport infrastructure projects assessment

Ex-ante analysis

Switzerland complies with EU legislation in the sense that Swiss law requires environmental impact assessment for infrastructure projects likely to have significant impact on the territory. No other sort of assessment is required de facto. Nevertheless, the Swiss laws have been amended in order to accommodate more strategic assessments, such as opportunity studies and sustainability assessment (provisory) for instance. Counties increasingly require analysis of socio-economic impacts of new projects because the federal government supports sustainable projects, i.e. projects for which the social, environmental and economic benefits are most obvious. Federal agencies also launch socio-economic studies on specific topics, such as the external benefits of transport. is often , but those are not systematic.

Ex-post analysis

Ex-post analyses are not compulsory. They are made when the government or other institutions require so. Such requirement may be stated in a legal text, such as, for instance, for transalpine freight policy.

3.11.3 Energy infrastructure projects assessment

Ex-ante analysis

As for transportation projects, the only mandatory analysis is the environmental impact assessment. But it does not apply for energy transmission lines, for which neither authorisation, nor even plan valid at county level is required. Decision stays at Federal level and it may only be discussed in case a new line would severely damage the environment or trouble land use strategy (which has to be declared in a sector plan), and even in this case, alternatives have to be considered only if they do not entail excessive costs for the energy company.

In the Alps, trans-national projects form a special case. The law applied is called the Alpine Convention, which has an Energy protocol[36], dated 1991. Art.2 §2

states that if new and big infrastructures are built, both parties assess the impact on the Alpine environment and on land use and on socio-economy (according to article 12). If the project is likely to generate impacts at the other side of the border, then the consultation right becomes international.

The fact that the energy sector is both private and monopolistic, at a higher level than transportation, makes that less assessments are produced or, at least, available. Private means that energy companies do not have to make public the decision process through which they have reached the decision of building a given infrastructure, whereas monopolistic (oligopolistic) means that the decision to build infrastructures may remain a mere political decision within the company.

Ex-post analysis

Ex-post analysis is not compulsory.

3.12 United Kingdom

3.12.1 General information

a) Transport investments

The HM Treasury is the main institution for the financial planning in the UK. It synthesizes and proposes to the Government (Cabinet) the spending proposal of each Ministry. The HM Treasury has, for many years, provided guidance to other public sector bodies on how proposals should be appraised, before significant funds are committed – and how past and present activities should be evaluated. The new edition of the *Green Book, Appraisal and Evaluation in Central Government*[37] (2003), incorporates some changes as regards the previous followed approach. First more emphasis is given to identification, management and realisation of benefits.
Secondly, the new edition introduces a discount rate of 3.5% in real terms, based on social time preference, while taking account of the other factors which were in practice often implicitly bundled up in the old 6% real figure.

In particular, the new Green Book includes, for the first time, an explicit adjustment procedure to redress the systematic optimism ("optimism bias") that historically has afflicted the appraisal process.

36 Protocole d' Application de la Convention alpine de 1991 dans le domaine de l'énergie (protocole "Énergie")

37 The Green Book represents an appraisal manual for the Central Government investment projects

Once the investment projects have been approved by the Cabinet these are assessed by the Financial and economic division of each Ministry under the supervision of a Senior Officer. Such an assessment is conducted following both the guidelines of the Green Book and some other ministerial/sectorial ones[38].

A clarification of the terms appraisal and evaluation is needed before going ahead in presenting the current ex ante and ex post methodologies in the UK. Appraisal is used for the ex-ante analysis and in this sense can be seen as the comparison of a potentially wide range of options, all of which are hypothetical. Evaluation is used in ex-post analysis, which compares a likely narrower range of options, one of which will be real.

b) Energy investments

Electric energy market adopted in UK separates generation from transmission. There are four transmission systems in the UK – one in England and Wales, two in Scotland, and one in Northern Ireland. Each is separately operated and owned. National Grid Company (NGC) is the biggest company covering England and Wales. It also operates electricity interconnectors – overhead lines connecting the transmission networks in England and Wales to Scotland and an undersea link that connects France and England.

Transmission investment is funded by the income it receives from charging the use of its system. In England and Wales the charges are dividing between generators and suppliers in a ratio of 25:75. The adopted approach of charging is the investment cost related pricing. This is based on the proportional change in flow on all lines resulting from the injection of generation or load into the system at the connection point. The cost of investment for each line is then shared in proportion to the flow injected by each user. This pricing method provides the level of return necessary to cover the existing investment.

Transmission infrastructures in UK are developed by four transmission companies according to their territory. However, project investment feasibility studies conducted by these companies, has to be approved by the Office of Gas and Electricity Markets (Ofgem). Ofgem is the regulator authority of Britain's gas and electricity industry.

3.12.2 Transport infrastructure projects assessment

Ex-ante analysis

“Our aims are to ensure that decisions on transport policy are made in the light of the best possible advice on their impacts, and to ensure that investment in all modes of transport and their management meets the Department's policy objective to seek good value for money” (DfT, UK Department for Transport)

38 For instance, the Department of Transport guidelines are adopted to value the time savings, while the ones of Health department for assessing health effects.

The governmental appraisal scheme is based on five criteria: environment, safety, economy, accessibility and integration (see Guidance on the Methodology for Multi-Modal Studies - GOMMMS). The economic appraisal of schemes is summarised on the Transport Economics and Efficiency (TEE) Table (see Applying the Multi-Modal New Approach to Appraisal to Highway Schemes - The Bridging Document). A scheme is justified in purely economic terms if it displays a Net Present Value (NPV) greater than zero, that is the sum of its stream of discounted benefits exceeds the sum of its stream of discounted costs. If the NPV is negative, this indicates that its discounted benefits are less than its discounted costs; therefore the 'Do-Minimum' is preferred in economic terms. Because the 'Do-Minimum' acts as the base case by reference to which the stream of net discounted benefits of the 'Do-Something' are measured, it by definition has an NPV of zero. If there are a number of competing 'Do-Something' options the preferred one in economic terms is selected using incremental analysis.

The main purpose of the DETR appraisal approach consists in:

- choosing between different options for solving the same problems and
- prioritising between proposal.

The Department of Transport uses a multi-criteria approach to appraisal all the infrastructure schemes. All the projects and all the modes are appraised following a common methodology. The criteria, which are at the basis of this methodology, are the follow

- Economy,
- Environment,
- Safety,
- Accessibility and
- Integration.

Each of these criteria are split in sub criteria. Some of them are quantitative measured, while some others are only qualitative assessed using a format and a guidance issued by the DETR.

The economy criteria are valuated analysing the following sub criteria:

- time savings and changes in vehicles operating costs;
- reliability/predictability of the travel time and
- regeneration of the economic deprived areas.

Project costs

Time savings, project costs and vehicle operating costs are quantitatively assessed using the appraisal methodologies adopted by the DETR till the 1988[39] which have been now included in the new multi-criteria approach, while, for the other sub criteria there is not a money value but only a qualitative assessment. The potential environmental impact of a proposed project is valuated looking the following items:

- noise;
- air quality;
- greenhouse emission;
- landscape;
- townscape;
- historical heritage;
- bio-diversity;
- water resources;
- physically fitness and
- journey ambience.

Noise, local air quality and greenhouse emission are measured in terms of change in the number of people affected. All the others sub criteria are measured through a qualitative analysis.

The safety criterion is assessed using a well established and widely accepted method for the calculation of the statistical value of life. The values used are derived on the same basis as given in Highways Economics Note No. 1 November 2003 and consist of three components:

- financial cost for the people directly involved into the accident (vehicles damages, ambulance costs and the costs of hospital treatment, legal expenses, etc.);
- loss of output due to injury. This is calculated as the present value of the expected loss of earnings plus any non-wage payments (national insurance contributions, etc.) paid by the employer and

39 Two are the methodologies previously used by DETR and now included in the new appraisal approach: COBA which is a cost benefit analysis developed for the road schemes, URECA developed in order to work in the case where travel demand change in response to the change in road capacity.

- human costs, based on WTP values, which represent pain, grief and suffering to the casualty, relatives and friends, and, for fatal casualties, the intrinsic loss of enjoyment of life over and above the consumption of goods and services.

Accessibility and integration criteria measured in terms of extent of the impact , ranging from neutral to large and in term of the impact direction, whether adverse or beneficial.

The results of all the valuation are synthesized in the Appraisal Summary Table.

Tab. 3.11 Appraisal summary table

			Public expenditure	NPV subsidy: £··· million
Problems	**Objectives**	**Qualitative impacts**	**Quantitative measure**	**Valuation**
ENVIRONMENT	Noise and vibration		e.g. households affected; change in dB(A)	Value of noise reduction PV £[····] million
	Air pollution emissions		e.g. households affected; change in emissions	Value of air pollution reduction PV £[····] million
	Landscape, townscape, biodiversity, heritage, water		e.g. landtake in hectares	N/A
	Greenhouse gases		e.g. change in emissions	Value of change in greenhouse gas emissions PV £[····] million
SAFETY	Accidents		e.g. road and rail accidents saved	Value of safety benefits: PV £[····] million
	Personal security		e.g. passengers affected	Value of security benefits: PV £[····] million
ECONOMY	Journey time and frequency		e.g. in-vehicle minutes saved walk/wait time saved frequency improvements	Rail user time savings: PV £[ ] million Road user time savings: PV £[····] million
	Crowding		e.g. change in crowded hours	Value crowding benefits: PV £[····] million
	Performance		e.g. change in average lateness	Value performance benefits PV £[····] million
	Station facilities and rolling stock quality		e.g. number of passengers affected	Station refurbishment: PV £[····] million New trains: PV £[····] million
	Financial costs and revenues		N/A	Net financial effect: NPV £[····] bn
	Wider economic impacts		e.g. additional jobs in designated regeneration area	N/A
ACCESSIBILITY	Reduction of barriers		e.g. disabled or encumbered passengers affected	N/A
	Severance		e.g. size of community affected	Value of severence reduction PV £[····] million
	Option values		e.g. number of people affected	Value of option PV £[····] million
INTEGRATION				

Source: SRA, Strategic Rail Authority (2003)

Ex-post analysis

"An evaluation (…) is an independent quantitative and qualitative assessment of the processes of implementing a scheme and its impacts. Evaluating major schemes will help the Department meet its commitment to assess the impacts of its policies, and provide the Department and

authorities with valuable evidence to inform future scheme development and decision-making.*"(Green Book).*

In the UK approach evaluation is defined as an analysis taken to mean process and impact evaluation from the point where the decision has been taken to go ahead with the scheme (that is, from the point where the construction contracts are awarded). It does not, therefore, include all the 'appraisal' processes leading up to the decision to go ahead. In other words, evaluation is the review of the *processes* that led to a road scheme coming to fruition, and the *impacts* that the scheme has had since its implementation. It should not be confused with *appraisal*, which is applied to determine whether a scheme should go ahead.

The aim of ex-post evaluations is to identify the contribution of the transport change to observed changes, which have already occurred.

The two key issues with this type of evaluation seem to be:

- the measurement of changes in the level and pattern of economic activity as a result of the intervention and
- the comparison of the actual level and pattern of economic activity after the intervention with the level and pattern which would have occurred had the intervention not taken place (the 'counterfactual').

In 2001, the Highways Agency introduced Post Opening Project Evaluation (POPE) that is a programme for evaluating post-implementation impacts of major road schemes. According to POPE Each scheme undergoes the same analysis (predominantly covering traffic and journey time impacts) one year and three to five years after opening. POPE has clear benefits in the way it has brought a systematic approach to evaluation and improved data retention to aid analysis.

Later, a study conducted by Oxera, in conjunction with Mott MacDonald, Social Research Associates (Sra), the Tavistock Institute and the Transport Studies Unit, University of Oxford (TSU) and overseen by the Highways Agency and the DfT, drew the following conclusions:

- there are important issues that POPE evaluations do not currently cover;
- the POPE framework should be retained but enhanced.

According to this study included some more issues should be addressed in the ex post. These include evaluation evidence on landscape, severance, local air quality, reliability, economy impacts, as well as on the processes involved in delivering schemes. Moreover the study develops an evaluation toolkit with consist in a menu of options for dealing with the suggested ex post issues.

The table below report all the issues to be tackled in the ex post analysis.

Tab. 3.12 Ex-post parameters

Environment	Noise Local Air Quality Greenhouse gases Landscape/Townscape Biodiversity Heritage Water Physical Fitness Journey ambience
Safety	Accidents Security
Economy	Transport Economic Efficiency (TEE) Reliability Wider Economic Impacts
Society	Access to public transport Wider accessibility issue Interchange Land use policy Other government policy Quality of life Social exclusion
Process	Processes involved in delivering schemes

3.12.3 Energy infrastructure projects assessment

Ex-ante analysis

From the ICF Consulting report (2002), some elements costs on transmission charges could be deducted below.

Network charges

Including in the network charges which constitute transmission tariff are the cost of construction, cost of network losses, cost of constraints, ancillary services and taxes.

The annual capacity charge for assets is based upon the following:

- 2.5% (40 year depreciation) of the gross asset value indexed by a measure of the Consumer Price Index;
- return of capital, measured on mid-year net asset value, which is currently set at 6.25% real pre-tax;
- transmission running costs which is currently 1.67% of the gross asset value and

- site specific maintenance charge which is based on forecasts of the site costs derived from a three-year rolling average of historic actual costs. This cost is expressed as a percentage of gross asset value in a range of 0.5 to 1.3%.

Calculation of asset values

In England and Wales, the gross asset values of National Grid's transmission assets are re-valued each year using one of two methods:

- modern equivalent asset (MEA) method: the gross asset value is indexed each year with reference to the prevailing price level for an asset which performs the same function as the original asset;

- retail price index (RPI) method: the original cost of an asset is indexed each year by an agreed formula.

The net asset value is calculated by using the average (mid year) gross asset value divided by a depreciation period of 40 years. The cross channel link is depreciated over 25 years.

