Determining the basic infrastructure charge

Contents

Summary

The Finnish Transport Infrastructure Agency has determined the infrastructure charge for 2027. The infrastructure charge is based on the Railway Market Directive 2012/34/EU of the European Union, the Finnish Rail Transport Act (1302/2018) and the Commission Implementing Regulation (EU) 2015/909. The infrastructure charge was determined for the railway operators using the state-owned railway network. The infrastructure charge for 2027 consists of the basic component of the basic infrastructure charge and the additional charge for the use of electric supply equipment. The infrastructure charge for 2027 was revised by supplementing the calculation data with data for 2024.

The infrastructure management costs were retrieved from the Finnish Transport Infrastructure Agency's cost management system after which the contents of the cost data were revised on the basis of separate reports. The basic component of the basic infrastructure charge (the direct cost generated by all railway traffic) was determined using a calculation based on econometric modelling, in which the cost function was determined using a regression analysis. Maintenance costs and replacement investments by line section were used as explanatory variables and the gross tonnes and rail kilometres by line section as independent variables in the cost function. The additional charge for the use of electric supply equipment was determined using a subtraction method in which the direct traffic-related costs were separated by experts from the costs incurred as a result of using the electric supply equipment of the electrified railway network and these costs were divided by the kilometres operated in rail traffic using electric supply equipment.

Based on econometric modelling, the basic component of the basic infrastructure charge levied on all railway transport performance is 0.2054 cents/gross tonne-kilometre. Based on the method used, the additional charge for the use of electric supply equipment is 0.0167 cents/gross tonne-kilometre.

The calculations used to produce the basic component of the basic infrastructure charge met the assumptions of linear regression in econometric modelling and the tests carried out on it. The definition of the additional charge for using electric supply equipment is in accordance with the requirements set out in the subtraction method defined in the Commission Implementing Regulation. The infrastructure charge calculations were produced and documented in a thorough and transparent manner and best international practices were used in the process.

1 Introduction

References to the following material are made in this appendix: the basic infrastructure charge calculation required under the Railway Market Directive 2012/34/EU, the legislative framework for determining the calculation, the method used by the Finnish Transport Infrastructure Agency in the Network Statement 2027 to calculate the basic infrastructure charge, the dataset compiled to calculate the charges and the results and evaluation of the calculations based on the dataset.

The infrastructure charge calculations have been produced by combining two methods permitted under the law. The econometric cost modelling based on marginal cost pricing has been used as the principal method and the principles of this modelling have been used to determine the Finnish infrastructure charge since 2003. The method produces the low infrastructure charges meeting transport policy objectives. The second method applied, the subtraction method, is used for determining the additional charge levied on the use of electric supply equipment.

Best international practices have been used in the infrastructure charge calculations even though so far the network statements of different countries and the appendices to them have contained only a limited amount of detailed information on the calculations. Efforts have been made to create sustainable practices that exceed international standards in terms of the accuracy and documentation of the calculations. Background reports and studies have been prepared to support the calculations.

The Finnish Transport Infrastructure Agency only levies the basic infrastructure charge in the timetable period 2027. As required under the law, the charges paid by traffic using electric supply equipment and the traffic not using it are itemised in the basic infrastructure charge.

The process of determining the basic infrastructure charge (Figure 1) consists of two parts: processing of the overall infrastructure management costs and the calculation of direct unit costs. Maintenance costs and replacement investments have been separated from the total infrastructure management costs to calculate the basic component of the basic infrastructure charge and the additional charge for the use of electric supply equipment. After this, non-eligible costs have been separated from total infrastructure management costs. The basic component of the basic infrastructure charge levied on all traffic is a result of econometric modelling, while the additional charge for using electric supply equipment has been calculated with a subtraction method. Processing and modelling of the cost data is discussed in more detail in chapter 4.

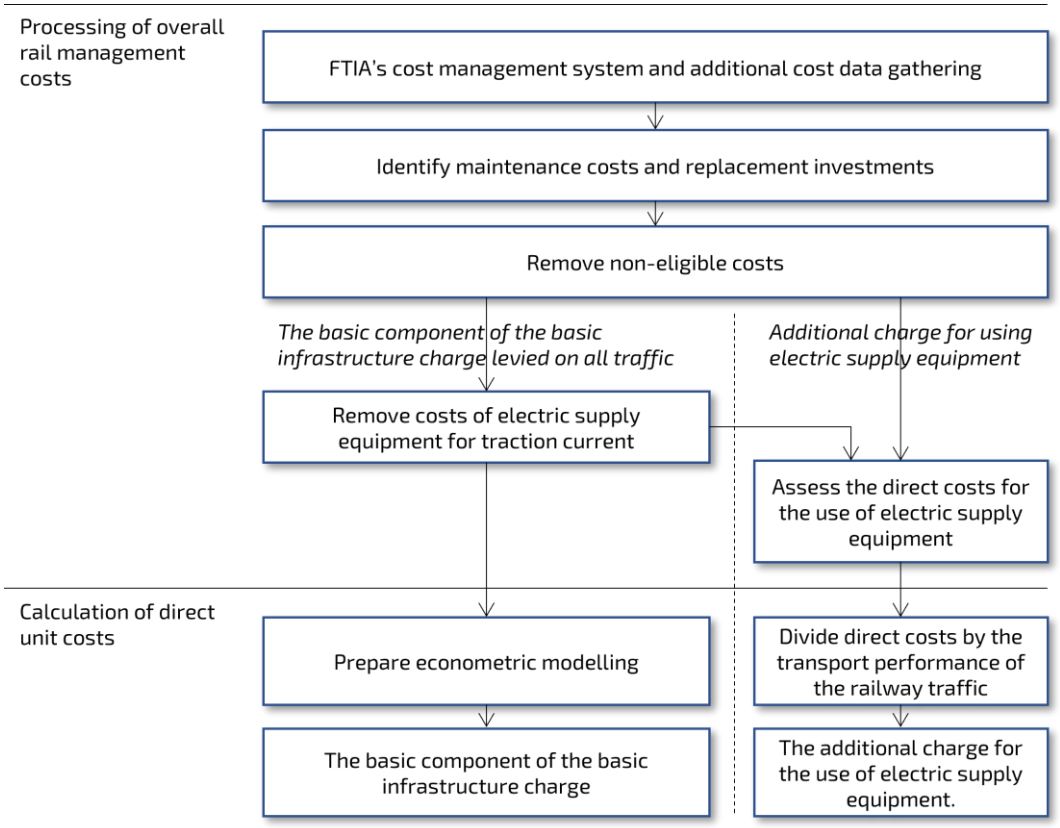


Figure 1. Determining the basic infrastructure charge.

2 Legislative considerations

The basic infrastructure charge is used to determine the price for the minimum access package. The pricing provisions are laid down in the Railway Market Directive 2012/34/EU of the European Union, the Finnish Rail Transport Act (1302/2018) and the Commission Implementing Regulation (EU) 2015/909. The focus in the legislation is on determining which costs should be used as a basis for the pricing of the minimum access package and the basic infrastructure charge levied by the Finnish Transport Infrastructure Agency.

