ANNEX III

Methodology for carrying out the cost-benefit analysis

1. GENERAL PRINCIPLES

1.1. **The objective of a cost benefit analysis (hereinafter referred to as 'CBA') in the context of Cohesion Policy is to support the major project assessment in order to:**

— assess whether the major project ***is worth*** **co-financing** (from an economic point of view);

— assess whether the major project ***needs*** **co-financing** (from a financial point of view).

1.2. **A CBA shall be:**

— carried out as soon as possible in the project preparation phase, usually at the end of the preliminary design stage of the project;

— viewed as an element of a major project application to be taken into consideration in conjunction with other documents prepared for major projects including those containing other information referred to in Article 101 (1) of Regulation (EU) No 1303/2013.

1.3. **A CBA shall comply with the following principles:**

— CBA must be performed against predetermined policy objectives;

— CBA requires to define the relevant social context and perspective (local, regional, national, transboundary, global);

— CBA requires a common measurement unit (usually monetary);

— CBA requires a comparison of a scenario of the new investment with a scenario without the new investment (incremental analysis [1]);

— CBA requires to state a reference period relevant for the project;

— CBA requires consideration of residual values of investment;

— CBA requires a risk assessment to deal with uncertainty.

1.4. **A CBA for a major project shall include the elements set out below:**

(1) Presentation of the context;

(2) Definition of objectives;

(3) Identification of the project;

(4) Results of feasibility studies with demand and option analysis;

(5) Financial analysis;

(6) Economic analysis;

(7) Risk assessment.

[1] Where a major project consists of a new asset, the revenues and operating costs (or the benefits and costs in the economic analysis) shall be those of the new investment.

2. ELEMENTS OF THE COST BENEFIT ANALYSIS

2.1. Presentation of the context and definition of objectives, identification of the project, feasibility of the project with demand and option analysis

2.1.1. *Presentation of the context*

This assessment requires the definition of the social, economic, political and institutional context. The key features to be described relate to:

(1) the socio-economic conditions of the country/region that are relevant for the project;

(2) the policy and institutional aspects, including existing economic policies and development plans with their policy objectives;

(3) the current infrastructure endowment and service provision;

(4) the perception and expectations of the population with relation to the service to be provided.

2.1.2. *Definition of project's objectives*

Clear objectives shall be defined for the project in order to verify that the investment responds to an existing need and to assess the results and the impact of the project. As far as possible the objectives should be quantified through indicators with baselines and target values.

The definition of the objectives shall be used to identify, where possible and appropriate, the project benefits in order to assess contribution of the project to welfare and to achieving the specific objectives of the priority axes of the operational programme(s).

2.1.3. *Identification of the project*

The identification of the major project shall take place taking into account the definition of a major project set out in Article 100 of Regulation (EU) No 1303/2013 and as well as the following principles:

(1) the project needs to be clearly identified as a self-sufficient unit of analysis, that is, technical lots, administrative or financial phases that cannot be regarded as being operational in themselves, shall be analysed within the CBA together with other phases comprising a major project.

(2) the impact area, final beneficiaries ([1]) and relevant stakeholders whose welfare counts in the aggregation of net benefits shall be taken into account.

(3) the body responsible for implementation is identified and its technical, financial and institutional capacities analysed.

2.1.4. *Feasibility of the project with demand and option analysis*

Feasibility studies, which normally cover the following aspects: demand analysis; option analysis; available technology; the production plan (including the utilisation rate of the infrastructure); personnel requirements; the scale of the project, location, physical inputs, timing and implementation, phases of expansion and financial planning; environmental aspects, climate change mitigation aspects (GHG emissions), resource efficiency and resilience to climate change impacts and natural disasters, shall be considered in the cost benefit analysis (where applicable).

It shall be taken into account that:

(1) **Feasibility analysis** identifies the potential constraints and related solutions with respect to technical, economic, environmental and climate change mitigation and adaptation, regulatory and institutional aspects. A project is feasible when its design satisfies the technical, legal, financial and other constraints relevant to the nation, region or specific site. Several project options may be feasible.

A summary of results of feasibility studies must be presented in the CBA. CBA must be consistent with the information presented in feasibility studies.

([1]) The population that benefits directly from the project.

