

ISP Transmission Cost Database: User Manual

19 March 2021



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1. Introduction

This manual has been drafted to help the Transmission Cost Database (TCD) users to interact and navigate through the TCD and its cost estimation tool to produce early stage cost estimates of transmission network capital project options. The user must refer to the report titled '*ISP Transmission Cost Database*' dated 19 March 2021 (the report) to gain additional understanding of the TCD, its development, organisation and the associated details underpinning its feature.

This user manual is subject to, and must be read in conjunction with the report and the assumption and qualifications contained in the report.

The report also contains dedicated appendices of abbreviation and glossary of common industry acronyms and terminologies used throughout the TCD and its cost estimation tool.

2. User Prerequisites

A user of this tool should be aware of the assumed prerequisites necessary to develop a cost estimate with this tool. It is expected that the user of the TCD be well versed with the electricity transmission network industry in Australia, especially the NEM. The user:

- Should be familiar with various assets types and the capital project development and delivery of such assets that forms the electricity transmission network infrastructure
- Should have general knowledge of industry practices and standards with respect to asset description and specifications, procurement arrangements, network design, regulatory approval processes, construction management and safety protocols
- Does not need to be an expert in all these areas but is expected to have access to resources to inform the use of the TCD and be fully aware of topics discussed above
- Has carried out professional work experience in the industry such that they would meet the prerequisites outlined above.

The user's approach must consider a range of input information which defines the project scope and determines the maturity of the project. The user of the TCD should define or have access to the scope of work in order to build the cost estimate. The information outlined in the scope should be objective and without bias to choose appropriate risk exposure and network element components known at the time of building the cost estimate. Useful sources of information the user can rely on include:

- Preliminary investigation, option and scoping reports (internal business documentations)
- Work briefs
- Single line diagrams which depict the project design
- General arrangement diagrams
- TNSP station building standards, Australian Standards
- Asset specifications (size, fault level, maximum demand)
- Access route map (desktop analysis)
- Preliminary environmental investigation

- Any other information available.

As the project development matures and advances through to final investment approval gates, such information will be re-evaluated and will also be supplemented by further project information. Re-evaluation of the project scope is dynamic and ongoing from a preliminary cost estimate all the way to the final cost estimate and it is the responsibility of the TCD user to conduct these regular updates.

Use of the TCD is not recommended if the user has advanced and definitive project scope details that can identify and easily itemise comprehensive scope of work at bespoke and granular level, such as for Class 3, 2 or 1 stages. In this case, the cost estimate should be built up using dedicated cost estimation software and a comprehensive risk analysis approach, including expert peer review.

3. Breaking down project into multiple network elements

A project and its overall cost estimate can be disaggregated into multiple distinctive cost estimates grouped by their attributes and risk characteristics. Each distinctive grouping is a unique 'network element' and a project is made up of multiple network elements. A network element is a group of transmission elements (building blocks) which share identical project attributes and risk. At a minimum, and if applicable, a project is disaggregated into the following network elements:

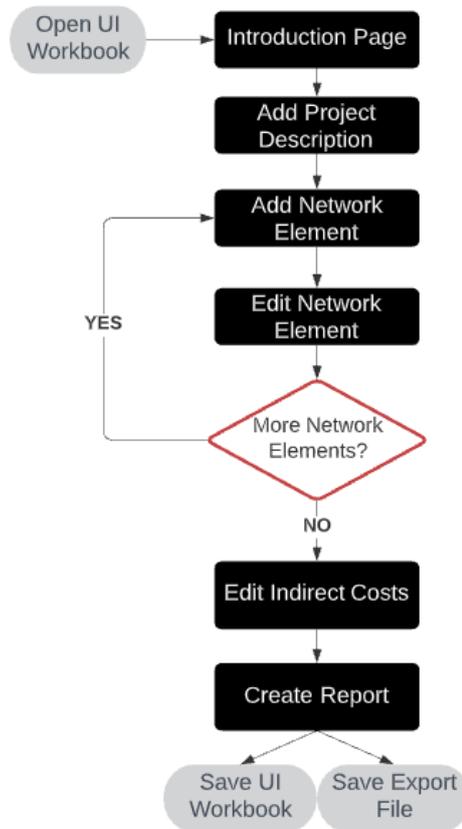
- Stations
- Overhead lines
- Underground cables.

Determination of a network element's attribute and risk is based on the scope of work of the project and the unique characteristics of that particular group of building blocks. For example, a network element which defines a station may contain a number of building blocks, such as switchbays and transformers, which share common attributes (Contract Delivery Model) and risks (Environmental Offset Risks). Stations which do not share the same site should be treated as separate network elements. Additionally, an overhead transmission line can traverse more than one terrain type or jurisdiction. Multiple network elements would be required to estimate the full length of the transmission line. Typically, maturation of a project scope would result in re-evaluation of the number of network elements necessary to develop a project cost estimate. The more defined a project scope is the more likely the user may choose to disaggregate network elements into more, smaller elements. Disaggregating a project into network elements is an accuracy vs effort trade-off exercise.