2.1 Railway Market Directive and the Rail Transport Act

In accordance with the Railway Market Directive, the following is stated on the scope of the infrastructure charge in section 132 of the Rail Transport Act (1302/2018):

> *In return for the infrastructure charge referred to in section 139, the infrastructure manager must provide all railway operators, in a fair and non-discriminatory manner, with the services included in the minimum access package referred to in point 1 of Annex II to the Railway Market Directive. In return for the infrastructure charge, the infrastructure manager must also guarantee access to the service facilities referred to in section 133.*

In accordance with the Railway Market Directive (2012/34/EU), the basic rule for determining the basic infrastructure charge is laid down in section 139 of the Rail Transport Act as follows:

> *The basic infrastructure charge levied on the services included in the minimum access package and referred to in section 132(1) above must be directly based on the costs resulting from railway operations.*

The costs directly resulting from railway operations are determined on the basis of the costs that are related to the provision of the minimum access package. Under point 1 of Annex II to the Railway Market Directive, the minimum access package must comprise the following:

> *a) handling of requests for railway infrastructure capacity*
> *b) the right to utilise capacity which is granted*
> *c) use of the railway infrastructure, including track points and junctions*
> *d) train control including signalling, regulation, dispatching and the communication and provision of information on train movements*
> *e) use of electric supply equipment for traction current, where available*
> *f) all other information required to implement or operate the service for which capacity has been granted.*

The inclusion of the minimum access package in the basic infrastructure charge determined by the Finnish Transport Infrastructure Agency has been assessed as follows:

- Paragraph a) concerns official administrative work that is relatively minor in scope and has not been included in the basic infrastructure charge.
- The content of paragraph b) has not been determined as an infrastructure management measure.
- The services referred to in paragraph c) and e) are examined in the section discussing the way in which the basic infrastructure charge is determined.[1]
- The services referred to in paragraph d) are currently outside the scope of the basic infrastructure charge but they are functions that could be priced as minimum access package services.
- The information referred to in paragraph f) is not an infrastructure management measure in the Finnish railway network.

2.2 Commission Implementing Regulation

The EU provisions supplementing the Railway Market Directive must be considered in the process of determining the basic infrastructure charge. *The Commission Implementing Regulation (EU) 2015/909 on the modalities for the calculation of the cost that is directly incurred as a result of operating the train service* lays down the costs that should be considered as direct costs incurred as a result of operating train traffic (Article 3) and the costs that may not be included in the direct costs (Article 4). It is specifically noted in the regulation that the charges levied on train traffic not using electric supply equipment may not include the costs specifically generated by electric traction (Article 4(1)(k)). The rules have been taken into account in the itemisation of infrastructure management costs for the purpose of calculating the basic infrastructure charge and in order to determine a separate price for the basic infrastructure charge levied on all traffic and for the additional charge for using electric supply equipment.

The main points of Article 3 are:

> ***Direct costs on a network-wide basis***
>
> *Direct costs on a network-wide basis shall be calculated as the difference between, on the one hand, the costs for providing the services of the minimum access package and for the access to the infrastructure connecting service facilities and, on the other hand, the non-eligible costs referred to in Article 4.*
>
> *Without prejudice to Article 4 and if the infrastructure manager can transparently, robustly, and objectively measure and demonstrate on the basis of, inter alia, best international practice that costs are directly incurred by the operation of the train service, the infrastructure manager may include in the calculation of its direct costs on a network-wide basis in particular the following costs:*

[1] The electricity transmission services are priced separately in a manner described in the Network Statement.

- *costs of staff needed for keeping open a particular stretch of line if an applicant requests to run a specific train service scheduled outside the regular opening hours of this line;*
- *the part of the costs of points infrastructure, including switches and crossings, that is exposed to wear and tear by the train service;*
- *the part of the costs of renewing and maintaining the overhead wire or the electrified third rail or both and the supporting overhead line equipment directly incurred as a result of operating the train service; the costs of staff needed for preparing the allocation of train paths and the timetable to the extent that they are directly incurred as a result of operating the train service.*

The Finnish Transport Infrastructure Agency includes the costs presented in section 1 in the costs incurred from the measures that are carried out to maintain the daily operability of the railway network (maintenance) as well as to repair and renew the infrastructure due to the wear and tear (replacement investments) resulting from railway operations. The specifications on the non-eligible costs presented in Article 4 are considered in determining these costs.

Article 4 presents special rail infrastructure management costs, which have been excluded from the modelling exercise, as follows:

Non-eligible costs

1. *The infrastructure manager shall not include in the calculation of direct costs on a network-wide basis in particular the following costs:*
    a. *fixed costs relating to the provision of a stretch of line which the infrastructure manager must bear even in the absence of train movements;*
    b. *costs that do not relate to payments made by the infrastructure manager. Costs or cost centres that are not directly linked to the provision of the minimum access package or to access to infrastructure connecting service facilities;*
    c. *costs of acquisition, selling, dismantling, decontamination, recultivation or renting of land or other fixed assets;*
    d. *network-wide overhead costs, including overhead salaries and pensions;*
    e. *financing costs;*
    f. *costs related to technological progress or obsolescence;*
    g. *costs of intangible assets;*
    h. *costs of track-side sensors, track-side communication equipment and signalling equipment if not directly incurred by operation of the train service;*
    i. *costs of information, non-track side located communication equipment or telecommunication equipment;*
    j. *costs related to individual incidences of force majeure, accidents and service disruptions without prejudice to Article 35 of Directive 2012/34/EU;*

k. costs of electric supply equipment for traction current if not directly incurred by operation of the train service. Direct costs of operation of the train services that do not use electric supply equipment shall not include costs of using electric supply equipment;
l. costs related to the provision of information mentioned under item 1(f) of Annex II to Directive 2012/34/EU, unless incurred by operation of the train service;
m. administrative costs incurred by schemes of differentiated charges referred to in Articles 31(5) and 32(4) of Directive 2012/34/EU;
n. depreciation which is not determined on the basis of real wear and tear of infrastructure due to the train service operation;
o. the part of the costs of maintenance and renewal of civil infrastructure that is not directly incurred by operation of the train service.

2. If the infrastructure manager received funding to finance specific infrastructure investments, which it is not obliged to repay and where such investments are taken into account in the calculation of direct costs, the costs of such investments shall not increase the level of charges without prejudice to Article 32 of Directive 2012/34/EU.

3. Costs excluded from calculation by virtue of this Article shall be measured or forecast on the basis of the time period referred to in Article 3(5).

In the non-eligible costs, the Finnish Transport Infrastructure Agency follows the procedure described in subsection 4.1 so that it can be ensured that non-eligible cost items are not included in the infrastructure charge.

3 Method of determining the basic infrastructure charge and the source data

3.1 General description

A dataset has been prepared to calculate the basic infrastructure charge and it describes the railway network of the Finnish Transport Infrastructure Agency as well as the railway operations and infrastructure management on the network. The dataset contains the following data:

- features of the railway network by line section,
- annual transport performance by line section, and
- annual cost of rail infrastructure management (maintenance and replacement investments) allocated to line sections considering the legal framework related to the cost assessment.

The determination of the basic infrastructure charge is primarily based on the *econometric cost modelling* described in Article 6 of the Commission Implementing Regulation (2015/909) (section 4.2.1 of this appendix), while the additional charge for using electric supply equipment is determined on the basis of the subtraction method described in Article 3 of the Commission Implementing Regulation. Econometric modelling of the dataset has been used to examine the ratio of costs by line section to the amount of infrastructure and the transport performance on the line sections. Costs that do not include the infrastructure management costs incurred from the use of electric supply equipment have been determined on the basis of econometric modelling. This gives the costs generated by the transport performance of train traffic (basic component of the basic infrastructure charge; cents/gross tonne-kilometre).

