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| **ΠΡΟΓΡΑΜΜΑ «ΜΕΤΑΦΟΡΕΣ» 2021 – 2027**  **Preparation of Feasibility Studies for Transport Investments**  **PART A**  **Guidance for Practitioners**  *Version 4*  *April 2024* |

***Document History***

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**Foreword**

The preparation of a proper and comprehensive Feasibility Study is a condition for the funding of projects under EU funds, as well as through other financing institutions.

This publication defines the content and substance of a Feasibility Study for transport investments that are to be selected and implemented within the framework of the Operational Programme for Transport (2021-2027). It provides preliminary guidance for each element of the Feasibility Study and provides information on the types of analysis that can be performed. The guidance applies equally to all transport investments, although it is recognised that projects of different type and different size will present information differently – this is considered within the guide through a categorisation of projects (see Annex I).

Maritime projects are not covered within the scope of this document. A separate guide for such investments has been prepared.

The application of this guide is mandated in order to standardise the structure and content of Feasibility Studies, assisting with timely preparation and submission, review and approval of the above studies and thus to the timely implementation of the projects.

Throughout this guide, projects are categorised as follows:

*Linear Projects: Comprises road, rail and urban metro/tram where route selection forms a part of the design activities.*

*Refurbishment/Upgrade: Projects which involve the renewal, refurbishment or upgrade of an existing asset such as an existing road or railway or an existing safety system. This includes upgrading a public transport system through the purchase of new fleet or refurbishment of existing fleet.*

*Systems: An investment that comprises electrical, communication or other IT and automation systems.*

*Local Infrastructure: A distinct investment in a specific location which may form part of a larger system.*

In addition to the above, a further distinction is made based on the scale of investment. Throughout this guide, reference is made to a reduced level of detail in the Feasibility Study for ‘**Small Projects’**, which are defined as projects where the capital cost estimate is less than €10m (excluding VAT).

This guide has been developed with reference to the range of existing material relating to project preparation in the transport sector, in order to maintain consistency with existing legal provisions covering project preparation, the most relevant being:

1. Article 73 of the REGULATION (EU) 2021/1060 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 24 June 2021 laying down common provisions on the European Regional Development Fund, the European Social Fund Plus, the Cohesion Fund, the Just Transition Fund and the European Maritime, Fisheries and Aquaculture Fund and financial rules for those  [Publications Office (europa.eu)](https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021R1060)
2. Απόφαση Υπουργού Υποδομών και Μεταφορών Αριθμ. ΔΝΣβ/1732/ΦΝ 466 «Εξειδίκευση του είδους των παραδοτέων στοιχείων ανά στάδιο και ανά κατηγορία μελέτης σε ό,τι αφορά τα συγκοινωνιακά (οδικά) έργα, τα υδραυλικά, τα λιμενικά και τα κτιριακά έργα.»  [FEK-2019-Tefxos B-01047-downloaded -15\_12\_2023.pdf](file:///C:\\Users\\matzoros\\Downloads\\FEK-2019-Tefxos%20B-01047-downloaded%20-15_12_2023.pdf)
3. ΓΓΔΕ - Εγκύκλιος 11: Οδηγός εκπόνησης μελετών Δημόσιων έργων του Ν.4412/2016 (Βιβλίο Ι)   [Downloads | Νομοθεσία Δημοσίων Έργων | Νομοθεσία (ggde.gr)](https://www.ggde.gr/index.php?option=com_docman&task=cat_view&gid=52)
4. Νόμος 4412 (ΦΕΚ Α' 147/08-08-2016) «Δημόσιες Συμβάσεις Έργων, Προμηθειών και Υπηρεσιών (προσαρμογή στις Οδηγίες 2014/24/ΕΕ και 2014/25/ΕΕ)»  [ΕΑΔΗΣΥ - Ν.4412 - Δημόσιες Συμβάσεις Έργων, Προμηθειών και Υπηρεσιών (eaadhsy.gr)](https://www.eaadhsy.gr/n4412/)-

Whilst technical concepts are presented at concept level in this Guide, it is noted that this publication may be supplemented by additional guidance on the methods of approach and analysis of the sub-modules. In this way, it is intended that this will build into a more comprehensive guide to the development of transport projects. In the absence of further specific technical advice, best practice may be employed through reference to comparable international guidance where appropriate.

The Feasibility Study that is presented in support of a project will therefore describe the full range of supporting analyses that were undertaken during the design and evaluation of the investment proposal, and is therefore a central part of the project documentation. Each of the relevant analyses required to be included in the Feasibility Study is presented below.

**The Feasibility Study Content**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  |  |  |  |
|  | **1** | **Objectives** |  |  |
|  |  |  |  |  |
|  | **2** | **Existing Situation** |  |  |
|  |  |  |  |  |
|  | **3** | **Demand Analysis** |  |  |
|  |  |  |  |  |
|  | **4** | **Options Analysis** |  |  |
|  |  |  |  |  |
|  | **5** | **Project Definition** |  |  |
|  |  |  |  |  |
|  | **6** | **Cost** |  |  |
|  |  |  |  |  |
|  | **7** | **Financial and Economic Analysis** |  |  |
|  |  |  |  |  |
|  | **8** | **State Aid** |  |  |
|  |  |  |  |  |
|  | **9** | **Procurement and Implementation** |  |  |
|  |  |  |  |  |
|  | **10** | **Operation Plan** |  |  |
|  |  |  |  |  |
|  | **11** | **Risk Assessment** |  |  |
|  |  |  |  |  |
|  | **12** | **Climate Vulnerability and Risk Assessment** |  |  |
|  |  |  |  |  |
|  | **13** | **EIA Summary** |  |  |
|  |  |  |  |  |

Contents

[1. Project Objectives 1](#_Toc158889793)

[1.1. Overview 1](#_Toc158889794)

[1.2. Setting Objectives 1](#_Toc158889795)

[2. Existing Situation – Project Context 3](#_Toc158889796)

[2.1. Location and outline of the project 3](#_Toc158889797)

[2.2. Current situation 3](#_Toc158889798)

[2.3. Complementarity with Other Projects 3](#_Toc158889799)

[3. Demand Analysis 5](#_Toc158889800)

[3.1. Introduction 5](#_Toc158889801)

[3.2. Available Methodologies 5](#_Toc158889802)

[3.4. Reporting of the Demand Analysis 7](#_Toc158889803)

[4. Options Development and Analysis 9](#_Toc158889804)

[4.1. Introduction 9](#_Toc158889805)

[4.2. Strategic Analysis 10](#_Toc158889806)

[4.3. Technical Analysis 11](#_Toc158889807)

[5. The Project Definition 17](#_Toc158889808)

[5.1. Overview 17](#_Toc158889809)

[5.2. Refining the Project 17](#_Toc158889810)

[5.3. Project Definition 17](#_Toc158889811)

[5.4. Project Indicators 17](#_Toc158889812)

[6. Cost 18](#_Toc158889813)

[6.1. Construction cost 18](#_Toc158889814)

[6.2. Operation and Maintenance cost 19](#_Toc158889816)

[6.3. Summary of expenditure profile 19](#_Toc158889817)

[7. Financial and Economic Analysis 20](#_Toc158889818)

[7.1. Overview 20](#_Toc158889819)

[7.2. Financial Analysis 20](#_Toc158889820)

[7.3. Economic Analysis 21](#_Toc158889822)

[7.4. Financing Plan 22](#_Toc158889823)

[8. State Aid 24](#_Toc158889824)

[8.1. Overview 24](#_Toc158889825)

[8.2. Demonstrating State Aid Compliance 24](#_Toc158889826)

[8.3. Practical Guidance on State Aid 25](#_Toc158889827)

[9. Procurement and Implementation Plan 27](#_Toc158889828)

[9.1. Procurement Plan 27](#_Toc158889829)

[9.2. Implementation Plan 27](#_Toc158889831)

[10. Operational Plan 29](#_Toc158889832)

[10.1. Scope of Operations 29](#_Toc158889833)

[10.2. Governance during Operations 29](#_Toc158889834)

[10.3. Operating Plan 29](#_Toc158889835)

[11. Risk Assessment 30](#_Toc158889836)

[11.1. Risk Identification and Management 30](#_Toc158889838)

[11.2. Risk Analysis 30](#_Toc158889839)

[11.3. Other Considerations 32](#_Toc158889840)

[11.4. Reporting 33](#_Toc158889841)

[12. Climate Vulnerability and Risk Assessment 35](#_Toc158889842)

[12.1. Overview 35](#_Toc158889843)

[12.2. Climate Vulnerability and Risk Assessment (Summary) 35](#_Toc158889844)

[13. Environmental Impact Assessment Summary 36](#_Toc158889845)

[13.1. General 36](#_Toc158889846)

Annex I Project Types and Analytical Requirements

Annex II Parameter Values (For economic and Financial Analysis

1. Project Objectives
   1. Overview

Objectives describe what is to be achieved by a project in terms of how they support general requirements such as economic development, safety, or environmental improvement. This section provides guidance on how objectives should be defined for a project.

* 1. Setting Objectives
     1. Project Goal

Define the overall Goal of the project, expressed as a simple statement that captures what the project is intended to achieve. The Goal should be phrased so that it relates to one or more of the following:

* Environmental Objectives, for example air quality, noise, segregation, emissions reduction or improving urban landscapes;
* Accessibility/Social Inclusion Objectives, such as facilitating access to specific services by citizens or improving connectivity along an important axis;
* Economic Objectives, relating to local business, or regional/national economic efficiency;
* Safety Objectives; and/or
* Policy Integration: Addressing a legal requirement for interoperability (e.g. railway signalling or air safety);

The Goal should not be related to the provision of infrastructure. It should focus instead on what an investment is being designed to achieve in terms of environmental, accessibility/social inclusion, economy, safety, or policy outcomes.

* + 1. Specific Objectives

Describe each Specific objective, (e.g., related to Economy, Environment, Safety, and others as appropriate).

Specific objectives are derived by breaking down the Goal to more specific points and in a quantified manner (to the extent possible), For example, the Goal might include an Environmental Objective such as “Improvement of the urban environment”. This should be broken down to a number of Specific Objectives such as

* Reduction of noise level in residential areas (measured in dB);
* Reduction of particulate emissions in the city centre (expressed in kg NOx);

The specific objectives should be presented according to the table below, and this forms an input to the Strategic Options Analysis described later.

*Table 1-1: Structuring of the Project Objectives*

|  |  |
| --- | --- |
| **Category**  *(use these standard categories)* | **Specific Objective**  *(add further objectives as necessary)* |
| 1. Environmental | *Describe Objective 1.1 here* |
|  | *Describe Objective 1.2 here* |
|  | *Describe Objective 1.3 here* |
|  |  |
| 1. Accessibility/Social Inclusion | *Describe Objective 2.1 here* |
|  | *Describe Objective 2.2 here* |
|  | *Describe Objective 2.3 here* |
|  |  |
| 1. Economic | *Describe Objective 3.1 here* |
|  | *Describe Objective 3.2 here* |
|  | *Describe Objective 3.3 here* |
|  |  |
| 1. Safety | Describe Objective 4.1 here |
|  | *Describe Objective 4.2 here* |
|  | *Describe Objective 4.3 here* |
|  |  |
| 1. Policy Integration | Describe Objective 5.1 here |
|  | Describe Objective 5.2 here |
|  | Describe Objective 5.3 here |

* + 1. Compatibility of the project with Community, National and Regional Policies

Describe the main Community, national and regional policies with which this project complies and describes how the project contributes to the achievement of the objectives of these policies. Given that the projects included in the “Transport” programme 2021-2027 are to be financed from Community and national funds, it goes without saying that they must comply with the above policies, as also provided for in the criteria for inclusion in the Programme. For these reasons it is necessary to demonstrate alignment with relevant policy documentation in the feasibility study with a coherent, complete and brief description.

**Required Outputs from this Section**

* Overall Project Goal
* Table with Specific Objectives
* Demonstration of compatibility with Community, National and Regional Policies

1. Existing Situation – Project Context
   1. Location and outline of the project

Provide a General Layout Plan in 1:50,000 scale or similar against a mapping background. Additionally, provide a wider location map to a larger scale if necessary to show the project location.

* 1. Current situation

The current situation should be described in a short and clear manner, with reference to the relevant Google map or to an existing general project layout from previous studies. The description should provide at least the following information, taking into account the type of the project:

* Present a description of the study area (including maps as necessary), describing topography, existing developed areas, watercourses, existing transport infrastructure and other relevant information;
* Present information on any Special Areas of Conservation, including Natura 2000 areas, supported by mapping, that are at risk of being impacted by the project;
* In the case of projects relating to *“systems”* provide a description of the existing asset and its condition;
* Present the existing demand scenario, utilising either a transport model or through collection of survey data and/or desktop research as necessary. Identify aspects where there is (or where is anticipated in the short term) a reduced level of service for users, supported by analytical data; and
* Present any information on archaeological sites, either confirmed or where there is a high risk of archaeological findings;

For Linear Projects, the description should cover the entire Project Impact Catchment Area (the Study Area being that area within which all feasible alignments are to be explored as part of the Option Analysis). For Linear Projects the description of the current situation can therefore be quite extensive.

* 1. Complementarity with Other Projects

In some cases, a project may have design interfaces with other projects that are to be delivered in the same location. In this regard, due consideration must be given to those other projects and it should be examined what measures are being undertaken to ensure that both projects will be delivered in a complementary way. This should present the following:

* Define complementary projects, where there are interfaces with the current project; and
* Identify how the proposed project takes into account the complementary project in such a way that public funds are being efficiently used. This should describe how the project has been designed in order to accommodate the complementary investment at a future date, by way of design features or coordination of delivery;

**Required Outputs from this Section**

* Description of Current Situation, including environmental constraints mapping
* Overview of Complementarity with other projects

1. Demand Analysis
   1. Introduction

Transport Demand Analysis describes the process of developing a representation of existing and future demand for transport that will use a new project. It provides an estimation of how demand will respond, over time, to changes in transport supply and demand. These outputs are necessary to support infrastructure design and operational planning, as well as project appraisal.