(2) **Demand analysis** identifies and quantifies the social need for an investment and considers as a minimum:

— the current demand, by the use of models and actual data;

— the forecast demand, from macroeconomic and sector forecasts and elasticity estimates of demand to relevant prices, income, and other core determinants;

— supply side aspects including the analysis of existing supply and expected (infrastructure) developments;

— network effect (if any).

(3) **Option analysis** is performed to assess and compare different alternative options which are found generally feasible to meet the existing and future demand for the project and to find the best solution. Options should be compared against different criteria, including for example technical, institutional, economic, environmental and climate change aspects.

The option analysis should be carried out in two steps; the first step looks at basic strategic options (i.e. type of infrastructure and location for the project) and the second step at specific solutions at the technological level. If the project is implemented as a Public Private Partnership this second step of the analysis should focus on the range of output specifications that may or may not be included in the output specifications of the Public Private Partnership project. The first step is usually based on (mainly qualitative) multi-criteria analyses while the second step normally uses mainly quantitative methods.

Key aspects of selecting the best option:

— to properly justify the solution sought, evidence is provided that the selected option is the optimal one of the various options considered during the technical feasibility study;

— if different alternatives have the same, unique objective and the same or very similar externalities, it is recommended that the selection should be based on the least cost solution per unit of output produced taking into account the long term operating and maintenance costs associated with the option;

— if the output and externalities are different in different options (assuming all share the same objective), the Member State is encouraged to undertake a simplified CBA for all main options to select the best option by determining which option is more favourable from a socio-economic point of view and the selection should be based on economic parameters of a project, including its Economic Net Present Value (ENPV). The simplified CBA shall be carried out based on approximate estimates of key financial and economic data, including demand, investment cost and operating costs, revenues, direct benefits and externalities, where relevant.

2.2. **Financial analysis**

As set out in Article 101(1)(e) of Regulation (EU) No 1303/2013, a financial analysis must be included in the CBA.

The financial analysis shall include:

(a) assessment of the financial profitability of the investment and of national capital;

(b) determining the appropriate (maximum) contribution from the Funds;

(c) checking the financial viability (sustainability) of the project.

Financial analysis should, where possible and appropriate, be carried out **from the point of view of the project owner** and/or operator allowing to verify cash flows and guarantee positive cash balance in order to verify the financial sustainability and to calculate the indices of financial return on the investment project and on capital based on the discounted cash flows.

If the owner and the operator are not the same entity, **a consolidated financial analysis**, which excludes cash flows between the owner and the operator, should be undertaken.

Where possible and appropriate, the financial analysis should be carried out in **constant prices** (prices fixed at a base-year), but expected changes in relative prices should be considered as part of the risk assessment.

2.2.1. *Discounted cash flow methodology, incremental method and other principles of financial analysis*

The financial analysis of major projects shall be carried out taking into account the rules set out in section III (Method for calculating the discounted net revenue of operations generating net revenue) of Commission Delegated Regulation (EU) No 480/2014, including: method for calculating discounted net revenue (including the reference period and the incremental method) and discounting of cash flow (including the financial discount rate in real terms).

The data required to perform a financial analysis are as follows:

(1) investment costs, including fixed investments, non-fixed investments including start-up costs, and, where appropriate, changes in working capital;

(2) replacement costs as defined in Article 17 (a) of Commission Delegated Regulation (EU) No 480/2014;

(3) operating costs as defined in Article 17 (b) and (c) of Commission Delegated Regulation (EU) No 480/2014;

(4) revenues as defined in Article 16 of Commission Delegated Regulation (EU) No 480/2014;

(5) source of funding including equity capital of the investor (either public or private), capital from loans (in this case loan repayment and interests are a project outflow in sustainability analysis) and any additional financial resources such as grants.

In sectors where this is relevant, including the environmental sector, **tariffs shall be fixed in compliance with the polluter-pays principle taking into account affordability**, as set out in Section III (Method for calculating the discounted net revenue of operations generating net revenue) of Commission Delegated Regulation (EU) No 480/2014, **and the full-cost recovery** ([1]).

Compliance with the full-cost recovery principle includes that:

(1) tariffs should aim as far as possible to recover the capital cost, the operating and maintenance cost, including environmental and resource costs;

(2) the tariff structure maximises the project's revenues before public subsidies, while taking affordability into account.