4. Cost estimation tool workflow

The cost estimation tool follows a structured workflow which guides the user from opening the cost estimation tool to generating a project cost estimate. It is critical that the user follows the cost estimation tool's intended workflow to ensure that the project cost estimate is fit for purpose. Figure 1 illustrates an overview of the intended cost estimation tool workflow as a flowchart.

Figure 1 Cost estimation tool workflow



The stages within the black boxes of the cost estimation tool flowchart require user interaction. The following section will provide detailed user instructions for each stage to generate a project cost estimate using the cost estimation tool.

5. Step-by-step cost estimation tool guide

5.1 Step 1: Introduction page

1. Enable content

Upon opening the cost estimation tool, an Excel security warning popup will appear as shown in Figure 2.

Figure 2 Security warning for enabling macros



It is critical that the user enables content to allow the macros to function. This warning popup may appear repeatedly after closing and reopening the file – please enable each time.

Note: The security warning popup may look different depending on the MS Excel version of the user. Please read the message to ensure that content/macros are enabled.

2. Read introduction page message

After enabling macros, the cost estimation tool will take the user to the *Intro* tab. The page details important information regarding the TCD including the purpose, disclaimer and copyright statement.

3. Start project

Note that at any point in this process, the user can save the file and return to it later to complete.

To start building a project, click on the *Start Project* button as shown in Figure 3 below.

Figure 3 Introduction page

Transmission Cost Database

IMPORTANT NOTICE

Purpose
AEMO has made the transmission cost database available as a companion resource to the Integrated System Plan (ISP) published under the National Electricity Rules. The database will be used by AEMO for estimating transmission costs and reviewing estimates received from TNSPs. The purpose of its publication is to increase transparency of the inputs used by AEMO to evaluate ISP network projects, and it is intended for an experienced audience. Use of the transmission cost database requires a highly developed understanding of the National Electricity Market power system and industry.

The database should be used in conjunction with the ISP Transmission Cost Database Report, to explain the assumptions, inputs and methodology underlying the database build, and the most recent version of the Transmission Cost Database User Manual, to explain how the database is used to estimate transmission costs. Please refer to the most up to date version of the ISP Inputs, Assumptions and Scenarios Report for details of ISP projects whose costs have been estimated by AEMO using this database.

Disclaimer
The database is only current as at the stated version date, and the information in it may change subsequently.

The database includes collated information and estimates from third parties and public reports based on a range of data for past and current network projects. The database output is considered high level only, commensurate with conceptual projects, and is not suitable for use in more advanced project stages where detailed design information is available. AEMO has sought to ensure the quality of the information, but the database may not be accurate or complete, and does not include all of the information that an investor, participant or potential participant in the National Electricity Market might require. You should always obtain advice from suitably qualified experts in relation to your specific circumstances, and on the use and interpretation of results from the database.

Accordingly, to the maximum extent permitted by law, AEMO and its officers, employees and consultants involved in the preparation of the transmission cost database and estimating tool:

- make no representation or warranty, express or implied, as to the currency, accuracy, reliability or completeness of the database contents or outputs;
- are not liable (whether by reason of negligence or otherwise) for any estimates, forecasts, opinions or other matters contained in or derived from the contents of the database, or any omissions from it, or in respect of a person's use of the database.

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Start Project ▶

Clicking the *Start Project* button will take the user to the project main screen shown in Figure 4 below.