Some basic cost-benefit formulations (Murray, 1998)

In the interconnection, generators prices are derived at the intersection of the demand function with the system merit of order supply curve while costs are derived from the accumulation of all generation costs that are used to meet the demand level. The total income is derived from the product of price, demand and its duration for all periods of the year, given by:

$$I_t = \sum_{t=0}^{8760} P_t H_t D_t$$

P is the generator price, D is the demand, H is the number of hours in the year for which a particular demand band exist, and the index t points out the period of hour t in the year. The number of 8760 shows the number of hours during a year (365*24). At each demand level, the cost is given by the sum of all generator prices that are used to meet that demand level.

$$C_t = \sum_{D=\min}^{D_t} P_t$$

The total system cost C_t is given by the sum for all periods:

$$C_t = \sum_{t=0}^{8760} C_t D_t H_t$$

The price and cost can be represented as functions of I which is the interconnection capacity (in GW) between, for example, two interconnected systems A and B.

$$P = A_p + B_p I$$

$$C = A_c + B_c I$$

Where
A and B are constants

If i is a generator that has generation investments in the two interconnected systems A and B, expressed per unit of the total capacity and is in a position to negotiate supply contracts with consumer in both system so that:

$$\sum G_i^A + G_i^B = \sum D_i^A + D_i^B$$

The gross profit for generator i, F_i in each system is given by the difference between the total income based on prices and generator costs.

$$F_i = D_i^A . P^A + D_i^B . P^B - G_i^A . C^A - G_i^B . C_B$$

Furthermore the F_i could be expressed by:

$$F_i = (A_p - A_c)(G_i^A + G_i^B) + I(B_p - B_c)(G_i^A - G_i^B) - 2I^2 B_p$$

The optimal transfer could be obtained by differentiating the previous equation with respect to obtain the maximum profit and equating to zero:

$$I^{opt} = (B_p - B_c)(G_i^A - G_i^B)/4B_p$$

If transmission charge for the generator i is represented by C_i, the previous equation becomes:

$$I^{opt} = [(B_p - B_c)(G_i^A - G_i^B) - C_i]/4B_p$$

The transmission company's profit is given then by the difference of its income from generator i and the maintenance and operation costs of the transmission.

Ex-post analysis

Ex post analysis is not compulsory in United Kingdom.

4. Approaches of international bodies and countries

The following chapter describes the findings for the international overview of infrastructure project appraisal. General assessment guidelines for three Non-European countries (Canada, United States and Japan) and two organizations (World Bank and European Union) have been analysed and are summarised in the following. Each sub-chapter is built-on the structure of the foregoing chapter "National Methodologies" (general information, transport sector, energy sector) which enables a direct comparison between the findings.

4.1 Canada

4.1.1 General information

The Canadian Treasury Board delivered officially in 1994 its guidelines for project appraisal. The guidelines are not sector-specific and are based on cost-benefit analysis (CBA): *"CBA is the key method in planning and decision taking on project implementation and it is specifically addressed at the quantification of all the important effects of the investment choices. It is the key tool in the quest for the value for money"* (Treasury Board of Canada, 1994).

The issuing of these guidelines complies with Chapters 540 and 545 of the Administrative Policy manual, dealing respectively with Major Crown projects and management and control of all other projects. The two chapters call for a comprehensive cost-benefit analysis to be presented at the preliminary project approval (PPA) stage. In a second phase the study should be refined and/or summarized in the submission for the effective project approval (EPA).

The core elements of the appraisal process are the identification and analysis of options. The CBA is the tool to identify the option that best conforms to the economic goal of maximizing net benefits for society at large.

4.1.2 Transport infrastructure project assessment

In addition to the above mentioned general guidelines, the Canadian Department of Transport also delivered a specific manual on CBA of transportation (Department of Transport Canada, 1994). This manual complies with the Treasury Board guidelines, but introduced some sector-specific adjustments.

The CBA approach in transportation moves from one basic principle: CBA is a tool to support the choice among a set of alternative options reaching the same goal.

For this reason the project assessment is composed of three main steps:

- identification of the problem and formulation of the base case and other options;
- application of CBA to compare alternatives and
- the choice of the best option.

The appraisal approach is the same for all transportation modes.

The Canadian Transport Guide sets out a number of standard steps to be followed for the analysis and also fixes the structure of the CBA report.

The first step consists in the statement of the problems or opportunities that will guide the formulation of options. A base case option (usually called the "do minimum option"), reflecting the best that could be done without significant investment, is the first to be formulated. Other possibilities are then examined.

All the options must be self-standing, meaning that each of them should:

- include all of the actions necessary to make the project work and
- include incremental benefits and costs attributable solely to the project.

The second step consists in the estimation of the costs, benefits and other effects for various options. At this stage a standard CBA should be carried out for each option following a standard framework that could enable a consistent comparison. Here are listed the main features:

- project timeframe must be equivalent to the economic life of the project concerned;
- costing of the resources used must be done at opportunity-cost values, hence shadow pricing should be applied;
- benefits are evaluated through a standard approach. Their quantification is carried out with an incremental effects methodology, while their monetization follows a "willingness to pay" perspective. These CBA methods should be applied to evaluate all benefits regarding safety, transportation efficiency (time savings and user costs) and productivity gains and
- Environmental effects must be as far as possible identified and quantified. The guide presents a number of possible effects to be considered such as: commercial losses, property value and damage, abatement and cleanup costs, habitat loss and health risks.

The third step consists in the comparison of the options. The discount rate to be applied is real 10%[40]. For all projects the net present values (NPV) should be calculated, along with the benefit-cost ratio (B/C Ratio), the pay-back period and the internal rate of return (IRR). The official

40 For financial analysis an 8.5% discount rate is currently used and is based on the average rate of outstanding Canadian federal government debt over the past 25 years. Sensitive analysis is carried out at 6.5% and 10.5%.

criterion to evaluate and compare the projects is the NPV; however the Guide states that the NPV criterion does not lead automatically to a yes/no decision.

Uncertainty should be assessed through a sensitivity analysis. The Guide provides a set of common critical variables. The evaluator should decide which one to consider and then should carry out the analysis stressing the values of these variables. In addition, the Guide recommends carrying out the analysis also for the discount rate and suggests using 7,5% and 12,5% as discounting factors[41]. The values of the NPV obtained for each option should be compared in order to find which option best react to the sensitivity analysis.

In Canada there are no official requirements for the submission of Transport projects to an ex post evaluation and no specific guidelines for this kind of evaluation were issued by any Governmental Body.

4.1.3 Energy infrastructure projects assessment

Regarding the Energy sector, no specific guidelines for the ex ante analysis nor the ex post evaluation, were issued yet in Canada by the National Resource Department. However, it can be argued that energy projects would have to undergo a CBA in compliance with the Guide to Benefit-Cost Analysis in Canada.

4.2 United States of America

4.2.1 General information

The USA has developed a complex system, both at the Federal and State level, for the evaluation of public projects. The main public offices involved in evaluation are:

- the Office of Management and Budget (OMB);
- the Congressional Budget Office (CBO) and
- the General Accounting Office (GAO).

The key department for the appraisal of public investment is the OMB, a part of the Executive Office of the President. The OMB is responsible for preparing the budget on behalf of the Federal President. The OMB is the main decisional instrument in the allocation of capital spending, both as far as federal investments are concerned and capital grants to States and other local Governments. Around 200 hundred budget examiners look at the submissions by a number of agencies. These well trained professionals are the core of the evaluation process: there is no

41 In Canada there is a growing consensus on lowering the values of the discount rates following the recent experiences of other countries such as UK and USA. For further discussion please see: Boardman A.E. et Al., (2006), "Cost-Benefit Analysis – Concepts and Practice", Third Edition, Pearson, Prentice Hall, New Jersey

single board where different projects are compared, so that the typical process is bottom-up, from the budget examiner to the top executives.

The CBO is an agency specifically set up to advise Congress on the approval of the Budget. It prepares economic and financial analysis relative to the alternative levels of expenditure and income for the total budget, and evaluates the macroeconomic implications of the single expenditure programmes (for example the effects on GNP of spending on infrastructures).

The GAO plays a role in evaluating the financial congruity and the formal correctness of the evaluations of the programmes and projects vis-à-vis the legal regulations. It can be said that more than evaluation, it carries out the ex-post monitoring of the investment programmes concerning their compliance with the evaluation procedures.

The institutional structure of the evaluation, at state and local level, follows the federal one.

Each one of the Office mentioned above, evaluate projects through a cost-benefit framework that shows some differences only in the methodologies to determine the discount rates[42].

The guidelines delivered by the OMB in 1992, are of special importance for the evaluation process of all kind of projects and programmes in the USA (Office of Management and Budget, 1992).

4.2.2 Transport infrastructure project assessment

The Department of Transportation (DoT) follows the framework addressed by the OMB.

The DOT includes one department for each mode of transport, but it provides a single guidebook for the CBA analysis of transportation projects (Minnesota Department of Transportation, 2005). Moreover two departments have delivered specific guidelines for Highways (Federal Highway Association, 1998) and Air Transport (Federal Aviation Administration, 1999).

The DOT methodology for ex-ante evaluation follows a two steps approach.

Firstly the project proponent should evaluate the consistency of the project with the strategic plan for transport infrastructural development in the USA; secondly the effects of the project should be evaluated quantitatively through a CBA.

Quantitative evaluation should be based on three phases: the analysis of the alternatives, the quantification of impacts and the evaluation of the outputs.

The DOT methodology follows largely the OMB approach:

42 The CBO applies a real rate equal to the real rate on the Treasury debt, which one assumes around the 2%. The GAO fixes the discount rate equal to the average nominal return on the Treasury debt placed on the market which falls due between one year and the length of the project under evaluation. For OMB please see below.

- financial values should be corrected in order to eliminate any distortion and then to be computed at their opportunity costs;

- fiven the fact that project implementation is financed by taxes, the costs are multiplied by a correction factor of 1.25 to reflect the excess burden of taxation (shadow price of public funds);

- the discount rate can be real or nominal according to how costs and benefits are measured. The nominal rate is supposed to be the market interest rate; the real one is calculated roughly by subtracting the expected rate of inflation from the nominal rate. However usually 7% real rate is used for "public investments". For the "investments within the government", that are assessed through a cost-effectiveness analysis whenever possible, the discount rate is based on the market rate on Treasury bonds with a maturity comparable to the period considered in the analysis;

- the project risk is assessed through a sensitivity analysis. The Guide recommends that all the major assumption should be varied and the NPV and the other outcomes recomputed to determine how sensitive they are to changes in the assumptions. The assumptions that deserve to be varied are identified as those determining the dominant benefit and cost elements;

- the standard criterion of choice is the NPV even though one is advised to quote the value of other criteria such as the IRR and

- the effects that are not quantifiable in monetary terms should be measured with alternative metrics or, if this is not possible, listed.

Concerning transport specific issues the DOT guidelines recommend the following approach:

- value of time is evaluated in monetary terms through a willingness to pay approach, using wage rate as reference value. This means that it is considered having a pure opportunity cost that can be estimated by the cost of one hour of work. It is differentiated by type of users and type of trip, but standard values at federal level are recommended[43];

- traffic safety is monetized with a willingness to pay approach coupled with a statistical estimation of the probability of accident occurrence. All physical as well as material damages are included and

- environmental impacts are quantified through an avoidance costs methodology and are computed for air, water pollution and noise.

The official discount rate to be applied is 7%. The calculation of the NPV, IRR and of the B/C Ratio is mandatory. However the official guidelines consider the net benefit value as the most important parameter to be used when choosing among feasible alternatives.

43 See note 42

Uncertainties should be addressed through a sensitivity analysis related to: the costs and benefits on which the criterion of choice is most dependent; to the rate of inflation. The core of the analysis is the estimation of the expected values and agencies are asked to provide indications of the minimum and maximum values and probability distributions.

In the USA there are no official requirements or guidelines that specify how to carry out an ex-post evaluation of transportation projects. However there is a growing demand for such activity especially coming from politicians seeking documentation for innovative programs involving risk and for judging initiative previously taken (Lee, 2000). Moreover, argumentation in favour of ex-post evaluation, strongly increased after a review on some major transit US projects, which demonstrated how systematically underestimations of costs and overestimations of users were occurring (Peckrell, 1990).

It is suggested to carry out an ex-post evaluation of project by means of a re-appraisal, after a certain period of time (Hayashi, Morisugi, 2000). There is no systematic use of it, or a specific legislative requirement.

4.2.3 Energy infrastructure project assessment

In USA there are no specific guidelines for the ex-ante or the ex-post evaluation of projects.

4.3 Japan

4.3.1 General information

In recent years evaluation of infrastructural projects has become a major concern in Japan (Morisugi, 2000):

"Due to the recent financial crisis, the public has demanded that the government must implement socially efficient public infrastructure investments. In response to these appeals, the government has decided to utilize the CBA for the evaluation of public investment projects".

4.3.2 Transport infrastructure project assessment

Starting by the end of the Nineties the Ministry of Construction started a research program in order to develop four specific guidelines for the evaluation of investment projects in the road, railway, airport and seaport sectors (Study Group on Road Investment Evaluation, 1999).

The ex-ante evaluation of transport project in Japan is carried out following an approach based on a mix of CBA and multi-criteria analysis. Each methodology serves a specific purpose:

- CBA serves to judge which project should be chosen among the available options and

- MCA is used for projects ranking.

Each of the four Ministry of Construction guidelines rules the implementation of the appraisal in its sector, but the methodology followed for the CBA is common:

- time value is evaluated in monetary terms using a wage rate approach. Values are differentiated by transport modes, type of users, type of trip and type of day;
- safety is monetized through a market price approach using statistical estimation to determine the probability of accidents to occur. The elements considered are material and physical damages, fatality and injuries, but also the social costs of dealing with accidents and
- environmental impact is computed following the methodologies of the IPCC (Intergovernmental Panel on Climate Change) or using European standards. Noise, air and water pollution and climate change are the elements to be considered.

The key indicator for project selection is the B/C ratio.

Road and seaport project should follow a specific procedure which differs from the one adopted for other sectors projects. This procedure is based on a two steps approach (Ueda, Hayashiyama, 2000).

In the first step the project is evaluated through a CBA. Project time reference is assumed to be 40 years, while the discount rate for the calculation of the NPV is fixed at 4%, Then B/C ratio should be calculated and, if it is higher than 1.2, the project is admitted in the list of the feasible options, otherwise a second appraisal should be carried out. This second stage of assessment is still based on the CBA, but tries to capture much more effects than the previous one. This second stage concentrates mainly in the calculation of the intangible effects of the projects.