Limitations of the polluter-pays principle and full-cost recovery principle in user charges and fees should:

(1) not jeopardize the financial sustainability of the project;

(2) as a general rule, be seen as temporary restrictions and maintained only as long as the issue of affordability of users exists.

2.2.2. *Results of the financial analysis*

(a) *Evaluation of financial profitability of the investment and national capital*

Financial Net Present Value (FNPV) is the sum that results when the expected investment and operating and replacement costs of the project (discounted) are deducted from the discounted value of the expected revenues.

Financial Rate of Return (FRR) is the discount rate that produces a zero FNPV.

The financial profitability of an investment is assessed by estimating the financial net present value and the financial rate of return of the investment (**FNPV(C) and FRR(C)**). These indicators compare investment costs to net revenues and measure the extent to which the project's net revenues are able to repay the investment, regardless of the sources of financing. In some cases (in the context of State Aid and private operators) the calculation of FRR(Kp) is required. Interest payments shall not be included in the calculation FNPV(C).

For a project to require the contribution of the Funds:

FNPV(C) before the EU contribution should be negative and FRR(C) should be lower than the discount rate used for the analysis (except for some projects falling under State aid rules for which this may not be relevant).

([1]) Specific Union's legislative provisions existing for water and waste sectors (namely: Water Framework Directive and Waste Framework Directive) shall be taken into account in application of these principles.

If a major project shows **high financial profitability** (i.e. FRR(C) is substantially higher than the financial discount rate) it will, as a general rule, be considered sufficient for an investor to implement the project without Union contribution. A Union contribution may be justified only if it is demonstrated that the investment is not bankable on its own considering that the risks for an investor to implement the project e.g. **highly innovative** project may be too high to carry out the investment without a public grant.

The financial profitability of national capital is assessed by estimating the financial net present value and the financial rate of return on capital (**FNPV(K) and FRR(K)**). These indicators measure the extent to which the project's net revenues are able to repay the financial resources provided by the national funds (both private and public sources).

Calculation of FNPV(K) and FRR(K) requires that:

— the financial resources — net of EU support — invested in the project are treated as outflows disregarding investment costs;

— capital contributions are considered at the moment they are actually paid out for the project or reimbursed (in the case of loans);

— interest payments are included in the table for the analysis of the return on capital (FNPV(K));

— operating subsidies are not included in the table for the analysis of the return on capital (FNPV(K)).

For a project to require the contribution of the Funds:

FNPV(K) with Union assistance should be negative or equal to zero, and FRR(K) should be lower or equal to the discount rate, otherwise appropriate justification has to be provided.

When relevant, the return on the project promoter's capital (FRR(Kp)) should also be calculated. This compares the net revenues of the investment with the resources provided by the promoter: i.e. the investment cost minus the non-reimbursable grants received from the EU and/or the national/regional authorities. This exercise can be particularly useful in the context of State aid in order to verify that the intensity of the aid (EU and national assistance) provides the best value-for-money with the objective of limiting public financial support to what is necessary for the project to be economically or financially viable. If the project expects a substantial positive return (i.e. significantly above the national benchmarks on expected profitability in the given sector) it shows that the grant received would bring supra-normal profits to the beneficiary and therefore the Union contribution may not be justified.

(b) *Determination of the appropriate (maximum) contribution from the Funds*

Determination of the appropriate (maximum) contribution from the Funds for revenue generating projects shall be done in accordance with one of the methods for determining the potential net revenue in accordance with Article 61 (Operations generating net revenue after completion) of Regulation (EU) No 1303/2013 and Annex V to Regulation (EU) No 1303/2013 and Section III of Commission Delegated Regulation (EU) No 480/2014 setting out rules for calculation of the discounted net revenue of operations generating net revenue.

(c) *Ensuring financial viability (sustainability)*

The financial sustainability analysis is based on undiscounted cash-flow projections. It is mainly used to show that the project will have year by year sufficient cash resources at its disposition enabling it to always cover expenditures for investment and operations throughout the entire reference period.