Figure 4 Cost estimation tool main screen

Project Main Screen

1

Add Project Description

Name

Description

Display Cost and Risk Data

Data Source: AEMO TCD Cost and Risk Data Data Source Date: 16 March 2021

2

+ Add
📄 Duplicate
- Remove
✎ Edit

List of Network Elements

Network Element Number	Network Element Name	Description

3

Select Network Element to Add Components

Please Click a Network Element from List of Network Elements

Edit Network Element >>>

4

Set Indirect Cost Choice

Edit Indirect Costs >>>

5

Export Project Cost Summary

📄 Create Report

⚠️

🗑️ Reset Project

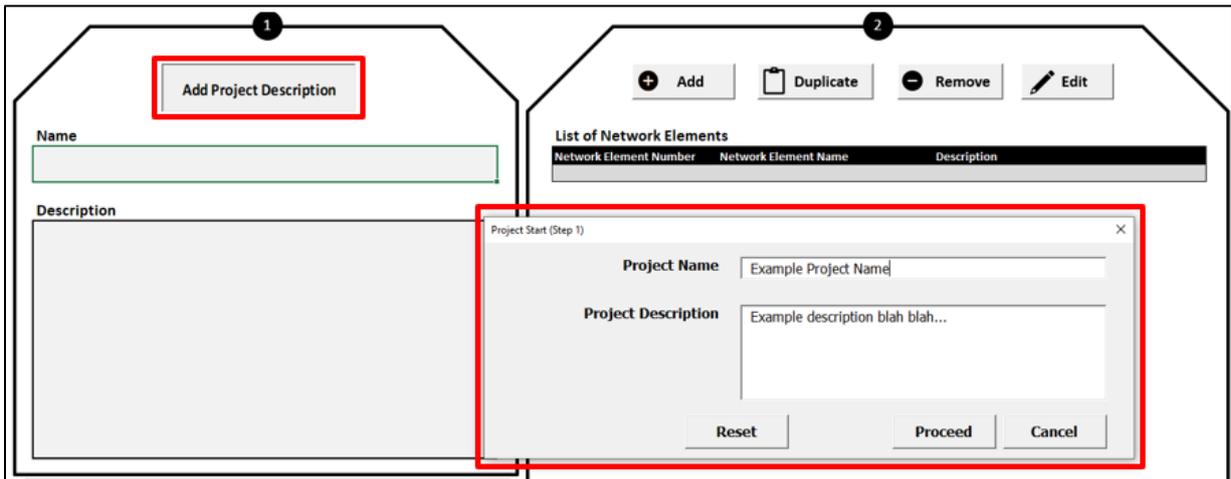
On the project main screen, each section is numbered to help the user navigate the cost estimation tool in creating a project cost estimate.

5.2 Step 2: Describe your project

1. Add project description

Click on *Add Project Description* to assign a name and description for the overall project. A user form will appear for the user to input the project name and description, as shown in Figure 5 below.

Figure 5 Adding project description



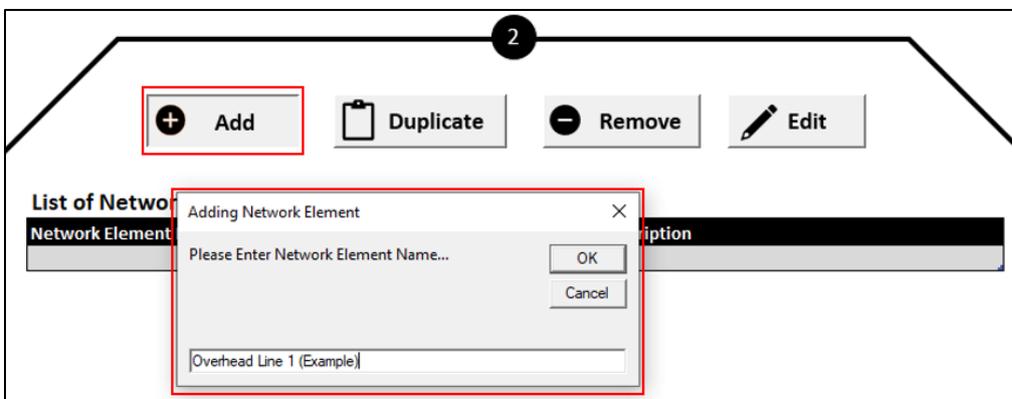
Click *Proceed* after filling out the name and description fields. The user can clear the current inputs by pressing the *Reset* button. To edit the name and description at a later point, click *Add Project Description* and make amendments. *Note: the project name and description will appear on the generated output reports.*

5.3 Step 3: Describe each network elements within the project

1. Add network element

Click *Add* to add a new network element. Two input boxes will appear one after the other, requiring the user to input the network element name and description. Enter an appropriate name and press *OK* – repeat for description. An example is shown in Figure 6 below.

Figure 6 Adding network elements



After completing the input boxes, the user's entry will appear in the table *List of Network Elements* and a network element number will be assigned.

Figure 7 Table of network elements added

 Add	 Duplicate	 Remove	 Edit
List of Network Elements			
Network Element Number	Network Element Name	Description	
1	Overhead Line 1 (Example)	500kV DCST - 100km (Example Description)	
2	Example Name 2 --> Description blank		

Note: a name must be assigned when adding a network element, however the description can be left blank.

The user has the option to add all network elements at this stage. Alternatively, the user can progressively add and edit network elements. It is suggested that the user complete all entries for the first network element, this is particularly important if the user plans to employ the duplicate functionality discussed below.