Given the breadth of applications for Transport Models, it is natural that there is a wide range of guidance available for their construction and application. The requirements presented in this guide are based on Transport Modelling Guidance prepared by JASPERS (The Use of Transport Models in Transport Planning and Project Appraisal).[[1]](#footnote-2)

* 1. Available Methodologies

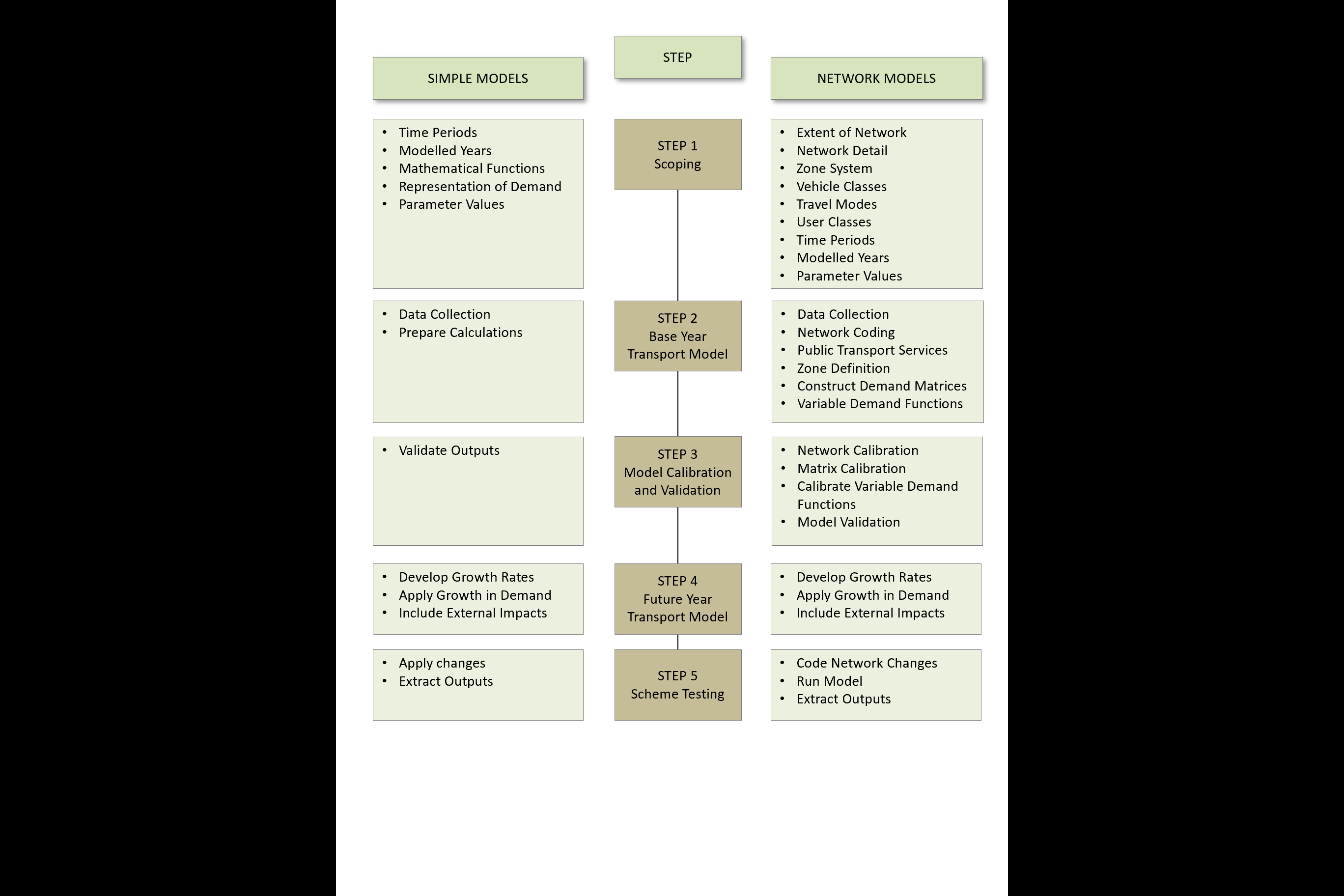
The methodology for the Demand Analysis will generally depend on the complexity of the project investment and its likely impacts. The following forms are available to support the analysis of transport projects (and which are referenced also in Annex I):

|  |  |  |
| --- | --- | --- |
| Simple Models  (SM) |  | *Projects where impacts are fully understood. Calculation can be undertaken using spreadsheets or basic calculations.* |
|  |  |  |
| Assignment Models  (ASM) |  | *Projects with Fixed Transport Demand, and where only impact is re-routing of trips. .* |
|  |  |  |
| Mode Share Models  (MSM) |  | *Projects where there is an expected change in demand between different transport modes, but without any broader impacts on trip choice.* |
|  |  |  |
| Variable Demand Models  (VDM) |  | *Projects where significant changes in the transport network are likely to impact on the decisions behind travelling (destination or trip frequency).* |

*Proprietary software tools are generally used for the above, with the exception of Simple Models.* For further information on selecting the appropriate form of Demand Analysis to suit a particular function, please see Table 5-1 of the JASPERS Guidance on Transport Modelling1.

* 1. Developing a Transport Model

Regardless of the functionality and method of modelling chosen, the procedure for developing a Transport Model is the same. In general, the steps to be followed in model development are presented below and should be followed in this sequence during the development of any transport modelling tool. The procedure applies equally for Simple Models as well as network models, although the level of detail that needs to be presented in a Simple Model is clearly much more limited.



*Figure 3-1: Steps in a Transport Modelling Activity*

In all cases, the Demand Analysis using Transport Models (particularly during the appraisal of the Preferred Option) shall take account of the standard parameter values presented in Annex II in their operation, and in the generation of output indicators.

* 1. Reporting of the Demand Analysis

It is crucial that any transport model is not a “black box” for project justification. The modelling process, input data, assumptions and outputs should be fully and transparently justified and documented to allow external review and understanding.

*General Information*

* Present all input assumptions, data collected, analysis methods applied.
* Present the procedure for construction, calibration and validation of the model.

*Without the Project:*

* A representation of demand on sections of the network in the vicinity of the project in the Without-Project Scenario for the Opening Year, the Design Year (Opening Year + 15 years), and the Horizon Year (End of Appraisal Period);

*With the Project (Preferred Option)*

* A representation of demand on sections of the network in the vicinity of the project for the With-Project Scenario for the Opening Year, the Design Year (Opening Year + 15 years), and the Horizon Year (End of the Appraisal Period);
* In the case of transport models using software packages, provide also study-area indicators for the Opening Year and Design Year to include as appropriate:
  + Network passenger-km by transport mode;
  + Network veh-km by vehicle type;
  + Network veh-hours by vehicle type;
  + Emissions (CO2);
  + Pollutants (if applicable);
  + Accident calculations (if applicable); and
  + Other indicators as dictated by the model abilities and specifications.

It is essential that there is a clear connection between the outputs of the Demand Analysis presented in this section of the report with the inputs to the Economic Analysis presented in Section 7 showing continuity between both analyses. The reporting should be prepared either within the Feasibility Study Report, or in the case of more complex models it can be prepared as an external stand-alone document (Transport Modelling Report) with a simple reference in the Feasibility Study Report. Whichever approach is chosen, the reporting should include all the information as set out in the JASPERS Transport Modelling Guidance1.

* 1. Using the Transport Model

The transport modelling is generally used at two points during project development, as follows:

* During the Options Analysis, the transport models are used to generate initial demand forecasts for each option for input to the Preliminary Appraisal (see Section 4.3.3). At this stage, an initial less-detailed version of the transport model can be used to support the option selection; and
* Following the Selection of the Preferred Option, the Transport Modelling is used to inform the final Economic and Financial Analysis (see Section 7).

**Required Outputs from this Section**

* As per requirements of the Transport Modelling Report (see JASPERS Transport Modelling Guidance)

1. Options Development and Analysis
   1. Introduction

When preparing a transport project, the identification and testing of alternative solutions is an important part of the process. Defining a series of relevant solutions and examining them for a given problem, allows the optimal project to be defined. This process is described as Options Analysis and Testing and ensures that the chosen project solution has the best potential for achieving a good economic and financial case.

Defining and selecting the optimal solution relies on good engineering and planning expertise. It requires the testing design solutions that differ in terms of scale, design parameters, alignment, technology, and operational specifications. The ultimate range of solutions depends on the skill and judgement of the design team, but if properly defined will ensure that the optimum design solution can emerge.

The Feasibility Study shall describe fully the process of Options Development and Analysis including all the options considered and the details of the analysis. The elements to be reported in the Feasibility Study are as shown below:

|  |  |
| --- | --- |
| Strategic Analysis  (Section 4.2) | Defines the *type* and strategic characteristics of the investment. |
|  |  |
| Technical Options Analysis  (Section 4.3) | Defines the appropriate technical design solution, supported by Concept design (or Preliminary Design if relevant). |
|  |  |
| Preferred Option  (Section 5) | Defines the final solution that will later undergo further refinement (Section 6), and which will undergo Preliminary Design and final appraisal (Section 8). |

Each Stage of Options Analysis is supported by an appropriate design and analytical exercise to compare and evaluate options, with the level of analysis and design becoming deeper as the designers narrow towards the final set of options.

* 1. Strategic Analysis

The Strategic Analysis should elaborate the rationale behind the selection of the type and the strategic characteristics of the project to be developed. The Strategic Analysis can achieve this requirement by one of three methodologies:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ***Method 1:***  *Link to Statutory Plan or Programme* |  | ***Method 2:***  *Compliance obligation according to a relevant EU Requirement* |  | ***Method 3:***  *Strategic Options Analysis* |

* + 1. Method 1: Link to Statutory Plan or Programme

The project has been identified in a statutory plan such as a Sustainable Urban Mobility Plan, Regional Transport Plan or National Transport Plan, which has been subject to a Strategic Environmental Assessment and where there is a clear recommendation for the type of project. The Feasibility Study shall refer to the statutory plan, the related environmental approval, and a reference to the specific recommendation within the plan.

* + 1. Method 2: Compliance obligation according to relevant EU requirements

The investment is required as part of a compliance requirement according to relevant EU legislation (e.g. compliance with the Railway Directives). The Feasibility Study shall refer to the relevant requirements.

* + 1. Method 3: Strategic Options Analysis

Where the type of project is not supported by an existing statutory plan nor compliance obligation, the Feasibility Study shall demonstrate how the project type and its basic characteristics has been defined. This is referred to as a Strategic Option Analysis. Examples of strategic analyses include:

* Refurbishment vs replacement of rolling stock
* Construction of new road vs upgrade of existing road
* Metro Project vs Urban Rail vs Bus Rapid Transit

The Strategic Options Analysis shall be undertaken as follows:

1. *Define the Strategic Options*: These should be defined as solution *types* at strategic level and not detailed project solutions.
2. Evaluate the Strategic Options: The framework should use a Multi-Criteria Analysis (MCA) that compares the project types against the project objectives which should be grouped under the categories shown in Table 1.1. The comparison should be supported by some high-level analysis (demand, cost, environmental and economic analysis) as necessary to inform a Multi Criteria Analysis of the Strategic Options.

The selected Strategic Option shall be taken forward to the Technical Analysis.

* 1. Technical Analysis

The Technical Analysis describes the development of the design solution for the chosen strategic option. The Technical Options Analysis is normally accompanied by some form of Cost Benefit Analysis and Demand Analysis to inform the option selection and testing. As such, this section should be read in conjunction with Sections 3 and 7 of this document. The sequence for the Technical Options Analysis is presented below.

* + 1. Step 1: Defining the Options

The key requirement in defining options in a transport project is that there is good flexibility in deriving possible solutions. As such, the parameters that are used to define solutions should not be fixed but should instead respond to the needs or objectives of the project. The following variables are relevant for transport projects, depending on the project type:

* Design parameters (pavement structure, design speed, target capacity, gauge etc)
* Alignment or Location
* Operational Aspects (how the project is to be used, considering for example ticketing technologies, passenger information, arrangements for maintenance, timetabling and fare structures for public transport services etc)

All these variables may not apply in all cases. For example, a rail rehabilitation may not require any consideration of alignment if the permanent way is already defined.

When considering a project, it is therefore necessary to consider which variables will apply, and then to consider those in defining alternatives. Table 4-1 below shows which of those might typically be relevant to examples of infrastructure objectives:

Table 4-1: Considering Alternatives for Transport Projects

|  |  |  |  |
| --- | --- | --- | --- |
| **Project Type**  *(see Annex I for more detail)* | **Design Parameters** | **Operating Plan** | **Alignment or Location** |
| Linear Projects | **ü** | **ü** | **ü** |
| Refurbishment or Upgrade Projects | **ü** | **ü** |  |
| Systems |  | **ü** |  |
| Local Infrastructure | **ü** | **ü** | **ü** |

Interpreting the above, it follows that for many projects, the design team should consider alternatives across more than one category of variables. A limited number of alternative technical options should be defined (at least 2). Nevertheless, for some projects (e.g. linear projects) the range of options may be much larger, and in such cases a Screening Exercise may be required to reduce this (see Step 2 below).

* + 1. Step 2: Screening

Where the defining of options leads to a high number of alternative technical options, it is possible to reduce this number before proceeding to the Preliminary Appraisal. This is done through a process of ‘Screening’ and is an optional activity, mainly relevant for linear projects where there are multiple variables and hence multiple technical options.

The Screening Process is intended to take the large number of alternatives defined in Step 1 down to a more manageable number of alternatives for further analysis. Screening comprises an initial review of alternatives to screen out those that are not consistent with the project objectives.

Requirements for screening are as follows:

* *The project options are presented at an early stage of design (e.g. Concept Design) which shall outline broadly the layout and scale of each option.*
* *For each option, an indicative cost estimate shall be prepared, based on unit rates (e.g. cost per km).*
* *Where demand and project impact differs between project options, demand and project impact of each option shall also be examined at a very superficial level to gain an initial understanding of each, using some basic analyses.*

A Multi-Criteria Analysis shall be used to determine how each alternative supports each project objective (see Section 1.2). Where excessive alternatives are rejected through the screening then it is clear that the alternatives have not been adequately defined – a minimum of three candidate options should emerge from the Screening process.

The table below shows an example of a screening based on project objectives, and is based on a Multi-Criteria Analysis (MCA). Impacts are classified on a 5-point scale and the result sees those options selected which mostly contribute to objectives, although noting that some refinement may be required during the later stages of development to address any negative impacts (for example below, the conflict of Option 2a with Objective 5).

**üü** Option contributes significantly to this objective

**ü** Option contributes slightly to this objective

**-** Option has no contribution to this objective

***x*** Option conflicts slightly with this objective

***xx*** Option conflicts significantly with this objective

*Table 4-2: Screening of Options (Multi-Criteria Analysis)*

|  | OBJECTIVE 1 | OBJECTIVE 2 | OBJECTIVE 3 | OBJECTIVE 4 | OBJECTIVE 5 | RESULT |
| --- | --- | --- | --- | --- | --- | --- |
| Option 1 | **üü** | **ü** | **üü** | - | **ü** | *Accept* |
| Option 2a | **ü** | **ü** | **ü** | **ü** | ***x*** | *Accept* |
| Option 2b | **ü** | **üü** |  | **ü** | - | *Accept* |
| Option 2c | **ü** | - | **ü** | **ü** | **ü** | *Accept* |
| Option 3 | **üü** | ***x*** | **ü** | ***xx*** | ***xx*** | *Reject* |
| Option 4 | - | **ü** | - | - | - | *Reject* |
| Option 5 | **ü** | ***x*** | **üü** | ***xx*** | - | *Reject* |

It is noted that the purpose of the Screening (outlined above) is to facilitate the rejection of options that are clearly less beneficial. In the above example, Options 3-5 score quite poorly against multiple objectives, and the decision has been taken to exclude them from subsequent option analysis. Options 1 and 2, however, all score better, and whilst some outperform others in certain objectives there is no clear preferential option emerging – for this reason they are all taken forward to the next stage of option analysis where a deeper analysis will allow the preferred option to be selected. This reflects the intended approach to the Screening, which is based on expert judgement as much as quantitative analysis.

This screening exercise therefore has a role to avoid options which contain fundamental weaknesses, which can lead to project cancellation or multi-year delays. The results of the Screening should also be used to highlight any specific project matters that have the potential to complicate the project in the future, and hence which should be accounted for in the design stage.

* + 1. Step 3: Preliminary Appraisal

The Preliminary Appraisal is the final stage of analysis before selection of the preferred design option. As it involves fewer technical options, a more detailed level of analysis is possible in order to inform the final selection. The requirements for the Preliminary Appraisal are as follows:

* The technical options are elaborated to a Concept Design or Preliminary Design (as appropriate) which shall provide more detailed information on the layout and specification of each option in order to understand more fully the cost and impacts.
* The Design shall be costed for each of the options. A reasonable estimate of the cost based on benchmarks or initial itemised cost estimation can be sufficient.
* Where demand models have been used, and where there is an expected difference in demand resulting from the different options, then generate demand forecasts for each option.
* Summarise the environmental impacts of each option, considering the baseline information, and the impact of the project in generating externalities such as noise, pollution, emissions etc. This should relate to the technical option analysis also where it is presented in the EIA.
* Undertake a risk assessment of the option, considering technical challenges in its delivery (such as innovative technology, risk of unforeseen environmental or archaeological impacts, technical capacity etc).

