
Annex 10 - Structure and Logic of the REGIO Rail Unit Cost Tool

For reasons of cost efficiency and accessibility, the REGIO Rail Unit Cost Tool is designed using the VBA functions of Microsoft Excel.

In order to design several different input and output masks that make the user inputs as simple as possible, several different excel worksheets have been created that are connected through actions buttons, which automatically hide the other sheets while switching between the different masks.

Additional to the input and output masks, there are several sheets used for the calculation of the outputs (e.g. the database of existing projects, the price normalisation factors, etc.), which are however hidden at any point in time while the user is inserting project data into the REGIO Rail Unit Cost Tool. Some of them need to be periodically updated to ensure the well-functioning of the REGIO Rail Unit Cost Tool.

In the following paragraphs the structure of the REGIO Rail Unit Cost Tool is outlined. Firstly, the algorithms of the REGIO Rail Unit Cost Tool are presented, specifying the sheets displayed in each operational stage. Secondly, information on the minimum technical requirements of the system used to run the REGIO Rail Unit Cost Tool is provided. The last section provides information on how to maintain the REGIO Rail Unit Cost Tool, by updating specific hidden sheets.

The logic of the REGIO Rail Unit Cost Tool

The initial mask appearing to the user is the **home** page. Here, it is possible to select one of the two functions of the REGIO Rail Unit Cost Tool.

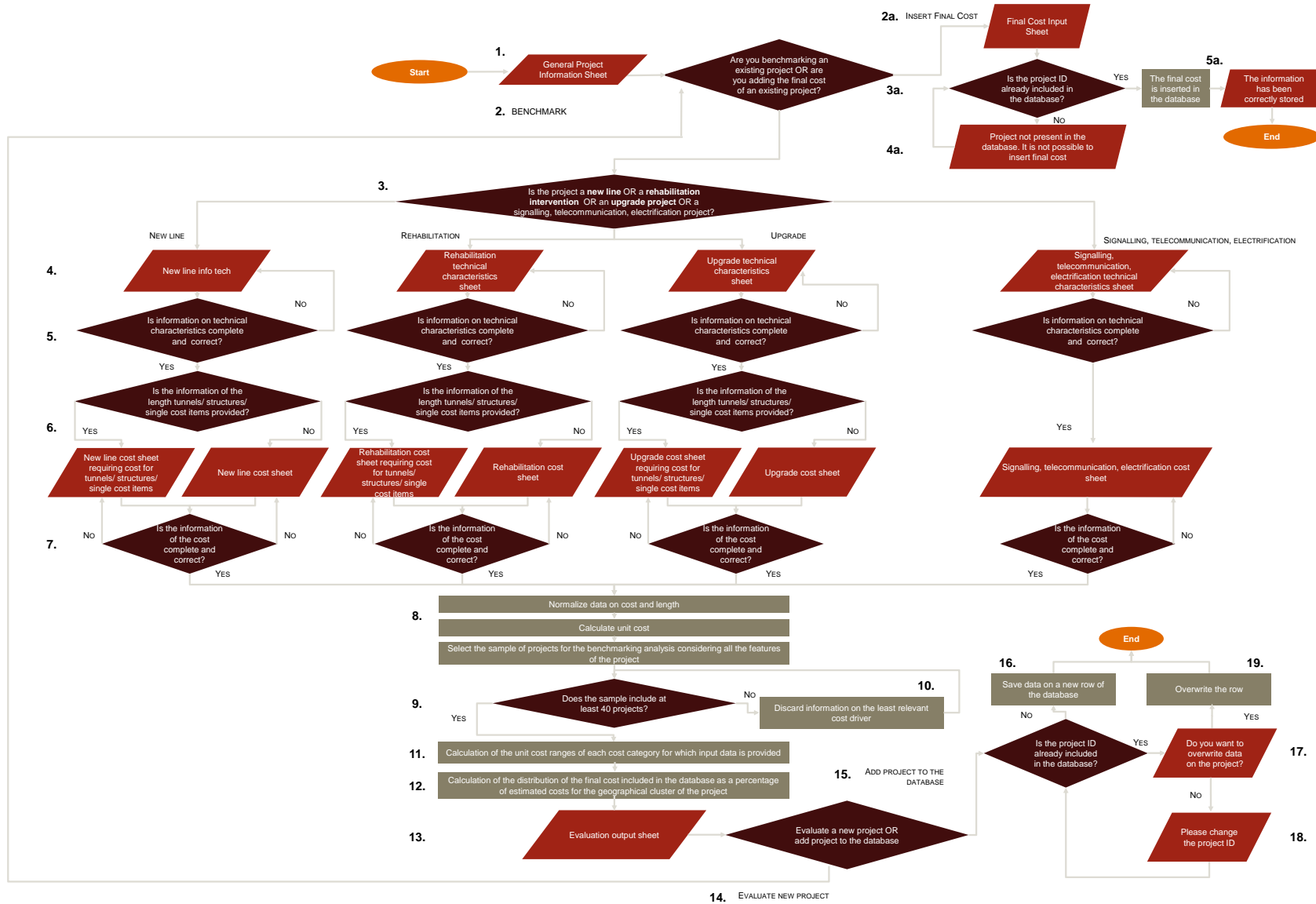
The REGIO Rail Unit Cost Tool can be used for two different purposes:

- **Benchmark.** The users have the possibility to benchmark the investment cost of an existing project with that of similar projects already included in the database;
- **Forecast.** The users have the possibility to forecast the average costs of projects with specific technical characteristic.

Benchmark

The picture below outlines the functioning of the benchmarking activities of the REGIO Rail Unit Cost Tool. Below, an explanation of each phase is provided, specifying in bold the sheets displayed to the user for each of them.

Figure 1 – The algorithm of the REGIO Rail Unit Cost Tool (Benchmark)



The "Benchmark" process starts with the sheet **General project information sheet**. The user should insert:

- the project ID;
- the project title;
- the country where the project is located;
- the base year;
- the type of cost.

Depending of the category of works selected different sheets are displayed to insert information on the technical characteristics of the project (i.e. **Project new line info tech**, **Project upgrade line info tech**, **Project rehabilitation info tech** or **ELSITE info tech**) (3). All the fields displayed in this sheet are mandatory.

(4) The first input sheet concerns the technical characteristics of the project and is tailored to the category of infrastructure works selected. It includes mandatory fields - which refer to cost drivers and are used to create the sample for the benchmarking analysis or refer to information needed- to calculate the base infrastructure cost - and non-mandatory fields. The latter refer to the kilometres of line on which a determined work is performed. I.e. in case no signalling works is included in the project, the user do not have to compile the fields referring to the length of signalling. (5) The REGIO Rail Unit Cost Tool checks the completeness and correctness of the information provided. In case mistakes are spotted, a message is displayed next to the related field.

(6) Once the user has correctly inserted information on technical characteristics, the REGIO Rail Unit Cost Tool displays the sheet to input project cost (i.e. **Project new line info cost**, **Project upgrade line info cost**, **Project rehabilitation info cost** or **Project ELSITE info cost**). In this sheet, the user has the possibility to include information on:

- the total cost of the investment and the cost of its component (planning and design activities, construction, ancillary cost and its subcomponents);
- the cost of single works for which a length greater than zero has been inserted among the technical characteristics of the project. It is not possible to include cost for works which length has not been specified in the previous sheet. (i.e. the field to insert the cost of tunnels is displayed only if the kilometres of tunnels were greater than zero in the technical characteristics sheet).

(7) The REGIO Rail Unit Cost Tool checks the completeness and coherency of the information on cost and, in the case of positive outcome, enables the user to proceed.

(8) The REGIO Rail Unit Cost Tool calculates the unit cost of the project under assessment. Firstly, data on project cost and length are normalised. The normalisation of cost is based on the information included in the sheet **Inflation Rate** that is not displayed to the user. Secondly, the unit cost of the project under assessment is calculated for each cost category for which data has been provided.

(9) The REGIO Rail Unit Cost Tool creates the sample for the benchmarking analysis. The database is filtered based on the technical features of the investment under assessment. In case the sample of projects identified includes less than 40 projects, the information on the least relevant cost driver is discarded and more generic sample is selected. The process is reiterated until a sufficient sample is identified (10). Based on the unit cost of the projects included in the sample, the REGIO Rail Unit Cost Tool determines the unit cost ranges for each cost category included in the project under assessment (11).