An additional charge is levied on the use of electric supply equipment and this charge is added to the basic component of the basic infrastructure charge. The additional charge levied on the use of electric supply equipment is collected on all electrically hauled stock. The additional charge has been determined using the calculation method laid down in Article 3 of the Commission Implementing Regulation (section 4.2.2 of this appendix). In this method, expert evaluation has been used to separate the network-wide costs of infrastructure management of the electrified rail network from the infrastructure costs directly incurred from rail traffic operations and these costs have been divided by the kilometres operated in rail traffic using electric supply equipment.

3.2 Feature data of the railway network and scope of the study

The dataset used for the calculations includes the following feature data of the railway network:

- division of the railway network into line sections,
- line length of the line section,
- track length of the line section,
- multi-rail line sections, and
- electrification.

The feature data was compiled for 70 line sections from the Network Statement and the Railway Information Extranet. The calculation data covers the entire length of the railway network managed by the Finnish Transport Infrastructure Agency (excluding railway yards and a small number of short sidings). In 2024, a total of 5,614 km of the Finnish railway network was in transport use and 5,559 km of this was covered by the calculation data.

3.3 Transport performance data

The dataset includes the annual statistical data on the kilometres operated by line section in gross tonnes (total weight of rolling stock and cargo). The figures for the period 2013–2014 are from the traffic information system of VR and for the period 2015–2024 from the infrastructure manager's traffic information system.

3.4 Cost information

The data on total infrastructure management costs as regards the basic component and the additional charge for using electric supply equipment are from the Finnish Transport Infrastructure Agency's cost calculation system and it covers the period 2013–2024. The total infrastructure management costs have been grouped by cost category (see section 4.1.1). The costs incurred from the use of the minimum access package have been identified and the non-eligible costs listed in Article 4 have been excluded (see section 4.1.2). To determine the basic component of the basic infrastructure charge, the following items have been identified from the remaining data: cost of maintaining line sections and replacement investments, which serve as the source data for the econometric modelling. The modelling produces the direct unit costs generated by train traffic.

The datasets of the basic component of the basic infrastructure charge contain the following maintenance costs allocated to line sections each year:

- superstructure maintenance;
- maintenance of turnouts and turnout heating;
- maintenance of trackside equipment and devices;
- bridge maintenance;
- maintenance of substructure, foundation structure and railway areas;
- maintenance of train control systems and safety installations; and
- maintenance material, such as rails, sleepers and ballast as well as materials related to equipment and instruments.

The dataset of the basic component of the basic infrastructure charge contains the following replacement investment costs allocated to line sections each year:

- renewal and cleaning of superstructure, such as the ballast bed;
- renewal of rails, sleepers, overhead wires and supporting lines;
- renewal and repair of turnouts;
- grinding of rails and turnouts; and
- such material as rails, sleepers and ballast and other structural material.

To determine the additional charge of the basic infrastructure charge based on the use of electric supply equipment, the cost of infrastructure management of

the electrified railway network and the infrastructure costs directly incurred from traffic identified by experts have been retrieved from the dataset. The costs have been divided by the transport performance generated using electric supply equipment, which has resulted in the additional charge for the train traffic using electric supply equipment.

The costs related to electric supply equipment have been grouped in the following categories and subcategories:

- electrotechnical bridge maintenance;
- maintenance, renewal and inspections of electric railway systems and substations;
- maintenance of high-tension track equipment, 110 kV systems, lighting, heating stations and transformers;
- maintenance of other special track systems;
- separately contracted maintenance work for the electrified railway network; changes of overhead wires and supporting lines, changes of hangers, changes of phase breaks, changes of section insulators, changes of disconnectors and their anchor arms, changes of circuit breakers and disconnectors at feeder stations, basic overhead line maintenance; and
- materials: overhead wires and supporting lines, hanger materials, phase breaks, section insulators, circuit breakers, disconnectors and anchor arms.

To determine the costs of using electric supply equipment, experts have estimated the dependence between costs and traffic for each of these categories. The estimates are given as dependence between 0% and 100%. An independent report based on interviews with experts has been prepared on the dependencies and published in the FTIA publication series.[2]

[2] The costs of the electric supply equipment directly incurred by the operation of the train service (in Finnish). FTIA publications 59/2020

4 Calculations and basic infrastructure charges

4.1 Infrastructure management costs incurred by the Finnish Transport Infrastructure Agency

To verify the costs eligible for the infrastructure charge calculations and directly incurred from traffic, a compilation and breakdown of the total costs of infrastructure management have been produced. This sub-chapter describes how the costs used in the minimum access package and further in the econometric cost modelling have been calculated on the basis of the total infrastructure management costs by subtracting the non-eligible costs (section 4.1.2) from the minimum access package costs (section 4.1.1).

The infrastructure management costs incurred by the Finnish Transport Infrastructure Agency have been entered in the agency's Sampo cost management system, which is based on the Kieku ERP system of central government. The infrastructure management costs have been retrieved from the Sampo cost management system and entered on the following on-budget accounts:

- 3110202 Railway infrastructure management
- 3110205 Traffic control service charge
- 311077xxxx Development investments (including railway network development investments)

The total infrastructure management costs incurred by the Finnish Transport Infrastructure Agency for each year (2013–2024) and by cost category (18 categories) are presented in Table 1 in Appendix 1 and in graphic in Figure 1 in Appendix 1. The categorisation of costs is based on a review carried out on the most detailed cost management system level (payment item).

4.1.1 Costs incurred from minimum access package

The infrastructure management costs and the minimum access package (MAP[3]) costs incurred by the Finnish Transport Infrastructure Agency have been itemised to calculate the basic infrastructure charge. Only the costs incurred from the minimum access package (MAP) have been considered in the calculation of the basic infrastructure charge.

Cost incurred from the minimum access package:

- ***Replacement investments (MAP)*** comprise the costs incurred from the renovation of line sections, safety installations and platforms. Replacement investments (other) comprise the other replacement investments.
- ***Maintenance costs (MAP)*** comprise the costs incurred from the maintenance of line sections, safety installations and platforms and from separately contracted line section maintenance (YPI and RHET). Maintenance costs (other) comprise the other maintenance costs.
- ***Electric supply equipment costs (MAP)*** comprise the costs incurred from the replacement of electric supply equipment, and the maintenance of the electric supply equipment, overhead wires and supporting lines,

[3]The English abbreviation MAP is used for the Minimum Access Package.

and the maintenance of turnouts and control equipment on the line sections with electric supply equipment. Electric supply equipment costs (other) comprise the other electric supply equipment costs.

- ***Costs of using filtering equipment of electrical disturbances (MAP).***
- ***Train traffic control costs (MAP + other)*** comprise the costs incurred from traffic control, traffic control centres and control rooms, capacity management and system maintenance. In addition to the minimum access package costs, train traffic control costs also include other costs, such as systems development and training. The costs incurred from train traffic control are not included in the infrastructure charge.

The average MAP costs for the period 2013-2024 are EUR 286 million per year and EUR 266 million per year when excluding costs of electrical supply equipment. An average of EUR 206 million of these can be allocated to track sections. The detailed cost breakdown is provided in Table 2 of Appendix 1.

4.1.2 Non-eligible costs

This section describes how non-eligible costs have been separated from total infrastructure management costs (Article 4 of the Commission Implementing Regulation).