2. Duplicate network element

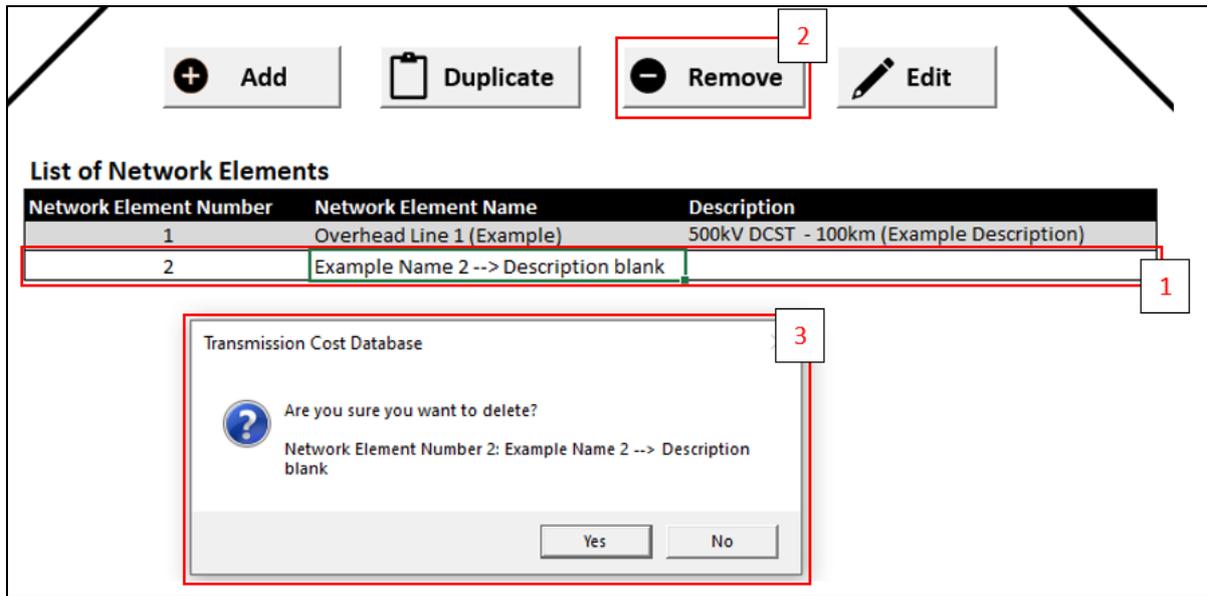
The duplicate functionality of the cost estimation tool allows the user to replicate an existing network element entry and its associated entries assigned by the user in *Step 4: Edit Network Element*. This functionality is useful in cases where the user has one or more network elements that have largely similar inputs. Instead of adding and editing an entire network element again, the user can duplicate an existing network element and make small amendments to the duplicated network element.

Select the network element to be duplicated by clicking on the corresponding row within the table *List of Network Elements* (can be any column). After selecting the network element, click on *Duplicate*. Two input boxes will appear similar to that of the *Add* functionality. The user will be required to assign a name and description to the new network element.

3. Delete network element

Select the network element to be deleted by clicking on the corresponding row within the table *List of Network Elements* (can be any column). After selecting the network element, click on *Remove*. A confirmation warning will appear before deleting the network element. Confirm the appropriate network element has been selected and click *Yes* to proceed with the deletion. If the user made the wrong selection or no longer wishes to delete the network element, click *No* to cancel.

Figure 8 Removing network elements



The network element and all user inputs that had been assigned to this network element number in *Step 4: Edit Network Element* will be permanently deleted. The user must be cautious when removing network elements, as the cost estimation tool cannot recover the network element and associated entries once deleted.

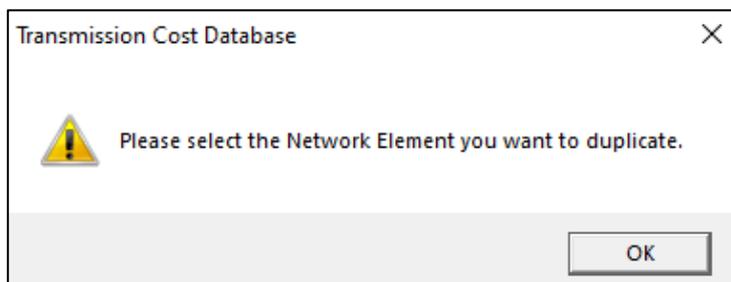
4. Edit network element

Select the network element to be edited by clicking on the corresponding row within the table *List of Network Elements* (can be any column). After selecting the network element, click on *Edit*. The input boxes from the *Add* button will appear. Make changes to the name and description and press *OK*. The changes will be updated within the *List of Network Elements*.

5. Tips / caution

For the *Duplicate*, *Remove* and *Edit* buttons, an error will occur if the user has not selected an appropriate cell within the *List of Network Elements*. The error message can be seen in Figure 9 below.

Figure 9 Invalid cell selection warning



In the example below using three network elements, to duplicate/remove/edit the user must click on any of the yellow cells Network Element 1 (blue cells for Network Element 2 and green for Network Element 3). Any other cell selection will lead to the above error. Press *OK* on the error message to proceed and click the appropriate cell before using the duplicate/remove/edit functionalities.