The purpose of the Preliminary Appraisal is to understand, based on a subset of parameters, the indicative level of economic feasibility of a project. It will also assist with the selection of the preferred option through the examination of the project cost and performance through measurement of key parameters (e.g. cost/time saving). The Options Analysis shall use the following framework for comparison of options:

*Table 4-3: Framework for Presenting the Result of the Preliminary Appraisal*

|  |  |  |
| --- | --- | --- |
| **Economic Analysis** | **Environmental Impact** | **Technical Feasibility** |
| The Economic Analysis shall be based on a Cost Benefit Analysis or Cost Effectiveness Analysis, depending in the project type (See Section 7 of this document). Note that the Economic Analysis should include any additional costs relating to mitigating environmental impacts. | What are the key impacts of each design solution on key environmental assets that are not possible to mitigate through design. | What are the challenges in delivering the project, that relate to the project design and costing, that are not fully mitigated through the project design. |
| See Section 4.3.3.1 below | See Section 4.3.3.2 below | See Section 4.3.3.3 below |

* + - 1. Economic Analysis

**Economic Analysis Method 1: Cost Benefit Analysis (See Simplified Analysis in Section 7.3.3)**

If the output and externalities are different in different options (assuming all share the same objective), a simplified CBA for all main technical options to identify 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, namely on the Economic Net Present Value (ENPV) and the Economic Rate of Return. 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 (see above). Ultimately the designer may select whichever benefits to account in the Preliminary Appraisal, although it is recognised that the following benefits will generate the majority of user benefits for many transport projects:

* + *Time Savings;*
  + *Operating Cost Savings;*
  + *Accident Savings;*
  + *Emissions Savings;*

**Economic Analysis Method 2: Cost Effectiveness Analysis**

If the alternative technical options have the same, unique objective and the same or very similar externalities, the analysis can 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.

* + - 1. Environmental Impact

The summary of Environmental Considerations should be prepared with reference to the analysis undertaken in the EIA. It should outline the main impacts of the investment for each option, showing the relative impacts for each option, for example:

* + *Impact on Groundwater*
  + *Landscape;*
  + *flora and fauna;*
  + *human settlements;*
  + *groundwater;*
  + *contribution to climate change mitigation and adaptation objectives;*
  + *Noise;*
    - 1. Technical Feasibility

The Technical Feasibility focuses on those aspects of the project that might give rise to significant risk of delivery on time or within budget. It should consider issues such as:

* + *Affordability;*
  + *Scale of project;*
  + *Institutional capacity and need for expertise;*
  + *Level of design innovation;*
  + *Difficult or unknown construction conditions;*

The results of the Preliminary Appraisal shall be presented within an overall framework that considers Economic, Technical and Environmental parameters as above. The outcome of the analysis should clearly define the preferred solution and the basis for selecting it. For certain projects, where the project may be defined as individual components, this Preliminary Appraisal may be undertaken individually for each component.

**Required Outputs from this Section**

* Presentation of the Strategic Options Analysis, showing the options identified and the Strategic Analysis according to objectives.
* Presentation of the Technical Options Analysis
* Presentation of the final table showing Economic, Environmental and Technical Feasibility for each option, along with the basis for the final decision on the Preferred Option.

1. The Project Definition
   1. Overview

The Option Analysis will lead to the selection of a Preferred Option for the project to be taken forward for final appraisal (Cost Benefit Analysis). Nevertheless, prior to freezing the final option, there is a final opportunity to further refine the selected option as necessary in order to improve its performance or further mitigate its impacts.

* 1. Refining the Project

The project definition stage should seek ways to improve the performance of the project without any fundamental change in the project scope or functionality. The following activities should be considered:

* Measures to reduce the cost of the project without any reduction in quality or performance, and without any increase in project scope. This activity is referred to as Value Engineering;
* Mitigation measures to address any environmental impact of the project, arising from the EIA procedure or through consultation with key stakeholders; and
* Operational modifications in order to improve the effectiveness of the project investment or reduce risk.
  1. Project Definition

The Project should finally be presented in detail to include all key components and elements to form a stand-alone investment that can operate successfully upon completion.

* 1. Project Indicators

This should also include the presentation of indicators that form the basis for delivery of the project, and subsequent auditing. As a minimum, the project indicators in the Operational Programme should be used, where the project is included under EU funds.

**Required Outputs from this Section**

* Description of modifications made as part of the Project Refining.
* A presentation of the impacts of the modifications, considering cost (capital cost and operating cost), environmental impact and technical risk.
* Project Definition,
* Project Indicators

1. Cost
   1. Investment cost

The Investment Cost should be calculated in accordance with relevant codes guiding project costing (Ministerial Decisions, where applicable). Investment costs should be presented as both Nominal Costs (without inflation) and Real Costs (including inflation). Project contingency of either 9% (increased to 15% for projects with a value below €5m) is also permitted. VAT should also be included in the project cost as a separate item.

Investment costs should be established based on the current Design Stage (at least Preliminary Design) and should be presented as incremental costs over the Without-Project scenario. In the case of supply projects (e.g. bus fleets, safety systems, rolling stock), market pricing should be used. A template for the CAPEX is presented below.

*Table 6-1: Example template for the CAPEX (to be adjusted as appropriate for the project type)*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Year** | **Designs/ Supervision** | **Expropriations** | **Earthworks** | **Structural Works** | **Hydraulic Works** | **Road Substructure** | **Pavement** | **Signs / Safety** | **E/M Installations** | **Landscaping** | **Waste Management** | **Archaeology** | **Utilities Works** | **Total** |
| 2023 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2024 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2025 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2026 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2027 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| .. |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| .. |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Total** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

Present expenditure by component such that the share of expenditure across the key components is visible. Definition of components for each project type is presented in the table below. A different structure for presenting the cost breakdown will be required depending on the project type, and is informed by relevant design codes in some cases (e.g. Circular 11 in the case of Road Projects). An indicative structure for cost breakdown by project type is presented in Table 6-2.

*Table 6-2: Suggested components for cost reporting*

|  |  |
| --- | --- |
| **PROJECT TYPE** | **SUGGESTED COMPONENTS** |
| **Linear Projects** |  |
| *Roads* | *Design Supervision, expropriations, earthworks, structural works, hydraulic works, substructure, pavement, signs, electromechanical installations etc (See Table 6-1)* |
| *Railways* | *Design Supervision, expropriations, earthworks, permanent way, structures, hydraulic works, signalling, rolling stock, buildings (stations), electrical systems etc* |
| *Metro* | *Design Supervision, expropriations, earthworks, tunnelling, structures, hydraulic works, signalling, rolling stock, buildings (stations), electrical systems etc* |
| **Refurbishment or Upgrade Projects** |  |
| *Road Upgrade* | *Design Supervision, expropriations, earthworks, structural works, hydraulic works, substructure, pavement, signs, electromechanical installations etc (See Table 6-1)* |
| *Railway Upgrade* | *Design Supervision, expropriations, earthworks, permanent way, structures, hydraulic works, signalling, rolling stock, buildings (stations), electrical systems etc* |
| *Rail Electrification* | *Design Supervision, electromechanical installations Supply infrastructure, earthworks, structural works,* |
| *Road Safety* | *as appropriate for road upgrade or new road construction* |
| *New Metro Fleets* | *Fleet, depot upgrades, electromechanical installations* |
| *Refurbished Metro Fleets* | *Fleet, depot upgrades, electromechanical installations* |
| *New Bus Fleets5* | *Fleet, charging equipment, depot upgrades, grid works, traffic management works, systems* |
| **Systems** |  |
| *Rail Systems* | *On-board equipment, trackside equipment, back-office systems* |
| *Aeronautical Systems* | *Infrastructure, equipment, back-office systems* |
| **Local Infrastructure** |  |
| *Rail Stations* | *Structures, systems* |
| *Level Crossings* | *Road works, level crossings, signalling* |

* 1. Operation and Maintenance cost

The incremental operation and maintenance cost of the investment must be calculated for the full appraisal period. Costs should be presented as both Nominal Costs (without inflation) and Real Costs (including inflation). This may be based on one of the following:

* Benchmarking against comparable operations, with relevant adjustment factors made for Greek conditions;
* Extrapolation of existing operating costs at aggregate level, and used to estimate the additional operating cost of an increase in existing operations; or
* An estimation based on first principles that examines the contribution of materials, staff and administrative costs in managing the infrastructure.

The operation and maintenance cost should be presented according to the incremental increase over the Without-Project scenario, hence describing the additional public funds that will be required to ensure a sustainable operation and maintenance throughout the life of the infrastructure

* 1. Summary of expenditure profile

The final capital and operating/maintenance cost should be presented as follows:

* Expenditure by year (over the full appraisal period);
* Expenditure by type (capital or operating);

**Required Outputs from this Section**

* Capital Cost, by year of expenditure and by cost component
* Operating Cost, including an allowance for inflation, over the full appraisal period

1. Financial and Economic Analysis
   1. Overview

The Economic and Financial Analysis is relevant throughout the full project development process. It has been presented earlier in this document how Economic Analysis is used to support in the selection of the preferred option, where the results of the economic analysis are assessed alongside criteria covering environmental impact and technical feasibility.

Nevertheless, for the final selected option, a final and full Economic Analysis is required, in order to justify the use of public funds in the proposed project investment. This final Economic Analysis shall use methodologies and standardised parameter values in order to ensure a consistent benchmark against all projects.

Parameters values for the Financial and Economic Analysis have been standardised to ensure consistency across projects. The parameter values set for transport projects are attached in Annex 2 of this Guide.

* 1. Financial Analysis

Financial Analysis shall be based on the provisions of the relevant documentation, the Economic Appraisal Vademecum 2021-2027, the Guide to Cost-Benefit Analysis of Investment Projects 2014-2020 and common practice. The financial analysis includes the following cash flows regarding the With-Projct scenario:

**Capital Expenditure (CAPEX)** cash flow that refers to the investment cost and includes all the historical and future costs for the project to be implemented, allocated in main cost categories and years of implementation. The CAPEX for the financial analysis should be based on the data presented in Section 6 (Investment Costs) showing clearly the application of discounting.

**Operating Expenditure (OPEX)** cash flow that refers to all the costs necessary for the project to be operational. OPEX shall be presented in annual basis and divided, if desired, to maintenance and operation costs separately. If O&M plan is not available, a concept one shall be presented to substantiate the corresponding cost. The OPEX for the financial analysis shall be based on the data presented in Section 6 (Investment Costs) showing clearly the discounting.

**Project Revenues** cash flow that refers to the user revenues paid during project operation. When revenues are also received in project’s implementation period, they must be included in revenues cash flow.

**Project Residual Value (RV**). Residual value is calculated based on the remaining value at the end of the appraisal period in accordance with the Vademecum.

The Financial Analysis should report the FNPV/C and FNPV/K, as well as the FIRR for the investment.

If the project is not sustainable during operation period, the promoter shall identify the financing plan that will allow the corresponding deficit to be overcome (e.g., loan).

* 1. Economic Analysis
     1. Economic Appraisal Level of Detail Criteria

It is recognised that some smaller projects may not require a full economic appraisal, and hence a more simplified version of the methodology is defined for those projects defined as ‘Small Projects’ (capital value of less than €10m excluding VAT) or where only an indicative early result is desired (for example to assist with option analysis).

The criteria to be used to decide whether to perform a Full or a Simplified Economic Appraisal depend on the project’s various characteristics and shall be defined by the project’s promoter on a case-by-case basis. Nevertheless, it is useful to provide a general indicative framework for accessing the need of a Full or a Simplified Appraisal.

* **Project magnitude** is one of the Appraisal detail selection criteria. Small projects, meaning the projects with an investment cost of less than €10m (excluding VAT) could be evaluated from an economic point of view by using Simplified Appraisal. Large or strategic projects shall be evaluated through a Full Appraisal;
* **Project Type** is another Appraisal detail selection criterion which is not dependent entirely on the project magnitude. A small project with a medium or high added value to the transport networks’ economic performance (e.g., a small new port serving an island, a new suburban railway station, a missing transport link or a bottleneck overcoming) that requires a detail analysis to capture its wide economic benefits might need to be evaluated through a Full Appraisal.
* **Project Phase** (see Chapter 9). Simplified Economic Appraisal can be used in an early project planning process (Functional Studies) to support, among other criteria, the selection of the preferred option.
  + 1. Full Economic Appraisal

The Full Appraisal is described in the EU Guidelines for Cost Benefit Analysis, and the Vademecum. It comprises the capture of all economic costs and benefits for reporting the economic impact of the project, such as:

* Capex, Opex and Residual Value
* Travel Time
* Emissions and Pollutants
* Transport Costs (Vehicle Operating Costs)
* Noise
* Accidents
* Consumer Surplus

Particular attention shall be given to the following requirements:

* The Appraisal shall use the parameter values set out in Annex II of this document, for all projects, in order to ensure consistency. Standard parameter values may be overwritten by local values in certain circumstances, where shown in Annex II.
* The Incremental approach between Without-Project and With-Project scenarios shall be applied in the Economic Analysis. Therefore, economic costs and benefits shall be estimated for both scenarios.
* Operating costs (O&M) shall be checked against sectoral benchmarking and documented accordingly.
* Wider impacts achieved through the multiplier effect (e.g., contributions to regional gross domestic product or unemployment rates) shall be excluded from the analysis. Induced impacts on local economies shall also be excluded.
* In-kind contributions (e.g., railway superstructure materials to be reused) supplied during either implementation or operation periods shall be included in the analysis at (at least) their market value, even if they do not correspond to an actual financial cash flow.
* Revenues paid by the users are not considered as economic revenues and shall not be included in economic analysis.
  + 1. Simplified Economic Appraisal

The Simplified Economic Appraisal is a variation on the Full Appraisal, with the following characteristics:

* It uses only a subset of the parameters listed under Full Appraisal, such as Travel Time and/or Accidents. In general the Simplified Appraisal will only consider those impacts that are the most relevant for the project in question;
* Economic CAPEX, OPEX and Residual Value are estimated based on financial costs excluding VAT. No other fiscal correction is applied unless a national conversion factor is available, or a simplified assumption can be applied. It is based on indicative costs, acquired based on benchmarking or application of unit costs;
* It considers standard parameters instead of site-specific parameters for the appraisal;
* A Simple Model is used to estimate incremental demand;
* Financial Revenues are still not included;
* Economic benefits (costs) are roughly estimated with limited, or no disaggregation based on average parameters values; and
* ENPV, ERR and Benefit over Cost Ratioare still documented**.**

The Economic Analysis should report the EIRR, ENPV and Benefit Cost Ratio for the investment.

* 1. Financing Plan

The Feasibility Study Report should outline the sources of funding for the project, including the allocations of public funds, EU grants, loans and other sources. The Table below presents a template for such information:

*Table 7-3: Template for the Financing Plan*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Year** | **Source of Total Investment Costs (€)** | | | | | **Of Which EIB/EIF Loans** |
| **Total Investment Cost** | **Union Assistance** | **National Public** | **National Private** | **Other (Specify)** |
| **(a)=(b)+(c)+(d)+(e)** | **(b)** | **(c)** | **(d)** | **(e)** | **(f)** |
| **2023** |  |  |  |  |  |  |
| **2024** |  |  |  |  |  |  |
| **2025** |  |  |  |  |  |  |
| **2026** |  |  |  |  |  |  |
| **Total** |  |  |  |  |  |  |

**Required Outputs from this Section**

* Financial Analysis of the Preferred Option
* Economic Analysis of the Preferred Option, according to the project type (see Annex II regarding requirements for different project types)
* Financing Plan

1. State Aid
   1. Overview

State aid to undertakings is generally prohibited under EU Law (Treaty on the Functioning of the European Union (TFEU), Article 107(1)). Where public aid is granted to an undertaking, this may give the company in question a selective financial advantage, leading to distortion of competition and hence the proper functioning of the internal market.

However, public aid to undertakings may be ‘compatible’ with the internal market under certain circumstances. Such conditions are determined through an assessment of State Aid compatibility.