Key aspects of financial sustainability analysis are as follows:

(1) financial sustainability of the project is verified by checking that the cumulated (undiscounted) net cash flow is positive (or zero) on an annual basis and over the entire reference period considered;

(2) the net cash flows to be considered for this purpose should:

— take into account investment costs, all (national and EU) financial resources and cash revenues and operating and replacement costs at the moment they are paid, repayments of entity's financial obligations as well as capital contributions, interests and direct taxes;

— exclude VAT unless VAT is not recoverable;

— not take into account the residual value unless the asset is actually liquidated in the last year of analysis considered;

(3) in the case of an operation not subject to the requirements set out in Article 61 of Regulation (EU) No 1303/2013, or whenever negative cash-flows are projected in the future, it must be indicated how costs will be covered with a clear long-term commitment of the beneficiary/operator to provide adequate funding from other sources to ensure the sustainability of the project;

(4) if projects fall within a pre-existing infrastructure, such as capacity extension projects, the overall financial sustainability of the system operator in the 'with-project scenario' (more than the capacity of the single extended segment) must be checked and a sustainability analysis at a system operator level must be performed and results must be taken into account in the risk assessment.

2.2.3. *Financial analysis in Public Private Partnership (PPP)*

The following aspects shall be taken into consideration when the financial analysis is carried out for major projects implemented as PPPs:

(1) The financial discount rate may be increased above the standard rate set out in Section III (Method for calculation of the discounted net revenue of operations generating net revenue after completion) of the Commission Delegated Regulation to reflect a higher opportunity cost of capital to the private investor. This higher opportunity cost should be justified by the beneficiary on a case-by-case basis, providing evidence, where possible, of the private partner's past returns on similar projects, or other relevant factual evidence.

(2) In case of PPP schemes where the owner of the infrastructure is different from the operator a consolidated financial analysis, covering both the owner and operator, must be carried out.

(3) Unless private partner is chosen in a fair, transparent and open competitive procedure assuring the best 'value for money' for public partner ([1]), in order to check the financial profitability of the private capital and avoid unduly high profit generated by EU support an indicator measuring the financial profitability of the invested capital to the private investor (FRR(Kp)) shall be calculated ([2]), comparing the net revenues accrued by the private partner with the resources provided during investment (either through equity or loans). The resulting FRR(Kp) shall be compared with national or international benchmarks on expected profitability in the given sector.

2.3. **Economic analysis**

As provided for by Article 101(1)(e) of Regulation (EU) No 1303/2013, an economic analysis must be included in the CBA.

Economic analysis is an analysis that is undertaken using economic values, reflecting the social opportunity cost of goods and services.

2.3.1. *Key steps of economic analysis*

The economic analysis should be carried out in **constant accounting (shadow) prices** and shall be undertaken taking the financial analysis cash flows as a starting point.

Economic analysis includes the following steps:

1. Fiscal corrections to exclude indirect taxes (e.g. VAT, excise duties), subsidies and pure transfer payments granted by a public entity (e.g. payments from national healthcare systems) from the economic analysis. Where indirect taxes/subsidies are intended to correct for externalities, these shall be included in the economic analysis, if considered to adequately reflect the social marginal value of the related externalities and provided that there is no double-counting with other economic costs/benefits.

2. Conversion of market to accounting (shadow) prices by applying conversion factors to financial prices to correct for market distortions. If conversion factors are not available from a national planning office and in the absence of significant market distortion for simplification the conversion factor can be set at one (CF=1). Conversion factors may be higher (or lower) than unity when accounting prices are greater (or smaller) than market prices.

([1]) Conditions should be specified in the national guidance document on PPP.
([2]) If private partner has been already selected; otherwise it should be described how this aspect will be assured.

3. Monetisation of non-market impacts (corrections for externalities): externalities shall be estimated and valued, as appropriate, using stated or revealed preference method (e.g. hedonic pricing) or other methods.

Economic analysis shall consider **direct effects only** in order to avoid double-counting while generally shadow pricing and monetisation of externalities account for indirect effects.

Financial revenues in the form of user fees, charges and tariffs shall be excluded from the economic analysis, and replaced with estimation of the direct effects on users, either through 'willingness to pay' or accounting prices. User fees, charges and tariffs especially in sectors not exposed to market competition, in regulated sectors or strongly influenced by political considerations should not be used as a proxy for 'willingness to pay' of user.

4. Discounting of the estimated costs and benefits: once the stream of economic costs and benefits is estimated, the standard discounted cash flow methodology shall be applied using a social discount rate (SDR).