(12) REGIO Rail Unit Cost Tool elaborates the distribution of the final cost (as a percentage of the estimated cost) for the projects located in the same geographical cluster of the project under assessment (two clusters are identified, Cohesion and non-Cohesion countries). The calculations are performed in the sheet **inpt_calc** which is always hidden to the user.

(13) REGIO Rail Unit Cost Tool displays the outcomes of the benchmarking analysis in the sheet **Evaluation output**. The position of the unit cost of the project under assessment within the respective unit cost ranges is displayed in different charts. In addition, the user has the possibility to choose a variation range for the final cost and the system calculates the probability that the variation of the final cost of the project falls within this range.

The user can start the evaluation of a new project (14) or decide to add the data of the investment assessed to the database included in the sheet **DB** (15).

In order to insert a new project in the database a password is required. The password is: “admin”.

The REGIO Rail Unit Cost Tool checks whether the project ID is already included in the database. (16) In case of negative outcome, the data is included in a new row of the database. Otherwise, (17) the REGIO Rail Unit Cost Tool asks the user if he/she wants to overwrite the existing data. In case of negative answer, the user is required to change the project ID (18), otherwise the data included in the database are overwritten.

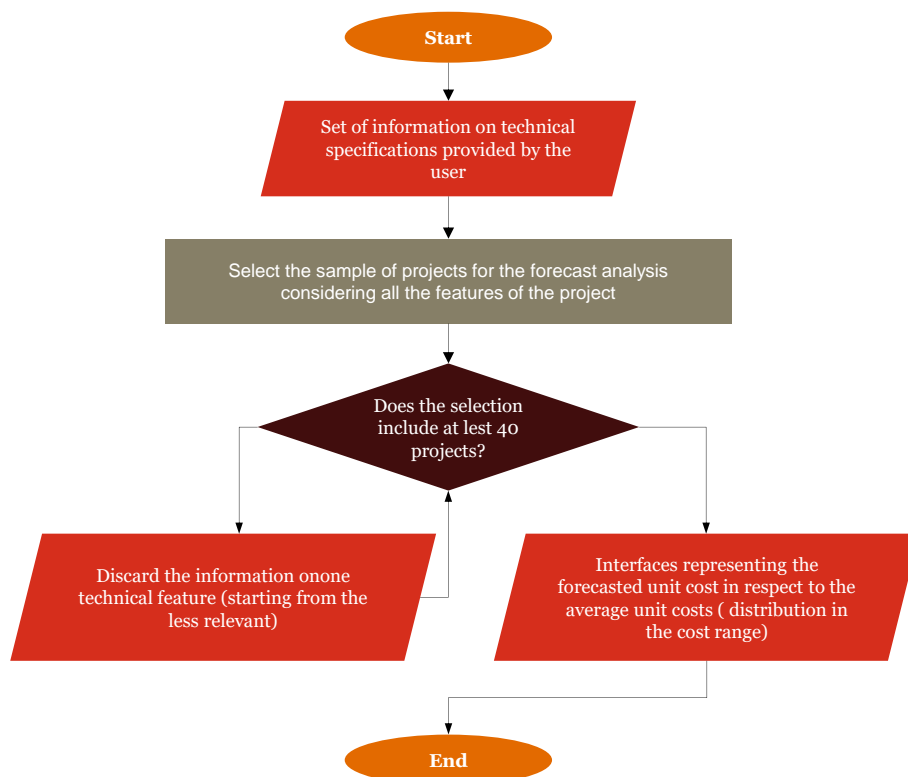
Insert Final Cost

(2a) In case the user chooses to insert data on the final cost of project, he/she is redirected to the **Final cost input sheet**. When the user inserts the project ID, the system immediately checks if the project is included in the database and retrieves (and displays) the title and the estimated cost of the project. Otherwise, these fields remain blank. The user can in any case insert the final cost (3a). However, if the project is not included in the database, the final cost is not included in the database (4a). Otherwise, the systems informs the user the information has been stored (5a).

Forecast

The picture below outlines the functioning of the forecast activities of the REGIO Rail Unit Cost Tool. Below, an explanation of each phase is provided, specifying in bold the sheets displayed to the user for each of them.