The following costs specified in Article 4 are not included in the infrastructure management cost data:

Table 1. Costs specified in Article 4(1) that are not included in the infrastructure management costs of the Finnish Transport Infrastructure Agency.

Costs specified in Article 4	***Explanation***
d) network-wide overhead costs, including overhead salaries and pensions.	The network-wide overhead costs are paid from the operating expenditure of the Finnish Transport Infrastructure Agency and they are not included in the total infrastructure management costs examined in this appendix.
e) financing costs.	Financing costs of the on-budget appropriations are not considered in the accounts of the Finnish Transport Infrastructure Agency. The Finnish Transport Infrastructure Agency only collects financing for infrastructure management through infrastructure charges, which do not involve financing costs.
f) Costs related to technological progress or obsolescence.	The cost data does not include costs related to technological progress or obsolescence. These costs refer to write-downs that may have to be made when assets that have not yet reached the end of their useful life in terms of accounting are replaced.
l) Costs related to the provision of information mentioned under item 1(f) of Annex II to Directive 2012/34/EU, unless incurred by operation of the train service.	Costs related to the provision of information are paid from the operating expenditure of the Finnish Transport Infrastructure Agency and they are not included in the total infrastructure management cost data examined in this appendix.
m) Administrative costs incurred by schemes of differentiated charges referred to in Articles 31(5) and 32(4) of Directive 2012/34/EU.	The system of infrastructure charges does not include cost impact mechanisms referred to in the regulation, which means that the total infrastructure management cost data examined in this appendix does not include administrative costs of this type.
n) Depreciation which is not determined on the basis of real wear and tear of infrastructure due to the train service operation.	The Finnish Transport Infrastructure Agency receives its funding from the State Budget and thus it does not make any depreciation in its accounts. The agency publishes annual financial statements, in which the depreciation is estimated on the basis of commercial accounting methods.

The infrastructure management data contains the following non-eligible costs referred to in Article 4 of the Commission Implementing Regulation (references to categories in Table 1 are shown in bold and in italics):

Table 2. Costs specified in Article 4(1) that are included in the infrastructure management costs of the Finnish Transport Infrastructure Agency in full or in part.

Costs specified in Article 4	***Explanation***
(a) Fixed costs relating to the provision of a stretch of line which the infrastructure manager must bear even in the absence of train movements.	***Maintenance costs (MAP)*** and ***Replacement investments (MAP)*** include the costs incurred from the minimum access package, which include both fixed and variable costs. The fixed costs related to a line section do not depend on the volume of train traffic and they are not included in the infrastructure charge in econometric modelling.
(b) Costs that do not relate to payments made by the infrastructure manager. Costs or cost centres that are not related to the provision of the minimum access package or the right to access the infrastructure connecting service facilities.	The cost data only includes charges paid by the Finnish Transport Infrastructure Agency. ***Replacement investments (other), Maintenance costs (other) and Electric supply equipment costs (other)*** include railway yard costs and they are not considered in the infrastructure charge calculations.
c) Costs of acquisition, selling, dismantling, decontamination, recultivation or renting of land or other fixed assets.	As a rule, these cost items are not included in the infrastructure management costs. Costs items included in the infrastructure managements costs have been excluded from the cost data.
g) Costs of intangible assets.	**Information systems** containing software licences are not considered as costs in the infrastructure charge calculations. The Finnish Transport Infrastructure Agency does not have any other intangible assets related to infrastructure management.
h) Costs of track-side sensors, track-side communication equipment and signalling equipment if not directly incurred by operation of the train service.	These costs are included in the following categories: ***Replacement investments (MAP)*** and ***Maintenance investments (MAP)***. Costs that do not directly arise from railway operations are not considered in the econometric modelling.
I) Costs of information, non-track side located communication equipment or telecommunication equipment.	These costs are included in the following categories: ***Replacement investments (MAP)*** and ***Maintenance investments (MAP)***. Costs that do not directly arise from railway operations are not considered in the econometric modelling.
j) Costs related to individual incidences of force majeure, accidents and service disruptions without prejudice to Article 35 of Directive 2012/34/EU.	***Clearing of accident sites and rescue services*** and ***Contaminated land areas and environmental management***, which include damage-related costs are not considered in the infrastructure charge calculations.
k) Costs of electric supply equipment for traction current if not directly incurred by operation of the train service. Direct costs of operation of the train services that do not use electric supply equipment shall not include costs of using electric supply equipment.	The electric supply equipment costs are divided into two categories: ***Electric supply equipment costs (MAP)*** and ***Electric supply equipment costs (other)***, which have both been excluded from the calculations producing the basic component of the basic infrastructure charge. The cost of infrastructure management of the electrified railway network directly incurred from railway operations are estimated by experts on the basis of a detailed cost itemisation and allocated to train traffic using electric supply equipment.
o) The part of the costs of maintenance and renewal of civil infrastructure that is not directly incurred by operation of the train service.	***Maintenance costs (other)*** are not considered in the infrastructure charge calculations.

The interpretation is that Article 4(2) of the Commission Implementing Regulation applies to such projects of the Finnish Transport Infrastructure Agency that are funded from the TENT-T scheme. These are ***development investments***, which are not considered in the basic infrastructure charge calculations.

In addition to the non-eligible costs specified in Article 4, the following cost categories are also excluded from the infrastructure charge calculations for 2023: ***Data communications***, ***Supervision***, ***Property management***, ***Rail Training Centre***, ***Reports and R&D*** and ***Administrative costs***. In addition, the **electricity transmission service** is a cost that is not included in the infrastructure charge calculation.

4.2 Determining the basic infrastructure charge

The following costs incurred from the minimum access package and referred to in section 4.1.1 from which the non-eligible costs referred to in section 4.1.2 have been subtracted are considered in the calculation of the basic infrastructure charge for 2027:

- Replacement investments (MAP) that comprise the costs allocated to line sections and that have been capitalised in the line section balance sheet of the on-budget account 3110202 (Railway infrastructure management).
- The part of the maintenance costs (MAP) that can be allocated to line sections directly or on the basis of a questionnaire survey carried out among railway network maintenance managers.
- Electric supply equipment costs (MAP) that can be allocated to the cost categories listed in section 3.4.

Replacement investments and maintenance costs are processed using econometric modelling (Article 6 of the Commission Implementing Regulation) and the costs for the use of electric supply equipment using the subtraction method (Article 3 of the Implementing Regulation).

Train traffic control costs (MAP) will not be considered in the infrastructure charge calculations for 2027 because their dependence from train traffic has not yet been determined. Certain MAP costs that cannot be allocated to line sections will be similarly treated.

Econometric modelling takes into account the dependence between the examined costs and traffic volumes so that the non-traffic costs or fixed costs do not impact the level of basic infrastructure charges. Paragraphs a, h and i of Article 4 (Non-eligible costs) are considered on this basis.

Econometric modelling requires that replacement investments and maintenance costs are allocated to specific line sections. The allocation is based on the payment item-level entries in the cost management system specifying a line section. Example:

> On-budget account: 3110202 Railway infrastructure management, TA1
> Project: RTHH-49 RO 1105 Huopalahti–Vantaankoski renovation, H
> Project: RTPP-49 RO 1105 HUOPALAHTI–VANTAANKOSKI, P
> Events: PR00011594 RO 1105 Hpl–Vks superstructure and bridge repairs, TP, v
> Payment item: L00000K0L IR132183A13 RO 1105 Renovation of ground supports and vaults on the Louhela station bridge, M, v

Line section: RO 1105
Year: 2013
Category: Replacement investments (MAP)
Specific category: Replacement investments line sections

The basic component of the basic infrastructure charge for 2027 is calculated on the basis of account line sections and in these calculations the divisions into line sections used as the basis for cost data and transport performance data are identical. This change has eliminated the need to allocate cost data to line sections used as a basis for transport performance data. The costs for which the transport performance line section is not known are not considered in the calculations.