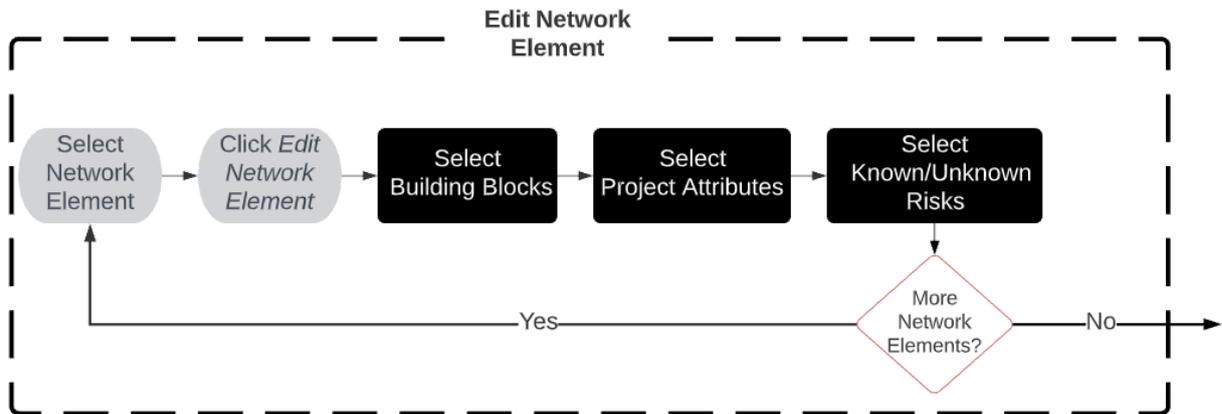
Figure 10 Example of valid and invalid cell selections

Network Element Number	Network Element Name	Description
1	Overhead Line 1 (Example)	500kV DCST - 100km (Example Description)
2	Example 2	
3	Example 3	

5.4 Step 4: Edit network element

Step 4 involves choosing the appropriate building blocks that forms the network element, inputting the quantities, selecting project attributes and risk factors for the nominated network element in the table *List of Network Elements*. This step will guide the user through different screens for each assignment. The workflow of this stage can be seen in Figure 11 below.

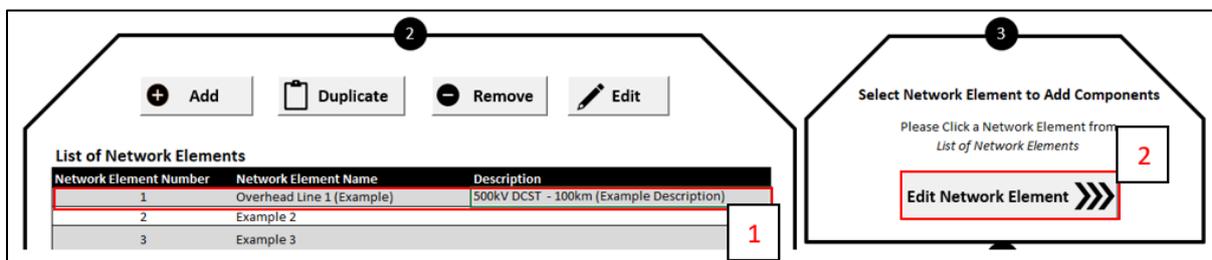
Figure 11 Editing network elements flowchart



1. Select network element to edit

Select the network element to be edited by clicking on the corresponding row within the table *List of Network Elements* (can be any column). After selecting the network element, click on *Edit Network Element*.

Figure 12 Selection of network element to edit



The cost estimation tool screen will switch from the *Project Main Screen* to *Building Block Selection* screen.

2. Select building blocks

- a) The selected network element number, name and description will appear on the top left of the screen. The user should verify that the appropriate network element has been selected prior to assigning inputs.

- b) The five orange cells are user input fields and a dropdown list will appear upon clicking within the cells. The user must select the inputs from top to bottom (i.e. starting with *Category* and ending with *Quantity*). Upon selecting an input for each input field, a description and set of notes will appear for the corresponding selection. The description and notes serve the purpose of aiding the user with the selection process. Furthermore, the cost summary preview table on the bottom-left will be populated based on the selected building block and quantity.

Figure 13 Building block selection interface

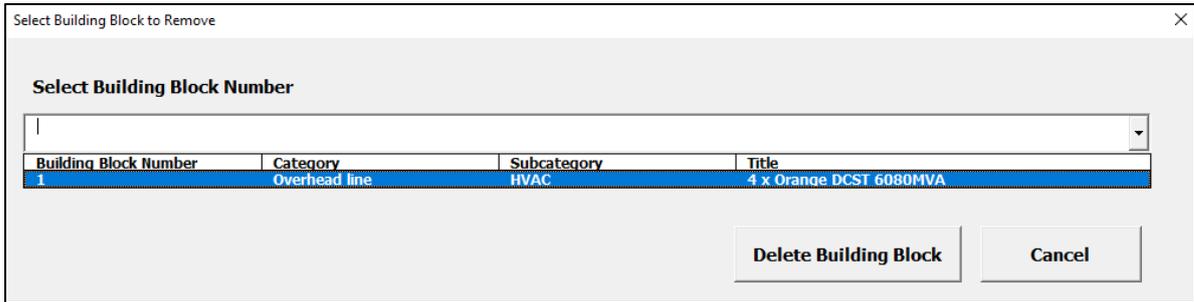
The interface is divided into three main sections:

- Input fields:** Five orange input fields for:
 - Category: Overhead line
 - Sub Category: HVAC
 - Voltage kV: 500
 - Details: 4 x Orange DCST 6080MVA
 - Quantity: 100 km
- Description and notes:**
 - Description:** Overhead lines double circuit single tower, quad conductor per phase
 - Notes:**
 - Plant amount includes: Strain + Structural tower associated costs (steel tower with single earth peak, structural foundation steel, foundation leg steel, climbing barrier, fittings, insulators) and insulator and conductor. 85% suspension, 15% strain and 400m span. Sag and OPGW has been appropriately assigned
 - Civil and structural works includes: Tower concrete footing, soil tests, installation of tower and foundations
 - Electrical works includes: installation of conductor (setup, draw wires, stringing, clamping off), installation of OHEW/OPGW (draw wire, stringing, clamping off)
 - Secondary system and testing and commissioning is accounted in the terminating end in the substation switchbay cost
- Cost summary preview:**

Costs (\$M)	
Plant	\$67,365,100
Civil and structural Works	\$52,120,750
Electrical Works	\$66,861,000
Secondary Systems	\$0
Design & Survey	\$10,099,057
Testing & Commissioning	\$0
Contractor Project Management & Overheads	\$13,982,457
Easement/ Property Costs	\$4,000,000
Environmental Offset Costs	\$24,000,000
Total	\$ 238,428,364

- c) After filling out the input fields and verifying that the appropriate selection has been made, click on the **+** button. The selected building block will be added to the user selection table on the right of the screen. Repeat *step a)* to *step b)* to add all relevant building blocks to the selected network element.
- d) To delete a selected building block, click on the **-** button. A popup will appear as shown in Figure 14 below.

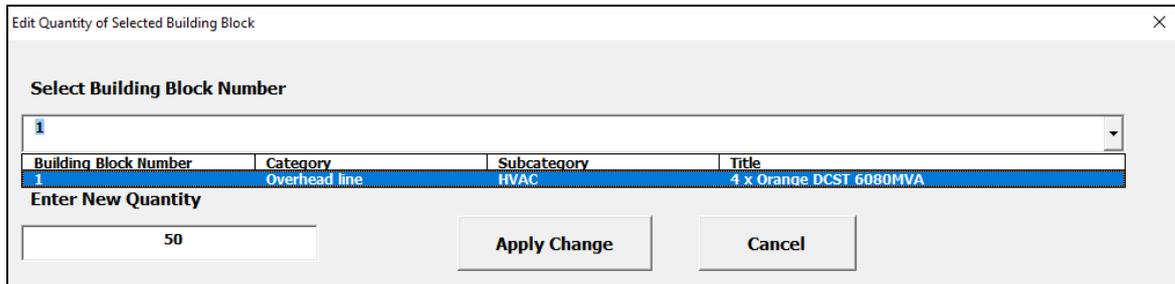
Figure 14 Removing a selected building block



Select the building block from the dropdown list to be deleted and click *Delete Building Block*. A confirmation popup will appear, click *OK* to proceed delete the selected building block.

- e) To change the quantity of a selected building block, click on the  button. A popup will appear as shown in Figure 15 below.

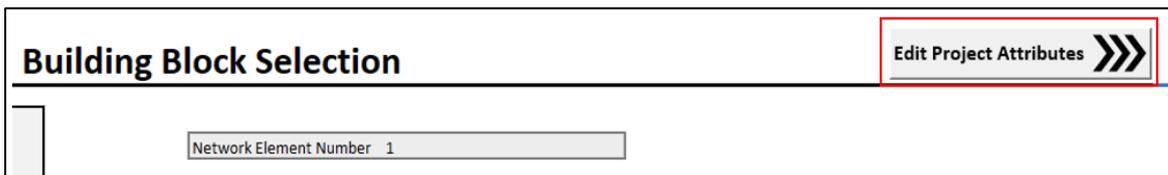
Figure 15 Changing the quantity of a selected building block



Select the building block and enter the new quantity to be applied for the building block. Click *Apply Change* and click *OK* on the confirmation popup. The quantity and total cost for the edited building block will be updated in the list of selected building blocks on the right. *Note: editing a quantity to '0' is allowed, but this quantity cannot be changed at any time in the future. It is best to delete any element that has zero quantity.*

- f) Once the user has entered all building blocks to the selected network element click on the *Edit Project Attributes* button on the top-right of the screen.