Figure 2 - The algorithm of the REGIO Rail Unit Cost Tool (Forecast)



The "Forecast" process starts with the sheet **Forecast Configuration sheet**. The user should insert:

- the work category;
- the country;
- the length;
- the speed category;
- the operation type;
- the type of environment.

This **Forecast Configuration sheet** gives the possibility to select the technical characteristic of the project, of which the user would like to forecast the unit cost. The category is selected by clicking on the correspondent project characteristic. The REGIO Rail Unit Cost Tool checks the completeness and correctness of the information provided. In case mistakes are spotted, a message is displayed next to the related field.

The REGIO Rail Unit Cost Tool creates the sample for the forecast analysis. The database is filtered based on the technical features of the investment under assessment. In case the sample of projects identified includes less than 40 projects, the information on the least relevant cost driver is discarded and a more generic sample is selected. The process is reiterated until a sufficient sample is identified.

Based on the unit cost of the projects included in the sample, the REGIO Rail Unit Cost Tool determines the forecasted unit cost ranges for each cost category. REGIO Rail Unit Cost Tool displays the outcomes of the forecast analysis in the sheet **Forecast OUTPUT**.

Minimum system requirements to use the REGIO Rail Unit Cost Tool

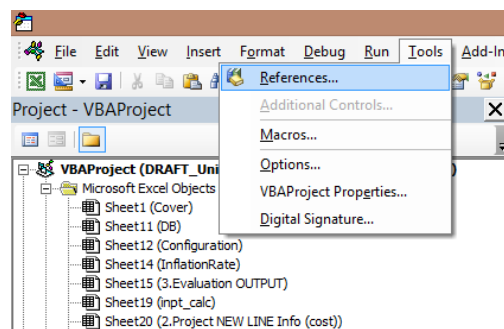
The current version of the REGIO Rail Unit Cost Tool is based on a Visual Basic macro, which operates on MS Excel. The REGIO Rail Unit Cost Tool has been developed on Microsoft Office 2013 and tested for all the Microsoft Office versions subsequent to MS 2010. Compatibility issues might arise if older versions of Microsoft Office are employed.

Additionally, the Visual Basic macro requires the following references from the Microsoft Office Library:

- Visual Basic for Applications;
- Microsoft Excel 15.0 Object Library;
- Microsoft Forms 2.0 Object Library; and
- Microsoft Office 15.0 Object Library.

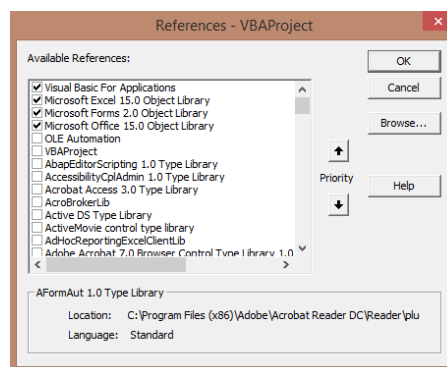
The Object Library references can be activated and deactivated on the REGIO Rail Unit Cost Tool by opening the Visual Basic Editor with the shortcut “Alt + F11”. In Visual basic editor window, the user should click the “Tools” button in the menu bar and select the “References...” option from the drop-down menu (as in figure below). The operation can be performed only when the macro is not running. If the macro is still running when the Visual Basic Editor is opened, the macro can be paused by clicking the “Reset” button in the menu bar.

Figure 3 - References option in the Tools drop down menu



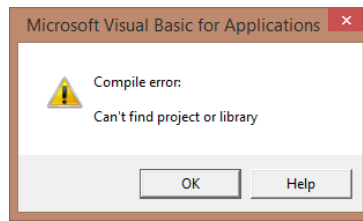
The “References – VBA Project” dialog box will display, where the user can select the required Object Library references by marking the checkbox in front of the object. It is important to check the following four boxes: Visual Basic for Applications; Microsoft Excel 15.0 Object Library; Microsoft Forms 2.0 Object Library; and Microsoft Office 15.0 Object Library as shown in the figure below.

Figure 4 - “References – VBA Project” dialog box



In case one or more of the Object Library references required by the Visual Basic macro (Visual Basic for Applications; Microsoft Excel 15.0 Object Library; Microsoft Forms 2.0 Object Library; and Microsoft Office 15.0 Object Library) are not activated, the following error message is displayed on the screen.