The costs arising from turnout heating comprise the costs of the energy needed for heating turnouts. These costs are allocated to line sections in accordance with the number of heated turnouts.

4.2.1 Basic component of the basic infrastructure charge

Using the datasets described above, the Finnish Transport Infrastructure Agency has prepared a modelling to determine the basic component of the basic infrastructure charge. The datasets cover the period 2013–2024. In the modelling, a cost function has been determined on the basis of a linear regression analysis, in which the costs (maintenance and replacement investments by line section) are used as the explanatory variable, and transport performance (gross tonnes by line section) and track kilometres (by line section) are used as independent variables.

The dataset has been compiled by adding up the costs and transport performance during a period of 12 years (2013–2024). By combining datasets of several years, the impacts of replacement investments can be divided equally over the period in review. The calculation method was selected on the basis of a thesis on the topic produced for the Finnish Transport Infrastructure Agency.[4]

The following function is used as the cost function:

$ln\, C_i = \alpha + \beta_{rd\_km}\, ln\, rd\_km_i + \beta_{brt}\, ln\, brt + \epsilon_i$, in which

C_i means infrastructure management costs on line section *i*
α, β_{rd_km} and β_{brt} are the estimated coefficients of the model
rd_km_i means total track length on line section *i* (length of the line section × number of tracks on the line section)
brt transport performance on line section *i* in gross tonnes
ϵ_i error term of the costs of line section *i* , which is the difference between econometric modelling and actual cost.

In the calculation, track length is the length of the line sections multiplied by the number of tracks on each line section. Transport performance on a line section means the transported gross tonne volume during the period in review, which includes the total weight of the train (including cargo).

[4] Evaluating the econometric modeling of the marginal cost of railway infrastructure use (in Finnish). Finnish Transport Infrastructure Agency. Thesis 8/2020.

The marginal cost of traffic has been estimated from the dataset by constructing a cost function, which examines the ratio of transport performance on each line section (gross tonnes) and track length to costs on all line sections. In addition to turnout heating, no other electric supply equipment costs have been included in the examination.

Model estimation was carried out on the basis of the R computing software. The coefficients of the estimated model (cost function) and the explanation rate are as follows[5]:

- Number of observations N = 70
- Explanation rate R^2 = 0,6460
- Model coefficients:
  - Standard α = 9,8019
  - Transport performance β_{brt} = 0,2827
  - Track length β_{rd_km} = 0,5574
- Standard error = 0,6496.

The results of the cost function estimation (incl. key figures) as well as the statistical tests carried out on the modellings are presented in Appendix 3.

The marginal cost (the cost directly resulting from an individual train service performance) has been calculated using partial derivation of the cost function with respect to the service performance. The resulting marginal cost function indicates how much the infrastructure management costs examined change as a result of one additional train service performance (gross tonne-kilometre, brtkm).

The marginal cost (MC) is presented as follows[6]:

$$MC_i = \beta_{brt} \frac{e^{\alpha+\beta_{rd\_km} \ln rd\_km_i+\beta_{brt} \ln brt_i+\frac{\sigma^2}{2}}}{brt_i\, rt\_km_i}$$, in which

rt_km_i is the length of line section *i* and is $\sigma^2$the estimate of the model error term variance.

The marginal cost has been estimated separately for each line section contained in the dataset. Due to substantial differences in track length, transport performance and costs between line sections, there is also substantial variation in marginal costs between line sections.

The marginal cost (MC) determined for the pricing of the basic infrastructure charge has been calculated by weighting the marginal costs for each line section by the volume of the service performance on the line sections as follows:

$$MC = \frac{\sum brtkm_i\, MC_i}{\sum brtkm_i}$$

[5] The modelling has been made using the ordinary least squares method. Reports produced by the Finnish Transport Agency and the Finnish Rail Administration also present comparisons on the suitability of other methods.

[6] On formula derivation, see for example *Munduch, Gerhard & Pfister, Alexander & Sägner, Leopold & Stiassny, Alfred. (2002). Estimating Marginal Costs for the Austrian Railway System. Vienna University of Economics, Department of Economics, Department of Economics Working Papers.*

The marginal cost determined using econometric modelling – that is, the basic component charged for all traffic performance – is 0.2054 cents/gross tonne-kilometre, as adjusted on the basis of the 2024 cost index.

Based on the data, the dependency between transport performance and the costs that must be considered in the calculation of the infrastructure charge amounts to 28.3%. In other words, when transport volumes grow by one per cent, infrastructure management costs increase by 0.283%.

The infrastructure charge has been calculated using the R programming language and the calculation code is described in Appendix 4.

4.2.2 Additional charge for the use of electric supply equipment

The additional charge levied on the use of electric supply equipment has been determined using the method laid down in Article 3 of the Commission Implementing Regulation. In this method, expert evaluation has been used to separate the network-wide separate costs of infrastructure management of the electrified rail network from the infrastructure costs directly incurred from rail traffic operations and these costs have been divided by the kilometres operated in rail traffic using electric supply equipment. The proportion of direct costs is based on the view of ten independent experts on the dependencies between component wear and tear and railway traffic. The report on the topic has been published in the FTIA publication series[7].

The average annual costs of infrastructure management of the electrified rail network in the period 2014–2024 are presented below. The information is based on the classification used by the Finnish Transport Infrastructure Agency in its cost monitoring and estimates of the proportion of the costs directly resulting from rail traffic are also given. The cost dataset of infrastructure management of the electrified rail network in 2013 is not fully comparable with the figures for subsequent years and for this reason it is not included in the data used in the calculations. The figures presented below are index-adjusted to 2024 price level.

Electrotechnical maintenance of bridges consists of periodical earthing inspections carried out independently of railway traffic. These costs averaged EUR 0.243 million/year in the period 2014–2024 and 0% of them (EUR 0 million/year) were costs directly resulting from rail traffic.

Maintenance of the electrified railway system consists of the work carried out as part of annual maintenance contracts and separately contracted work. Work carried out as part of the maintenance contracts consists of inspections to ensure network safety and accessibility and the work is not related to transport performance (70%). Costs directly resulting from traffic include maintenance costs for section insulators, phase breaks and overhead lines of scissor crossings (30%), 10% of which are estimated to be due to replacement investments made before the end of the life cycle. Annual costs averaged EUR 4.743 million in the period 2014–2024 and 27% of these costs (EUR 1.280 million/year) were costs directly resulting from rail traffic. The separately contracted work consists of inspections and other work carried out to ensure the safety and accessibility

[7] The costs of the electric supply equipment directly incurred by the operation of the train service (in Finnish). FTIA publications 59/2020

of the rail network and the work does not include costs that are directly related to traffic. Separately contracted work averaged EUR 0.311 million/year in the period 2014–2024 and 0% (EUR 0/year) of this was work directly resulting from traffic.