On the basis of Social Rate of Time Preference (SRTP) the following benchmarks for social discount rate are estimated: 4,95 % for Cohesion Member States and 2,77 % for other Member States. For simplification as a general rule a **social discount rate of 5 % shall be used as a benchmark in Cohesion Member States** (Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Greece, Hungary, Latvia, Lithuania, Malta, Poland, Portugal, Romania, Slovakia, Slovenia) and **3 % in other Member States** (Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Spain, Sweden, United Kingdom).

Member States may establish a benchmark for the social discount rate which is different from 5 % or 3 %, on the condition that they:

(1) provide justification for this reference on the basis of economic growth forecast and other parameters determining the SDR under the SRTP approach; and

(2) ensure its consistent application across similar projects in the same country, region or sector.

Information on the different benchmark shall be made available to beneficiaries and the Commission at the start of the operational programme.

2.3.2. *Calculation of the economic performance indicators*

The following **economic performance indicators** (as defined below) are the key indicators of the economic analysis:

(1) **Economic Net Present Value** (ENPV) is the main reference indicator for project appraisal. It is defined as the difference between the discounted total social benefits and costs.

(2) For a major project to be acceptable from an economic standpoint the project's economic net present value should be positive **(ENPV>0)** demonstrating that the society in a given region or country gains from the project because the project's benefits exceed its costs and therefore, the project should be implemented.

(3) **Economic rate of return** (ERR) is the internal rate of return calculated using the economic values and expressing the socio-economic profitability of a project.

(4) Economic rate of return should be greater than the social discount rate **(ERR>SDR)** to justify EU support to a major project.

(5) **Benefit/Cost ratio** (B/C) is defined as the net present value of project benefits divided by the net present value of project costs.

(6) Benefit/Cost ratio should be greater than one **(B/C>1)** to justify EU support to a major project.

The main economic benefits per sector to be considered in the economic analysis are set out in table 1. Additional economic benefits can be added if needed and justified. In some specific cases those benefits may become economic costs e.g. increased vehicle operating costs in certain road projects.

Table 1

Sector/Subsector	Economic benefits
Water supply and sanitation	(i) improved access to drinking water and wastewater treatment services in terms of availability, reliability and quality of the service (ii) improved drinking water quality (iii) improved quality of surface waters and preservation of ecosystem services due to pollution abatement (iv) resource cost savings for both producers and customers (v) improved health (vi) reduction of GHG emissions
Waste management	(i) reduction of health and environmental hazards (reduced contamination of air, water, soils) (ii) reduction of landfill space/costs (for waste treatment facilities) (iii) recovery of materials, energy and production of compost (avoided cost of alternative production/generation, including externalities) (iv) reduction of GHG emissions (i.e. CO_2, CH_4) (v) reduction of visual disamenities, noise and odours
Energy	*Energy Efficiency projects* (i) energy savings (expressed by the economic value of energy including externalities) (ii) increase of comfort (iii) reduction of GHG and non-GHG emissions *Renewable Energy Sources projects* (i) reduction of energy costs for substitution of the energy source e.g. by displacement of fossil fuels alternatives (expressed by the economic value of energy generated by likely displaced alternative, including externalities) (ii) reduction of GHG emissions *Electricity/gas grids and infrastructure* (i) increase and diversification of energy supply (value of incremental gas/electricity supplied, including externalities) (ii) increase of security and reliability of energy supply (reduction in supply disruptions) (iii) reduction of energy costs for substitution of the energy source (iv) market integration: variation in surpluses stemming from price alignment effects across places (for transmission) or time (for storage) (v) improved energy efficiency (vi) reduction of GHG and non-GHG emissions
Roads, Railways, Public Transport	(i) reduction in generalised costs (for movement of goods/people): — time savings — vehicle operating costs savings (ii) accident savings (iii) reduction of GHG emissions (iv) reduction of non-GHG emissions (i.e. local air pollution impacts) (v) reduction of noise emissions (e.g. some urban projects)