Figure 5 - Error message for missing project library



In this case, the missing Object Library references should be activated.

The maintenance of the REGIO Rail Unit Cost Tool

The REGIO Rail Unit Cost Tool is a dynamic tool, as its structure allows integrating and upgrading the database and consequently the benchmark and forecast analysis. Indeed, once the analysis of a specific project is completed, the user has the possibility to include data related to the investment assessed in the database.

However, although this feature provides several benefits, it also requires continuous maintenance to preserve the REGIO Rail Unit Cost Tool's effectiveness.

In order to edit the file, unprotecting the sheets is necessary. The password is "REGIO2018".

In order to ensure the correct functioning of the REGIO Rail Unit Cost Tool the following maintenance activities are necessary: monitoring of the projects included in the database and update of the PPP-Inflation index.

Monitoring of the projects included in the database

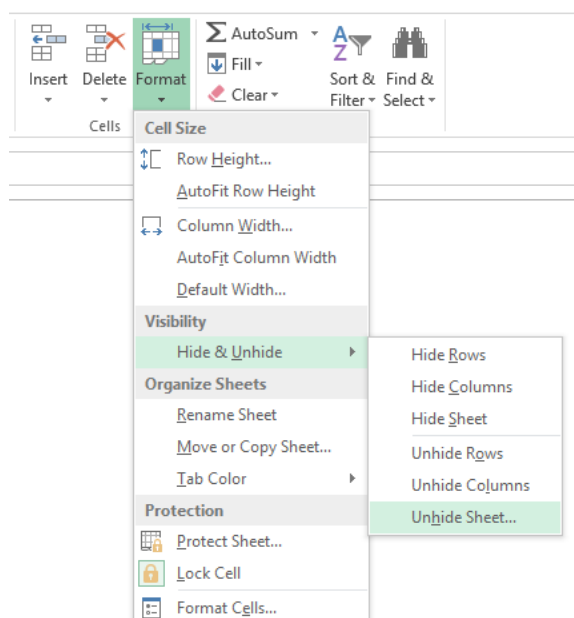
When populating of the database, the experts involved in the Rail Unit Cost study double-checked the project information provided, before inserting it to the database. The aim of this activity was to ensure that the technical features and costs included in the database were correct and matched the definition provided by the authors of the study. In cases of incorrect data or mismatch between the project cost definitions, the information was discarded.

In order to guarantee the effectiveness of the database, and avoid to incorrectly skew the data, it is crucial that the new project information included is coherent with the instructions given in the REGIO Rail Unit Cost Tool Instruction. The correct insertion of the collected information and the coherence with the authors' definition would contribute to reduce the risk of errors. The inclusion of incorrect costs might lead to the creation of a skewed set of data and might compromise the results of future analyses.

To ensure that high-quality data is included in the database and used for the analysis, a periodical check of the database is required.

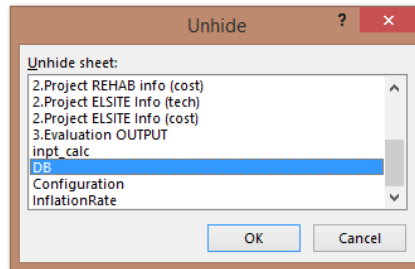
The database used for the analysis is included in the hidden *DB* spreadsheet of the REGIO Rail Unit Cost Tool (red tab). If necessary, the *DB* tab can be unhidden by selecting the visibility option "Unhide Sheet" on excel (upper-hand side of the "Home" tab of the ribbon, by selecting the "Format" icon, and opening the "Hide & Unhide" drop-down menu), as displayed in figure below.

Figure 6 – Format icon and Hide & Unhide drop down menu



The DB spreadsheet should be selected from the list of hidden tabs in the excel file (as in figure below). Once the spreadsheet has been selected, the user should enter the access key in the popup that will appear on the screen.

Figure 7 - Unhide menu



The database is structured in the form of an excel table. An overview of the REGIO Rail Unit Cost database is reported in figure below.