Maintenance of high-tension equipment consists of work carried out as part of annual maintenance contracts and separately contracted work. Annual costs averaged EUR 2.623 million in the period 2014–2024 and none of these costs are allocated to the additional charge of the basic infrastructure charge payable by traffic using electric supply equipment. Separately contracted work comprises maintenance of 110 kV systems, lighting and heating stations. According to the report, these costs are not traffic-related. Separately contracted work averaged EUR 1.308 million/year in the period 2014–2024.

Maintenance of transformers and turnout heating equipment, which include periodic inspections and replacements of components, is also included as part of the maintenance of high-current track equipment. The average costs for the transformers in 2014-24 were EUR 0.090 million/year, of which 50% (EUR 0.045/year) were directly caused by traffic and EUR 0.154 million/year for turnout heating equipment, of which 35% (EUR 0.054/year) were directly caused by traffic.

Separately contracted electrified railway maintenance work comprises the work carried out as part of annual maintenance contracts and separate work. Separately contracted electrified railway maintenance work consists of changes of overhead wires and supporting lines, changes of hangers, changes of phase breaks, changes of section insulators, changes of disconnectors and their anchor arms, changes of circuit breakers and disconnectors at feeder stations, basic overhead line maintenance and hangers. An expert assessment of to what extent these maintenance costs are traffic-related is given in Table 3.

Table 3. Traffic-related nature of separately contracted electrical maintenance work.

Type of cost	***To what extent is the work traffic-related***	***Cause***
Overhead wires	90%	Direct physical contact, contact force, vibration
Hangers	90%	Vibration of the overhead line caused by traffic, 10% acceleration and vibration caused by wind
Phase breaks	85%	Direct physical contact, contact force, vibration
Grouping insulators	95%	Direct physical contact, contact force, vibration
Disconnectors and their anchor arms	10%	The operating current of the rolling stock causes the disconnectors and their anchor arms to wear
Circuit breakers and disconnectors at feeder stations.	20%	The operating current of the rolling stock causes circuit breakers and disconnectors to wear
Basic overhead line maintenance	0%	Is not traffic-related
Hangers	5%	Vibration of the overhead line system caused by traffic
Transformers	50%	Operating current of the rolling stock causes transformers to wear.

Annual costs of maintenance contract work averaged EUR 3.220 million in the period 2014–2024 and EUR 1.223 million/year of these costs were costs resulting from rail traffic. Annual costs of separately contracted work averaged EUR 2.565 million in the period 2014–2024 and EUR 0.974 million of these costs were costs resulting from rail traffic.

Replacement of overhead wires and supporting lines is separated from other electrical maintenance in the cost accounting of the Finnish Transport Infrastructure Agency. Annual costs of replacing overhead wires averaged EUR 0.713 million in the period 2014–2024 and 90% of these costs (EUR 0.642 million/year) were costs directly resulting from rail traffic. Annual costs of replacing supporting lines averaged EUR 1.618 million and 5% of these costs (EUR 0.081 million/year) were costs directly resulting from rail traffic.

Material costs are divided into material costs related to annual maintenance contracts and material costs related to separate work. The material costs of maintenance contracts consist of the same components as separately contracted electrical maintenance work. These costs averaged EUR 0.310 million/year in the period 2014–2024 and 38% of them (EUR 0.118 million/year) were costs directly resulting from rail traffic. Material costs related to separate work comprise materials of heating stations and other materials. Material costs of heating stations averaged EUR 0.113 million/year in the period 2014–2024 and 40% of them (EUR 0.045 million/year) were costs directly resulting from rail traffic. Costs of other materials averaged EUR 0.592 million/year and 0% of them were directly resulting from rail traffic.

Maintenance of other special trackside systems and other work comprises inspection costs that do not directly result from train traffic. These costs averaged EUR 0.685 million/year in the period 2014–2024 and 0% of them (EUR 0 million/year) were costs directly resulting from rail traffic.

All in all, the electrified railway infrastructure management costs totalled EUR 19.288 million/year and EUR 4.462 million/year of them were costs directly resulting from rail traffic.

The transport performance of traffic using electric supply equipment averaged 26,787 million gross tonne-kilometres in the period 2014–2024.

When the sum of the electrified railway infrastructure management costs directly resulting from traffic is divided by transport performance, the additional charge for the use of electric supply equipment is 0.0167 cents/gross tonne-kilometre (2024 price level). This figure is the additional charge for the traffic using electric supply equipment/transport performance.

4.3 Unit values of basic infrastructure charge

The Finnish Transport Infrastructure Agency uses an index method taking into account changes in the cost of infrastructure maintenance when adjusting the basic infrastructure charge. The charges are linked to the point figure 133.66 (annual average for 2024) of the sub-index '*Railway maintenance*' of Statistics Finland's cost index of civil engineering works (2010 = 100). The Finnish Transport Infrastructure Agency uses the annual rates of changes for the index-based adjustment of the charges.

Considering the research results described in this appendix and the above-mentioned preconditions for determining the charges, the basic infrastructure charge will be levied in the period 1 January–31 December 2027 as follows:

- Based on the econometric modelling described in chapter 4.2.1, the basic component of the basic infrastructure charge levied on all railway transport performance is 0.2054 cents/gross tonne-kilometre.
- Based on the modelling described in chapter 4.2.2, the additional charge for the use of electric supply equipment on all electrically hauled railway transport performance is 0.0167 cents/gross tonne-kilometre.

5 Evaluation of the results

5.1 Evaluating the basic component of the basic infrastructure charge

The results of econometric modelling can only be interpreted if the assumptions given in the modelling are met. The linear regression model used in modelling must meet five Gauss-Markov theorem standard assumptions, so that the model is the most effective and accurate linear estimator (BLUE, best linear unbiased estimator) for the phenomenon being examined. In addition, if the model's error terms are normal, BLUE can be found using the smallest sum of squares method. The assumptions are:

1. explanatory values are independent and fixed, i.e. non-random constants
2. explainers have no linear dependencies
3. all error terms have the same expected value
4. all error terms have the same variance
5. error terms do not correlate with each other
6. error terms are normally distributed

Condition 5 only applies to series data, e.g. time series. Line section cross-section materials cannot be arranged as a series, so condition 5 cannot be applied.

Conditions 1 to 4 and 6 are met with the drawn up model. The tests related to the modelling are described in Appendix 3.

The explanation rate of the econometric model determining the basic component of the basic infrastructure charge is 0.646. The explanation rate states to what extent the infrastructure management costs can be attributed to performance (gross tonne-kilometres and track lengths of line sections). The model is estimated to have a high explanation rate.

5.2 Evaluation of the additional charge for the use of electric supply equipment

Determining the electric supply equipment costs directly resulting from traffic is based on a detailed classification of the cost of electrified railway infrastructure management and detailed and documented interviews with ten experts. The views of these experts reinforce the earlier view that most of the direct costs resulting from the use of electric supply equipment are related to the equipment and components that are in directly contact with the rolling stock. The main differences in the views among the experts were related to factors affected by regional weather conditions.

The international comparison of network statements has not yet provided methodological support or comparative information to determine the additional charge for the use of electric supply equipment. The calculation method used in Finland is similar to the method used in France, which, like the Finnish system, is based on the classification of costs and the percentage-based assessment of

the manner in which the cost depend on train traffic. In international comparisons, the difference between the charges paid by traffic using electric supply equipment and other traffic is small in Finland.