During the second appraisal the Benefit Incidence Table (BIT, also called the Morisugi Table, by its inventor) should be drawn. The BIT is a matrix that has a list of potential effects in row and a list of the different groups of stakeholders in column (transport companies, landowners, household, government and so on). In each cell, the monetized cost or benefit of a specific effect for a defined stakeholder is reported[44].

Hence, the sum of each line isolates the cost or benefit generated by a single effect on all the stakeholders and the sum of each column shows the whole cost or benefit the project generates on a specific group of stakeholder. This tool enable the evaluators to considerate the largest number of effects and also facilitate their quantifications.

44 A similar approach, is suggested also by the EU funded project RAILPAG (Railways Project Appraisal Guidelines). RAILPAG recommends the utilization of the SE matrix for projects requiring a more refined distributional analysis. “The SE Matrix takes advantages of the information that should be available for the traditional CBA, to present t in a way that relates effects (in the rows) and stakeholders (in columns) summarising the main economic and financial implications of the project and showing the transfers between stakeholders and the distribution of costs and benefits. It also incorporates markers for non-monetised effects and overall indicators of the probability of the investment”. RAILPAG is available at: www.railpag.com

Fig. 4.1 Benefit Incidence Table (BIT)

Benefit Incidence Matrix

Item \ Stake-Holder	Transport Company	House-hold	Firm	Land-Owner	Govern-ment	Sum.
Investment Costs	-29					-29
Running Cost	- 6					- 6
Toll Revenue	10					10
Saving of OPC for Travel		5	7			12
Saving of Time for Travel		23	27			50
Price Changes in Commodity Markets		- 3	3			0
Price Changes in Land Markets		-30	-22	52		0
Wage Changes in Labour Markets		12	-12			0
Subsidy	25				-25	0
Tax		- 1	- 2	-12	15	0
Sum.	0	6	1	40	-10	37

Source: Ueda, 2002

It seems that since 2000 in Japan "an ex-post evaluation of the Transport project had to be conducted formally" (Hayashi, Morisugi, 2000). However no specific guidelines to date have been written on how to perform the evaluation.

4.3.3 Energy infrastructure project assessment

A detailed research of the Japanese energy market has shown that no guidelines for project assessment of transmission grids exist.

4.4 World Bank

4.4.1 General information

The World Bank (WB) systematically evaluates investment projects before and after their implementation.

Project ex-ante evaluation is carried out by the country desks (the offices in charge of investment operations for each specific country where the WB intervenes), while the Operations Evaluation Department (OED) is responsible for ex-post evaluations.

The methodologies and the approaches used by the WB have continuously improved during the years and the Bank has always been representing a benchmark in the project evaluation field (Grasso et. al, 2003).

4.4.2 Ex-ante assessment for transport and energy projects

To appraise its operation, the WB uses the same approach sector wide, which is based on the economic analysis of investment operations (Belli, 2001).

The WB carries out an ex-ante appraisal of all the projects it finances. These projects are evaluated following the general methodological approach of the WB that is strongly based on the CBA framework and is quite strict in its prescriptions. In fact a set of compulsory elements should be contained in the appraisal:

- analysis of the alternative;
- financial analysis;
- economic analysis;
- analysis of uncertainties and
- cost-effectiveness analysis.

Following the Bank's operational manual (WorldBank, 1994), the economic evaluation serves to ensure that the financed projects promote the development goals of the borrower country and the Bank's poverty reduction strategy.

Consideration of alternatives is at the heart of the analysis. Each project design should be compared with other mutually exclusive alternatives and also the "do-nothing" scenario should be considered.

Costs and benefits generated by each alternative should be evaluated through an incremental approach, comparing the expected values with those of the "without the project" scenario.

All values should be stated in constant price terms (i.e., 1998 dollars), except where changes in relative real prices can be confidently forecast.

Flows are considered at their opportunity cost values, and then shadow pricing is applied. Discounting for future is done on benefits, net of costs, usually at a conventional 12% real rate.

To be acceptable a project should:

- have a non negative expected net present value (NPV) and
- have a NPV higher than or equal to the expected NPV of mutually exclusive project alternatives.

The WB generally does not accept projects for financing with an internal rate of return less than 10 percent (Adler, 1987).

Externalities should be taken into account as far as possible. The consideration of domestic and cross-border externalities is strictly required while project's global externalities have to be considered only in specific cases[45]. Externalities' effects should be, as far as possible monetized and computed in the economic analysis.

Focusing more on transport project appraisal (World Bank, 1994):

- the costs and benefits considered should include all elements which contribute to individual welfare. On the cost side these include purchased inputs (for example, fuel), non-purchased inputs (time) and quality of service characteristics (such as comfort, convenience, reliability, flexibility, etc.);

- the total benefit measurement includes benefits both to existing users and producers of transport services, and to those who are new users generated by an improvement, picked up in the "rule of half" measure[46];

- effects on non-users (for example, noise or air pollution impacts on residents adjacent to a road or airport) should also be included and

- national economic growth rates are the main basis for future demand forecasting. The impact of growth on transport demand will then depend on the income elasticity of transport demand[47]. This varies between passenger and freight, by mode, and by country type. Some suggested values are provided directly by the Bank[48], but where possible local experience should be analysed.

Regarding transport specific externalities, the Guide prescribes some methodologies to be followed:

- time value is estimated in monetary terms through a willingness-to-pay approach based on the opportunity cost of time. Values are based on average per capita income of users and should increase following the growth rate of the GDP of the country. The effect of time saving should be different by type of user, type of trip and type of day;

45 When payments related to the project are made under an international agreement or projects or project components are financed by the Global Environment Facility.

46 The "rule of half" measure is used as a consumer surplus measure, estimating the full benefit obtained by original travellers for origin-destination combinations and half the benefit obtained by new travellers or generated traffic

47 The rate of change of quantity of transport services demanded with respect to rate of changes in income

48 For a list of parameters please see "Generic Valuation Conventions at: www.worldbank.org/transport/pol_econ/econ_apr.htm#basic

- traffic safety is monetized and should be alternatively evaluated with a willingness-to-pay or a human-capital approach, depending on the specific benefit to be quantified. Material and physical damages, as well as fatalities and injuries have to be considered and

- environmental effects are evaluated through an avoidance-cost technique. Some of the effects to be computed are: air, ground and water pollution, noise, vibration, construction, aesthetically displeasing structure and reduced biodiversity of plants or animals.

According to the Bank's policy, the economic analysis should take into account the possible range in the values of the basic variables and assess the project's outcome with respect to changes in these values. For these reasons, the switching values of key variables[49], and the sensitivity of the project's NPV to change in the most important variables (e.g., delays in implementation, cost overruns, users or revenues overestimation and so on), should be assessed.

4.4.3 Ex-post assessment for transport and energy projects

The Bank puts a strong emphasis on evaluating the results achieved through its projects[50] in terms of the impact generated on people and on their needs (World Bank, 2006a).

To evaluate the effectiveness of its projects, the Bank uses the following instruments (World Bank, 2006b):

- implementation Completion Reports: These are prepared at the end of every WB loan disbursement period, anywhere from one to ten years. They identify the accomplishments, problems and lesson-learned. The report is prepared by the Bank operational staff and is submitted to the Executive Directors for information purposes;

- project Performance Assessment Reports: They rate projects on their outcome (taking into account relevance, efficacy, and efficiency), sustainability of results, and institutional development impact. One in four completed projects (or about 70 a year) is chosen for a Project Assessment Report, which takes OED staff about six weeks to produce and normally includes a field mission and

49 The value that each variable must assume to reduce the NPV of the project to zero

50 Regarding the ex-post evaluation of single projects, it is to be noted that this kind of practice is now much more spread in other regional development banks, such as the Inter-American Development Bank (IADB) or the Asian Development Bank (ADB), than in the WB. In fact the WB in the last years has been concentrating much more on the implementation of development programmes than on single infrastructural projects, leaving the latter to Regional Development Banks. Today these Banks carry out an extensive activity of projects' ex-post evaluation and have delivered comprehensive literature and procedural manuals on this issue. For further information please see: Inter-American Development Bank (2003), "Ex-post evaluation of operations", General Operational Policies available at: www.iadb.org/exr/pic/VII/OP_305.cfm and Asian Development Bank (2000), "Guidelines for the preparation of project performance audit reports", available at: www.adb.org/Documents/Guidelines/PPAR/default.asp?p=evaltool and Asian Development Bank (2006), "Guidelines for preparing performance evaluation reports for public sector operations", Operations Evaluation Department, available at: http://www.adb.org/Documents/Guidelines/Evaluation/PPER-PSO/default.asp

- impact Evaluation Reports: These assess the economic worth of projects and the long-term effects on people and environment. These "second looks" at projects are performed five to eight years after the close of loan disbursements.

4.5 European Union

The following chapter deals with assessment methodologies of the European Union. The chapter provides a brief insights on Guidelines and recommendations of all the DGs and/or EU bodies involved to some extent with evaluation issues in general terms as well as with Transport and/or Energy specific evaluation topics.

A stronger emphasis is given to those DGs and/or bodies where evaluation and/or sector specific activities are more developed or are most concerned with Transport and/or Energy project evaluation issues. Firstly the DGs roles in evaluation procedures is analyses with a special attention to DG BUDGET as it provides a general framework for the evaluation activities within the DGs. Secondly the EIB evaluation approach is presented.

4.5.1 DG Budget

DG Budget plays a central role in the evaluation activities within the Commission, as it carries out a sort of coordination of the evaluation activities of the various DGs.

DG Budget is not involved in sector-oriented evaluations, but its approach sets out the general framework for evaluations and shows the best practices in this field.

DG Budget most important guide on evaluation is "Evaluating EU activities – A practical guide for the Commission services" , which provides an overview of the Commission's rules and good practices concerning evaluation of EC's activities.

This guide provides guidance on possible ways to organise the evaluation function and covers all the phases of an evaluation activity, ranging from the specific typology of evaluation to be chosen to the dissemination of the evaluation findings. In addition it contains a package of methodological tools and techniques related to different phases of an evaluation. DG Budget guide are channelled both to those who carry out as well as to those who utilise evaluations. In addition it should assist those with a responsibility for organising the evaluation structure within the Commission services.

In its first part, the guide sets down the basic objectives and characteristics as well as the scope of evaluation in the Commission. More specifically evaluation is considered as "a judgement of interventions according to their results, impacts and needs they aim to satisfy". Evaluation should then represent a tool useful for:

- Contributing to the design of interventions, including providing input for setting political priorities;

- Assisting an efficient allocation of resources;
- Improving the quality of the intervention;
- Reporting the achievements of the intervention.

Subsequently the guide defines the profile, the role, tasks and resources of the evaluation function within the Commission. In this section the guide states that the evaluation function should be embedded in the Strategic Planning and Programming unit of the DGs ensuring a timely and effective feedback of the evaluation findings into the decision-making process and the policy priority setting.

In the following chapters the guide describes the four phases of an evaluation process: The Structuring, Observing, Analysing, and Judging phases.

The second part of the guide focuses more on the structuring and implementation phases of the evaluation activity. This section explains step by step the activity to be undertaken to set up an evaluation as well as to carry it out. It starts from the mandate for an evaluation project, the setting out of the evaluation questions and the drafting of proper and effective Terms of Reference (ToR) when the evaluation activities is to be outsourced.

Regarding the evaluation implementation phases, the guide explains the role of the Steering Group as well as of its specific composition and also it goes throughout all the administrative activities required during an evaluation. More specifically this chapter provides a useful comparison between advantages and disadvantages of having an evaluation conducted internally or externally to the Commission. The chapters provides also a review and a short description of all the methodologies that could be used (SWOT analysis, focus group, case studies, input-output models, econometric modelling, Expert panels, CBA etc.) and for each one it provides their level of suitability in each different phase of an evaluation (Structuring, observing, analysing, judging).

Finally the chapter provides the roles and the function of the evaluation reports (Inception, Interim, Draft final report and Final report) and sets out the way for their validation.

In its last part the guide addresses the feedback mechanism related to evaluation findings at the end of the evaluation process. These mechanisms relate to both reporting and dissemination and the use of evaluation results. More specifically it states the most appropriate sorts of communication vehicles depending of the audiences to be reached.

DG Budget has also two other guidelines , which are specifically channelled at the evaluation of programmes expenditures. One concerns the ex ante evaluation of expenditures programmes while the second deals with the intermediate and ex post evaluation of the same kind of programmes. The first guidelines deal more with the structuring phase of that kind of evaluation, while the second one focus on the data collection and data analysis techniques.

As said above, DG Budget evaluation guidelines are neither sector specific nor specifically channelled for projects. Both transport as well as energy infrastructure projects are then not

directly interested by the specificities of the DG Budget evaluation activities. However, as far as EVATREN is concerned, DG Budget guidelines should be considered as a general blueprint for evaluation activity approach also for TREN specific projects.

4.5.2 DG Regional Policy

The DG Regio (hereinafter the DG) can finance programmes or single projects to achieve its objectives of regional policy. For the new programming period 2007-2013, DG's objectives are:

- convergence;
- regional competitiveness and employment and
- European territorial cooperation.

Programmes are composed by a number of projects that pursue a specific objective, while projects are identified "as a series of activities intended to accomplish an indivisible task of a precise economic or technical nature" (Art. 39 Reg. 1083/2006), pursuing a clearly identified goal.

Regarding projects, the Commission distinguishes between major projects and other projects on the basis of their total cost. For the new programming period 2007-2013, the EC adopted new thresholds for the definition of major projects. They should be projects financed under the Cohesion Fund or the ERDF and whose total costs will exceed EUR 25 Million in the case of the environment and EUR 50 million in other cases" (Art. 39 Reg. 1083/2006) (European Commission, 2006). In the previous programming period, thresholds were EUR 50 million for the ERDF, EUR 10 million for the Cohesion Fund and EUR 5 million for ISPA.

Major projects should follow the same procedure for the co-financing decision regardless their specific sector.

The DG developed one of the most comprehensive framework, within the EU, for the evaluation of investment projects. More specifically it provides a detailed methodology both for the ex-ante and ex post evaluation of investment projects financed under the Cohesion Fund or the ERDF.