Figure 8 - Overview of the REGIO Rail Unit Cost Database

#	id	title	country
1	2008-LU-91700-P	Deployment of ETCS Level 1 on Luxembourg railway network	LU
2	2011-ES-60001-P	Upgrade of Spanish high-speed lines and trains to ERTMS 2.3.0.d	ES
3	2012-SE-60028-P	Upgrade to an uniform Swedish system requirement for ERTMS, Level 2	SE
4	2015-CZ-TM-0238-M	ETCS Kolín - Praha Junction (including)	CZ
5	2009-AT-60148-P	ERTMS deployment on Corridor E (Dresden-Constanta) Trackside equipment	AT
6	2015-CZ-TM-0377-M	ETCS Prerov - Ceska Trebova	CZ
7	2015-ES-TM-0118-W	ERTMS (ETCS+GSMR) deployment on Atlantic Corridor. Section Vitoria – Bilbao – San Sebastián	ES
8	2007-AT-60450-P	ERTMS deployment on Corridor B (Stockholm-Naples) – Austrian section	AT
9	2012SI161PR001	Implementation of digital radio system GSM-R on Slovenian Railway Network	SI
10	2015-IT-TM-0168-W	ERTMS trackside equipment on Italian sections of the ERTMS/Core Network Corridors in compliance with TET	IT
11	2014-ES-TM-0514-W	ERTMS deployment on the section Valladolid – Burgos	ES
12	2015-CZ-TM-0174-M	ETCS Beroun-Plzeň-Cheb	CZ
13	2005GR161PR010	Signalling and telecommunications for the railway line Kiato - Athens - Thessaloniki	GR
14	2014-DK-TM-0183-W	ERTMS Trackside deployment along the section Copenhagen H – Køge Nord – Ringsted in East Denmark	DK
15	2014-FR-TM-0545-W	ETCS Deployment on the French part of the Antwerp-Basel route	FR
16	2010GR161PR010	COMPLETION OF ELECTRIFICATION FOR DOUBLE RAILWAY LINE IN SECTION SKA - KIATO	GR
17	2014-ES-TM-0510-W	ERTMS DEPLOYMENT ON BARCELONA COMMUTER LINES	ES
18	2013HU161PR013b	Modernisation of Cegléd traction substation, the line section Gyoma (excl.) – Békéscsaba (incl.) and ETCS ir	HU
19	2012-ES-08113-P	Electrical Facilities for Medina del Campo-Salamanca section. Railway line Medina del Campo-Salamanca-F	ES
20	2014GR161PR005	Completion of signalling - telecommanding (ETCS LEVEL 1) in 3 sections of Railway / M axis PATHEP and inte	GR
21	2015-NL-TM-0264-W	ERTMS track-side deployment on the Kijfhoek-Roosendaal-Belgian border railway line	NL
22	2010-FR-92204-P	Adaptation of the existing line between Mulhouse and the border for use by high-speed (TGV) or intercity	FR
23	2014-ES-TM-0400-W	ATLANTIC CORRIDOR: RAILWAY CONNECTION AVEIRO – SALAMANCA – MEDINA DEL CAMPO. WORKS OF EN	ES
24	2014PL161PR001 & 2016PL16CFMP003	Modernizacja linii kolejowej E 65/C-E 65 na odcinku Warszawa - Gdynia - w zakresie warstwy nadrzędnej LC	PL
25	2015-PL-TM-0022-W	Electrification of railway lines no. 278 and 274, Wegliniec - Zgorzelec section	PL
26	2010BG161PR004b	Plovdiv – Svilengrad Railway Electrification and Upgrading of Corridors IV and IX, Phase 2: Parvomai – Svil	BG
27	2008-ES-92512-P	Upgrading of the Barcelona-France line and access for operating an international gauge	ES
28	2000ES16CPT002	High speed rail link MAD-BCN-FRA, Madrid-Lleida Stretch: Electrification, Signalling and Communication W	ES
29	2007-EE-27020-P	Cross-border section Tartu-Valga railway reconstruction/ upgrading	EE
30	2002SI16PP003	Upgrading the Ljubljana-Zidani Most-Maribor railway line	SI
31	2012-DK-91161-P	Electrification of the last part of the section between Copenhagen and Esbjerg and construction of a new tr	DK
32	2013LT161PR001	Construction of the Second Track on the Vilnius Bypass, section Kyviskes - Valciunai	LT
33	2012-FR-91013-P	Sillon Alpin Sud	FR
34	2011-UK-93069-P	Priority Axis 26: North West England Electrification, Manchester-Liverpool	UK
35	2012-UK-26060-P	Completing Priority Axis 26 (PP 26) North and delivering the TEN-T Core Rail Network in the United Kingd	UK
36	2014-DE-TA-0285-M	Upgrade and electrification of route section Horka station – German/Polish border (planning approval sect	DE
37	2010-UK-92219-P	Priority Axis 26: Nuneaton North Chord and Kennett Re-signalling Works	UK
38	2007-NL-05020-P	Works for replacement of legacy systems by 15/25 kVAC on one of the remaining sections in the Netherlan	NL