* 1. Demonstrating State Aid Compliance

Demonstrating alignment with rules on State Aid is compulsory for all investments. As such, it is necessary to demonstrate within the Feasibility Study how such compliance is achieved. This can be achieved through the following process:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ***Step 1:***  *State Aid Assessment* |  | ***Step 2:***  Is Aid Exempted through an Existing Regulation? |  | ***Step 3:***  *Approval from Competent Authority* |

**Step 1: State Aid Assessment**

Using appropriate legal expertise, assess the project under the following questions. The investment is considered to be State Aid where the following conditions are cumulatively met:

* public resources are channelled to public or private undertakings (‘undertaking’ refers to any entity engaged in economic activity, irrespective of its legal form)
* the advantage is selective, i.e. only conferred on certain undertakings
* the measure distorts or threatens to distort competition by favouring the beneficiary
* the measure affects trade between EU Member States.

Only in cases where *all* of the above criteria are met, then the investment can be considered to be State Aid. Should the investment be considered State Aid, or where any doubt exists, then proceed to Step 2.

**Step 2: Is Aid already exempted through an existing Regulation?**

Where a project investment is likely to be State Aid, it may be permitted through an existing regulation. Typical cases include the General Block Exemption Regulation, De-Minimis Aid or Regulation 1370 on the provision of Public Service Contracts as Services of General Economic Interest.

Should there be such a legal provision based on the investment type, the aid intensity and investment value, then the State Aid may be considered compliant.

Where no such provision exists, or where there is doubt, then proceed to Step 3.

**Step 3: Notification**

Where a project involves State Aid, and it cannot be deemed compatible through either of the above steps, then a notification is required. This should be done through the National Competent Authority and approval for the project sought prior to submitting the investment for financial support.

* 1. Funding Gap Analysis

If, after the State Aid Compliance exercise, the project is considered to fall under State Aid Rules, a funding gap analysis shall be performed to calculate state aid intensity. The following steps shall be applied:

1. *In the case of projects where only a part of the project involves State Aid, that component of the infrastructure falling under State Aid shall be identified.*
2. *CAPEX, OPEX and revenues of the infrastructure falling under State Aid shall be identified;*
3. *Weighted Average Cost of Capital (WACC) shall be estimated.*
4. *Funding gap analysis shall be performed to calculate state aid intensity, using WACC as discount rate.*
   1. Practical Guidance on State Aid

When there is potential state aid in an investment project, a number of principles are recommended to the project promoter:

* Seek advice early and think state aid first. Build State Aid implications into initial appraisal and reconsider the state aid implications as project develops.
* Allow enough time for clearance and be aware that the competent authority may require changes to schemes which are notified to it.
* Be aware of the risks of implementing unapproved aid – the cost of misjudgement will be high, and it is not within the power of the promoter to resolve the issue.
* Seek insofar as possible to fit any proposals to an existing approved aid or the general block exemption.
* Invoke the assistance of the National competent authority to ensure that the requisite notification is made. Any decision not to notify must be discussed with the state aid team in advance. Obtain advice from your state aid experts and lawyers.
* It is better to make the notification and have it approved at the outset rather than seeking to retrofit an approval.
* The notification should be as thorough as possible from the beginning, give a full break down of the costs of the investment, explain all the background to the project, set out project time-schedule and milestones, highlight safety issues and describe in detail the environmental and transport advantages of the project.
* It may be useful to pre-notify the proposed aid so as to expedite the approval process.

**Required Outputs from this Section**

* Demonstration of State Aid Compliance.

1. Procurement and Implementation Plan
   1. Procurement Method

The selected form of procurement for the investment should be presented in detail. This should describe:

* Type of Procurement (Supplies, Construction Works, Services, or a combination of each);
* Type of procedure (Open Tender, Competitive Dialogue or other relevant form);
* Delivery Model (Works Contract, Design and Build, Design Build Operate, Concession etc).

For procurement of Goods, the draft tender specifications or the schedule of terms should be included as an annex to the Feasibility Study.

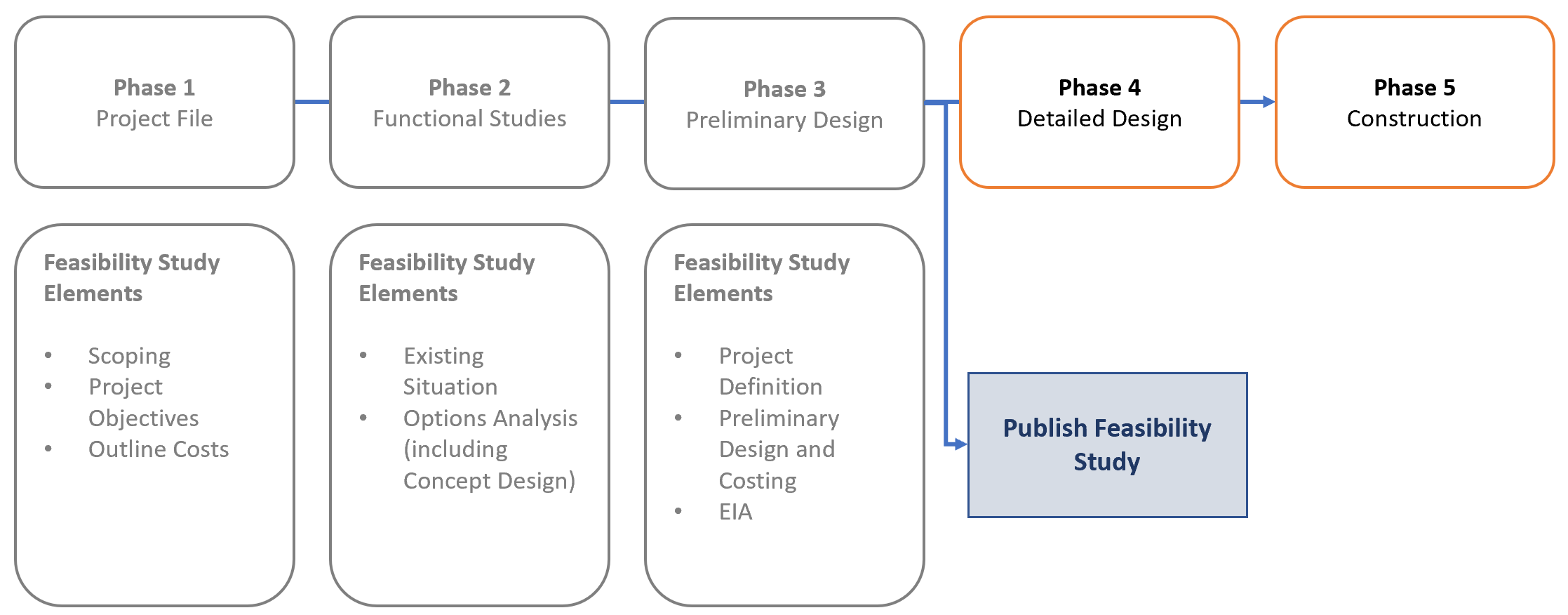
* 1. Implementation Plan

The Implementation Plan allows the scheduling of project activities to be understood, such that the timing of expenditure can be properly planned The Plan should include all phases of the project from the current stage (at the time of preparing the Feasibility Study) through to commencement of operations following construction.

The structure of the Project Cycle is outlined below, showing how the different Phases of the Project Cycle feed into the preparation of the Feasibility Study. It is shown how the Feasibility Study Report is delivered upon completion of Phase 3 (Preliminary Design).

The Implementation Plan should set out, in the Feasibility Study, the overall timeplan for the detailed design (Phase 4), and the Construction Period (Phase 5). This should show the duration of the works period with an estimation of works start and completion dates.

Where there are any residual issues relating to environmental permitting or development consent, these should be shown clearly within the Plan.



It is stressed that a rational and realistic assessment of the duration of the various activities is extremely important in relation to the planning of public funds and the maximisation of the financial absorption of the Programme. The above-mentioned estimates should be based as far as possible on statistics from previous similar projects or at least on the experience of the staff involved in these projects.

**`**

**Required Outputs from this Section**

* Procurement Plan
* Implementation Plan as a Gantt Chart

1. Operational Plan
   1. Scope of Operations

Describe the operational activities of the project. This should consider the following:

* Public Services (e.g. bus or rail services)
* Maintenance
* Environmental Monitoring
* Safety Inspections
* Operation of any IT systems associated with the investment
  1. Governance during Operations

For each of the above activities, outline the following:

* What legislative provisions apply to such activities (if any) and what is the scope of those provisions;
* who will be the entity responsible for each activity;
* whether any capacity building/training is required in the case of new technologies;
* The manpower requirement where this is not covered through existing functions of the responsible entity; and
* The related annual cost for such operations and maintenance, which shall also relate to the financial analysis undertaken earlier.
  1. Operating Plan

Where there is a change to existing operations required due to the new investment, outline what aspects of the operations are changing and how this has been designed to improve the operating viability of the investment.

**Required Outputs from this Section**

* Scope of Operations
* Outline of Governance for each operating item
* Report on modification of operations where this is proposed

1. Risk Assessment
   1. Risk Identification and Management

Risk Assessment is an integral part of the feasibility study and contributes to the understanding and recording of potential problems of the project, the assessment of their impact and the timely formulation of preventive and corrective measures to ensure the implementation of the project. This risk analysis, in order to be complete and successful, requires the cooperation of all key stakeholders, i.e. the study team, the Beneficiary, any external experts, local community bodies, etc.

The methodology proposed below is based on Annex III of Implementing Regulation 207/2015 and this guide is further specified in order to be a tool for immediate and practical application. The proposed risk analysis shall be qualitative and shall include the following:

1. ***General Information***

* Phase of the project (See Section 9.2 for Definitions)

1. ***Present the Risk***

* Describe the risk
* Describe the causes
* Describe the impact

1. ***Analyse the Risk (see section 11.3 below)***

* Establish the probability of the occurrence of the risk
* Establish the severity of impacts
* Conclude on the Risk Assessment

1. ***Manage the Risk***

* Who is the responsible body for this risk: This would be one of the bodies who are responsible for the preparation, implementation and operation of the projects.
* What measures are proposed to minimise this risk, relevant to this project only.
* What wider Risk management Strategies are being used to manage this risk.
* Assessment of residual risk after implementation of the measures

In order to define and describe the risks, it is proposed that the list of risks in Annex III of EU Implementing Regulation 207/2015 should be used as a starting point. It should be stressed that the definition of risks is not usually limited to those described in that list and all additional risks that may arise from other reasons, e.g. specific local circumstances, must be identified.

* 1. Risk Analysis

A sequential analysis of risk shall be undertaken according to the procedure set out below. This shall be undertaken for each project risk identified above.

**Step 1: Probability**

In the analysis of the risk (part b of section 11.2), the probability of the occurrence of the risk shall be assessed on a scale from 1 to 5 as set out in the table below:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Probability of occurrence (P) | 1 | 2 | 3 | 4 | 5 |
| Quality scale | Rarely | Very small | Medium | Large | Very large (almost certain) |
| Quantitative scale | P ≤ 5 % | 5-20 % | 20-50 % | 50-80 % | P ≥ 80 % |

Since, as a rule, there are no relevant statistics, the experience of the study team and the Beneficiary, as well as the adherence to the participatory procedure described above, are crucial for a reliable qualitative assessment of the likelihood of occurrence and for the corresponding assessment of the materiality of the effects described below.

**Step 2: Severity**

The severity of the effects shall also be assessed on a scale from 1 to 5 as set out in the table below:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Risk impact assessment | 1 | 2 | 3 | 4 | 5 |
| Quality scale | Insignificant | Small | Moderate | Large | Disastrous |

**Step 3: Grading and defining the Risk Mitigation Measures**

The risk assessment shall be derived from the probability of occurrence with the severity of the impact and shall be reflected in the so-called risk assessment register presented below:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Probability | 1 | 2 | 3 | 4 | 5 |
| Severity | 1 | 1 | 2 | 3 | 4 | 5 |
| 2 | 2 | 4 | 6 | 8 | 10 |
| 3 | 3 | 6 | 9 | 12 | 15 |
| 4 | 4 | 8 | 12 | 16 | 20 |
| 5 | 5 | 10 | 15 | 20 | 25 |

The final colour coding of the level of risk is shown in the table below:

|  |  |
| --- | --- |
| Colour | Risk assessment |
|  | Negligible |
|  | Small |
|  | Medium |
|  | Large |
|  | Extreme |

On the basis of the above findings, a series of additional risk mitigation measures shall be proposed. These shall look to reduce either probability or severity, in order to reduce the overall risk to the project delivery.

**Step 4: Residual Risk Assessment**

The assessment of the residual risk after the implementation of the measures completes the risk analysis. Please note that, as a rule, the remaining risk should be at most medium. If this is not possible, consideration should be given to the implementation of the risk avoidance or transfer strategy as described above.

* 1. Other Considerations

Risk prevention/reduction measures should be concise but clearly formulated and should be practicable.

Redesign should be strongly considered in cases where the occurrence of the risk is almost certain and the results are large or extreme for the project.

Risk transfer is one technique for risk management and can be done partially or totally. For example, project promoters transfer the risk of project failures, etc. to insurance companies, through appropriate insurance contracts, the provisions of which are generally determined by the Beneficiary in the tender documentation. There are also cases where the Beneficiary assigns tasks (e.g. the preparation of project studies) to another entity because it considers that it does not have the required skills and/or staff to commission, control and approve the studies in a timely and effective manner.

It is often customary for public bodies to transfer the responsibility for dealing with risks to the project promoters for risks that are not under the control of the Contractor (e.g. delays in studies due to lack of timely approval by the competent department, etc.). The use of such terms in the tender documents should be used carefully, as it may discourage bidders, can lead to legal disputes that then lead to long delays and cost overruns of the works.

In addition, a number of general points are made here in relation to the Risk Management:

* The risk management should identify risks that are practical and which may arise in the future, either at design, implementation or operational stage. The design team should carefully consider what can potentially go wrong with the project, and develop already some proposals for avoiding or mitigating such risks – such as including additional measures in the design or some operational protections. This practical approach is important in order to maximise the chance of a successful project;
* The risk management should focus on those risks where there is the ability of the project team to develop such mitigation measures, and on measures that are within the control of the project team. For example, delays during the planning process are a common risk, but the real cause of such delays should be understood (e.g. public opposition or unclear environmental impacts) and effort made during the design process to address these issues in order to address the root cause of such delays. Measures should be clear and targeted, and be over ana above what is normally undertaken as part of project implementation;
* The exercise should focus on future risks that will arise after the preparation of the Feasibility Study, and not risks that are purely related to the Feasibility Study Stage. In this way, the risk management should always look forward;
* It should be clear when identifying risks who is the responsible entity for addressing or managing such risks, and with a clear understanding and agreement of that entity that they are the most appropriate entity for implementing the risk management measures; and
* The risk management is a continuous process. Risks should be monitored regularly (monthly) during Phase 4 (Detailed Design) and Phase 5 (Construction) in order to ensure that the project team is dealing with the most recent project situation.
  1. Reporting

The summary of the risk analysis should be presented in tabulated form, based on the Table 11-1 overleaf.

**Required Outputs from this Section**

* Risk Assessment in Tabular Format (see Table 11-1)

*Table 11-1: Template for Risk Assessment*

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Phase1 | Risk description | Impact | Probability of occurrence | Severity of impact | Risk assessment | Risk Management Body2 | Measures | Residual risk |
|  |  |  |  |  |  |  |  |  |
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1. *See Section 9 of this document for definition of project phases*
2. *Risk management bodies for the specific projects are their Beneficiaries, who are responsible for the preparation, implementation and operation of the projects.*
3. Climate Vulnerability and Risk Assessment
   1. Overview

In general, infrastructure projects require an assessment of their vulnerability to climate change risks along with the inclusion of mitigation measures in the project as appropriate. The Climate Vulnerability and Risk Assessment is based on an assessment of climate ‘hazards’ for the location of the project and follows a standardised procedure for the definition of mitigation measures.