In the next paragraph we will provide a detailed insights into the methodologies used by the DG for project evaluation, with a special focus for the Transport and the Energy sectors.

Ex-ante assessment

Major projects applications should be submitted to the European Commission (EC) by a Member State or a managing authority, together with a specific set of information as stated in Art. 40 of Reg. 1083/2006[1]. This information regards general topics about the features of the projects as well as a complete technical, economical and financial appraisal.

According to 1083/2006 Regulation concerning the ex-ante evaluation, Member States should submit to the Commission:

- the results of the feasibility study;
- a timetable for the project implementation;
- a cost-benefit analysis, including a risk assessment and the foreseeable impact on the sector concerned and on the socio-economic situation of all the Member States and of all the potentially affected regions;
- an analysis of the environmental impact;
- a justification for the public contribution and
- the financial plan showing total planned resources and the planned contribution from all the available sources.

Following Reg. 1083/2006, the EC is in charge of providing indicative guidance on how to carry out the CBA. However, it should be noted that the EC in its Proposal for a Regulation on ERDF, Cohesion and ESF, issued in 2004 (European Commission, 2004), was discussing whether or not to fix stricter methodological prescriptions. In fact, Art. 40 states that the Commission was in charge of offering the Member States methodological support and of agreeing reference values for the principal parameters of the CBA analysis.

However the Commission since the 1997 has been delivering its own guidelines on cost-benefit analysis and then project analysis is suggested to be referred to this methodology (European Commission, 1997).

The last version of the guide provides a common analytical framework for major projects (European Commission DG Regional Policy, 2002).

The guide is structured in two parts: the first part presents the general approach, while the second provides sectorial applications.

The guide fixes all the elements that should be presented in an ex-ante appraisal and also recommends parameters and methodologies to be used in the assessment. For example it contains suggested values for time horizon differentiated by sectors and discounting rates for economic and financial analysis.

The elements suggest to be included in a project appraisal are the following ones:

- project identification;
- option analysis;
- demand analysis;

- financial analysis;
- economic analysis;
- multicriteria analysis and
- analysis of uncertainties (Sensitivity, Scenario and Risk analysis).

The financial analysis is specifically important because it is the basis for the application of the Equity Gap[51], which is the approach the EC uses to determine the amount it will fund.

The guide recommends the calculation of performance indicators which should be the base for the financing decision. The net present value and the internal rate of return should be calculated both on financial and economic values, then also the benefit cost ratio should be computed.

Both for energy and transport projects, the guide identifies methodologies and parameters, but also provides suggested values for the financial and economic net present values and expected benchmarks for the rate of returns.

Regarding transport projects, the focus is especially on road and railway projects even if the same principles are suggested for other modes. In this section the guide provides an insight on transport project evaluation. More specifically it suggests methods for:

- analysis of the demand;
- optimal pricing of services;
- quantification of safety enhancement and time savings and
- evaluation of the environmental impact.

The estimation of the potential demand should include:

- composition of 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 form other modes and the generated or induced traffic and
- sensitivity of the expected traffic flows for some critical variables such as: strategies of competing modes, levels of congestion of alternative modes, tariffs and elasticity to time and costs.

51 The “equity gap” or “financing gap” is the name of the current approach used to determine the Commission co-financing rate on the project total costs. This approach works as follow: C is the present value of total cost of the investment, 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 co financing rate and G is the EU grant defined as follows: r=(C-R)/C and G=E*r.

Regarding fares the guide suggests to reconsider the estimates of demand for the various tariff hypothesis and to associate the correct traffic volumes of each of them. Efficient pricing should be based on long-term marginal social costs and requires the "internalisation of external costs" (Polluter Pays Principle), including congestion and environment costs.

The economic analysis should include the quantification and monetization of the external effects generated: time benefits, safety benefits and environmental costs.

- time benefits are calculated generally using national estimates provided for evaluation purposes by some European countries. These estimates have different values by reason and sometimes by transport modes, in particular for passengers. In their absence it is possible to derive value of time from user's actual choices or to re-adjust and re-weight the estimates from other studies on the basis of income levels;

- environmental externalities should be monetized using local values or, in their absence, it is possible to apply 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) to the "physical" estimates of pollutants and

- safety benefits should be calculated referring to the average dangerousness levels by transport mode. This is suggested by the average cost by vehicle-km or passenger-km of the total costs of accidents pertaining to a specific mode (costs of dead and injured people). Accidents total cost should be net of the component which has already been internalised by insurance costs.

Regarding energy projects, the guide focuses separately on energy transport, distribution and production projects. The first two typologies are discussed jointly, while the latter is treated separately. The most relevant aspects underlined are: demand analysis, price dynamics, external effects and risk analysis.

Forecasts of total demand as well as tariffs are crucial factors in energy projects and as for transport project demand should be calculated for all tariff levels considered. External effects should be monetized through a "willingness-to-pay" approach (for example quantifying the costs the users must incur to acquire energy) or, in the case of environmental externalities, through the cost of the measures necessary to neutralise possible negative effects an air, water, land.

For the new programming period 2007-2013, the DG Regio will adopt some new orientations for ex ante project evaluation complying with Regulation 1083/2006 (European Commission, 2006). Their essential features have been already anticipated by the DG Regio through a Methodological Working Document (European Commission DG Regional Policy, 2006). This document presents "a set of working rules which will lead to more consistency and rigour in future cost benefit analysis for ERDF and Cohesion Fund applications and hence to better informed decision making".

The document tries to provide a stricter framework for CBA analysis and for these reasons it provides methodological approaches and reference values for many different parameters. Some of the key issues of the document are the followings:

- reference period, to be intended as the number of years for which forecasts are provided in the CBA, should be equal to the economic useful life of the project and long enough to encompass longer term impacts. The commission provides directly average time horizon by sector. Energy reference period is 15-25 years, railways 30, ports and airport 25, roads 25-30;

- discount rate for the financial analysis should tend to reflect the opportunity cost of capital to the investor. It is set at 5% in real terms, however values differing from 5% should be accepted only in duly justified cases: Member State's specific macroeconomic conditions; The nature of the investor: for instance, the discount rate can be higher for PPP projects, where the inclusion of private funds may increase the opportunity cost of capital; Sector concerned reason; When a Public private partnerships (PPP) is implementing the project (in this case a higher rate should be used in order to reflect the higher opportunity cost of capital to the private investor),

Shadow wage to correct labour market distortions should be determined as a weighted average of the shadow wage for competitive labour markets, the shadow wage for labour markets with involuntary unemployment and the shadow wage for labour markets with informal activities and

- discount rate for the economic analysis is based on long–term growth and pure time-preferences rates. Benchmarks should be 5,5% for the Cohesion countries and 3,5% for the others. Reflecting Member State specific conditions, different values may be justified.

Special attention is devoted to projects generating revenues and to those cases when private partners are involved in the projects. In these cases, the contribution from the Funds should be determined prudently so that no undue profit is reaped by the private investor. The document provides indications of what could be the normal expected profitability of projects by sector, and hence what could be the right mix of loans and public grants to finance it. Energy projects show a medium high expected profitability and then should be financed mainly by loans. Ports, tolled roads and public transport are supposed to have medium-low profitability and then deserve to be financed by a mix of loans and grants. Railways and road without tolls have low or none profitability and need public grants to borne investments.

Specifically regarding the transport sector, the document proposes that Member States develop their own guidance frameworks taking into account of specific institutional settings.

Ex-post assessment

Art. 49 of Reg. 1083/2006 states that "the Commission should carry out an ex-post evaluation of all the operational programmes, which have been implemented under each objective".

The evaluation should examine the extent to which resources were used, the effectiveness and efficiency of Fund programming and the socio-economic impact. It is aimed at identifying the factors contributing to the success or failure of programme's implementation and at identifying good practices.

There are no specific prescriptions regarding major projects.

The EC does not provide any guidance on how to carry out the ex-post evaluation. However some basic principles could be taken by an ex-post evaluation commissioned by the DG in 2004, on a sample of projects co-financed by the Cohesion Fund (European Commission DG Regional Policy, 2004).

This evaluation concentrated on the four beneficiary countries: Ireland, Spain, Portugal and Greece. It took into account projects implemented in the period 1993-2002 and already completed or almost completed by 2003.

The evaluation was carried out on three levels:

- at programme level, through the evaluation of the appropriateness of the programme management and implementation system;
- at sample level through the assessment of a group of 200 project in terms of effectiveness, efficiency and impact and
- at in-depth project level, through a quantitative re-appraisal of 60 out of 200 projects. Their socio-economic impacts were studied in detail using the CBA approach and following the guidance of the DG Regio Guidelines.

4.5.3 DG Transport and Energy

The DG TREN is responsible for the development of Community transport and energy policies, including dealing with State aid. In addition to that the DG is responsible for managing the financial support programmes for the trans-European networks, technological development and innovation. Priorities for the future years action are:

- contributing to the EU's competitiveness by completing the internal market and pursuing an active industrial policy strategy ;
- contributing to the opening-up of the market in the transport and energy networks and services.
- encouraging sustainable development, by promoting renewable energy sources and reducing energy demand;
- delivering the trans-European energy and transport networks, with particular emphasis on cross border sections and missing links;
- increasing safety and security in the transport and energy sectors.

As all the DGs, DG TREN follows the DG Budget guidelines and applies its specific expertise within this framework for the appraisal process. Since transport and energy projects are usually funded by resources activated by other DGs, the appraisal project follows the guidelines set by

these DGs. As stated in Council Regulation (EC, Euratom) No 1605/2002 dated June 25th 2002, Article 27, point 4:

"In order to improve decision-making, institutions shall undertake both ex ante and ex post evaluations in line with guidance provided by the Commission. Such evaluations shall be applied to all programmes and activities which entail significant spending and evaluation results disseminated to spending, legislative and budgetary authorities."

According to such a regulation, DG TREN carries out an ex ante evaluation activity, whose aims are to:

- adjust its decision and
- assess the results of its actions.

Furthermore, as reported in Evaluation Charter, the DG TREN applies the standards defined by the Commission in the field of evaluation as described in standard n° 23 Internal Control. Such standards define the rules that all the services must follow in their management of resources and are intended to guarantee a consistent level of internal control throughout the Commission. The standards are structured around the following five key control components:

- control environment;
- performance and risk management;
- information and communication;
- control activities and
- audit and evaluation.

Some information concerning the DG TREN appraisal approach could be found in The Council Regulation (EC) No.2236/95 "General rules for granting of Community financial aid in the field of Tran-European networks" (modified by the Council Regulation 1655/99), which provides that the decision to grant Community assistance should take account of:

- project maturity;
- effects of community intervention on public and private finance;
- soundness of the financial package;
- direct or indirect socio economic effects;
- environmental consequences.

All project should be submitted by the presentation of a specific application that should include information such:

- the body responsible for carrying out the project;
- a description of the project concerned and the type of the Community aid envisaged;
- the result of cost/benefit analysis, including the result of the potential economic viability analysis and the financial profitability analysis;
- the position of the project, according to the guidelines, in the field of transport, on the axes and nodes;
- consistency with regional planning;
- a summary description of the environmental impact based on the assessment carried out in accordance with Council Directive 85/337/EEC of 27 June 1985 and the SEA-Proposal (COM (96) 511 Final) on the assessment of the effect of certain public and private projects on the environment and
- a statement that alternative possibilities of public and private financing have been examined.

No guidelines regarding how to carry out the benefit/cost analysis are given. Recently the DG TREN has commissioned ECORYS Transport and CE Delft to study the expenditures and costs of transport infrastructures, to propose an adequate classification of expenditures and to propose a method for translating data on expenditures into data on costs. The objectives of this study are threefold:

- to set out a classification of infrastructure expenditures;
- to detail the various components of such expenditures for five modes of transportation and
- to set up a methodology to move from annual series of expenditures to costs, including fixed and variable elements.

Moreover two research projects commissioned by DG TREN and aimed at providing a common framework for project assessment have just been concluded: HEATCO (Developing Harmonised European Approaches for Transport Costing and Project Assessment) and RAILPAG (Project Appraisal Guidelines). The HEATCO main aim is to give a set of harmonised guidelines for project assessment on EU level while RAILPAG project provides with a common framework for the appraisal of railway projects across the EU.

As regards ex post evaluation, no specific guidelines are given. For other details, please refer to paragraph 2.7.3.

4.5.4 DG Environment

The Strategic Planning & Evaluation Unit of the DG is the responsible for co-ordination of evaluation activities within DG Environment and participates in the Commission's Evaluation Network. The DG represents an independent assessment body checking the relevance,

efficiency, effectiveness and value added of policy development and policy implementation. The DG's general aim in terms of evaluation is also to ensure it as an integral part of the policy cycle. Moreover, ex-post results are supposed to feed back the future policies.

A guide for desk officers concerning how to perform the evaluation (planning, management and practical use of evaluation) is restrictedly available only (*Evaluation: how to do it – Guide for desk officers*). It clarifies the responsibilities of various actors (operational units, evaluation function and financial unit) in an evaluation process (DG BUDGET, 2004).

The DG Environment issued the guidelines and the directives for the EIA procedure (85/337/EEC and the amending 97/11/EC) that applies to many categories of infrastructural projects, including large transport facilities such as TENs. The directives have been implemented into various national normative.

A relevant document concerning the SEA of transport projects, domain both of DG ENV and DG TREN, is the "SEA manual. A sourcebook on strategic environmental assessment of transport infrastructure plans and programmes" (BEACON, 2005). In the manual, focusing on SEA and EIA, also CBA is considered as a tool for the phase of project choice and prioritisation, in particular for those projects in which the economic dimension is dominant.

The DG ENV is not charged with ensuring directly the project's Environmental Impact Assessment conformity that is DG TREN's responsibility. The DG ENV is limited an informing DG TREN about environmental constraints dealing with the project.

4.5.5 DG Employment, Social Affairs and Equal Opportunities

Policy areas in which the DG performs evaluations are: Employment, European Social Fund (ESF), Working Conditions, Inclusive Society, Gender equality. None of them focuses on transport or TENs specifically.