The columns of the Database present the technical characteristics and the cost categories identified. Each row of the DB spreadsheet contains the data of a specific project. The project ID and the project title uniquely identify the projects.

The check on the data of a specific project could be done by searching for the project ID or the project name with the excel function “Find” (upper-hand side of the “Home” tab of the ribbon, from the “Find & Select” drop-down menu) and going through the columns corresponding to the project line. The individual technical or cost data can be directly edited or deleted from the corresponding cell containing the data element concerned. In case a whole project should be deleted from the database, the corresponding line should be eliminated from the table. An entire line can be deleted from the table by right-clicking the corresponding line number in the left-hand side of the spreadsheet and selecting the option “Delete” from the toolbox.

Update of the cost normalisation index

The REGIO Rail Unit Cost Tool has been set up to calculate the cost normalisation index between countries. This process allows to compare costs undertaken in different countries and years. The output costs are indeed the result of a multiplication of the costs inputted by the user, and the cost normalisation index. At the moment, the REGIO Rail Unit Cost Tool calculates the cost normalisation index for all European countries from 1990 to 2017 and estimates the cost normalisation index from 2018 to 2043, as the data required for the calculation of the index (inflation indicators, PPP and exchange rate) are not available yet.

The estimation of the cost normalisation index is performed by the RRUCT for a specific year, only if the inflation indicators, PPP and exchange rate for that year are not available in the database. Otherwise, if the data are available in the database, the RRUCT will calculate the index based on the data imputed by the user.

The weighted compound annual growth rate (CAGR) is used for the estimation of the data required for the calculation of the cost normalisation index; specifically, the PPP Base Euro, the PPP Base Euro (all) and the Inflation countries index. The CAGR formula has been adapted to give a greater weight to the data of the last years. In addition, the CAGR formula automatically refines the cost normalisation index as the data, required for the calculation of the index, are inserted.

The *Inflation indicator* has been estimated as stable at 2%, based on the price stability objective of the European Central Bank.

Future updates of the REGIO Rail Unit Cost Tool will need to include the latest PPP-inflation figures as well as the costs of the most recent European projects. Ideally the REGIO Rail Unit Cost Tool should be updated once a year with such values.

The following activities demonstrate how to update the normalisation factor table, using the latest conversion and inflation figures.

- 1) **“Unhiding” the spreadsheet InflationRate.** The spreadsheet *“InflationRate”* is hidden in the REGIO Rail Unit Cost Tool. The user needs to right-click on the sheet tabs and select the option *“Unhide...”* from the menu (as in Figure 7 - Unhide menu). The *“InflationRate”* spreadsheet should be selected from the *“Unhide menu”* (see Figure 7 - Unhide menu). Once the spreadsheet has been selected, the user should enter the access key in the popup menu that appears on the screen. The *“InflationRate”* spreadsheet is organised in a series of tables (as in figure below). The data are categorised in each table per countries and years. The title of each table is reported on the upper left-hand side of the table, in blue font. The overview of the *“InflationRate”* spreadsheet is reported in figure below.