Sector/Subsector	Economic benefits
Airports, Seaports, Intermodal	(i) reduction in generalised costs (for movement of goods/people) — time savings — vehicle operating costs savings (ii) quality of service improvements (e.g. provision of airport contact gates) (iii) reduction of GHG emissions (iv) reduction of non-GHG emissions (v) reduction of noise emissions
Research & Innovation	(i) benefits to businesses (establishment of spin-offs and start-ups, development of new/improved products and processes; knowledge spillovers) (ii) benefit to researchers and students (new research, human capital formation, social capital development) (iii) benefits to the general public (reduction of environmental risks, reduction of health risks, cultural effects for visitors)
Broadband	(i) Increased take-up and improved quality of digital services, including e-Commerce, for citizens and businesses (especially in rural areas); (ii) Increased take-up and improved quality of digital services, including e-Government and e-Health, for public administration.

2.3.3. *Climate change mitigation and adaptation in the economic analysis*

The CBA must take into account costs and benefits of the project in the context of Greenhouse Gas emissions and climate change. The quantification of the project's Greenhouse Gas emissions and the estimate of economic cost of carbon (or CO2) emissions used to monetise the externalities of such emissions shall be based on a transparent methodology aligned with the EU 2050 decarbonisation objectives. As for climate adaptation, costs of measures aiming at enhancing the resilience of the project to climate change impacts that are duly justified in feasibility studies should be included in the economic analysis. The benefits of those measures, e.g. measures taken to limit the emissions of GHG or enhance the resilience to climate change and weather extremes and other natural disasters, should also be assessed and included in the economic analysis, if possible quantified, otherwise they should be properly described.

2.3.4. *Simplified economic analysis in special cases*

In certain limited cases where the benefits of a major project are very difficult or impossible to quantify and monetise, but where costs can be predicted with reasonable confidence, notably for major projects driven by necessity to ensure compliance with EU legislation, a **cost-effectiveness analysis (CEA)** can be performed. In such cases the appraisal shall focus on verifying that the project is the most efficient solution for the society to supply a given, necessary service at the pre-defined conditions set out. In addition, qualitative description of main economic benefits should be provided.

CEA is carried out by calculating the cost per unit of 'non monetised' benefit and is required to quantify benefits but not to attach a monetary price or economic value to the benefits.

The conditions for applying CEA are as follows:

— the project produces only one project output which is homogenous and easily measurable;

— this output is a crucial supply, entailing that action to secure it is essential;

— the aim of the major project is to achieve the output at minimum cost;

— there are no significant externalities;

— there is a wide evidence of appropriate benchmarks to verify that the chosen technology meets the minimum required cost performance criteria.

2.4. **Risk assessment**

As set out in Article 101(1)(e) of Regulation (EU) No 1303/2013, a risk assessment must be included in the CBA. This is required to deal with the uncertainty that always permeates investment projects. Risk assessment enables the project promoter to better understand the way the estimated impacts are likely to change should some key project variables turn out to be different from those expected. A thorough risk analysis constitutes the basis for a sound risk-management strategy, which in turn feeds back into the project design. Particular attention should be paid to climate change and environmental aspects.

The risk assessment shall comprise two steps:

(1) **Sensitivity analysis**, which determines the 'critical' variables or parameters of the model i.e. those whose variations, positive or negative, have the greatest impact on the project's performance indicators, shall take the following aspects into consideration:

— the critical variables are the ones whose 1 % variation results in more than 1 % variation of the NPV;

— the analysis is carried out by varying one element at a time and determining the effect of that change on the NPV;

— the **switching values** are defined as the percentage change the critical variable should assume to make the NPV equal to zero;

— **scenario analysis** allowing the study of the combined impact of determined sets of critical values and in particular, the combination of optimistic and pessimistic values of a group of variables to build different scenarios, which may hold under certain hypotheses.

(2) **Qualitative risk analysis** including risk prevention and mitigation, which shall include the following elements:

— a list of risks to which the project is exposed;

— a risk matrix showing for each identified risk:

— the possible causes of failure,

— the link with the sensitivity analysis, where applicable,

— the negative effects generated on the project,

— the ranked (e.g. very unlikely, unlikely, about as likely as not, likely, very likely) levels of probability of occurrence and of the severity of impact,

— the risk level (i.e. combination of probability and impact).

— identification of prevention and mitigation measures, including the entity in charge of preventing and mitigating the main risks, standard procedures, where appropriate and taking into account best practices, where possible, to be applied to reduce risk exposure, where considered necessary.