4.5.6 DG Internal Market and Services

All the TEN T projects, being financed by TEN T grants, have to respect the Directive 2004/18/EC, which sets the coordination of procedures for the award of public works contracts, public supply contracts and public service contracts. The DG Market is charged to monitor the respect and the implementation of this directive and, furthermore, it is involved into the analysis of the PPPs phenomena with regards to Community Law on public procurement and franchising.

4.5.7 DG Economic and Financial Affairs

DG ECFIN plays a role of advisor for DG TREN, and the other Directorates involved in the TEN projects and in Structural Funds, on all forms of financial assistance other than grants. Since its General Director is a member of Boards of Directors of EIB, ECFIN support all the

DGs in dealing this institution. The ECFIN does not directly assess single projects, but has a sort of veto power since it can reject them.

4.5.8 European Investment Bank

Three different groups are allowed to submit projects to the European Investment Bank (EIB) in order to obtain the bank's loans. They are:

- potential promoters (private or public companies);
- commercial banks wishing to involve the EIB in their finance plans and
- public authorities, international or national development finance institutions.

Such a project promoter variety doesn't allow for a standardization of the information requested to submit the project. However, some information should be strictly provided. These are:

- general and legal information about the borrower;
- financial data;
- technical data: general design and technical description of the project, study and implementation; detailed estimate of investment;
- environmental data: environmental design of the project; where necessary environmental impact assessment as well as measures taken to ensure public consultation; where appropriate, planned provision of an "Environmental Management Plan" for the project and
- economic data: in order to calculate the project rate of return.

At this stage a multidisciplinary team (economic, financial, technical, environment) checks whether the project meet the EIB eligibility criteria. A project is considered eligible if it contributes to EU economic policy objectives, which are:

- promotion of economic and social cohesion (development of poorer regions) in the EU;
- improvement of EU transport and telecommunications infrastructure (rail, air, road connections and bridges);
- secure energy supplies - production, transfer and distribution, more efficient energy use, alternative energy supplies;
- development of a competitive, innovative and knowledge-based European economy;
- investment in human capital (schools, universities, laboratories, research centres, hospitals etc.);

- natural and urban environment schemes (water, waste, cleaner air, urban transport etc.);
- development of small and medium sized enterprises;
- industrial projects improving EU competitiveness and
- projects that support EU's external co-operation and development policies.

Once the eligibility criteria have been verified, the Bank could:

- suggest improvements to the technical, economic or environmental specifications of the project submitted for financing;
- draw the promoter's attention to certain procedures to be followed (award of contracts, compliance with environmental requirements, etc.) and
- request modifications to the loan application.

Once the EIB's has verified if its financial involvement is supposed to generate value added, the appraisal procedure begins. The Directorate General for Lending Operations launches the appraisal procedure and a team, responsible for establishing an appraisal timetable, is set up. At this stage a site visit to the promoter is organized.

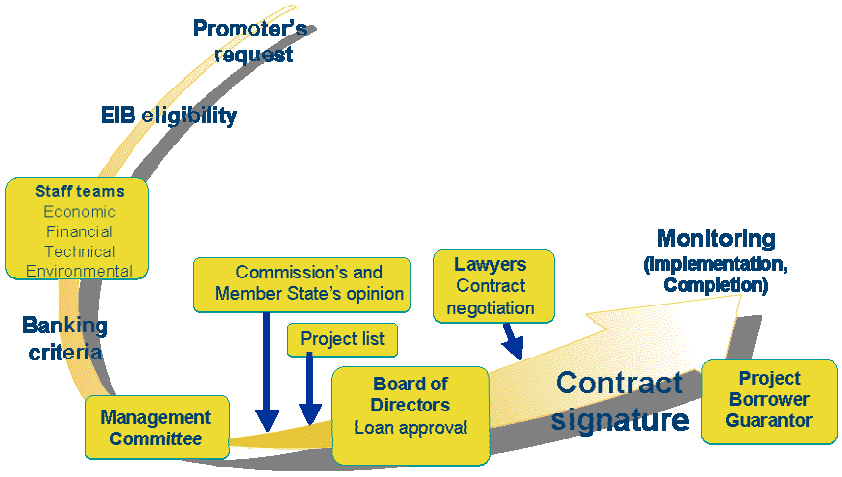
After the site visit, if findings are positive, a detailed project appraisal is carried out. It basically consists in the following activities:

- verifying if the project contribution to EU objectives;
- selection of the worst/best case studies in the market/sector project to be used as benchmark;
- testing the project technical soundness and technical risk related to the work in object and
- identification of project cost and comparison to other similar projects.

Moreover, the Bank checks:

- measures taken to cope risks;
- operating costs;
- environmental impact of the project by performing different types of analyses (EIA, SEAs, SISs);
- price, tariffs and financial return of the project;
- economic benefits and
- financial and credit risk analysis.

Fig. 4.2 EIB Project Cycle



Source: EIB, 2006

The EIB appraisal results are subject to the Commission and Member State opinion and then and, if this results positive, the loan is approved by the Bank Board of directors. At this point the appraisal phase is concluded and the contracting one usually begin.

5. The European debate on assessment methodologies

Chapter 5 describes the European debate on assessment methodologies. It commences with general methodological improvements which focus on risk analysis, opportunity costs of public funds and option value. Following this theoretical discussion implications on modelling will be analysed. Finally, general recommendations for the future are described in Chapter 6.3.

5.1 Methodological improvements

5.1.1 Risk analysis

The evaluation process necessarily entails a forecasting exercise: assumption on costs, benefits and effects have be done before they are realized. This means introducing in the economic analysis uncertainty and risk issues.

Before going into the description of methods by which such issues are considered into the economic appraisal, a distinction should be made between risk and uncertainty concepts: risk is subject to empirical measurements, while uncertainty involves a non-quantitative issues. According to this definition, it becomes apparent that risk, but not uncertainty, could be analysed in terms of probability distribution, that is indicating the likelihood of the realized value of a variable falling within stated limits.

Dealing with uncertainty

Currently the most common method for describing uncertainty is sensitivity testing. It consists in four steps

1. selecting variables to which a project design is most sensitive;
2. determining the possible range of variation from the base value;
3. determining the effect of such variation on the project value (changes in NPV and IRR);
4. interpreting the results.

Further results of the sensitivity testing are the identification of Switching Values (SVs) and Sensitivity Indicators. Switching values identifies the percentage change in a variable for the project NPV become zero, while the sensitivity indicators compare the percentage change in a measure of project worth (e.g. NPV).

Tab. 5.1 Dealing with uncertainty: Sensitivity indicators and switching values

Calculation of Sensitivity Indicator

$$SI = \left(NPV_b - NPV1 / \left(V_b - V1\right)\right) / \; NPV_b V_b$$

where $\boldsymbol{V_b}$ is the value of the variable in the base case

$\boldsymbol{NPV_b}$ is the value of the NPV in the base case

V1 is the value of the variable in the sensitivity test

NPV1 is the value of the NPV with the sensitivity test.

Calculation of a Switching Value

$$SV = 100 * \left(NPV_b \,/ \left(NPV_b - NPV1\right)\right) * \left(\left(V_b - V1\right) / V_b\right)\%$$

where the variables are defined as before.

The sensitivity testing allows to identify those variables which influence more the project results and, then, to mitigate the effects by adopting ad hoc measures. Despite its easiness, this methods is quite criticised for its significant limits:

- it does not take into account the probability of the occurrence of events;
- it doesn't appear clear if variable change are changes from expected value (i.e. the base case estimate of the value of the variable is its average value) or are deviation from most likely values and
- the use of given percentage of variation range for the variables describes a homogeneous kind of variability which is far from the real world.

Qualitative risk modelling

Qualitative way to model risk is usually adopted in situation where benefits/cost for a particular project cannot be reasonably estimated (e.g. poverty impact, etc.). An application of this method consists in the construction of the *risk matrix* that locates each identified risk within a matrix whose dimensions are "probability of occurrence" and "seriousness of impact". Table 4.1 provides an example of the risk matrix: the numbers 1-10 categorize different risk sources identified during the project preparation stage.

Tab. 5.2 Risk matrix: Impact and probability analysis

Probability	**Impact**		
	Low	**Medium**	**High**
Low	4	6	1,2,5,7,9
Medium	8, 10	3	
High			

Different format of the risk matrix could be designed in order to give useful information regarding the risk allocation among the relevant stakeholders.

Furthermore such a matrix could be used to attribute different risk management to particular project participants, in order to design a system of penalties and rewards. The format of the risk matrix could be also be adapted for isolating the risk components which are subject to the management control from those which couldn't be controlled.

Quantitative risk modelling

Once the key variable of the project have been identified it should be specified a number of data points (values above or below the base case, upper or lower to data values, etc.) and a frequency (likelihood) of each of this values.

By associating these data points with frequency a probability function could be constructed. Then, the values of these key variables are used to derive a cumulative distribution function for project indicator (NPV, IRR). The quantitative risk modelling, in practice, involves the choice of several variables and then make them varying simultaneously. Many procedures could be used for doing that but Monte Carlo method is currently the most used[52] in risk analysis. The main result of this way of conducting risk analysis is an average expected net present value (ENPV) associated to a probability distribution.

Such a way of operating shows two main limits:

- the problem of data availability and the degree to which a situation can be objectively defined as risky one and
- the extent of covariance between the selected variables.

The result of quantitative risk analysis is a classification of projects based on their economic return and their risk degree. Given such information the problem is which is the acceptable risk level from a social standpoint (Government).

According to Arrow-Lind (1970), since the Government is an operator which operate on the behalf of a large number of taxpayers and carries out a large number of investment projects, in

52 Monte Carlo simulation is based on generating large amounts of random numbers based on a statistical model.

practice it realizes a sort of risk pooling and spreading. The consequence is that the public operator is assumed to be risk neutral. Assuming risk neutrality for the public sector, while the private one is characterized for being risk adverse, implies the social discount rate to be lower than the discount rate used for private project. Consequently, the NPV and IRR criteria would be less strict for the public projects than for the private ones and a higher share of resource would be allocate in the public sector rather than in the private one.

In reality the public operator cannot be considered completely risk neutral: usually the investment decisions are taken by decentralized authorities which doesn't operate with a large investment portfolio (no possibility for risk pooling) and there could be a form of risk – political-administrative risk- to which the government is not neutral. Furthermore, even assuming the validity of the Arrow – Lind theorem, there are some exceptions to this view as the case of very large project, whose benefits are a relevant share or are strictly correlated to the national income, and projects whose benefits affect a particular group of individuals. In such situations the government could hardly be considered risk neutral.

5.1.2 Marginal opportunity cost of public funds

The first definition of MOCPF dates back to Pigou, to name the social cost of a unit of money used to finance a public expenditure and thus subtracted to the society as a whole. In other words: if the state use one Euro of public funds to finance a project, independently from its socio-economic convenience, causes a loss in collective richness, due to alternative uses of that Euro.

The loss (dually: the gain if public funds are saved) is traditionally due to three causes:

- *higher taxation* that increase the distortion from an efficient consumption pattern;
- *public* debts that diverts capitals from private investments and
- *inflation* that rises if public spending is financed with printing money.

The shadow cost of an expense *I'* (an investment, for example) is then different, and generally higher, than the nominal amount spent *I*. The same effect exists also in terms of generated public funds. For example, a decrease of unitary taxes due to higher total revenues thanks to higher demand, causes a surplus gain higher than the nominal surplus itself. In other words, the shadow price to be considered for a public spending is higher than the nominal price if the spending is financed by higher taxes or debt or inflation. On the other side, a generation of public funds by the implementation of a project has a positive shadow benefit if the taxes / debt / inflation doesn't rise in relative terms.

Limiting the discussion to tax revenues, the costs that increase the shadow price of the taxes are the costs of collection, compliance and the deadweight loss due to changes in economic behaviour of firms and households (Campbell & Brown, 2003). The first two are independent from the level of taxation, while the third, the deadweight loss, is strictly dependent on it and is the main effect usually considered in literature.

The deadweight loss (D) or the surplus gain (S) exist both for a raise/decrease in taxation or for raise/decrease in debt due to bond finance. This concept should be reflected in the evaluation of infrastructural investments, where the public funding for investments is common[53], substituting the spending or the revenues with shadow prices that consider this effect.

Deadweight loss generated by debt funding

The first effect that determines the existence of a shadow price is the effect of funding public expenses with bonds. The sold of bonds diverts part of savings from private investments to public, up to the level that equalises the gains between the two types of investments. But the private investment is subjected to a taxation rate and the shift to bonds eliminates this revenue. This amount must be added to the value of the public funds financed by bonds, to form its shadow price (Boadway and Bruce, 1984; Campbell & Brown, 2003).

Deadweight loss generated by tax increase

The second form of deadweight loss resulting from public financing of investments is caused by the raise of taxation level in order to collect the necessary amount. A rise in the tax rate causes a reduction in after–tax incomes and this causes a decline in the quantity of labour supplied. The decrease depends on the elasticity of the labour to after-tax wages. The decrease seems to be the algebraic sum of a positive effect of welfare generated by the increase of leisure time spent and lower income available for leisure.

Another way of considering the phenomenon is that a lower after-tax income decrease the expenses of households and firms and hence the consumption and the surplus-generating investments.

Cost-benefit analysis under opportunity cost of public funds

In estimating shadow prices for public funds several issues must be considered: country economies, border conditions etc. The literature suggests values of shadow prices coefficient δ around 20-25% for industrialised countries, or lower (Boadway and Bruce, 1984; Campbell & Brown, 2003; Fiorito, 2000). The inclusion of such shadow price in CBA indicators is the same of any other shadow price. The standard formulation of NPV

$$NPV = \sum_t (W_t - I_t + RV_t) / (1+i)^t$$

(with W: surplus, I: investment, RV: residual value, i: social discount rate, t: year), will change. In the simplest form, including only the opportunity cost of public fund for investment financing, it will be:

$$NPV = \sum_t (W_t - (1+\delta)I_t + RV_t) / (1+i)^t$$

53 In general is mode common the negative effect D due to finance than the surplus S due to taxation decrease.

In general, since the effect, as explained above, modifies also the other costs and benefits and the demand, also the surplus W depends on δ. That is to say that all the public funds, positive or negative, should be shadow-priced and not only the lump sum of the investment.