Figure 16 Progressing to next screen/step



The cost estimation tool screen will switch from the *Building Block Selection* screen to the *Network Attribute Selection* screen.

3. Select project attributes

Adding project attributes to the selected network element follows a similar process to adding building blocks. Refer to the steps in *Select Building Blocks*. The key differences are that there is:

- Less input fields
- No edit quantity button

- A progress update is available above the table of included attributes which assists the user to know how many attributes have been assigned and how many have not yet been assigned.

It is important to refer to the most relevant sources of project information describing the characteristics of the network elements and the environment it is being built on objectively and accurately.

The user should also consider the overall project size (length of line, number of bays) when making judgement on the 'project network element size' attribute (i.e. economy of scale factor) for each individual network element. For example, consider the entirety of the overhead line project size, instead of focusing only on a specific segment (i.e. network element) of the project if the project is being delivered in entirety by contracted parties.

Once the user has entered all project attributes to the selected network element click on the *Edit Risks* button on the top-right of the screen.

4. Select known / unknown risks

Adding risks to the selected network element follows a similar process to adding attributes. Refer to the steps in *Select Project Attributes*. The key differences are that there are:

- Two categories for each of transmission lines, stations, and underground cables
- Two progress counters above the inclusion table.

It is important to objectively choose the most appropriate level of risk exposure, considering all the available information at the time of building the cost estimate.

Once the user has entered all relevant risk factors to the selected network element click on the *Finish Editing Network Element* button on the top-right of the screen.

Note: If the user proceeds without adding at least one known and one unknown risk, the Cost estimation tool will automatically add a blank entry. This will not affect the calculation of the project cost estimate; however, it is needed for the Cost estimation tool to function correctly and cannot be deleted by the user. It should also be noted that although the user can proceed without selecting all unknown risks, the user must select the appropriate risks later to develop a Class 4/5 estimate.

5. Repeat Steps 1 – 4

To edit another network element, repeat steps 1 – 4.

Note: The user can re-edit a network element by clicking on the network element on the main screen and clicking the Edit Network Element button.

6. Guidance on selection of attributes/risks

The cost estimation tool provides detailed descriptions and notes to assist the user to select the appropriate attribute and risk factors for each network element.

Each project attributes have multiple choices that describes, either qualitatively or quantitatively, the various aspects of the given scope of work such as the size of the work, site geography, interface issues, delivery timing, contractual arrangements etc. that have impact on costs.

Each known risk has three levels of choice, one defined as 'Business as Usual' and two others for varying levels of risk. The use of BAU is considered the default selection where the user has no additional information about this aspect of risk.

For unknown risks, the default selection is Class 5, as the TCD has been developed primarily for production of Class 5 estimates. Class 4 may be used where significant engineering design work has

been carried out to develop the work scope and building block detail. Class 3/2/1 is intended for AEMO use only, for cross-checking of TNSP estimates of projects at advanced stages.

The TCD user should read and understand the factor and choices available to them and choose the most appropriate one that closely matches their project. Given the prerequisites as stated in the beginning of this Appendix, and the detailed descriptions and notes provided for every attribute and risk factors and their choices, the TCD user is expected to select the appropriate choices accurately reflecting the characteristics of their project. The phrasing and style of the provided descriptions and notes are intuitive and includes commonly used industry wordings to allow this.

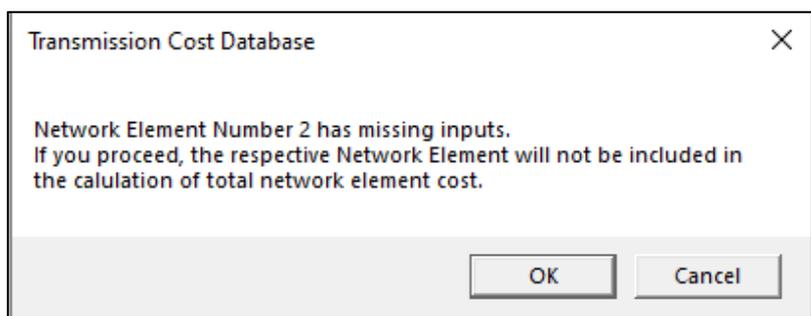
5.5 Step 5: Edit indirect cost

1. Edit indirect costs

Once the user has finished editing all network elements, click on *Edit Indirect Costs*. The cost estimation tool will load the *Indirect Cost Selection* screen. The time taken to load will vary depending on the number of network elements and associated inputs for the project.

Note: If the user clicks Edit Indirect Costs and has not assigned at least one entry for building blocks, project attributes and risks, a warning message will appear as shown in Figure 17 below.

Figure 17 Indirect cost warning message



The user has the option to proceed and exclude the network element from being included in the cost estimate, or to cancel and finish assigning inputs.

2. Select indirect cost fields

On the *Indirect Cost Selection* screen, select the appropriate inputs from the dropdown list in a similar manner to *Add Building Blocks*. After inputting all fields, click on the  button to refresh the indirect costs. The summary of the indirect cost categories will be updated on the right of the screen.