Appendix 1. Infrastructure Management Costs 2013-24

Table 1. Infrastructure management costs incurred by the Finnish Transport Infrastructure Agency in the period 2013–2024 (EUR million) (Source: Sampo cost management system). The abbreviation MAP means the costs incurred from the minimum access package. Nominal costs.

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Replacement investments (MAP)	112,97	97,38	67,48	81,18	93,51	164,80	98,44	123,65	138,81	130,41	112,82	171,74
Replacement investments (other)	16,21	24,52	26,73	50,00	48,24	54,03	44,56	46,32	43,16	74,73	55,25	53,56
Maintenance costs (MAP)	123,17	127,15	129,08	133,97	147,30	136,01	152,97	177,00	159,95	176,17	171,41	164,82
Maintenance costs (other)	22,79	10,94	9,77	9,49	9,90	10,46	11,35	11,97	17,79	19,85	16,96	14,21
Electric supply equipment costs (MAP)	15,30	19,86	18,86	20,60	20,73	19,69	19,43	20,23	22,07	20,88	20,92	19,76
Electric supply equipment costs (other)	4,06	3,66	3,44	2,82	3,55	1,29	1,60	2,36	2,45	1,00	1,25	1,05
Electricity transmission service	10,47	10,19	9,64	10,19	10,60	11,37	9,97	12,27	13,96	17,86	17,14	15,63
Development investments	279,75	277,59	204,27	216,24	162,02	113,22	123,13	137,45	195,55	312,29	256,34	235,13
Train traffic control costs (MAP + other)	48,39	51,61	55,69	54,64	51,28	53,75	82,17	75,03	76,66	75,60	79,98	77,80
Data systems	4,23	5,62	5,77	7,02	10,13	11,69	7,10	7,97	6,91	7,55	8,46	10,29
Data communications	13,86	14,62	14,40	15,35	19,94	19,66	15,25	10,41	9,88	9,80	10,15	10,31
Supervision	4,55	4,96	4,99	4,66	4,49	4,86	5,01	5,57	5,27	5,25	5,31	4,57
Property management	1,73	2,21	1,70	1,94	2,01	1,52	1,03	0,98	1,03	2,57	1,73	1,61
Rail Training Centre	0,00	0,00	0,40	3,72	9,24	1,87	1,01	1,76	1,76	1,52	1,71	1,62
Contaminated land areas and environmental management	1,00	0,56	0,60	0,48	0,46	0,44	0,49	0,47	0,37	0,28	0,61	0,34
Clearing of accident sites and rescue services	0,51	1,31	2,48	4,57	7,00	6,96	3,79	4,34	10,14	7,82	7,03	7,47
Reports and R&D	1,38	2,65	2,36	2,67	3,63	3,39	6,37	8,58	10,16	10,03	12,44	13,23
Administrative costs	1,97	1,23	1,83	2,52	2,88	3,11	2,62	3,93	2,61	4,42	5,40	7,69
Total	**662,35**	**656,07**	**559,51**	**622,07**	**606,94**	**618,11**	**586,26**	**650,29**	**718,52**	**878,01**	**784,91**	**810,82**

Figure 1. The total infrastructure management costs of the Finnish Transport Infrastructure Agency are presented by category and year (2013–2024) in the figure below. The abbreviation MAP refers to the costs of minimum access possibilities. Costs adjusted to the 2024 price level using an index.

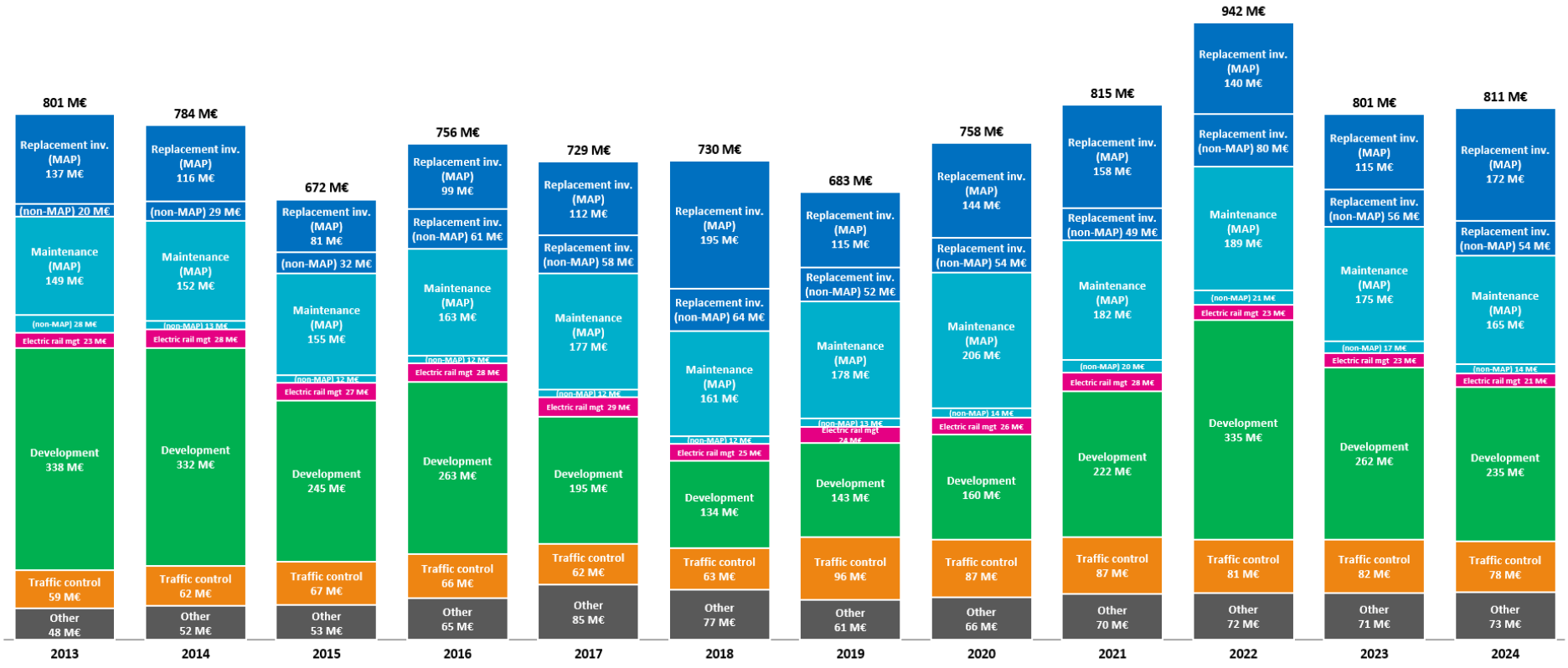


Table 4. Costs incurred from the Minimum Access Package in the period 2013–2024 (EUR million) (source: Sampo cost management system). Train traffic control costs also include non-MAP costs and thus they are not included in the total amounts. Nominal costs.