5.1.3 Equity and distributive issues

The conventional CBA produces as output a single indicator of net welfare gains (or losses). The NPV is an aggregate measure of benefit, supposing that the benefit, if the efficiency is guaranteed, will be redistributed to all the society by the mechanism of perfect markets hypothesised. The assertion is clearly weak, since the hypothesis of perfect markets is hardly verified. The efficiency is thus no sufficient condition for equity. Starting from these considerations, the CBA can be improved to evidence who gains the benefits and who pays the costs inside the theoretical concept of "society" as a whole.

The issue is seldom developed. Theoretical contributions are mature but not very numerous, manuals usually cite the existence of it, guidelines, where adopted, almost never suggest to perform such analysis. According to HEATCO survey (Tavasszy, 2005), the only guidelines implementing it are the Japanese guide for road projects (Japan Research Institute, 2000) and the Netherlands' guide (CE, 2000), the RAILPAG research programme guidelines. The theoretical foundations of these approaches can be found in Morisugi & Ohno (1995) or Campbell & Brown (2005).

A first approach to equity issues is so to perform a *distributional analysis*, evidencing the various stakeholders and to calculate a NPV for each one's point of view. This is called Benefit Incidence Matrix by Morisugi & Ohno (1995) or SE Matrix in Railpag (EIB, 2005). The shape of this matrix is represented in following table.

Tab. 5.3 *SE Matrix of Railpag*

	Stakeholder 1	**Stakeholder 2**	**Stakeholder i**	
Effect 1	E_{11}	E_{21}	E_{i1}	$\sum_i E_{i1}$
Effect 2	E_{12}	E_{22}	E_{i2}	$\sum_i E_{i2}$
…				
Effect j	E_{1j}	E_{2j}	E_{ij}	$\sum_i E_{ij}$
	$\sum_j E_{1j}$	$\sum_j E_{2j}$	$\sum_j E_{ij}$	$\sum_{ij} E_{ij}$ = NPV

The matrix can be filled performing a CBA for each stakeholder from its point of view and including only the effects it experiences. The number obtained represents a net present value for the actor, positive or negative. If no effects or actors are forgotten, the algebraic sum of all the stakeholders' values gives the total aggregated NPV as if it was calculated in the conventional way, due to the fact that all transfers have opposite signs for different stakeholders and their sum is zero.

For example, consumers benefit from time savings or higher reliability and may incur in higher costs due to an increase in tariffs. The government will increase its tax revenues but will also increase its expenditure in investment, operator will see a reduction in production costs etc. The following table illustrates a possible result for a transport investment with positive NPV. It's clear that the users are gaining from the project while the others to actors are loosing.

	Users	**State**	**Operator**	**Sum**
Investment		-10		-10
Tariff	-5		5	0
Prod. costs			-4	-4
Time	20			20
Taxes		5	-5	0
Sum	15	-5	-4	6

The distributional analyses can be performed from the point of view of:

- actors (users, producers, state, taxpayers, other producers, …);
- generations (present users, future taxpayers, …);
- regions or areas (where impacts are localised: some regions gain, some loose) and
- economic sectors (industry A, industry B, customers, …).

Another way of considering the equity issues stands on a more philosophical stage and deals with the market centred general principles of the technique. The *technical* solution of the impact matrix here presented is only a partial response to this. The issue of equity tends to overlap with the discussion about CBA limits, since it is largely the more controversial one. The main questions raised by equity can be summarised in:

- the use and the meaning of the demand curve: CBA's core concept of willingness to pay has no direct connection to individual welfare. This is due to disinformation, non perfect economic rationality, unfair income distribution, etc. In particular, the use of WTP concept, independently from the income distribution, assigns unjustifiably large decision weight to high income persons, while one can object that everyone's preferences regarding policy decisions should receive the same weight, irrespective of income;
- the hypothesis of Kaldor-Hicks efficiency, usually implicitly assumed. It says that if there is a hypothetical costless redistribution from those who prefer the project to those who do not that would, make the project Pareto efficient (Adler & Posner, 2000);
- the hypothesis of additivity of costs and benefits (Sen, 2000) and
- the treatment of conflicts.

The main reply to the first criticism is positive NPV's mean that the project creates net welfare gains, "makes the pie larger". Any policy that passes the cost-benefit test but creates net losses

for the poor can be transformed into a Pareto improvement by simply making the tax system more progressive. The main point against this hypothesis is that redistribution of gains is not costless.

5.1.4 Option value

Real option theory

A recent innovation in the project appraisal practice has been the introduction of the real option theory. Derived by the financial options (Balck, Sholes 1972, Merton, 1973), the real option theory has been developed during the 1970s, but has become a project evaluation element only during the 1990s.

It is based on the consideration that for those projects, which have a long-term time horizon and imply a large investment in a quite uncertain context, the gain/losses *opportunity* should be taken into account as well as the traditional project cash flow value.

The idea of adopting the option value theory in project appraisal rises from the dissatisfaction in using the traditional NPV indicator. Such dissatisfaction derives from the observation that NPV doesn't fully capture the future strategic project opportunities and, as a consequence underestimates the value of the investments.

The main concept of option theory could be summed up in four points:

1. once a project is undertaken a problem of opportunities identification and definition rises;

2. such opportunities should be properly valuated;

3. the interaction between the identified opportunity (compound option) should be taken into account and

4. the opportunities value should be quantitatively valued.

Dixit and Pindyck (1994) demonstrate that, in the presence of uncertainty, postponing an investment is supposed to have an option value. Basing on the orthodox theory an investment should be carried out, when the expected net present value results higher than 0. Dixit and Pindyck suggested that such a theory neglects some important factors and, above all, the investment irreversibility. According to this consideration it should be considered that an investment could be postponed in the time and that the project returns are subjected to uncertainty. Dixit and Pindyck noticed that, under the hypothesis of uncertainty, the capability of deferring the investment has a value that could be compared to the one of a call option (*financial call option*). Such a value is translated in a monetary flow when the investment is carried out. Therefore the non investing value isn't equal to 0 as the traditional thought, but is a positive value and the NPV should exceed this value in order to justify the investment.

In order to clarify how the introduction of the option value analysis impacts on evaluation the following example, based on Pindyck (1991) could be useful. Consider an investment whose cost amounts to 800. Suppose that the investment will realise a certain revenue in the first year of 100. For the following years the investment return could be either 50 with a probability of 0.5 or 150 with a probability of 0.5. Considering the hypothesis of irreducible uncertainty the net present value is calculated as follow:

$$NPV = -800 + \sum_{t=0}^{\infty} \frac{100}{(1.1)^t} = 300$$

Such result is obtained considering a 10% discount rate and supposing that the investment can be immediately realised (t=0). The additional information which is available a year later (t=1) make varying the NPV results.

When NPV is calculated in t=1 and the investment return is 50, it results:

$$NPV(p = 50) = -\frac{800}{1.1} + \sum_{t=1}^{\infty} \frac{50}{(1.1)^t} < 0$$

meaning that there's no interest in undertaking the investment.

On the other side considering the probability that the revenues will be 150 the NPV in t=1 will be:

$$NPV(p = 150) = -\frac{800}{1.1} + \sum_{t=1} \frac{150}{(1.1)^t} = 772$$

Thus the expected NPV at t=1 is given by

$$½ (0) + ½ (772) = 386$$

which results greater than the NPV calculated for t=0. It appears clear that deferring the investment of one year make available information which increase the value of future decisions. Such a difference between the NPV of the optimally timed decision and the NPV calculated in the case of an immediate investment decision is identified as option value. It expresses the investor's willingness to pay for being better informed in decision taking, in other words it express a sort of flexibility value.

Option value and expanded net present value

According to the option value approach the traditional NPV has two important limits:

- it doesn't take into account the dynamic aspect of uncertainty, that is the project capability of creating/destroying opportunity during the time and

- it is based on a subjective valuation of the discounted cash flow, since it depends on the hypothesis that a utility function has been identified.

Using the "Expanded Net Present Value" (ENPV) these limits can be overcome. The ENPV could be simply indicate by the following expression:

ENPV = (Expected discounted value of cash flow in the project scenario + Value of the options available in the project scenario) – (Expected discounted value of cash flow in the without project scenario + Value of the options available in the without project scenario)

or more simply:

ENPV = E(NPV) + (Value of the option created by the project – Value of the option destroyed by the project)

Where E(NPV) represents the expected value (mathematical expectation) of the NPV. Such expression suggests the idea that the project could be considered as an option which could be taken up by activating the project. Moreover it indicates that in the "without project scenario" at least one of the available options is destroyed: the project.

Following the approach of the financial option, the project could be regarded, in the without project scenario, as a *call option* since it gives the right, at a certain time (the expiration date) and for a certain price (i.e. investment cost), to enter into possession of an asset. Such an asset is made up by the NPV and the value of the option created or destroyed by the project.

Real option theory and evaluation

The application of the real option approach in project valuation has significantly changed the way to approach to this issue by introducing the concept of management flexibility. Such a flexibility, which consists in the project adapting capability, represents part of the project value and should be valuated.

According to the real option theory an investment project could be considered as an opportunity structure since it includes one o more options which could be taken up. More precisely the relevant option types that could be identified in an investment project are:

- *deferring option*, meaning that the investment decision shouldn't be taken immediately but could be deferred during the time;
- *expanding option,* which is the opportunity to strategically modify the project dimension;
- *abandoning option,* which is the opportunity to abandon a project early when the state of nature turn out worse than originally expected;
- *switching option*, which is the opportunity to switch the project use and
- *contracting option,* which is the opportunity to shut down operations temporally.

Approaching a project investment through the real option theory underlines a peculiar characteristic of a project investment, which couldn't be analysed by the traditional analysis: the *project sequential nature*. An investment project could create or destroy compound options, which are options that, once exercised, create a series of nested new options. Generally two types of interactions acting between options could be identified:

- *temporal interactions*: which means that the links between options works according to the project advancing process and
- *project interactions*: the link consists in the fact that the exercise of an option is preparatory for the exercise of another one.

The real option analysis suggests some consideration both on the objective of ex ante and ex post analysis too.

As regards the ex ante analysis it appears clear that the question isn't only if the project objectives could be reached more efficiently by another project or more effectively by making an alternative use of the resources. Looking at an investment project as an opportunity structure means that its efficiency should be analysed in terms of capability of opportunity exploiting and should be measured by an indicator which takes into account not only the predictable benefits but also the options that the project could generate.

Concerning the ex post analysis the real option approach suggest that the interim analysis (made during the project activation) should take into account how the project is effectively exploiting the project opportunities. Furthermore the ex post analysis, made at the project conclusion, should valuate the options that the project has created or destroyed, and gives information concerning the opportunity to exercise them in relation to the project examined or to a linked project family.

5.2 Modelling implications

The previous section has shown, how decisive the setting of parameters and assumptions in can be for CBA. Another aspect in this context is the representation of the complex and dynamic reality in a formalised assessment framework. For this task powerful computer models have been developed and applied to support decision-making in infrastructure program planning throughout the past decades. The complexity of the real world consists of several dimensions:

- the mutual interference of multiple projects in complex infrastructure networks;
- the dynamics and feedback mechanisms of transport, economy, ecology and social development;
- the development path of technical progress and innovation and
- the influence of incentives, regulation and opportunities on individual behavioural patterns.

The current section starts with a brief discussion of current CBA methods, which will in most parts be a repetition of the elaborations of Chapters 2 to 4. Then the different aspects of complexity and the modelling tools available to address these issues are discussed in turn. The section concludes with some evidence on the precision of model applications in transport investment planning.

The section focuses on transport infrastructure. As it is mostly public, the benefits from investments are more relevant in the political debate than in the privatised energy market. Nevertheless, the chapter will draw cross-section conclusions.

5.2.1 Current CBA methods

In standard transport investment planning and assessment two or more static future scenarios are considered and compared against each other in terms of project costs and benefits. Costs commonly include the annualised expenditures or capital costs plus the expected running costs for maintaining and operating the investment project. In case of an investment project replacing an existing one the difference in running costs between the old and the new asset may even lead to negative costs.

The list of benefits balanced against the costs vary between the methods, but usually range around a set of standard items. Core elements are the development of user time and operating costs. For their assessment, scenarios on the future development of transport demand feed into models allocating this demand to transport modes and travel routes in the networks. This leads to the classical four stage procedure of transport modelling:

1 Generation of transport demand based on forecasts of socio-economic key variables (population, employment, GDP, GVA, income, car ownership, etc.),

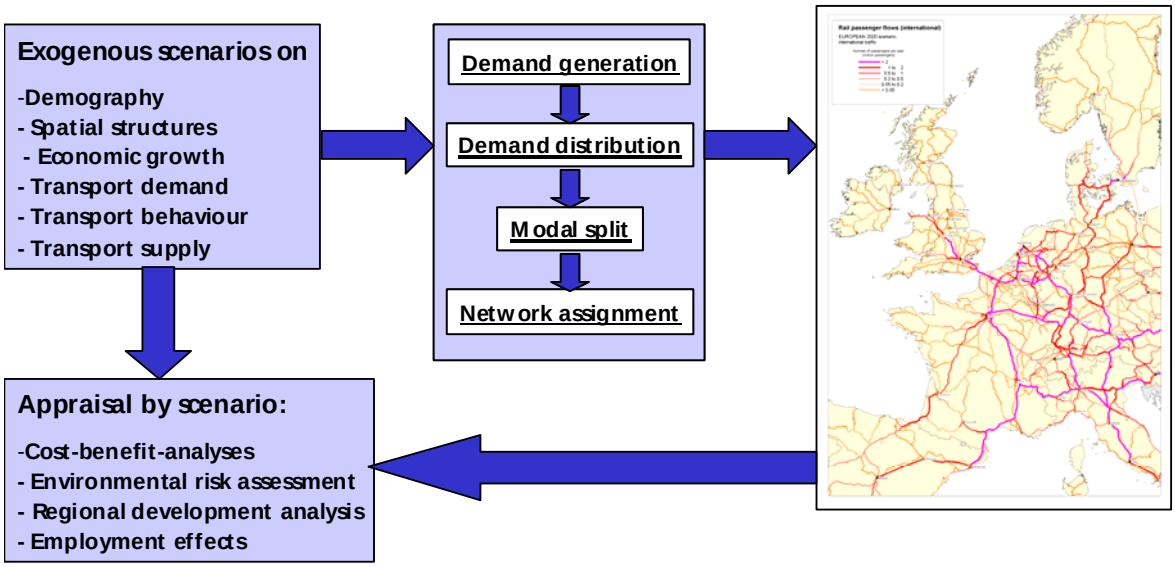
2 Demand distribution based on the mutual accessibility, on transport prices and on the relative development of socio-economic parameters of all regions considered,

3 Modal split allocating demand in general or per origin-destination (O-D) relation to the means of transport considered based on distances and on the availability, costs and the attractiveness of each mode and

4 Network assignment routing the demand to roads, railway lines, ports or airports based on capacities, costs, interchanges, and other route-specific characteristics.