— interpretation of risk matrix including an assessment of the residual risks after the application of prevention and mitigation measures;

— In addition the risk assessment may, where appropriate (depending on project size, data availability), and should, where the residual risk exposure is still significant, include the probabilistic risk analysis, which involves the following steps:

(1) **Probability distributions for critical variables** informing about the likelihood of occurring a given percentage change in the critical variables. Computing the probability distribution of critical variables is necessary to carry out a quantitative risk analysis.

(2) **Quantitative risk analysis** based on Montecarlo simulation, providing probability distributions and statistical indicators for expected result, STD, etc. of project financial and economic performance indicators.

The main risks per sector to be taken into account in the risk assessment are set out in Table 2.

In order to assist the project promoters in preparation of qualitative risk analysis in line with this Regulation, Member States are encouraged (if they consider this appropriate and/or feasible) to develop national guidelines on valuation of certain standard project risks, and list of mitigation and prevention measures across sectors.

Table 2

Sector/Subsector	Specific risks
Water supply and sanitation	Demand risks: (i) Water consumption lower than predicted (ii) Connection rate to public sewage system slower than predicted Design risks: (iii) Inadequate surveys and investigation e.g. inaccurate hydrological predictions (iv) Inadequate design cost estimates Land acquisition risks: (v) Procedural delays (vi) Land cost higher than predicted Administrative and procurement risks: (vii) Procedural delays (viii) building or other permits (ix) utility approval (x) Legal proceedings Construction risks: (xi) Project cost overruns and delays in construction (xii) Contractor related (bankruptcy, lack of resources) Operational risks: (xiii) Reliability of identified water sources (quantity/quality) (xiv) Maintenance and repair costs higher than predicted, accumulation of technical breakdowns Financial risks: (xv) Tariff increases slower than predicted (xvi) Tariff collection lower than predicted Regulatory risks (xvii) unexpected political or regulatory factors affecting the water price Other risks: (xviii) Public opposition
Waste management	Demand risks: (i) Waste generation lower than predicted (ii) Waste flow control/delivery insufficient

Sector/Subsector	Specific risks
	Design risks: (iii) Inadequate surveys and investigation (iv) Choice of unsuitable technology (v) Inadequate design cost estimates Land acquisition risks: (vi) Procedural delays (vii) Land cost higher than predicted Administrative and procurement risks: (viii) Procedural delays (ix) Building or other permits (x) Utility approvals Construction risks: (xi) Project cost overruns and delays in construction (xii) Contractor related (bankruptcy, lack of resources) Operational risks: (xiii) Waste composition other than predicted or having unexpectedly large variations (xiv) Maintenance and repair costs higher than predicted, accumulation of technical breakdowns (xv) Process outputs fail to meet quality targets (xvi) Failure to meet limits of emissions produced by the facility (to air and/or water) Financial risks: (xvii) Tariff increases slower than predicted (xviii) Tariff collection lower than predicted Regulatory risks: (xix) Changes of environmental requirements, economic and regulatory instruments (i.e. introduction of landfill taxes, bans on landfilling) Other risks: (xx) Public opposition
Energy	Demand risks: (i) Demand shortfalls (ii) Evolution of prices of different competing fuels (iii) Inadequate analysis of climatic conditions affecting the energy demand for heating and/or cooling Design risks: (iv) Inadequate design cost estimates (v) Inadequate site surveys and investigation (vi) Innovation in energy production/transmission or energy storage technology making the one in the project obsolete Land acquisition risks (vii) Land costs higher than predicted

Sector/Subsector	Specific risks
	(viii) Higher costs for the acquisition of rights of way (ix) Procedural delays Administrative and procurement risks: (x) Procedural delays Construction risks: (xi) Project cost overruns and delays in construction (xii) Flooding, landslides, etc. (xiii) Accidents Operational risks: (xiv) Maintenance and repair costs higher than predicted, accumulation of technical breakdowns, for example those caused by climate change impacts (xv) Long out-of-service time for accident or external causes Financial risks: (xvi) Changes in the tariff system and/or in the system of incentives (xvii) Inadequate estimate of energy price trends Regulatory risks: (xviii) Changes of environmental requirements, economic instruments (i.e. RES support schemes, EU ETS design) Other risks: (xix) Public opposition
Roads, Railways, Public Transport, Airports, Seaports, Intermodal	Demand risks: (i) Traffic forecasts different than predicted Design risks: (ii) Inadequate site surveys and investigation (iii) Inadequate design cost estimates Administrative and procurement risks: (iv) Procedural delays (v) Building permits (vi) Utility approvals Land acquisition risks: (vii) Land costs higher than predicted (viii) Procedural delays Construction risks: (ix) Project cost overruns (x) Flooding, landslides, etc. (xi) Archaeological findings (xii) Contractor related (bankruptcy, lack of resources) Operational risks: (xiii) Operation and maintenance costs higher than expected