Guidance on undertaking the Climate Vulnerability and Risk Assessment has been prepared by the National Coordination Authority of the Ministry of Development and Investments, in collaboration with JASPERS, and with the support of the Ministries of Environment and Energy (RIS) and Infrastructure – Transport (YPYME). The guidance presents the methodology for climate-proofing of investments across multiple sectors, including transport.

The Guidance can be downloaded from <https://adaptivegreecehub.gr/eleghos-klimatikis-anthektikotitas/>

* 1. Climate Vulnerability and Risk Assessment (Summary)

The Feasibility Study should present the Climate Vulnerability and Risk Assessment, either by presenting the work within Section 12 of the Feasibility Study or by making reference in this section of the Feasibility Study to a standalone Climate Vulnerability and Risk Assessment for the project.

**Required Outputs from this Section**

* Climate Vulnerability and Risk Assessment according to the Guidance provided by https://adaptivegreecehub.gr/eleghos-klimatikis-anthektikotitas/

1. Environmental Impact Assessment Summary
   1. General

Provide a reference to the EIA (document number) where the project has been subject to an Environmental Impact Assessment. Also provide a summary of the status of the EIA – highlighting if it has been submitted and approved.

For projects not subject to EIA, the main environmental impacts and risks should be outlined, also reflecting the environmental impacts considered as part of the options analysis.

**Required Outputs from this Section**

* Summary of status of EIA
* Link to EIA documentation and to the approval from the relevant authority

**Annexes**

*Annex I Project Types and Analytical Requirements*

*Annex I I Parameter Values (For economic and Financial Analysis)*

***Annex I***

*Project Types and Analytical Requirements*

***Annex I: Project Types and Analytical Requirements***

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  | **Option Analysis** | | | **Economic Analysis** |  | | | | | | |
|  | Objectives | Existing Cond | Demand | *Strategic* | *Screening* | *Prelim Appraisal1* | *Detailed Appraisal2* | State Aid | Procurement Plan | Operational Plan | Risk Analysis | Climate | EIA Status |
| **Linear Projects** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| *Roads* | **ü** | **ü** | MSM | **ü** | **ü** | *CBA* | *CBA* | **ü**3 | **ü** | **ü** | **ü** | **ü** | **ü** |
| *Railways* | **ü** | **ü** | MSM | **ü** | **ü** | *CBA* | *CBA* | **ü** | **ü** | **ü** | **ü** | **ü** | **ü** |
| *Metro* | **ü** | **ü** | VDM | **ü** | **ü** | *CBA* | *CBA* | **ü** | **ü** | **ü** | **ü** | **ü** | **ü** |
| **Refurbishment or Upgrade Projects** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| *Road Upgrade* | **ü** | **ü** | ASM | **ü** |  | *CBA* | *CBA* | 3 | **ü** | **ü** | **ü** | **ü** | **ü** |
| *Railway Upgrade* | **ü** | **ü** | MSM | **ü** |  | *CBA* | *CBA* | **ü** | **ü** | **ü** | **ü** | **ü** | **ü** |
| *Rail Electrification* | **ü** | **ü** | MSM | **ü** |  | *CEA* | *CBA* | **ü** | **ü** | **ü** | **ü** | **ü** | **ü** |
| *Road Safety* | **ü** | **ü** | SM | **ü** |  | *CBA* | *CBA* | 3 | **ü**6 | **ü** | **ü** | **ü** | **ü** |
| *New Metro Fleets* | **ü** | **ü** | MSM | **ü** |  | *CBA* | *CBA* | **ü** | **ü** | **ü** | **ü** | **ü** | 4 |
| *Refurbished Metro Fleets* | **ü** | **ü** | MSM | **ü** |  | *CBA* | *CBA* | **ü** | **ü**6 | **ü** | **ü** | **ü** | 4 |
| *New Bus Fleets5* | **ü** | **ü** | MSM | **ü** |  | *CBA* | *CBA* | **ü** | **ü**6 | **ü** | **ü** | **ü** | 4 |
| **Systems** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| *Rail Systems* | **ü** | **ü** |  | **ü** |  | *CEA* |  | **ü** | **ü**6 | **ü** | **ü** | 7 | 4 |
| *Aeronautical Systems* | **ü** | **ü** |  | **ü** |  | *CEA* |  | **ü** | **ü**6 | **ü** | **ü** | 7 | 4 |
| **Local Infrastructure** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| *Rail Stations* | **ü** | **ü** | MSM | **ü** |  | *CEA* | *CBA* | 3 | **ü** | **ü** | **ü** | **ü** | **ü** |
| *Level Crossings* | **ü** | **ü** | SM | **ü** |  | *CEA* | *CBA* | 3 | **ü** | **ü** | **ü** | **ü** | **ü** |

1. *Preliminary Appraisal uses simplified CBA to understand comparative performance between Options.*
2. *For projects <€10m, these are defined as Small Projects, and a Detailed Appraisal is not generally required.*
3. *A State Aid Assessment is required where there is any form of private sector financing or impact on existing concessions*
4. *Provide this information only where the project is subject to an EIA*
5. *Assumes that projects include ancillary infrastructure to support operations*
6. *Draft tender specifications or schedule of terms should be included with the Feasibility Study*
7. *Applicable only to those parts of the investment that are considered ‘Infrastructure’.*

***Annex II***

*Parameter Values (For economic and Financial Analysis)*

**ANNEX A. Default Parameters Values**

*Table of Contents*

[A. Key Parameters 1](#_Toc152841462)

[B. Value of Time 2](#_Toc152841463)

[**B1. Passenger Transport** 2](#_Toc152841464)

[**B2. Freight Transport** 3](#_Toc152841465)

[B2.1 Road Freight Transport 3](#_Toc152841466)

[B2.2 Rail Freight Transport Component of Travel Time 3](#_Toc152841467)

[B2.3 Cargo Component of Travel Time 3](#_Toc152841468)

[B2.4 Ramp-Up in Transport Cost Component of Freight Travel Time Benefits 3](#_Toc152841469)

[B2.5 Assumed Freight Train Loading (tons) 3](#_Toc152841470)

[C. Vehicle Operating Cost 5](#_Toc152841471)

[**C1. Passenger Transport** 5](#_Toc152841472)

[C1.1 Passenger Perceived VOC (€ per vehicle per 100 km in real terms) 5](#_Toc152841473)

[C1.2 Passenger Economic VOC (€ per vehicle per 100 km in real terms) 5](#_Toc152841474)

[**C2. Freight Transport** 5](#_Toc152841475)

[C2.1 Freight Perceived VOC (€ per vehicle per 100 km in real terms, 2023 prices) 5](#_Toc152841476)

[C2.2 Freight Economic VOC (€ per vehicle per 100 km in real terms, 2023 prices) 6](#_Toc152841477)

[D. Safety 7](#_Toc152841478)

[**D1. Road Transport** 7](#_Toc152841479)

[D1.1 Collision Costs (€ per incident, 2023 Prices, also applied to Rail Transport) 7](#_Toc152841480)

[D1.2 Motorways Accident Rates (Casualty per 10^9 Vehicle-kms, 2021) 7](#_Toc152841481)

[D1.3 National and Regional Roads Accident Rates (Casualty per 10^9 Vehicle-kms) 7](#_Toc152841482)

[D1.4 Road Accident marginal costs (2023 prices) 8](#_Toc152841483)

[**D2. Rail Transport** 8](#_Toc152841484)

[D2.1 Rail Accident marginal costs (2023 prices) 8](#_Toc152841485)

[E. Air Quality 9](#_Toc152841486)

[**E1. Passenger Road Transport** 9](#_Toc152841487)

[E1.1 Air pollution Marginal Costs – Road Passengers (2023 prices) 9](#_Toc152841488)

[**E2. Freight Road Transport** 10](#_Toc152841489)

[E2.1 Air pollution Marginal Costs – Road Freight (2023 prices) 10](#_Toc152841490)

[**E3. Passenger Rail Transport** 12](#_Toc152841491)

[E3.1 Air pollution Marginal Costs – Rail Passengers (2023 prices) 12](#_Toc152841492)

[**E4. Freight Rail Transport** 13](#_Toc152841493)

[E4.1 Air pollution Marginal Costs – Rail Freight (2023 prices) 13](#_Toc152841494)

[**E5. Air Pollution Costs (NOX, NMVOC, SO2, PM)** 13](#_Toc152841495)

[E5.1 Air Pollution Costs NOX, NMVOC, SO2, PM (2023 prices) 13](#_Toc152841496)

[F. Climate Change (CC) 14](#_Toc152841497)

[**F1. Passenger Road Transport** 14](#_Toc152841498)

[F1.1 Climate Change Marginal Costs – Road Passengers (2023 prices) 14](#_Toc152841499)

[**F2. Freight Road Transport** 15](#_Toc152841500)

[F2.1 Climate Change Marginal Costs – Road Freight (2023 prices) 15](#_Toc152841501)

[**F3. Rail Transport** 17](#_Toc152841502)

[F3.1 Climate Change Marginal Costs – Rail (2023 prices) 17](#_Toc152841503)

[**F4. Carbon Cost 2023-2050** 17](#_Toc152841504)

[F4.1 Carbon Cost Forecasts (euros per ton CO2) 17](#_Toc152841505)

[G. Noise Costs 18](#_Toc152841506)

[**G1. Passenger Road Transport** 18](#_Toc152841507)

[G1.1 Noise Marginal Costs – Road Passengers (2023 prices) 18](#_Toc152841508)

[**G2. Freight Road Transport** 20](#_Toc152841509)

[G2.1 Noise Marginal Costs – Road Freight (2023 prices) 20](#_Toc152841510)

[**G3. Rail Transport** 21](#_Toc152841511)

[G3.1 Noise Marginal Costs – Rail Passengers (2023 prices) 21](#_Toc152841512)

[G3.2 Noise Marginal Costs – Rail Freight (2023 prices) 21](#_Toc152841513)

[H. Operation & Maintenance (O&M) Costs (2023 Prices) 22](#_Toc152841514)

[**H1. Road Infrastructure** 22](#_Toc152841515)

[H1.1 O&M Financial Costs 22](#_Toc152841516)

[H1.2 O&M Economic Costs 22](#_Toc152841517)

[**H2. Railway Infrastructure Manager O&M Costs** 23](#_Toc152841518)

[H2.1 Asset Replacement & Heavy Maintenance Financial Costs 23](#_Toc152841519)

[H2.2 Asset Replacement & Heavy Maintenance Economic Costs 23](#_Toc152841520)

[H2.3 Routine O&M Financial Costs (passenger transport) 24](#_Toc152841521)

[H2.4 Routine O&M Economic Costs (passenger transport) 24](#_Toc152841522)

[H2.5 Routine O&M Financial Costs (freight transport) 24](#_Toc152841523)

[H2.6 Routine O&M Economic Costs (freight transport) 24](#_Toc152841524)

[**H3. Railway Operator Costs** 25](#_Toc152841525)

[H3.1 Financial Costs (passenger transport) 25](#_Toc152841526)

[H3.2 Economic Costs (passenger transport) 25](#_Toc152841527)

[H3.3 Financial Costs (freight transport) 25](#_Toc152841528)

[H3.4 Economic Costs (freight transport) 25](#_Toc152841529)

# Key Parameters

|  |  |  |
| --- | --- | --- |
| **Pamameter** | **Value** | **Remarks** |
| Present Value Year | 2023 |  |
| Financial Discount Rate (%) | 4% or national one (if different) | Real annual, No State Aid |
| Weighted Average Cost of Capital | Real or nominal annual, State Aid |
| Social Discount Rate (%) | 3% or national one (if different) | Real annual |
| Appraisal Period (years), Linear infrastructure Projects, local infrastructure projects | 30 | Including construction period |
| Appraisal Period (years), Public Buses | 15 | From start of operation |
| Appraisal Period (years), Rail Rolling Stock | 30 | From start of operation |
| Appraisal Period (years), Systems | Depending on the system | From start of operation |
| Consumer Price Index (%) | <https://www.statistics.gr/el/statistics/-/publication/DKT90/-> | Hellenic Statistical Authority |
| Shadow Labour Pricing | SW = W\*(1-t)\*(1-u) | W: Wage, t: national income taxation (**9%**), u: regional unemployment[[2]](#footnote-3) |

# Value of Time

## B1. Passenger Transport

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Type of Vehicle** | **Average Occupancy (passengers/vehicle)** | **Journey Purpose / Occupant** | **Value in €/Hour (2023 prices)** | **Remarks** |
| Car | 1,81 | Business | 21.78 | elasticity to GDP/capita: 0.70 |
| Commuting | 10.89 |
| Private | 7.04 | elasticity to GDP/capita: 0.50 |
| Tourism | 7.61 |
| Other | 8.90 |
| **Weighted Average** | **12.96** | **elasticity to GDP/capita: 0.59** |
| Bus | 27,30 | Business | 8.70 | elasticity to GDP/capita: 0.70 |
| Commuting | 4.35 |
| Private | 6.19 | elasticity to GDP/capita: 0.50 |
| Tourism | 5.82 |
| Other | 8.90 |
| **Weighted Average** | **7.40** | **elasticity to GDP/capita: 0.55** |
| Rail Intercity Service | - | Business | 7.85 | elasticity to GDP/capita: 0.70 |
| Commuting | 3.92 |
| Private | 7.43 | elasticity to GDP/capita: 0.50 |
| Tourism | 5.30 |
| Other | 10.68 |
| **Weighted Average** | **7.92** | **elasticity to GDP/capita: 0.56** |
| Rail Standard Service | - | Business | 5.23 | elasticity to GDP/capita: 0.70 |
| Commuting | 2.62 |
| Private | 4.95 | elasticity to GDP/capita: 0.50 |
| Tourism | 3.53 |
| Other | 7.12 |
| **Weighted Average** | **5.28** | **elasticity to GDP/capita: 0.56** |

## B2. Freight Transport

### B2.1 Road Freight Transport

|  |  |  |
| --- | --- | --- |
| **Type of Vehicle** | **Value in €/vehicle-hour (2023 prices)** | **Remarks** |
| LGV | 14.40 | elasticity to GDP/capita: 0.70 |
| HGV | 34.28 |

### B2.2 Rail Freight Transport Component of Travel Time

| **Train Type** | **Traction** | **Value in €/train-hour (2023 prices)** | **Growth Factor** |
| --- | --- | --- | --- |
| Block Train | electric with OH cost | 463.79 | *Consumer Price Index (%)* |
| electric without OH cost | 442.79 |
| diesel with OH cost | 515.38 |
| diesel without OH cost | 466.71 |
| Wagonload train | electric with OH cost | 508.09 |
| electric without OH cost | 487.59 |
| diesel with OH cost | 579.30 |
| diesel without OH cost | 524.20 |
| Container train | electric with OH cost | 436.41 |
| electric without OH cost | 411.01 |
| diesel with OH cost | 480.94 |
| diesel without OH cost | 438.02 |

### B2.3 Cargo Component of Travel Time

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | **Cargo Added Value Category** | | | **Growth Factor** |
| **Low Added Value:**  **< 6000 euro/ton,**  **e.g., bulk/aggregates** | **Ordinary:**  **6000-35000 euro/ton,**  **e.g., other rail and sea** | **High Added Value:**  **> 35000 euro/ton,**  **e.g., combined, parcels, refrigerated, roro** |
| € per Ton-Hour (2023 prices) | 0.00 | 0.23 | 0.70 | *Consumer Price Index (%)* |

### B2.4 Ramp-Up in Transport Cost Component of Freight Travel Time Benefits

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Type** | **Ratio of Travel Time Benefits Achieved** | | | | |
| **Year 1** | **Year 2** | **Year 3** | **Year 4** | **Year 5** |
| All goods | 0.44 | 0.55 | 0.66 | 0.77 | 0.89 |
| Containers | 0.50 | 0.60 | 0.70 | 0.80 | 0.90 |
| Bulk | 0.44 | 0.55 | 0.66 | 0.77 | 0.89 |
| Wagonload | 0.42 | 0.53 | 0.64 | 0.76 | 0.88 |