Figure 12 illustrates the procedure of advanced contemporary CBA methods. In these procedures the condition of transport networks and the related economic, social and environmental impacts at a particular time are represented in much detail. But the assessment relies on point-to-point scenarios, which are determined by exogenous parameters and thus are not capable of dealing with the feedback between investments or other policy actions and the development of the economy, the environment and the society.

Fig. 5.1 Schematic presentation of advanced classical CBA methods in transport



Source: Fraunhofer-ISI

In variations of this basic approach the steps 1 and 2 and / or 3 and 4 may be performed simultaneously taking account of more general decision processes of people or firms. Very advanced models, such as System Dynamics (SD) or Computable General Equilibrium (CGE) models consider and compute all four steps at once. This, however, involves an interactive process (CGE) or the stepwise modelling of decision processes over time. These approaches, however, exceed the framework of standard CBA methods and thus will be treated later in this section.

5.2.2 The complexity of networks

Commonly transport infrastructure plans are initiated by local authorities who have a good knowledge of regional conditions, deficiencies, requirements and potential benefits or risks. In the case of national states this might be municipalities (as in Sweden), districts or federal states (as in Germany). On the European level the entities proposing investment projects of trans-European interest are the national states. The financing of investment measures, however, in most cases, is provided to a large extent by higher governmental levels. These are national governments or the European Union.

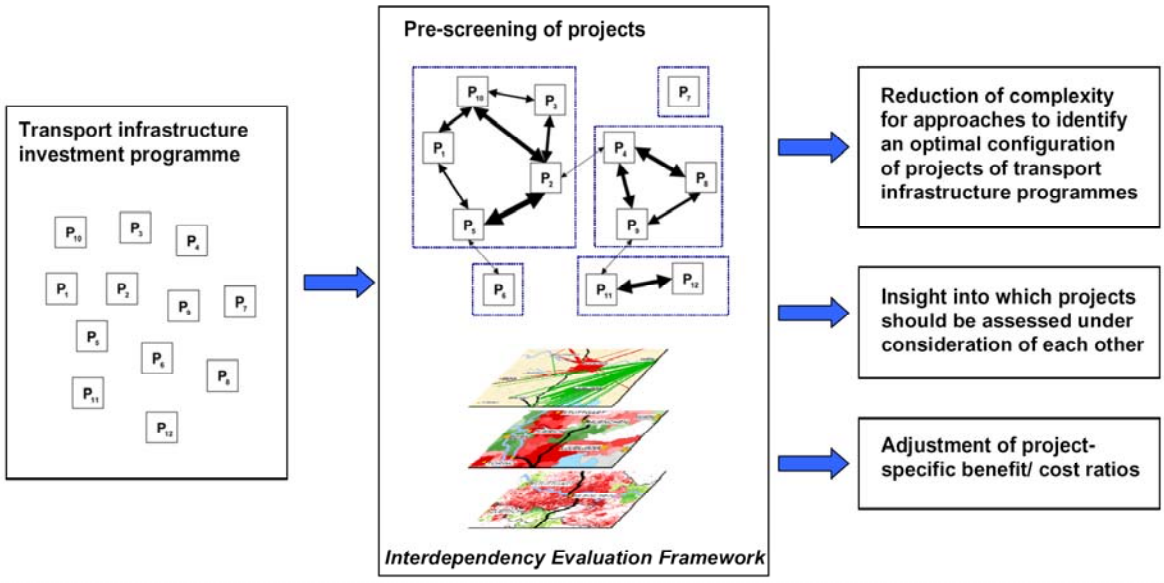
The consequence of this disperse structure of responsibilities is that the investment demand raised by local authorities risks to be rather a “political shopping list” overstating benefits and understating costs (Rothengatter 2006). A further impact of local transport plans that inter-relationships between different projects are overseen or willingly ignored. These mutual inter-relations might be positive in the case of supplementary projects, but might also be negative in case of competing investments.

On the European scale this problem has been recognised and addressed through the assessment of the TEN-T corridors. The TEN-STAC project (NEA et al. 2003) has installed large computer

models of the road and railway networks of the enlarged European union and associated eastern European countries. For a set of policy development scenarios a huge number of combinations of investment projects has been assessed to identify the most beneficial way to allocate the TEN-T funds.

The computation process involves a careful screening of project bundles in order to identify obvious conflicts. To formalise this procedure Szimba (2006) has developed an algorithm based on the geographical position of core points of each project. With a reduced set of possible project combinations the rather time-consuming assessment process can be carried out with much less resources required. The principle scheme of the process is presented by Figure 13.

Fig. 5.2 Principle scheme of the pre-scanning process



Source: Szimba, 2006

In the lasted German Infrastructure Investment Plan (BMVBS 2003) the screening and analysis of project interferences has been included, which was not the case in the previous infrastructure plans. However, a formal procedure to identify all possible conflicts between projects does not exist.

Another question related to the complexity of networks is who actually benefits from an investment. For example the introduction of a new bus or tramway line connecting a remote area to the city centre will also be beneficial for inner-city travellers experiencing a higher frequency where the new line feeds into the existing network. The quantification of these so-called "Mohring-benefits" (Doll and Jansson 2006) requires the application of sophisticated network models.

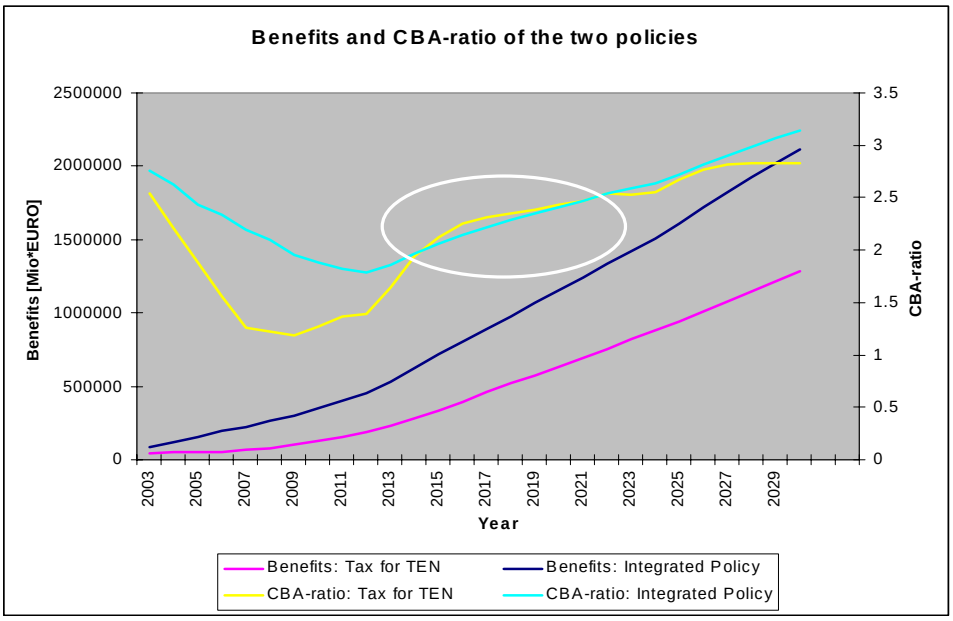
5.2.3 The dynamics of systems

In section 2.3.2 the ASTRA system dynamics model has been introduced as a tool to study the dynamic development and the feedback between different sectors of the economy and the society. One of the basic concepts of system dynamics is that particular processes happen and interfere at different speeds and are triggered by non-continuous processes. One of the most important driver of economic activities is the development of the size and the age structure of population. This follows a long-term path and can only marginally be influenced by external factors. Population determines demand and demand induces investments, which are again of a more of less long life span and which generate financial obligations and induce new demand in the future. Thus, orienting current investment programs at the medium-term population development might lead to considerable over-capacities with the related financial and environmental loads for future generations.

The various cost and benefit categories analysed in CBA develop over time to a different degree. For example the costs of infrastructure maintenance increase decisively with the aging of the asset and with growing traffic demand. This also holds for congestion costs, but – below a particular level of congestion – user benefits increase with growing traffic volumes. Due to the development of vehicle technology and – again below a certain congestion level – transport emission, noise and to some extent accident rates per vehicle kilometre will decrease while excessive demand towards the end of the asset's life cycle will cause these costs to raise again. Therefore, the benefit-cost-ratio of a transport infrastructure investment is determined by the time horizon of its computation.

The graph in Figure 14 generated by the ASTRA model (Schade 2005) demonstrates that the preference for particular measure might alter several times. The model runs analyse two alternatives of financing the TEN-T investment programme: By income taxes and by user charges within an integrated transport policy. The graph shows the development of the benefit-cost ratios (turquoise and yellow curves) and the level of benefits (blue and pink cures) until 2030. Between 2014 and 2020 the tax financing alternative seems to be beneficial, while before and after this period the integrated policy shows a higher benefit-cost ratio.

Fig. 5.3 CBA scenarios of TEN-T financing with ASTRA



Source: Schade, 2004

There, economic performance does not develop with the same rates across different regions. Thus, shifts in transport demand patterns, location changes of people and firms, and income changes will take place. By providing access to regions transport is not only influence by geographical dynamics, but is determining it to a large extent. This in particular holds for big investment projects. For an appropriate assessment of big investments, the space- and time-related dynamics must in any case be considered.

5.2.4 Dynamics and spatial complexity

The ASTRA model consists of 25 countries, and within each country of four functional zones representing different settlement types. But this does not suffice to model local impacts and related small-scale policies. On the other hand, the computation times of sophisticated network models are usually too long to model dynamic processes over time. Thus there is a conflict between geographical or sectorial detail.

A detailed assessment of several models and model combinations for project assessment has been carried out by the IASON project (Renes et al., 2004). In the spatial context the Models SASI and CGEurope have been analysed and compared to the outputs of ASTRA and the econometrics model E3ME by a series of case study applications. But all the models showed limitations in the geographical and / or in the sectorial accuracy.

To overcome this gap the EC has launched the TRANS TOOLS project. The model shall enable the EC to analyse new infrastructure investments and fiscal instruments and provide aggregated congestion forecasts on a European scale. Among others, the TRANS-TOOLS model shall overcome a number of shortcomings of prior European models, such as limited geographical

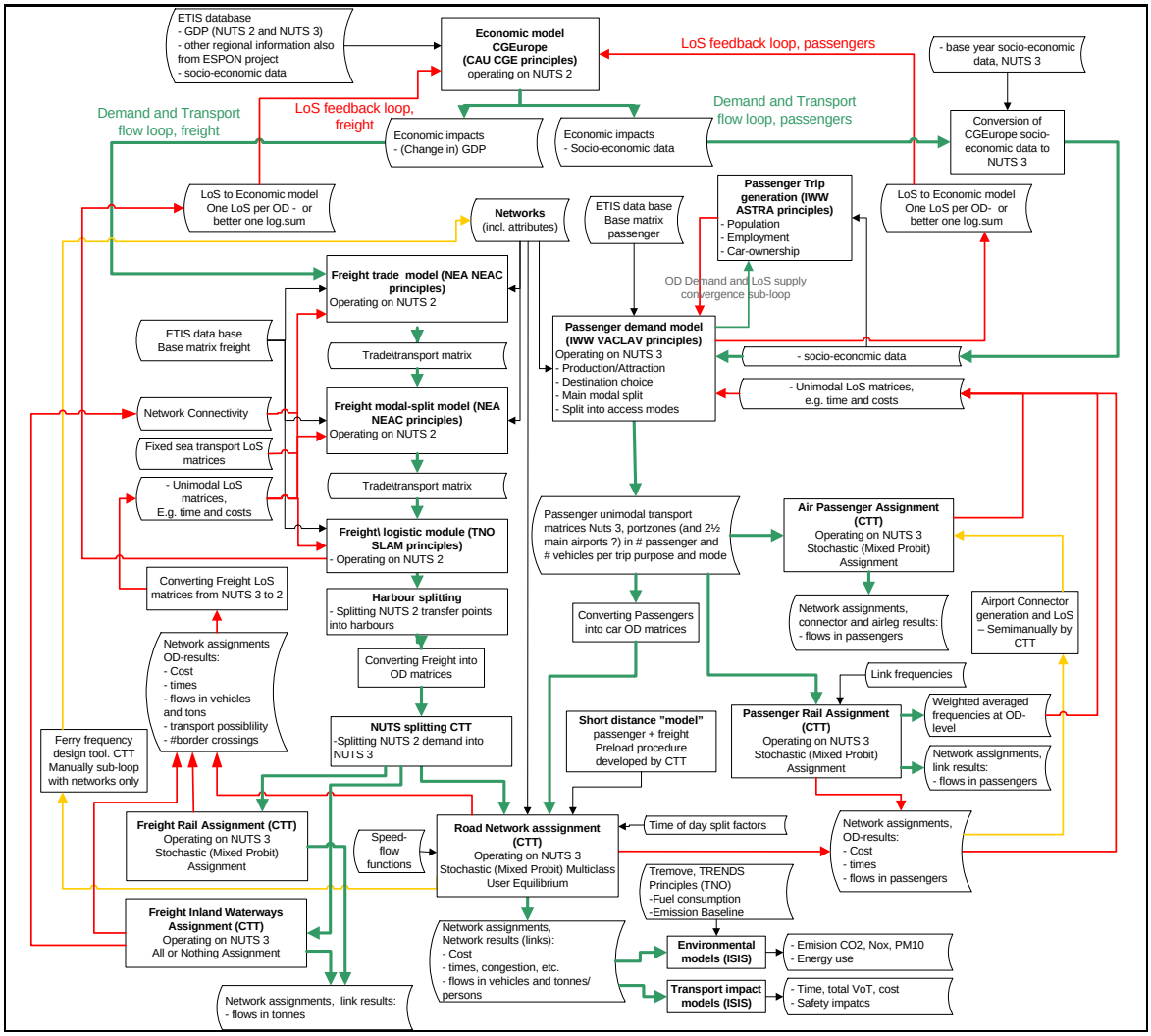
detail, weak consideration of intermodal logistics chains or missing links to the economic sector. Therefore it consists of the following components:

- European Transportation Model system;
- Regional Economic model (SCGE-model);
- Freight models;
  - trade (Simultaneous Model);
  - destination choice (Gravity Model);
  - logistics (Nested Logit Model) and
  - mode-chain choice (Nested Logit) for freight.
- passenger model;
  - trip frequency, destination choice and mode choice (Nested Logit);
- assignment models for all modes;
  - mixed Probit, multi-class, stochastic user equilibrium methods;
- impact models (environment, safety, economics,…) and
- feedback and conversion mechanisms.