Figure 9: "Inflation rate" spreadsheet overview

	A	B	C	D	E	F	G
2	<u>PPP Base Dollar</u>						
3							
4			Year				
5	Country	Unit		2000	2001	2002	2003
6	Austria	Euro	AT	0.91	0.92	0.90	0.89
7	Belgium	Euro	BE	0.90	0.89	0.87	0.88
8	Czech Republic	Czech Koruna	CZ	14.34	14.29	14.46	14.19
9	Denmark	Danish Krone	DK	8.68	8.67	8.56	8.66
10	Estonia	Euro	EE	0.47	0.49	0.49	0.49
11	Finland	Euro	FI	0.98	1.00	1.00	1.00
12	France	Euro	FR	0.93	0.91	0.90	0.93
13	Germany	Euro	DE	0.94	0.93	0.91	0.90
14	Greece	Euro	GR	0.67	0.67	0.66	0.69
15	Hungary	Forint	HU	110.16	114.13	118.14	122.15
16	Ireland	Euro	IE	0.94	0.97	0.98	1.01
17	Italy	Euro	IT	0.81	0.81	0.82	0.83
18	Latvia	Euro	LV	0.36	0.35	0.36	0.38
19	Luxembourg	Euro	LU	0.96	0.96	0.96	0.97
20	Netherlands	Euro	NL	0.89	0.90	0.90	0.93
21	Poland	Zloty	PL	1.83	1.83	1.80	1.81
22	Portugal	Euro	PT	0.66	0.67	0.67	0.67
23	Slovak Republic	Euro	SK	0.52	0.51	0.52	0.54
24	Slovenia	Euro	SI	0.53	0.56	0.58	0.61
25	Spain	Euro	ES	0.74	0.75	0.74	0.76
26	Sweden	Swedish Krona	SE	9.17	9.38	9.41	9.50
27	Switzerland	Swiss Franc	CH	1.79	1.76	1.71	1.72
28	United Kingdom	Pound Sterling	UK	0.71	0.69	0.69	0.70
29	European Union (28 countries)	Euro	EU	0.88	0.87	0.86	0.85
30	Bulgaria	Bulgarian Lev	BG	0.54	0.55	0.56	0.56
31	Croatia	Croatian Kuna	HR	3.79	3.86	3.88	3.99
32	Lithuania	Euro	LT	0.45	0.43	0.42	0.40
33	Romania	Romanian Leu	RO	0.62	0.81	0.98	1.18
34	Data extracted on 26 Oct 2017 08:54 UTC (GMT) from OECD.Stat						
35							

- 2) **PPP Base Dollar update.** The user need to fill it out the cells of the column (per country) in the “*PPP Base Dollar*”, which are underlined in yellow. Additionally, the user needs to update the data of the cells containing “typed-in” numbers in the “*PPP Base Dollar*” table, in case they have been modified (from the previous OECD publication). The source page can be found by clicking the description of the date of the extraction of the previous information (“*Data extracted on the 26 Oct 2017 ...*”). The link will direct the user to the PPP page of the OECD database. It is then necessary to download the relevant file and paste the information in the REGIO Rail Unit Cost Tool table;
- 3) **Exchange rate update.** In the “*Exchange rate*” table, the user needs to insert the new information in the column corresponding to the new year. Then the Exchange rate figures relative to the previous years must be updated, as previously done for the “*PPP Base Dollar*” table. The necessary information can be retrieved from the following link (<https://data.oecd.org/conversion/exchange-rates.htm>). The link will open a web page where the user will be able to select the appropriate countries and years. Once the information has been downloaded, the user can paste the new information on the existing table;
- 4) **Inflation update.** The data in the row “*Inflation Indicator*” (row 169 of the spreadsheet) of the “*Inflation(I)*” table should be replaced with the most recent figures downloaded, as for the “*PPP Base Dollar*” table (step 3). In this case, the other rows of the table will be automatically updated. The link (<https://data.oecd.org/price/inflation-cpi.htm>), reported next to the table name will redirect the users to the appropriate page where the latest inflation figures might be retrieved;
- 5) **Inflation countries update.** The “*Inflation countries*” table needs to be updated as in step 3). The user can find the link (http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=sts_inppd_m&lang=en) to the source next to the table title;

Automatic update of the remaining info. Once all the above steps are completed, the REGIO Rail Unit Cost Tool will automatically adjust all the other information and replace the estimation with the values calculated based on the data imputed by the user. Following all the steps indicated, and updating all the information in a correct way is crucial for the correct functioning of the REGIO Rail Unit Cost Tool as a small

mistake in the insertion of data can impact the calculation. Indeed, an error on one of the input table, would change the PPP-inflation index, which are applied to all cost components.