### 

### B2.5 Assumed Freight Train Loading (tons)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Type/Traction** | | | | | |
| **Block Train** | | **Wagonload Train** | | **Container Train** | |
| **Electric** | **Diesel** | **Electric** | **Diesel** | **Electric** | **Diesel** |
| Wagons | 18 | | | | 20 | |
| Gross Tonnage | 1705 | 1733 | 1705 | 1733 | 1385 | 1413 |
| Net Tonnage | 1143 | | | | 750 | |
| Tonnage/Wagon | 63.5 | | | | 37.5 | |

# Vehicle Operating Cost

## C1. Passenger Transport

### C1.1 Passenger Perceived VOC (€ per vehicle per 100 km in real terms)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Speed/ Year** | **2023** | **2025** | **2030** | **2035** | **2040** | **2045** | **2050** | **2055** | **2060** |
| **100-110** | 14.202 | 14.129 | 13.909 | 13.534 | 13.352 | 13.389 | 13.016 | 12.731 | 12.697 |
| **90-100** | 13.710 | 13.624 | 13.375 | 12.938 | 12.574 | 12.421 | 11.881 | 11.468 | 11.418 |
| **80-90** | 13.478 | 13.377 | 13.090 | 12.575 | 12.010 | 11.652 | 10.924 | 10.366 | 10.299 |
| **70-80** | 13.429 | 13.304 | 12.960 | 12.333 | 11.508 | 10.888 | 9.911 | 9.163 | 9.073 |
| **60-70** | 13.650 | 13.502 | 13.101 | 12.359 | 11.279 | 10.405 | 9.180 | 8.243 | 8.129 |
| **50-60** | 14.211 | 14.031 | 13.545 | 12.652 | 11.335 | 10.257 | 8.776 | 7.641 | 7.504 |
| **40-50** | 15.191 | 14.959 | 14.340 | 13.219 | 11.638 | 10.372 | 8.572 | 7.193 | 7.027 |

### C1.2 Passenger Economic VOC (€ per vehicle per 100 km in real terms)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Speed/ Year** | **2023** | **2025** | **2030** | **2035** | **2040** | **2045** | **2050** | **2055** | **2060** |
| **100-110** | 5.076 | 5.098 | 5.133 | 5.308 | 6.531 | 7.996 | 8.967 | 9.710 | 9.800 |
| **90-100** | 4.896 | 4.909 | 4.922 | 5.044 | 6.073 | 7.324 | 8.125 | 8.739 | 8.813 |
| **80-90** | 4.810 | 4.813 | 4.802 | 4.870 | 5.715 | 6.763 | 7.401 | 7.890 | 7.949 |
| **70-80** | 4.789 | 4.779 | 4.736 | 4.734 | 5.362 | 6.175 | 6.621 | 6.962 | 7.003 |
| **60-70** | 4.864 | 4.842 | 4.770 | 4.705 | 5.147 | 5.759 | 6.037 | 6.249 | 6.275 |
| **50-60** | 5.060 | 5.024 | 4.915 | 4.781 | 5.075 | 5.544 | 5.678 | 5.780 | 5.792 |
| **40-50** | 5.405 | 5.347 | 5.184 | 4.956 | 5.110 | 5.459 | 5.440 | 5.425 | 5.424 |

## C2. Freight Transport

### C2.1 Freight Perceived VOC (€ per vehicle per 100 km in real terms, 2023 prices)

|  |  |  |  |
| --- | --- | --- | --- |
| **Speed** | **LGV** | **HGV** | **Growth Rate in Real Terms** |
| **100-110** | 18.480 | 69.006 | **1.00** |
| **90-100** | 16.984 | 62.216 |
| **80-90** | 15.755 | 57.647 |
| **70-80** | 14.810 | 55.195 |
| **60-70** | 14.210 | 54.950 |
| **50-60** | 14.050 | 57.144 |
| **40-50** | 14.470 | 61.746 |

### 

### C2.2 Freight Economic VOC (€ per vehicle per 100 km in real terms, 2023 prices)

|  |  |  |  |
| --- | --- | --- | --- |
| **Speed/ Year** | **LGV** | **HGV** | **Growth Rate in Real Terms** |
| **100-110** | 9.197 | 33.781 | **1.00** |
| **90-100** | 8.452 | 30.478 |
| **80-90** | 7.841 | 28.221 |
| **70-80** | 7.371 | 27.020 |
| **60-70** | 7.072 | 26.900 |
| **50-60** | 6.992 | 27.974 |
| **40-50** | 7.201 | 30.227 |

# Safety

## D1. Road Transport

### D1.1 Collision Costs (€ per incident, 2023 Prices, also applied to Rail Transport)

|  |  |  |  |
| --- | --- | --- | --- |
| **Collision Type** | **Value** | **Remarks** | **Growth Factors** |
| Fatal | 3,133,251 | Based on Foundation For Economic & Industrial Research (IOBE) | Based on FEIR Health Inflation Rate |
| Serious Injury | 364,036 |
| Slight Injury | 60,564 |
| Damage only | 3,000 | Based on Hellenic Association of Insurance Companies statistical data | |

### D1.2 Motorways Accident Rates (Casualty per 10^9 Vehicle-kms, 2021)

|  |  |  |  |
| --- | --- | --- | --- |
| **Casualties per 10^9 V-kms** | | | |
| **Fatal** | **Serious Injuries** | **Minor Injuries** | **Damage only** |
| 5.20 | 3.53 | 40.20 | 413 |

### D1.3 National and Regional Roads Accident Rates (Casualty per 10^9 Vehicle-kms)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **National Roads (NR)** | | | **Regional Roads (RR)** | | |
| **Fatal** | **Serious Injuries** | **Minor Injuries** | **Fatal** | **Serious Injuries** | **Minor Injuries** |
| **Accidents Rate (indicative)** | *23.5* | *17,3* | *141.7* | *29.9* | *31,4* | *209,4* |
| *Light vehicle speed < 60km/h: regional network link, Light vehicle speed 60km/h<v<90km/h: national road link, Light vehicle speed >90km/h: motorway link,*  *Based on traffic model* ***v-kms per road type category*** *the corresponding road network type percentages are identified. In this example it is assumed that 40% is motorway, 35% is national road and 25% is regional road category.*  *Accident rate per road category and collision type is estimated using the following equations.*  *Accident Rate Fatal NR= 20.6 X (% Motorways)/ (% NR)*  *Accident Rate Serious Injuries NR= 15.1 X (% Motorways)/ (% NR)*  *Accident Rate Minor Injuries NR= 124.3 X (% Motorways)/ (% NR)*  *Accident Rate Fatal RR= 18.7 X (% Motorways)/ (% RR)*  *Accident Rate Serious Injuries RR= 19.6 X (% Motorways)/ (% RR)*  *Accident Rate Minor Injuries RR= 130.9 X (% Motorways)/ (% RR)*  *Accident Rate Damage only: 3,500 incidents per 10^9 v-kms (National Roads)*  *Accident Rate Damage only: 4,300 incidents per 10^9 v-kms (Regional Roads)*  ***If Simple Model is used the Table D1.4 corresponding values are applied*** | | | | | | |

### D1.4 Road Accident marginal costs (2023 prices)

| **Vehicle Category** | **Dense metropolitan area traffic during the day** | **Dense traffic on rural motorways during the day** |
| --- | --- | --- |
| Passenger Car (in €-cent/pkm) | 2.00 | 0.35 |
| Motorcycles and mopeds (in €-cent/ pkm) | 6.26 | -0.92 |
| Buses (in €-cent/pkm) | 1.13 | 0.07 |
| Coaches (in €-cent/pkm) | 1.13 | 0.07 |
| LCVs (in €-cent/vkm) | 1.08 | 0.52 |
| HGVs (in €-cent/tkm) | 0.14 | 0.10 |

## D2. Rail Transport

### D2.1 Rail Accident marginal costs (2023 prices)

|  |  |
| --- | --- |
| **Vehicle Category** | **Value (in €-cent/p-km or t-km)** |
| High speed trains | 0.14 |
| All other passenger trains | 0.42 |
| All freight trains | 0.14 |

# Air Quality

*General Comment applied to Air Quality costs:* ***Growth factor used is GDP per capita growth (%)***

## E1. Passenger Road Transport

### E1.1 Air pollution Marginal Costs – Road Passengers (2023 prices)

| **Vehicle category** | **Fuel type** | **Fuel efficiency (average real-world CO2-emissions)** | **COPERT category** | **Motor-ways** | **Urban roads** | **Other roads** | **Average all roads** | **Motor-ways** | **Urban roads** | **Other roads** | **Average all roads** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Passenger transport** | | | | **(€-cent per pkm)** | | | | **(€-cent per vkm)** | | | |
| Passenger car | Petrol | 2016 fuel efficient car: 99 g/km | Euro 6 | 0.092 | 0.160 | 0.098 | 0.117 | 0.144 | 0.252 | 0.155 | 0.184 |
| 2016 fuel inefficient car: 180 g/km | 0.092 | 0.160 | 0.098 | 0.117 | 0.144 | 0.252 | 0.155 | 0.184 |
| 2000 fuel efficient car: 161 g/km | Euro 3 | 0.133 | 0.217 | 0.141 | 0.164 | 0.209 | 0.342 | 0.221 | 0.258 |
| 2000 fuel inefficient car: 233 g/km | 0.133 | 0.217 | 0.141 | 0.164 | 0.209 | 0.342 | 0.221 | 0.258 |
| Diesel | 2016 fuel efficient car: 89 g/km | Euro 6 | 0.538 | 0.975 | 0.558 | 0.690 | 0.846 | 1.535 | 0.878 | 1.086 |
| 2016 fuel inefficient car: 119 g/km | 0.538 | 0.975 | 0.558 | 0.690 | 0.846 | 1.535 | 0.878 | 1.086 |
| 2000 fuel efficient car: 135 g/km | Euro 3 | 1.100 | 2.166 | 1.353 | 1.540 | 1.732 | 3.409 | 2.130 | 2.424 |
| 2000 fuel inefficient car: 176 g/km | 1.100 | 2.166 | 1.353 | 1.540 | 1.732 | 3.409 | 2.130 | 2.424 |
| LPG | 119 g/km | Euro 6 | 0.092 | 0.168 | 0.094 | 0.118 | 0.145 | 0.264 | 0.148 | 0.186 |
| CNG | 196 g/km | 0.093 | 0.165 | 0.095 | 0.118 | 0.147 | 0.260 | 0.150 | 0.186 |
| Full electric | 0 g/km | 0.072 | 0.057 | 0.052 | 0.060 | 0.113 | 0.090 | 0.081 | 0.095 |
| PHEV - petrol | 39 g/km | Euro 6 | 0.087 | 0.067 | 0.073 | 0.076 | 0.136 | 0.106 | 0.114 | 0.119 |
| Motorcycle | Petrol | Fuel efficient motorcycle: 100 g/km | Euro 3 | 0.332 | 0.362 | 0.298 | 0.331 | 0.349 | 0.380 | 0.313 | 0.347 |
| Fuel inefficient motorcycle: 128 g/km | 0.332 | 0.362 | 0.298 | 0.331 | 0.349 | 0.380 | 0.313 | 0.347 |
| Moped | Petrol | 70 g/km | Moped 4 stroke | 0.601 | 1.369 | 0.985 | 0.985 | 0.631 | 1.438 | 1.034 | 1.034 |
| Motorcycle | Electric | 0 g/km |  | 0.027 | 0.021 | 0.018 | 0.022 | 0.028 | 0.022 | 0.019 | 0.023 |
| Bus (18t) | Diesel | Fuel efficient bus: 954 g/km |  | 0.022 | 0.137 | 0.041 | 0.067 | 0.380 | 2.308 | 0.696 | 1.128 |
| Fuel inefficient bus: 1155 g/km |  | 0.467 | 2.203 | 0.832 | 1.167 | 7.880 | 37.190 | 14.052 | 19.708 |
| CNG | 1007 g/km | Euro 6 | 0.169 | 0.607 | 0.267 | 0.348 | 2.849 | 10.245 | 4.507 | 5.867 |
| Electric | 0 g/km |  | 0.013 | 0.042 | 0.018 | 0.024 | 0.212 | 0.713 | 0.306 | 0.410 |
| Coach | Diesel | Fuel efficient coach: 583 g/km |  | 0.027 | 0.240 | 0.061 | 0.109 | 0.406 | 3.623 | 0.924 | 1.651 |
| Fuel inefficient coach: 742 g/km |  | 0.565 | 3.041 | 1.002 | 1.536 | 8.526 | 45.879 | 15.114 | 23.173 |

## E2. Freight Road Transport

### E2.1 Air pollution Marginal Costs – Road Freight (2023 prices)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Vehicle category** | **Fuel type** | **Fuel efficiency (average real-world CO2-emissions)** | **COPERT category** | **Motor-ways** | **Urban roads** | **Other roads** | **Average all roads** | **Motor-ways** | **Urban roads** | **Other roads** | **Average all roads** |
| **LCV** | | | | **(€-cent per tkm)** | | | | **(€-cent per vkm)** | | | |
| LCV | Petrol | 2016 fuel efficient LCV: 105 g/km | Euro 6 | 0.235 | 0.258 | 0.234 | 0.242 | 0.163 | 0.179 | 0.162 | 0.168 |
| 2016 fuel inefficient LCV: 179 g/km | 0.235 | 0.258 | 0.234 | 0.242 | 0.163 | 0.179 | 0.162 | 0.168 |
| 2000 fuel efficient LCV: 198 g/km | Euro 3 | 0.413 | 0.550 | 0.388 | 0.450 | 0.286 | 0.381 | 0.268 | 0.312 |
| 2000 fuel inefficient LCV: 262 g/km | 0.413 | 0.550 | 0.388 | 0.450 | 0.286 | 0.381 | 0.268 | 0.312 |
| Diesel | 2016 fuel efficient LCV: 104 g/km | Euro 6 | 3.200 | 3.612 | 2.765 | 3.192 | 2.216 | 2.501 | 1.914 | 2.210 |
| 2016 fuel inefficient LCV: 133 g/km | 3.200 | 3.612 | 2.765 | 3.192 | 2.216 | 2.501 | 1.914 | 2.210 |
| 2000 fuel efficient LCV: 172 g/km | Euro 3 | 3.715 | 7.668 | 4.223 | 5.202 | 2.572 | 5.309 | 2.924 | 3.602 |
| 2000 fuel inefficient LCV: 225 g/km | 3.715 | 7.668 | 4.223 | 5.202 | 2.572 | 5.309 | 2.924 | 3.602 |
| Electric | full electric 0 g/km |  | 0.163 | 0.125 | 0.116 | 0.135 | 0.113 | 0.086 | 0.080 | 0.093 |
| **HGV** | | | | **(€-cent per tkm)** | | | | **(€-cent per vkm)** | | | |
| HGV 3.5t - 7.5t | Diesel | Fuel efficient HGV: 370 g/km | EURO VI | 0.295 | 1.761 | 0.476 | 0.844 | 0.243 | 1.452 | 0.393 | 0.696 |
| Fuel inefficient HGV: 450 g/km | EURO III | 5.177 | 13.272 | 7.198 | 8.549 | 4.270 | 10.946 | 5.936 | 7.051 |
| HGV 7.5t - 16t | Diesel | Fuel efficient HGV: 596 g/km | EURO VI | 0.090 | 0.430 | 0.140 | 0.220 | 0.348 | 1.665 | 0.541 | 0.852 |
| Fuel inefficient HGVs: 716 g/km | EURO III | 1.571 | 5.081 | 2.474 | 3.042 | 6.091 | 19.698 | 9.593 | 11.794 |
| HGV 16t - 32t | Diesel | Fuel efficient HGV: 716 g/km | EURO VI | 0.036 | 0.208 | 0.062 | 0.102 | 0.424 | 2.471 | 0.742 | 1.212 |
| Fuel inefficient HGVs: 875 g/km | EURO III | 0.767 | 2.795 | 1.282 | 1.615 | 9.120 | 33.215 | 15.242 | 19.192 |
| HGV >32t (truck trailer) | Diesel | Fuel efficient HGV: 848 g/km | EURO VI | 0.023 | 0.142 | 0.041 | 0.069 | 0.393 | 2.372 | 0.693 | 1.153 |
| Fuel inefficient HGVs: 1033 g/km | EURO III | 0.612 | 2.355 | 1.050 | 1.339 | 10.234 | 39.367 | 17.561 | 22.387 |
| LNG | LNG Euro 6 (> 32 t): 900 g/km | EURO VI | 0.020 | 0.099 | 0.033 | 0.051 | 0.340 | 1.649 | 0.546 | 0.845 |