The model represents 65 countries, 294 zones for trade modelling (NUTS-II) and 1286 zones (NUTS-III) for passenger and freight modelling. It is represented geographically to allow editing of infrastructure scenarios and permits to replace sub-modules to address various requirements towards computation speed and accuracy of results.

The conflict between geographical and sectorial detail is solved by letting the various specific models communicate with each other and transfer data and computation results. The structure of the TRANS-TOOLS model is presented by Figure 15.

Fig. 5.4 Structure of the TRANS-TOOLS model



Source: TRANS-TOOLS, 2006

A similar assessment approach linking the ASTRA system dynamics model to the VACLAV transport network model has been performed within the EU-Funded research project DESIRE (Kleist and Doll 2003). But in this case the transfer of data between the two models has been carried out manually, which has limited the number of intensity of data exchange. Finally, the scenario assessment in the DESIRE project was closer to the standard CBA methodology with point-to-point scenarios than to a real dynamic of transport flows over time.

5.2.5 Technical progress and innovation

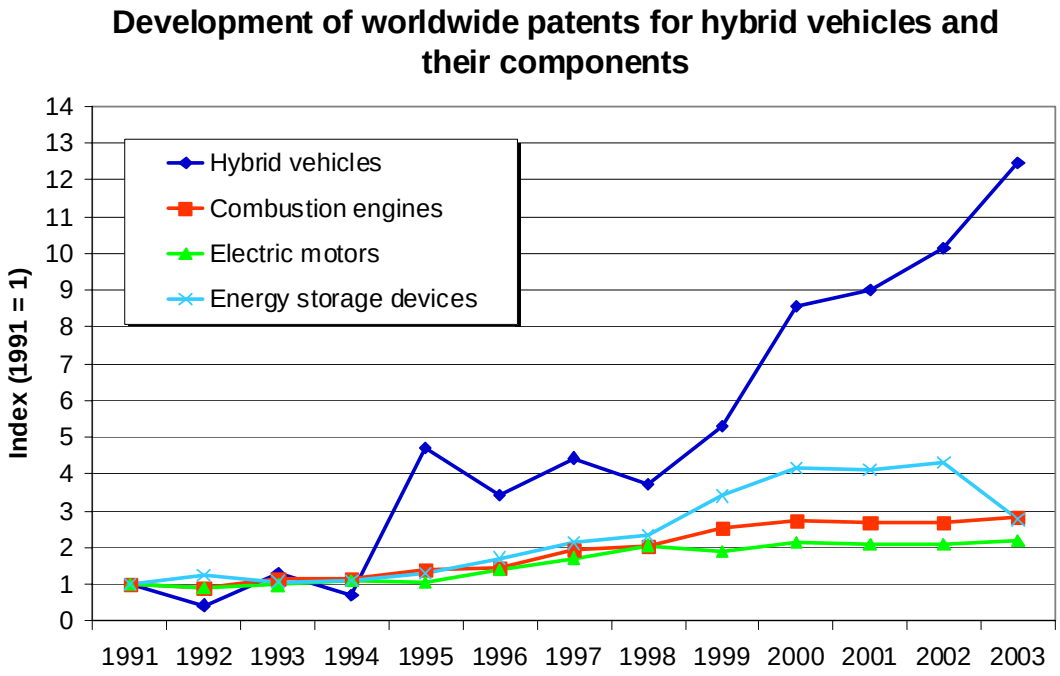
In some cases technical progress might be triggered by policy decisions, e.g. when regulatory frameworks put pressure on particular actors. But in most cases technological progress and innovations happen outside the transport sector. Nevertheless, fostering innovation is on the political agenda of the EU and of many member states in order to strengthen the competitiveness

of the European economy in a more and more global market. Therefore the appraisal of investment policies is required to answer the question whether the measure has an effect on technological progress and if yes, in which direction and to what degree.

Standard transport of economic models can not answer this question as they consider technical progress as an exogenous variable. For the endogenous modelling of technical change the application of multi-agent models seems promising. With these models it might, in some future, be possible to describe the likelihood of small or path breaking developments as a function of incentives, productivity gaps between countries, demand and other factors. But this type of modelling has not been successfully applied so far.

To illustrate which type of outputs might be generated models of indigenous technological change, the graph in Figure 16 presents the development of patents for hybrid vehicles in relation to the development of the input sectors (combustion engines, electric motors and electricity storage devices).

Fig. 5.5 Example: Technical change and innovation in the field of hybrid vehicles



Source: Fraunhofer-ISI

5.2.6 The limits of appraisal methods

Flyvbjerg (2006) reports, that during the past 70 years the accuracy of project assessment methods has not been improved. Despite the availability of better data and the application of large computer models project costs are systematically under-estimated and benefits are over-

estimated. This is particularly striking for rail projects, where 84 % are more than +/- 20 wrong (compare Table 17).

Tab. 5.4 Levels of inaccuracies of rail and road investment projects

	Rail	**Road**
Average inaccuracy (%)	-51.4 (sd=28.1)	9.5 (sd=44.3)
Percentage of projects with inaccuracies larger than **±20%**	84	50
Percentage of projects with inaccuracies larger than **±40%**	72	25
Percentage of projects with inaccuracies larger than **±60%**	40	13

Source: Flyvbjerg, 2006)

Flyvbjerg (2006) gives three reasons for this systematic bias:

- technical (data and models);
- psychological and
- political-economic (optimism and strategic misinterpretation).

Flyvbjerg then derives the concept of the "Reference Class Forecasting" Method. This relies rather on the real cost-benefit results of similar projects than on CBA and forecasts, which can be subject to errors and manipulation. The approach can be criticised as each project, in particular large investment projects, have their specific properties and thus are not easily comparable to each other. However, the analysis show clearly that it is most likely not a technical, but a psychological and political reasons hindering forecasts and cost benefit analyses from being precise.

Table 18 sets the various assessment models and methods discussed in the previous sections in relation to each other and discusses their strengths and weaknesses. Besides the general critique towards forecasts raised by the Reference Class Forecasting method, the table demonstrates the trade-off between computational efficiency and accuracy in one or another respect.

Tab. 5.5 Comparison of model approaches

Model type	Application cases	Strengths and opportunities	Weaknesses and threats
Standard CBA with network models	National approaches, TEN-STAC, TREMOVE	Transparency	No capture of dynamic effects and feedbacks
System Dynamics	ASTRA	Integrated model, transparent oututs	Limited spatial details
General equilibrium models (CGE)	TRENEN-II-STRAN	Closed economic theory	Very limited spatial and sectoral details
Spatial SD / SCGE	CG-Europe	Widening of scope of common CGEs	Computational limitations
Interlinked model clusters	TRANS-TOOLS	Capturing different effects by specific tools	Difficult application, no single model pattfor
Multi-Agent models	No application case yet	Explaining behaviour and innovation	So far no successful practical application
Reference Class Forecasting	US Transaportation Planning	Reduce strateigic and optimistic CBA-bias	Overlook unique properties / potentials

Source: Fraunhofer-ISI

5.2.7 Similarities between energy and transport

The previous sections have solely considered CBA model applications in transport investment planning. Similar approaches, however, also exist in the field of investment planning in the energy sector. Tab 5.6 aims at comparing these two industries. It reveals that in the energy sector a number of aspects, which are highly relevant for transport project assessment, are not relevant for energy infrastructure. Examples are socio-economic impacts or user effects.

On the other hand relevant energy issues, such as the security of supply, are not that dominant for transport networks. There are some aspects, e. g. the modelling of congested or dropped out lines, which are modelled much more accurately in the energy sector than in transport, as the consequences of shortages in supply in the two industries are different.

Tab. 5.6 CBA Aspects and their treatment in energy and transport investment planning

Aspect	Transport Networks	Energy Transmission Networks
Estimation and quantification of external effects	Air and GHG emissions of mobile and stationary sources, noise: generationa and disperion models; accident models, etc.	Air and GHG emisison and dispersion models for power stations; not relevant for transmission networks.
Elasticity of supply with quality of network supply	Induced traffic: assessment standard	Only relevant for areas with weak energy supply networks; less relevant for (western) Europe
Impact of new or dropped network links	Road: Detailled prediction with difficulties; rail and air: standard simulation models by service and / or network operators.	Very sophisticated modelling; daily network simulations with n-1 rule
Prediction of spatial and time-related demand structures	Most relevant in long term (15-30 years). Spatial structure most relevant	Rather relevant in medium term; availability of sophisticated models
Socio-economic impacts of investments	Feedback requires dynamic asessment: Macro-economic models (CGE, system dynamics, econometrics, mcpf, elasticities, etc.)	Relevant driven by price differentials, security of supply
User effects	Time savings, congestion, accidents, security. Models available	Congestion, security for the whole system. Network simulation models available
Productivity and innovation impacts	Relevant for general scenarios, not for network investments. New approach: Multi-Agent Modelling	As for Transport.
Inter-relation of different projects	Considered in sophisticated planning frameworks; computational problem	Captured by sophisticated network flow models
Regional economic development	Employment and entailed demand during construction; regression over infrastructure and GDP elsewhere; regional economic models (CGE, SD, econometrics)	Not relevant
Employment effects	Relevant for construction and operation phase; rough representation by elasticities based on input-output-tables	Not relevant: small effects on employment for the construction phase. No models in use

5.3 Recommendations

How can the entire evaluation process be improved, and most of all, how can it be made more effective in dealing with the real decision process, that seldom uses in full the present analytical tools? The improvements needed are probably manifold, and hereafter a few possible strategic lines of action are presented.

5.3.1 Technical improvements

Introducing the marginal opportunity cost of public funds, different from country to country, means filling the gap between financial and economic analysis, and it seems a task that cannot be further postponed. In fact, the financial constraints in public expenditures are becoming a dominant factor in decision making, and at present the "classic" CBA ignores the financial aspects, that are left aside for a different analysis, as if the two fields were totally separate. Obviously, the value of this “shadow cost” has to be defined, as the social rate of discount, at central level, and then transferred to each sector and to each administrative level.

At present, two projects that present identical NPV, and identical risk level and distribution, are considered as having an identical ranking, even if they present different degrees of reversibility in time. This example is made here in order to show another evident weakness of "classic" CBA. In the transport sector, were investments are very large and future demand uncertain , this is a crucial issue: the technical alternatives that are more flexible in time must show different values, specially in a context were the decision makers rarely have to respond of the long-run results. Introducing an “option value” of technical flexibility (derived from the financial theory of investments), seems another necessary improvement. Needless to say, this approach will show the large advantages of responding to increases of demand via technological solutions than via fixed civil works.

Income distribution issues are to be made explicit, especially since the decision makers are very interested in these aspects (also for local consent, and often just because they are short-sighted, re-election being a dominant objective). In this sense, the “classical” CBA can be easily re-engineered toward this aim. The World Bank has shown very good examples of this approach, specially in the case of privatisation policies.

5.3.2 The link between models and more simple tools

Models are telling more then CBA, but they are expensive, numerous, and seldom fully usable in the political arena (the problem of the "black box", but sometimes also of the time requested by this approach). Further, there is a trade off between the level of detail treated by models with respect to geographical representation and the accuracy of modelling the economy and the society. A solution could be meta-models, such as the TRANS-TOOL model, but the complexity of the system makes it difficult to apply and maintain them by non-expert users, i.e. results unfriendly for politicians.

A bridge can be built deriving the main shadow prices from sophisticated, regional or national models, and after an explicit political decision, passed over as inputs to specific projects, both sectoral and local.

A contradiction remains: "improved" standard tools, like CBA, tend to become complex themselves (more variables are added to approaches declared valuable just for their simplicity). Further work is needed on these aspects, even with a closer collaboration with policy-makers “of

good will". A way forward would be to make ex post analyses compulsory and to refer to their results when assessing new projects.

5.3.3 Some basic recommendations

Set aside the technicalities of evaluation presented above, a set of recommendations can be made anyway, within a simple framework of "good practices".

The evaluator has to be as independent as possible, and has to "sell" its independency as an added value in an open market. The agencies delivering the projects, even if public ones, cannot evaluate them. The Ministry of Finance or similar bodies are an exception, but still prone to "capture" mechanisms. A public international tender of evaluators, with results made public and object of political debate, seems to be highly recommendable. Projects have to be evaluated in terms of ranking, and never isolated.

The evaluation tools have to be as simple and transparent as possible, taking into account both the dimension of the project and the decisional context (for example, "local" stakeholders, and the central Ministry of Finance need different approaches)

Two types of alternatives have to be always present: technical alternatives (routes, capacity etc.) and modal alternatives. This implies that the evaluation process has to start as early as possible, and, then has to "follow" the subsequent political debate until the project is definite in its final form. The general mistake of evaluating "frozen" projects has to be avoided, since at that stage it is evident that only a positive verdict will be politically acceptable

The reference to similar projects carried out on the past should be made in order to cross-check the outputs of the CBA tools applied. Therefore, a large enough pool of ex post evaluations of projects using a more of less uniform and widely accepted appraisal method is required. Thus, the compulsory application of ex post analysis is recommended. This instrument itself could even provide the incentive to avoid biases and manipulations of ex-ante assessments.

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