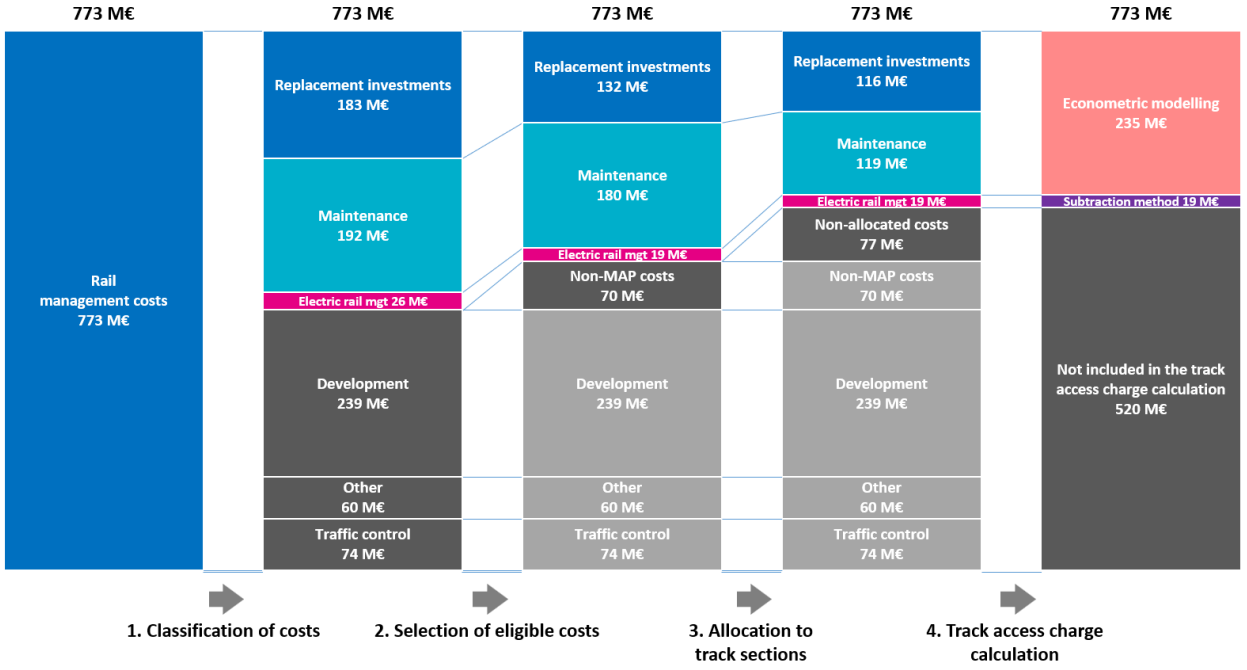
MAP costs	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Replacement investments (MAP)	112,97	97,38	67,48	81,18	93,51	164,80	98,44	123,65	138,81	130,41	112,82	171,74
Maintenance costs (MAP)	123,17	127,15	129,08	133,97	147,30	136,01	152,97	177,00	159,95	176,17	171,41	164,82
Electric supply equipment costs (MAP)	15,30	19,86	18,86	20,60	20,73	19,69	19,43	20,23	22,07	20,88	20,92	19,76
Train traffic control costs (MAP + other)	48,39	51,61	55,69	54,64	51,28	53,75	82,17	75,03	76,66	75,60	79,98	77,80
Total (excl. train traffic control)	**251,44**	**244,39**	**215,43**	**235,75**	**261,55**	**320,50**	**270,83**	**320,88**	**320,83**	**327,46**	**305,16**	**356,33**
MAP costs for line sections	192,72	176,42	140,81	155,88	191,05	258,88	186,70	244,47	260,99	239,08	200,55	222,41

Appendix 2. Establishment of infrastructure management costs for calculating unit values

The unit value calculation data is generated with steps shown in the figure below:

1. Rail maintenance costs are classified into replacement investments to be taken into account in the infrastructure charge, maintenance costs and electrical track maintenance costs as well as development investments traffic control costs and other costs excluded from the calculation.
2. Choice of costs between minimum access possibilities (MAP) and those not included in these (no MAP) costs.
3. Allocation of costs to track sections based on cost management system data.
4. Replacement investments and maintenance costs will be included in the econometric calculation of the basic component of the basic infrastructure charge, and the costs of electrical track maintenance will be included in the calculation according to the method for calculating the additional price of the use of electricity supply equipment.

The figure shows the average annual costs of track maintenance for the period 2013–2024. Costs adjusted to the 2024 price level using an index.



Appendix 3. Results of cost function estimation

Modelling result:

```
Residuals:
     Min       1Q   Median       3Q      Max
-1.61916 -0.47514  0.03248  0.49575  1.76209

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   9.8019     0.7215  13.586  < 2e-16 ***
ln_brt        0.2827     0.0473   5.978 9.70e-08 ***
ln_rd_km      0.5574     0.1004   5.552 5.23e-07 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’
1

Residual standard error: 0.6496 on 67 degrees of freedom
Multiple R-squared:  0.646,         Adjusted       R-squared:
0.6354
F-statistic: 61.13 on 2 and 67 DF,  p-value: 7.8e-16
```

The model parameters differ significantly from zero. Explanation rate of the model is 0.646.

Checking heteroscedasticity:

```
studentized Breusch-Pagan test

BP = 0.98964, df = 2, p-value = 0.6097
```

As the test statistics (BP) are less than 5.99, there is no heteroscedasticity in the dataset.

Variance analysis (ANOVA):

```
Analysis of Variance Table

Response: ln_eur
           Df Sum Sq Mean Sq F value    Pr(>F)
ln_brt      1 38.589  38.589  91.435 3.808e-14 ***
ln_rd_km    1 13.009  13.009  30.825 5.233e-07 ***
Residuals 67 28.276   0.422
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Both independent variables of the model explain a large proportion of the modelled variation.

Normal distribution of residual (error) term:

```
Jarque-Bera-test

X-squared 0.4509911
```

As the X-squared is less than 5.99, the residual terms of the dataset are distributed in a normal manner.

Multi-collinearity of explanatory variables

```
Variable Inflation Factors (VIF)
 ln_brt ln_rd_km
 1.262644 1.262644
```

There is no limit value defined for the VIF estimate for explanatory variables. The VIF value is defined by variable pair VIF = 1 / (1 - R^2). If the VIF value is greater than five, the explanatory variables are considered too multiple-collinear. Based on the test, the variables explaining the model do not have multi-collinearity.

Appendix 4. Calculation code

```
library(tidyverse)
library(lmtest)
library(readr)
library(tseries)
library(caret)

rm(list = ls(all.names = TRUE))

data <- read_delim("lähtödata.csv", ";", escape_double = FALSE, locale = locale(decimal_mark = ",", grouping_mark = " "), trim_ws = TRUE)

mallidata <- data %>% select(rd_km, rt_km, brt_yht, eur_yht, vuosi) %>%
 mutate(ln_brt = (log(brt_yht)), ln_eur = log(eur_yht), ln_rd_km = log(rd_km))
mallidata <- mallidata[mallidata$ln_brt > -Inf, ]
mallidata <- mallidata[mallidata$ln_eur > -Inf, ]

mallinnus <- lm('ln_eur ~ ln_brt + ln_rd_km', data=mallidata)
varianssi <- var(resid(mallinnus))
coeffs <- coef(mallinnus)

mallidata <- mallidata %>%
 mutate(MC = 100 * coeffs[2] * exp(coeffs[1] + coeffs[2] * ln_brt + coeffs[3] * ln_rd_km + 0.5* varianssi) / (brt_yht * rt_km)) %>%
 mutate(wMC = MC*(brt_yht*rt_km))

rajakust = sum(mallidata$wMC)/sum(mallidata$brt_yht*mallidata$rt_km)

summary(mallinnus)
bptest(mallinnus)
anova(mallinnus)
Jarque.bera.test(resid(mallinnus))$statistic
car::vif(mallinnus)
```