## E3. Passenger Rail Transport

### E3.1 Air pollution Marginal Costs – Rail Passengers (2023 prices)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Train type** | **Traction** | **Emission class** | **Metropolitan** | | | **Urban** | | | **Rural** | | |
|
| **Unit cost** | | **load factor** | **Unit cost** | | **load factor** | **Unit cost** | | **load factor** |
| **€-cent/pkm** | **€-cent/train-km** | **pax** | **€-cent/pkm** | **€-cent/train-km** | **pax** | **€-cent/pkm** | **€-cent/train-km** | **pax** |
| Highspeed train | electricity |  | 0.002 | 0.6 | 299 | 0.004 | 1.3 | 341 | 0.004 | 1.3 | 299 |
| Intercity train | electricity |  | 0.008 | 1.3 | 160 | 0.008 | 1.3 | 182 | 0.008 | 1.3 | 160 |
| diesel | with EGR/SRC\* | 0.532 | 46.3 | 87 | 0.432 | 37.6 | 99 | 0.261 | 22.7 | 87 |
| diesel |  | 0.801 | 69.7 | 87 | 0.768 | 66.8 | 99 | 0.460 | 40.1 | 87 |
| Regional train | electricity |  | 0.018 | 2.0 | 110 | 0.018 | 2.0 | 125 | 0.018 | 2.0 | 110 |
| diesel | with EGR/SRC8 | 1.733 | 53.7 | 31 | 1.328 | 41.2 | 35 | 0.810 | 25.1 | 31 |
| diesel |  | 2.399 | 74.4 | 31 | 2.265 | 70.2 | 35 | 1.367 | 42.4 | 31 |

\****Selective Catalytic Reduction (SCR) and Exhaust Gas Recirculation (EGR)***

## E4. Freight Rail Transport

### E4.1 Air pollution Marginal Costs – Rail Freight (2023 prices)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Train type** | **Traction** | **Emission class** | **Metropolitan** | | | **Urban** | | | **Rural** | | |
|  |
| **Unit cost** | | **load factor** | **Unit cost** | | **load factor** | **Unit cost** | | **load factor** |  |
| **€-cent/tkm** | **€-cent/train-km** | **ton** | **€-cent/tkm** | **€-cent/train-km** | **ton** | **€-cent/tkm** | **€-cent/train-km** | **ton** |  |
| Short container | electricity |  | 0.005 | 2.3 | 500 | 0.005 | 2.3 | 570 | 0.005 | 2.3 | 500 |  |
| diesel | EGR/SRC\* | 0.406 | 203.0 | 500 | 0.352 | 176.2 | 570 | 0.210 | 104.8 | 500 |  |
| diesel |  | 0.890 | 444.9 | 500 | 0.727 | 363.5 | 570 | 0.430 | 215.0 | 500 |  |
| Short bulk | electricity |  | 0.005 | 3.4 | 750 | 0.005 | 3.4 | 855 | 0.005 | 3.4 | 750 |  |
| diesel | EGR/SRC\* | 0.271 | 203.5 | 750 | 0.236 | 176.6 | 855 | 0.140 | 105.2 | 750 |  |
| diesel |  | 0.594 | 445.4 | 750 | 0.485 | 363.9 | 855 | 0.287 | 215.5 | 750 |  |
| Long container | electricity |  | 0.005 | 6.4 | 1400 | 0.005 | 6.4 | 1595 | 0.005 | 6.4 | 1400 |  |
| diesel | EGR/SRC\* | 0.146 | 204.7 | 1400 | 0.127 | 177.9 | 1595 | 0.076 | 106.5 | 1400 |  |
| diesel |  | 0.319 | 446.6 | 1400 | 0.261 | 365.2 | 1595 | 0.155 | 216.7 | 1400 |  |
| Long bulk | electricity |  | 0.005 | 7.3 | 1600 | 0.005 | 7.3 | 1823 | 0.005 | 7.3 | 1600 |  |
| diesel | EGR/SRC\* | 0.128 | 205.1 | 1600 | 0.111 | 178.2 | 1823 | 0.067 | 106.8 | 1600 |  |
| diesel |  | 0.279 | 447.0 | 1600 | 0.228 | 365.5 | 1823 | 0.136 | 217.1 | 1600 |  |

***\*Selective Catalytic Reduction (SCR) and Exhaust Gas Recirculation (EGR)***

**E5. Air Pollution Costs (NOX, NMVOC, SO2, PM)**

E5.1 Air Pollution Costs NOX, NMVOC, SO2, PM (2023 prices)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **€/ton NOX** | **€/ton NOX** | **€/ton NMVOC** | **€/ton SO2** | **€/ton PM (exhaust)** | | | **€/ton PM non exhaust** |
| **cities** | **rural** | **All areas** | **All areas** | **Metropolitan** | **Urban** | **Rural** | **average** |
| 5,900 | 3,600 | 400 | 6,800 | 304,300 | 98,000 | 37,700 | 28,300 |

# Climate Change (CC)

*General Comments applied to CC:* ***(a) Growth factor is CO2 €/ton price, (b) prices provided (except F4) are to be used only in Simplified CBA***

## F1. Passenger Road Transport

### F1.1 Climate Change Marginal Costs – Road Passengers (2023 prices)

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Vehicle category** | **Fuel type** | **Fuel efficiency (average real-world CO2-emissions)** | **COPERT category** | **Motor-ways** | **Urban roads** | **Other roads** | **Average all roads** | **Motor-ways** | | **Urban roads** | **Other roads** | **Average all roads** |
| **(€-cent per pkm)** | | | | | | | | | **(€-cent per vkm)** | | | |
| Passenger car | Petrol | 2016 fuel efficient car: 99 g/km | Euro 6 | 1.43 | 1.66 | 1.31 | 1.47 | 2.25 | | 2.61 | 2.06 | 2.31 |
| 2016 fuel inefficient car: 180 g/km | 2.60 | 3.01 | 2.38 | 2.66 | 4.09 | | 4.75 | 3.74 | 4.19 |
| 2000 fuel efficient car: 161 g/km | Euro 3 | 1.79 | 2.10 | 1.60 | 1.83 | 2.82 | | 3.30 | 2.52 | 2.88 |
| 2000 fuel inefficient car: 233 g/km | 2.47 | 2.90 | 2.21 | 2.53 | 3.90 | | 4.56 | 3.48 | 3.98 |
| Diesel | 2016 fuel efficient car: 89 g/km | Euro 6 | 1.32 | 1.46 | 1.15 | 1.31 | 2.08 | | 2.30 | 1.81 | 2.06 |
| 2016 fuel inefficient car: 119 g/km | 1.77 | 1.96 | 1.54 | 1.76 | 2.79 | | 3.09 | 2.43 | 2.77 |
| 2000 fuel efficient car: 135 g/km | Euro 3 | 1.54 | 1.70 | 1.34 | 1.53 | 2.43 | | 2.68 | 2.11 | 2.41 |
| 2000 fuel inefficient car: 176 g/km | 2.01 | 2.22 | 1.75 | 2.00 | 3.17 | | 3.50 | 2.76 | 3.14 |
| LPG | 119 g/km | Euro 6 | 1.26 | 1.38 | 1.08 | 1.24 | 1.98 | | 2.17 | 1.70 | 1.95 |
| CNG | 196 g/km | 2.07 | 2.27 | 1.78 | 2.04 | 3.26 | | 3.58 | 2.80 | 3.21 |
| Full electric | 0 g/km | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | 0.00 | 0.00 | 0.00 |
| PHEV - petrol | 39 g/km | 0.48 | 0.37 | 0.37 | 0.41 | 0.75 | | 0.58 | 0.58 | 0.64 |
| Motorcycle | Petrol | Fuel efficient motorcycle: 100 g/km | MC 250-750 Cm3 | 1.82 | 1.51 | 1.35 | 1.56 | 1.91 | | 1.58 | 1.41 | 1.64 |
| Fuel inefficient motorcycle: 128 g/km | MC >750 cm3 | 2.20 | 2.07 | 1.72 | 2.00 | 2.31 | | 2.18 | 1.80 | 2.10 |
| Moped | Petrol | 46 g/km | Moped 4 stroke | 0.72 | 0.72 | 0.72 | 0.72 | 0.75 | | 0.75 | 0.75 | 0.75 |
| Motorcycle | Electric | 0 g/vkm |  | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | 0.00 | 0.00 | 0.00 |
| Bus (18t) | Diesel | Fuel efficient bus: 954 g/km |  | 0.75 | 1.25 | 0.78 | 0.93 | 12.61 | | 21.05 | 13.21 | 15.62 |
| Fuel inefficient bus: 1155 g/km |  | 0.89 | 1.52 | 0.95 | 1.12 | 14.96 | | 25.72 | 16.06 | 18.91 |
| CNG | 1007 g/km | Euro 6 | 0.10 | 0.10 | 0.10 | 0.10 | 1.64 | | 1.64 | 1.64 | 1.64 |
| Electric | 0 g/km |  | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | 0.00 | 0.00 | 0.00 |
| Coach | Diesel | Fuel efficient coach: 583 g/km |  | 0.37 | 0.74 | 0.41 | 0.51 | 6.98 | | 13.94 | 7.72 | 9.55 |
| Fuel inefficient coach: 742 g/km |  | 0.44 | 0.98 | 0.51 | 0.64 | 8.37 | | 18.47 | 9.61 | 12.15 |

## F2. Freight Road Transport

### F2.1 Climate Change Marginal Costs – Road Freight (2023 prices)

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Vehicle category** | **Fuel type** | **Fuel efficiency (average real-world CO2-emissions)** | **COPERT category** | **Motor-ways** | **Urban roads** | **Other roads** | **Average all roads** | **Motor-ways** | | **Urban roads** | **Other roads** | **Average all roads** |
| **LCV (€-cent per tkm)** | | | | | | | | | **(€-cent per vkm)** | | | | |
| LCV | Petrol | 2016 fuel efficient LCV: 105 g/km | Euro 6 | 3.03 | 3.90 | 2.79 | 3.24 | 2.10 | | 2.70 | 1.93 | 2.24 |
| 2016 fuel inefficient LCV: 179 g/km | 5.15 | 6.63 | 4.75 | 5.51 | 3.57 | | 4.59 | 3.29 | 3.82 |
| 2000 fuel efficient LCV: 198 g/km | Euro 3 | 4.60 | 6.67 | 4.06 | 5.11 | 3.18 | | 4.62 | 2.81 | 3.54 |
| 2000 fuel inefficient LCV: 262 g/km | 6.09 | 8.83 | 5.37 | 6.76 | 4.22 | | 6.12 | 3.72 | 4.68 |
| Diesel | 2016 fuel efficient LCV: 104 g/km | Euro 6 | 3.28 | 3.42 | 2.88 | 3.19 | 2.27 | | 2.36 | 1.99 | 2.21 |
| 2016 fuel inefficient LCV: 133 g/km | 4.21 | 4.38 | 3.69 | 4.09 | 2.91 | | 3.03 | 2.56 | 2.83 |
| 2000 fuel efficient LCV: 172 g/km | Euro 3 | 5.16 | 4.73 | 3.45 | 4.45 | 3.57 | | 3.27 | 2.39 | 3.08 |
| 2000 fuel inefficient LCV: 225 g/km | 6.73 | 6.16 | 4.49 | 5.79 | 4.66 | | 4.27 | 3.11 | 4.01 |
| Electric | full electric 0 g/km |  | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | 0.00 | 0.00 | 0.00 |
| **HGV (€-cent per tkm)** | | | | | | | | | **(€-cent per vkm)** | | | | |
| HGV 3.5t - 7.5t | Diesel | Fuel efficient HGV: 370 g/km | EURO VI | 7.35 | 7.35 | 7.35 | 7.35 | 6.06 | | 6.06 | 6.06 | 6.06 |
| Fuel inefficient HGV: 450 g/km | EURO III | 8.43 | 10.23 | 8.14 | 8.93 | 6.95 | | 8.44 | 6.71 | 7.37 |
| HGV 7.5t - 16t | Diesel | Fuel efficient HGV: 596 g/km | EURO VI | 2.22 | 3.01 | 2.32 | 2.52 | 8.61 | | 11.67 | 9.00 | 9.76 |
| Fuel inefficient HGVs: 716 g/km | EURO III | 2.64 | 3.77 | 2.66 | 3.02 | 10.23 | | 14.63 | 10.31 | 11.72 |
| HGV 16t - 32t | Diesel | Fuel efficient HGV: 716 g/km | EURO VI | 0.81 | 1.27 | 0.88 | 0.99 | 9.58 | | 15.15 | 10.44 | 11.72 |
| Fuel inefficient HGVs: 875 g/km | EURO III | 0.96 | 1.61 | 1.04 | 1.21 | 11.38 | | 19.19 | 12.42 | 14.33 |
| HGV >32t (truck trailer) | Diesel | Fuel efficient HGV: 848 g/km | EURO VI | 0.68 | 1.08 | 0.74 | 0.83 | 11.29 | | 18.03 | 12.34 | 13.89 |
| Fuel inefficient HGVs: 1033 g/km | EURO III | 0.80 | 1.36 | 0.88 | 1.01 | 13.34 | | 22.77 | 14.63 | 16.92 |
| LNG | LNG Euro 6 (> 32 t): 900 g/km | EURO VI | 0.69 | 1.18 | 0.77 | 0.88 | 11.59 | | 19.78 | 12.85 | 14.74 |

## F3. Rail Transport

### F3.1 Climate Change Marginal Costs – Rail (2023 prices)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Train type** | **Traction** | **Unit cost** | | **load factor** |
| **Passenger transport** |  | **€-cent/pkm** | **€-cent/train-km** | **pax** |
| Intercity train | diesel | 0,329 | 28,63 | 87 |
| Regional train | diesel | 1,204 | 37,33 | 31 |
| **Freight transport** |  | **€-cent/tkm** | **€-cent/train-km** | **Ton** |
| Long container | diesel | 0,258 | 193,47 | 750 |
| Long bulk | diesel | 0,143 | 200,51 | 1400 |
| Short container | diesel | 0,121 | 169,01 | 1400 |
| Short bulk | diesel | 0,108 | 173,46 | 1600 |

## F4. Carbon Cost 2023-2050

### F4.1 Carbon Cost Forecasts (euros per ton CO2)

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

# Noise Costs

*General Comments applied to Noise costs:* ***(a) Growth factor used is GDP/capita.***