Sector/Subsector	Specific risks
	Financial risks: (xiv) Tolls collection lower than expected Regulatory risks: (xv) Changes in environmental requirements Other risks: (xvi) Public opposition
RDI	Demand risks: (i) Development of relevant industry (demand for research results and demand for private contracted research) (ii) Evolutions on labour market (demand for university graduates and impact on demand for education services in the area) (iii) Interest of the general public different than predicted Design risks: (iv) Inadequate design cost estimates (v) Inadequate site selection or delays in completing the project design (vi) Invention of a new RDI technology making the infrastructure's technology obsolete (vii) Lack of well-established technical engineering expertise Administrative and Procurement risks: (viii) Delays in obtaining building permits (ix) Unresolved property ownership rights (x) Delays in the acquisition of intellectual property rights or higher-than-expected costs for their acquisition (xi) Procedural delays to select the supplier and sign the procurement contract (xii) Supply bottlenecks Construction risks: (xiii) Project delays and cost overruns during installation of scientific equipment (xiv) Lack of ready-made solutions to meet the needs arisen during the construction or operation of the infrastructure (xv) Delays in complementary works outside the project promoter's control Operational risks: (xvi) Lack of academic staff/researchers (xvii) Unexpected complication connected with the installation of specialised equipment (xviii) Delays in making the equipment fully and reliably running (xix) Insufficient production of research results (xx) Unexpected environmental impacts/accidents Financial risks: (xxi) Insufficient committed funding on a national/regional level during the operational phase (xxii) Inadequate estimate of financial revenues (xxiii) Failure to meet the demand from users

Sector/Subsector	Specific risks
	(xxiv) Inadequate system for protection and exploitation of intellectual property (xxv) Loss of existing clients/users due to competition from other R+D centres
Broadband	Context and regulatory risks: (i) Change of orientation of the strategic policy (ii) Change in excepted behaviour of future private investors (iii) Change in regulations in the retail market (iv) Unsuccessful State-aid application Demand risks: (v) Lower than estimated service take-up from retail- and/or wholesale providers (vi) Low investments in 'last mile' network by service providers Design risks: (vii) Inadequate design cost estimates Administrative and procurement risks: (viii) Delays in project procurement (ix) Risk of not obtaining required property rights Operational and financial risks: (x) Increase in operational cost (xi) Insufficient committed funding on a national/regional level during the operational phase (xii) Loss of key personnel during project operation

Formulas

Formulas for financial analysis:

— **Financial net present value (FNPV)**

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

— **Financial rate of return (FRR)**

$$0 = \sum \frac{St}{(1+FRR)^t}$$

Where S_t is the balance of cash flow at time t and a_t is the financial discount factor chosen for discounting at time t; i is the financial discount rate.

Formulas for economic analysis

— **Economic Net Present Value (ENPV)**

$$ENPV = \sum_{t=0}^{n} \rho_t V_t = \frac{V_0}{(1+r)^0} + \frac{V_1}{(1+r)^1} + \ldots + \frac{V_n}{(1+r)^n}$$

— **Economic rate of return (ERR)**

$$0 = \sum \frac{Vt}{(1+ERR)^t}$$

— **Benefit/Cost ratio (B/C)**

$$B/C = \frac{\sum_{t=0}^{n} \rho_t B_t}{\sum_{t=0}^{n} \rho_t C_t}$$

Where V_t is the balance of net benefits (B-C) at time *t*, B is total benefits flow at time *t*, C is total social costs flow at time *t*, ρ_t is the social discount factor chosen for discounting at time *t*; *r* is the social discount rate.