IMPORTANT – If the user makes ANY changes to the network element inputs (building block/project attributes/risk) in a later revision, the user MUST click the refresh button again to update the indirect costs. The exported project cost summary WILL NOT reflect the correct indirect costs if the user does not update the values prior to exporting.

Once the user has updated the indirect costs, click *Finish Editing Indirect* to go back to the *Project Main Screen*.

5.6 Step 6: Generate project cost summary report

When the user has finished adding network elements, editing every network element (with attribute and risk factors), and updated the indirect costs, click *Create Report* on the *Project Main Screen* as shown in Figure

18 below. The button will create a project cost estimate in a separate Excel workbook based on the user's inputs.

Figure 18 Create report button on main screen

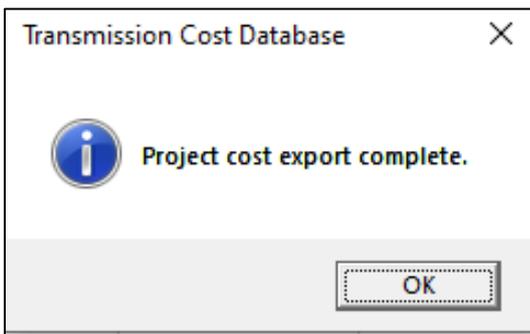


The time taken to load will vary depending on the number of network elements and associated inputs for the project.

Note: A similar warning message associated with the Edit Indirect Costs button will appear if the user has not assigned at least one entry for building blocks, project attributes and risks. If the user chooses to proceed, the exported project cost summary will omit any network element that has missing entries.

When the cost estimation tool has finished processing the data, a user alert message will appear as shown in Figure 19.

Figure 19 Alert message indicating completion of exporting outputs



Click *OK* to view the exported Excel workbook containing the project cost summary. The exported file will consist of three different project cost summary formats: *Output A*, *Output B* and *Output C*. It is recommended that the user reviews the user entries for each network element by referring to *Output C* which is a detailed cost breakdown of each network element, prior to the addition of indirect costs. *Output A* is a summary view showing the total cost for each network element, inclusive of adjustments and risks, with the addition of indirect costs. *Output B* is a summary view showing the total baseline cost for the project, adjusted baseline cost (which modifies the baseline cost based on attribute factors), known risk allowance, unknown risk allowance and indirect costs.

It is also recommended that the user saves both the cost estimation tool workbook and the exported project cost summary workbook for future reference. Furthermore, the saved cost estimation tool workbook can be edited by the user to add/remove entries in future revisions to create new project cost estimate reports.

5.7 Checklist

Prior to using the cost estimation tool		
1	Define project scope	Example: Deliver a new transmission line from A to B

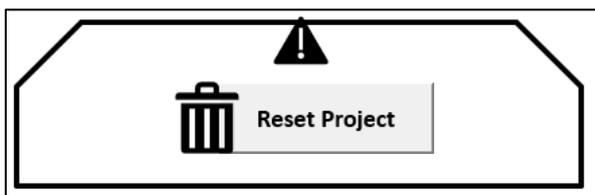
Prior to using the cost estimation tool		
2	Define key inputs and design	Where is it located? Easements? This will include a preliminary single line diagram
3	Identify key network elements	Station, overhead lines and/or underground cables
Using the cost estimation tool		
4	Have you added the project network elements?	<ul style="list-style-type: none"> Check that you have added each key network element on the project main screen
5	Does your cost estimate include overhead lines?	<ul style="list-style-type: none"> Check that you have added all associated overhead line building blocks Check that you have only applied overhead line attributes/risks to overhead line elements
6	Does your estimate include station components?	<ul style="list-style-type: none"> Check that you have added all associated station building blocks Check that you have only applied station attributes/risks to station elements
7	Does your estimate include underground cable components?	<ul style="list-style-type: none"> Check that you have added all associated underground cable building blocks Check that you have only applied underground cable attributes/risks to underground elements
8	Have you applied all attributes and risks?	<ul style="list-style-type: none"> Check that you have applied at least one project attribute and one risk for each network element
9	Have you updated the indirect costs prior to exporting?	<ul style="list-style-type: none"> Check that you have selected the appropriate indirect cost categories and that you have refreshed the costs prior to exporting the data

Note: a copy of typical output views is provided in the GHD report.

5.8 Reset project

At any point the user can clear all inputs to the cost estimation tool by clicking the *Reset Project* button as shown in Figure 20 below.

Figure 20 *Reset project button on main screen*



Numerous warning messages will appear requiring user confirmation to proceed with resetting the project workbook.

IMPORTANT – Once the project has been reset, the user CANNOT recover the data.

6. Qualification of generated cost estimate

Please see section 10 in the body of the report.

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