## G1. Passenger Road Transport

### G1.1 Noise Marginal Costs – Road Passengers (2023 prices)

| **Vehicle Type** | **Period** | **Conditions** | **EUR-cent / pkm** | | | | | **Vehicle Type** | **Period** | **Conditions** | **EUR-cent / vkm** | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Metropolitan** | **Urban** | | | **Rural** | **Metropolitan** | **Urban** | **Rural** |
| Passenger car | Day | Dense | 0.534 | 0.030 | | | 0.004 | Passenger car | Day | Dense | 0.854 | 0.048 | 0.007 |
| Thin | 1.293 | 0.083 | | | 0.010 | Thin | 2.069 | 0.133 | 0.016 |
| Night | Dense | 0.971 | 0.055 | | | 0.008 | Night | Dense | 1.554 | 0.087 | 0.013 |
| Thin | 2.356 | 0.152 | | | 0.017 | Thin | 3.769 | 0.244 | 0.028 |
| Motorcycle | Day | Dense | 8.442 | 0.476 | | | 0.072 | Motorcycle | Day | Dense | 9.286 | 0.524 | 0.079 |
| Thin | 20.471 | 1.323 | | | 0.155 | Thin | 22.518 | 1.455 | 0.171 |
| Night | Dense | 15.378 | 0.864 | | | 0.127 | Night | Dense | 16.916 | 0.950 | 0.140 |
| Thin | 37.283 | 2.408 | | | 0.277 | Thin | 41.011 | 2.649 | 0.304 |
| Bus. Coach | Day | Dense | Please see cells below | | | | | Bus. Coach | Day | Dense | 8.144 | 0.457 | 0.068 |
| Thin | Thin | 19.746 | 1.275 | 0.147 |
| Night | Dense | Night | Dense | 14.834 | 0.833 | 0.124 |
| Thin | Thin | 35.964 | 2.324 | 0.269 |
| **Bus, coach differentiated** | | | | | | | | | | | | | |
| Bus | Day | Dense | 0.609 | | 0.034 | 0.005 | | Bus | Day | Dense | 10.281 | 0.577 | 0.086 |
| Thin | 1.477 | | 0.095 | 0.011 | | Thin | 24.928 | 1.610 | 0.186 |
| Night | Dense | 1.109 | | 0.062 | 0.009 | | Night | Dense | 18.726 | 1.052 | 0.156 |
| Thin | 2.689 | | 0.174 | 0.020 | | Thin | 45.401 | 2.934 | 0.340 |
| Coach | Day | Dense | 0.319 | | 0.018 | 0.003 | | Coach | Day | Dense | 6.007 | 0.337 | 0.050 |
| Thin | 0.772 | | 0.050 | 0.006 | | Thin | 14.564 | 0.941 | 0.109 |
| Night | Dense | 0.580 | | 0.033 | 0.005 | | Night | Dense | 10.941 | 0.614 | 0.091 |
| Thin | 1.407 | | 0.091 | 0.011 | | Thin | 26.526 | 1.714 | 0.198 |

## G2. Freight Road Transport

### G2.1 Noise Marginal Costs – Road Freight (2023 prices)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Vehicle Type** | **Period** | **Conditions** | **EUR-cent / tkm** | | | **Vehicle Type** | **Period** | **Conditions** | **EUR-cent / vkm** | | |
| **Metropolitan** | **Urban** | **Rural** | **Metropolitan** | **Urban** | **Rural** |
| LCV | Day | Dense | 2.754 | 0.155 | 0.023 | LCV | Day | Dense | 1.907 | 0.107 | 0.016 |
| Thin | 6.677 | 0.431 | 0.050 | Thin | 4.623 | 0.299 | 0.035 |
| Night | Dense | 5.016 | 0.282 | 0.042 | Night | Dense | 3.473 | 0.195 | 0.029 |
| Thin | 12.161 | 0.786 | 0.091 | Thin | 8.420 | 0.544 | 0.063 |
| HGV total | Day | Dense | 0.772 | 0.043 | 0.006 | HGV total | Day | Dense | 9.520 | 0.535 | 0.079 |
| Thin | 1.872 | 0.121 | 0.014 | Thin | 23.083 | 1.491 | 0.172 |
| Night | Dense | 1.406 | 0.079 | 0.012 | Night | Dense | 17.340 | 0.974 | 0.144 |
| Thin | 3.409 | 0.220 | 0.025 | Thin | 42.040 | 2.715 | 0.313 |

**HGV differentiated**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| HGV 3.5 - 7.5 t | Day | Dense | 1.682 | 0.094 | 0.014 | HGV 3.5 - 7.5 t | Day | Dense | 6.246 | 0.351 | 0.052 |
| Thin | 4.077 | 0.263 | 0.030 | Thin | 15.145 | 0.978 | 0.113 |
| Night | Dense | 3.063 | 0.172 | 0.025 | Night | Dense | 11.377 | 0.639 | 0.094 |
| Thin | 7.425 | 0.480 | 0.055 | Thin | 27.583 | 1.781 | 0.206 |
| HGV 7.5 - 16 t | Day | Dense | 0.830 | 0.047 | 0.007 | HGV 7.5 - 16 t | Day | Dense | 8.931 | 0.502 | 0.074 |
| Thin | 2.011 | 0.130 | 0.015 | Thin | 21.653 | 1.399 | 0.162 |
| Night | Dense | 1.511 | 0.085 | 0.013 | Night | Dense | 16.266 | 0.914 | 0.135 |
| Thin | 3.663 | 0.237 | 0.027 | Thin | 39.437 | 2.547 | 0.294 |
| HGV 16 - 32 t | Day | Dense | 0.632 | 0.035 | 0.005 | HGV 16 - 32 t | Day | Dense | 10.025 | 0.563 | 0.083 |
| Thin | 1.532 | 0.099 | 0.011 | Thin | 24.306 | 1.570 | 0.181 |
| Night | Dense | 1.151 | 0.065 | 0.010 | Night | Dense | 18.259 | 1.026 | 0.151 |
| Thin | 2.791 | 0.180 | 0.021 | Thin | 44.269 | 2.859 | 0.330 |
| HGV > 32 t | Day | Dense | 0.672 | 0.038 | 0.006 | HGV > 32 t | Day | Dense | 11.236 | 0.631 | 0.093 |
| Thin | 1.630 | 0.105 | 0.012 |  | Thin | 27.244 | 1.760 | 0.203 |
| Night | Dense | 1.224 | 0.069 | 0.010 | Night | Dense | 20.466 | 1.150 | 0.170 |
| Thin | 2.968 | 0.192 | 0.022 |  | Thin | 49.619 | 3.205 | 0.370 |

## G3. Rail Transport

### G3.1 Noise Marginal Costs – Rail Passengers (2023 prices)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Vehicle Type** | **Period** | **Conditions** | **EUR-cent / pkm** | | | **Vehicle Type** | **Period** | **Conditions** | **EUR-cent / vkm** | | |
| **Metropolitan** | **Urban** | **Rural** | **Metropolitan** | **Urban** | **Rural** |
| High-speed train | Day | Dense | 0.15 | 0.08 | 0.01 | High-speed train | Day | Dense | 43.4 | 24.1 | 3.5 |
| Thin | 0.24 | 0.13 | 0.02 | Thin | 71.1 | 39.6 | 5.7 |
| Night | Dense | 0.26 | 0.15 | 0.02 | Night | Dense | 78.9 | 43.9 | 6.3 |
| Thin | 0.43 | 0.24 | 0.03 | Thin | 129.5 | 72.0 | 10.4 |
| Inter-regional passenger train | Day | Dense | 0.51 | 0.23 | 0.03 | Inter-regional passenger train | Day | Dense | 68.0 | 30.0 | 4.3 |
| Thin | 0.84 | 0.37 | 0.05 | Thin | 111.6 | 49.2 | 7.1 |
| Night | Dense | 0.93 | 0.41 | 0.06 | Night | Dense | 123.8 | 54.6 | 7.9 |
| Thin | 1.53 | 0.68 | 0.10 | Thin | 203.2 | 89.6 | 13.0 |

### G3.2 Noise Marginal Costs – Rail Freight (2023 prices)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Vehicle Type** | **Period** | **Conditions** | **EUR-cent / tkm** | | | **Vehicle Type** | **Period** | **Conditions** | **EUR-cent / vkm** | | |
| **Metropolitan** | **Urban** | **Rural** | **Metropolitan** | **Urban** | **Rural** |
| Freight train | Day | Dense | 0.15 | 0.06 | 0.01 | High-speed train | Day | Dense | 77.2 | 30.6 | 4.4 |
| Thin | 0.19 | 0.10 | 0.01 | Thin | 101.7 | 50.1 | 7.3 |
| Night | Dense | 0.27 | 0.11 | 0.02 | Night | Dense | 140.6 | 55.6 | 8.0 |
| Thin | 0.44 | 0.17 | 0.03 | Thin | 230.6 | 91.3 | 13.2 |

# Operation & Maintenance (O&M) Costs (2023 Prices)

## H1. Road Infrastructure

### H1.1 O&M Financial Costs

|  |  |  |
| --- | --- | --- |
| **Road Type** | **Maintenance Cost (euro/km, annually)** | **Operation Cost (euro/km, annually)** |
| 2 lanes (2 x 3.5 m) w/o shoulders | 24,500 | 5,000 |
| 2 lanes (2 x 3.5 m) with shoulders (2 x 1 m) | 30,700 | 6,100 |
| 3 lanes (3 x 3.5 m) with shoulders (2 x 1 m) | 41,400 | 7,500 |
| 2 x 2 lanes (4 x 3.5 m) with shoulders (2 x 1 m) | 52,100 | 9,000 |
| 2 x 2 lanes (4 x 3.5 m) with emergency (2 x 2 m) | 105,000 | 17,500 |
| 2 x 3 lanes (6 x 3.5 m) with emergency (2 x 2 m) | 142,500 | 23,000 |

### H1.2 O&M Economic Costs

|  |  |  |
| --- | --- | --- |
| **Road Type** | **Maintenance Cost (euro/km, annually)** | **Operation Cost (euro/km, annually)** |
| 2 lanes (2 x 3.5 m) w/o shoulders | 22,800 | 4,700 |
| 2 lanes (2 x 3.5 m) with shoulders (2 x 1 m) | 28,500 | 5,700 |
| 3 lanes (3 x 3.5 m) with shoulders (2 x 1 m) | 38,500 | 7,000 |
| 2 x 2 lanes (4 x 3.5 m) with shoulders (2 x 1 m) | 48,400 | 8,400 |
| 2 x 2 lanes (4 x 3.5 m) with emergency (2 x 2 m) | 97,500 | 16,300 |
| 2 x 3 lanes (6 x 3.5 m) with emergency (2 x 2 m) | 132,300 | 21,400 |

## H2. Railway Infrastructure Manager O&M Costs

### H2.1 Asset Replacement & Heavy Maintenance Financial Costs

| **Scope** | **Unit rate** | **Value** | **Frequency** |
| --- | --- | --- | --- |
| Rail grinding | km single line | 1,200 | 3 years |
| Worn Ballast Replacement | km single line | 1,200 | 5 years |
| Ballast Vibration | km single line | 4,800 | 5 years |
| Track Aligning | km single line | 1,200 | 5 years |
| Signilization joints replacement | km single line | 6,400 | 8 years |
| Ballast cleaning | km single line | 36,000 | 20 years |
| Railway Stations (RS) Switchers’ replacement | No | 18,000 | 20 years |
| RS Safety System Update | No | 1,200,000 | 20 years |
| RS Switchers safety system Update | No | 120,000 | 20 years |
| Safety System update per rail line block | km single line | 42,000 | 20 years |
| Electrification Pole Replacement | No | 18,000 | when needed |
| Electrification replacement | km single line | 54,000 | 20 years |
| Landscaping | km single line | 6,000 | annual |
| Landscaping | km double line | 8,400 | annual |
| Rural RS maintenance | sq.m. | 400 | annual |
| Rural Railway Stops maintenance | sq.m. | 200 | annual |

### H2.2 Asset Replacement & Heavy Maintenance Economic Costs

| **Scope** | **Unit rate** | **Value** | **Frequency** |
| --- | --- | --- | --- |
| Rail grinding | km single line | 1.100 | 3 years |
| Worn Ballast Replacement | km single line | 1.100 | 5 years |
| Ballast Vibration | km single line | 4.300 | 5 years |
| Track Aligning | km single line | 1.100 | 5 years |
| Signilization joints replacement | km single line | 5.700 | 8 years |
| Ballast cleaning | km single line | 32.000 | 20 years |
| Railway Stations (RS) Switchers’ replacement | No | 16.000 | 20 years |
| RS Safety System Update | No | 1.067.000 | 20 years |
| RS Switchers safety system Update | No | 106.700 | 20 years |
| Safety System update per rail line block | km single line | 37.400 | 20 years |
| Electrification Pole Replacement | No | 16.000 | when needed |
| Electrification replacement | km single line | 48.000 | 20 years |
| Landscaping | km single line | 5.400 | annual |
| Landscaping | km double line | 7.500 | annual |
| Rural RS maintenance | sq.m. | 380 | annual |
| Rural Railway Stops maintenance | sq.m. | 160 | annual |

### H2.3 Routine O&M Financial Costs (passenger transport)

|  |  |  |
| --- | --- | --- |
| **Type of Cost** | **Unit** | **Value** |
| Operation Cost | euro/passenger-hour | 1,07 |
| euro/1000 passenger-kms | 9,75 |
| Maintenance Cost | euro/1000 p-kms | 2,51 |
| Operation Cost | euro/train-hour | 131 |
| euro/train-km | 1,20 |

### H2.4 Routine O&M Economic Costs (passenger transport)

|  |  |  |
| --- | --- | --- |
| **Type of Cost** | **Unit** | **Value** |
| Operation Cost | euro/passenger-hour | 0,87 |
| euro/1000 passenger-kms | 7,98 |
| Maintenance Cost | euro/1000 p-kms | 2,23 |
| Operation Cost | euro/train-hour | 107 |
| euro/train-km | 0,98 |

### H2.5 Routine O&M Financial Costs (freight transport)

|  |  |  |
| --- | --- | --- |
| **Type of Cost** | **Unit** | **Value** |
| Operation Cost | euro/tn-hour | 0,034 |
| euro/1000 tn-kms | 0,332 |
| Maintenance Cost | euro/1000 tn-kms | 0,071 |
| Operation Cost | euro/train-hour | 11,44 |
| euro/train-km | 0,103 |

### H2.6 Routine O&M Economic Costs (freight transport)

|  |  |  |
| --- | --- | --- |
| **Type of Cost** | **Unit** | **Value** |
| Operation Cost | euro/tn-hour | 0,028 |
| euro/1000 tn-kms | 0,272 |
| Maintenance Cost | euro/1000 tn-kms | 0,063 |
| Operation Cost | euro/train-hour | 9,354 |
| euro/train-km | 0,084 |

**H3. Railway Operator Costs**

### H3.1 Financial Costs (passenger transport)

|  |  |  |
| --- | --- | --- |
| **Type of Cost** | **Unit** | **Value** |
| Operation Cost | euro/passenger-hour | 0,46 |
| euro/1000 passenger-kms | 29,56 |
| euro/train-hour | 163,08 |
| euro/train-km | 5,66 |

### H3.2 Economic Costs (passenger transport)

|  |  |  |
| --- | --- | --- |
| **Type of Cost** | **Unit** | **Value** |
| Operation Cost | euro/passenger-hour | 0,38 |
| euro/1000 passenger-kms | 24,18 |
| euro/train-hour | 133,40 |
| euro/train-km | 4,63 |

### H3.3 Financial Costs (freight transport)

|  |  |  |
| --- | --- | --- |
| **Type of Cost** | **Unit** | **Value** |
| Operation Cost | euro/tn-hour | 0,18 |
| euro/1000 tn-kms | 29,79 |
| euro/train-hour | 565 |
| euro/train-km | 11,41 |

### H3.4 Economic Costs (freight transport)

|  |  |  |
| --- | --- | --- |
| **Type of Cost** | **Unit** | **Value** |
| Operation Cost | euro/tn-hour | 0,15 |
| euro/1000 tn-kms | 24,37 |
| euro/train-hour | 463 |
| euro/train-km | 9,34 |

1. [*jaspers.eib.org/knowledge/publications/the-use-of-transport-models-in-transport-planning-and-project-appraisal?documentId=222*](https://jaspers.eib.org/knowledge/publications/the-use-of-transport-models-in-transport-planning-and-project-appraisal?documentId=222) [↑](#footnote-ref-2)
2. https://ec.europa.eu/eurostat/statisticsexplained/index.php?title=Unemployment\_statistics\_at\_regional\_level [↑](#footnote-ref-3)