Hypothetical Incremental Distribution Asset Model (HIDAM) User Manual

16 May 2013

Introduction

1. This document is a user manual for the hypothetical incremental distribution asset model (HIDAM), which provides inputs to the common distribution charging methodology (CDCM) and, indirectly, to the extra high voltage distribution charging methodologies (EDCM/FCP and EDCM/LRIC).

2. After introducing the structure of the workbook and some general concepts or elements of terminology, this user manual provides a description of the input data required for the model, and an overview of the calculations within each calculation sheet.

3. This document is not a specification of the model. For information on the calculations that take place within the HIDAM model, or of the way in which input data need to be obtained or the rules governing assumptions underpinning any input data, refer to the "Design of the Hypothetical Incremental Distribution Asset Model" document, known as the design document or the guidance notes.

Structure of the workbook

4. The HIDAM model is implemented as a standalone Microsoft Excel workbook in Excel 2007 file format. No software other than Microsoft Excel 2007 or above, or compatible software, is needed to operate the model.

5. The model relies on standard spreadsheet formulas. It does not use any macros, Visual Basic for Applications, pivot tables, solver, goal seek, or array formulas.

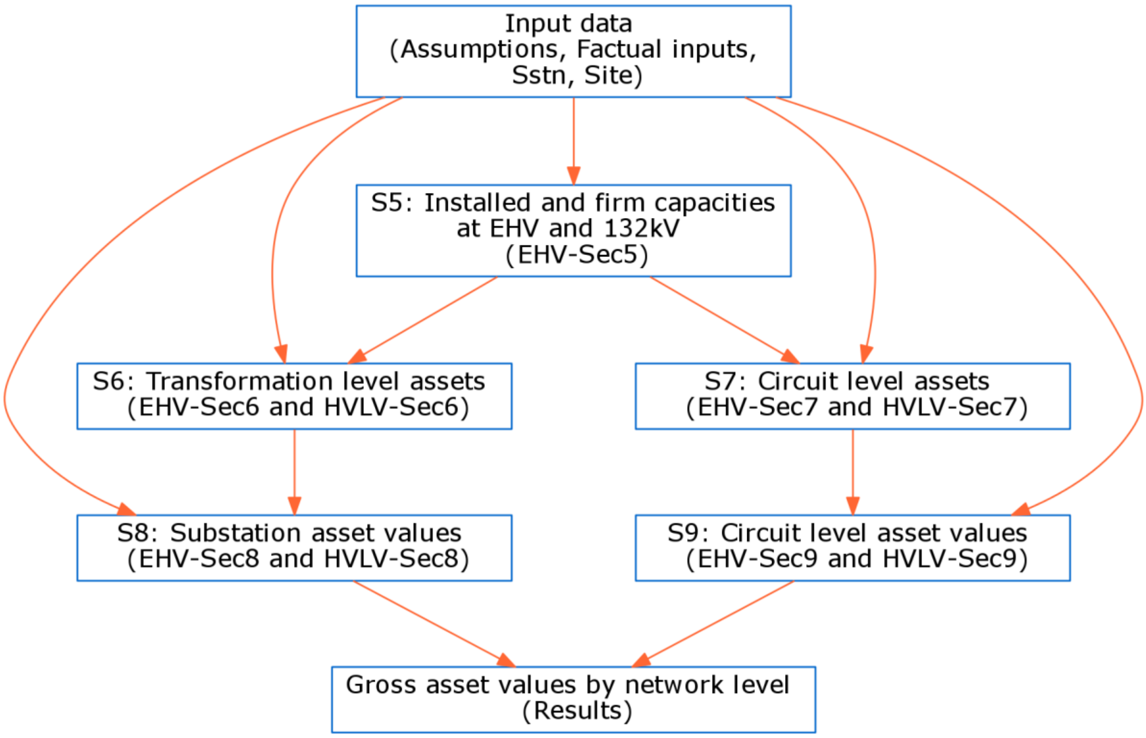
6. There are 15 worksheets in the HIDAM workbook. Table 1 provides a list of the sheets in the workbook and describes what each contains.

Table 1 Sheets within the HIDAM workbook

Sheet name	Contents
Index	Disclaimer and notices. List of tables in the model (with hyperlinks).
Assumptions	Input data for HIDAM assumptions. This sheet also provides feedback of selected diagnostics from calculation sheets.
Factual inputs	Input sheet for factual information.
Sstn	Input sheet for forecast maximum demand (including reactive power data) and existing firm capacity at each substation in the licence area.
Site	Input sheet for import capacity and maximum demand (including reactive power data) for EHV and 132kV connected sites in the licence area.
EHV-Sec5	Calculates firm capacity for each higher voltage substation configuration.
EHV-Sec6	Calculates coincidence factors and tests the size of the HIDAM at each of the higher voltage transformation levels.
EHV-Sec7	Calculates modelled 132kV and EHV circuit length.
EHV-Sec8	Calculates modelled substation asset values for higher voltages.
EHV-Sec9	Calculates modelled 132kV and EHV circuit costs.
HVLV-Sec6	Calculates modelled substation capacity for HV/LV and tests the size of the HIDAM at HV/LV.
HVLV-Sec7	Calculates modelled HV and LV circuit length.
HVLV-Sec8	Calculates modelled HV/LV substation asset values.
HVLV-Sec9	Calculates modelled HV and LV circuit costs.
Results	Displays modelled asset values of the HIDAM for each network and transformation level, as well as some summary statistics of the HIDAM.

7. Figure 1 shows a high level flow chart of how the model is organised.

Figure 1 Overall HIDAM flow chart



8. Calculation sheets covering higher voltage levels (primary substation and above) are labelled EHV; those covering the HV and LV systems are labelled HVLV.

Numbered data tables

9. Each worksheet is structured as a list of data tables, to be read from top to bottom.

10. Each data table has a unique four-digit number to identify it, and a name that describes what it contains.

11. Only table numbers that start with 17 are assigned for input data. Other table numbers are assigned to tables that carry out calculations or show results.

12. The order and numbering of the tables follows the logic of the model. A numbered calculation table never relies on an input or calculation that is below them in the sheet order or that has a higher table number.

13. Some cells and graphics display data that are sourced from tables below them: these feedback/diagnostic elements exist for convenience only, they are not part of the logic of the model's calculations and are not essential to its functionality. They are laid out in a visibly different way from calculation tables.

14. Beneath the table number and table name there is information relating the table to the HIDAM design document. This normally includes the variable names (acronym), and for most calculation tables, a reference to the equation number that the calculation table is performing.

15. In calculation tables, below the title and above the table itself, there are hyperlinks to the tables that the calculation table draws information from. Navigating to these hyperlinks will allow the user to work through the calculations within the HIDAM workbook. Information on the formulas used in the calculation tables is contained in text above the table columns.

General terminology

16. Table 2 lists terminology that is used across the workbook, including in the input data tables.

Table 2 HIDAM model terminology

Coincidence factor	Calculated as the sum of maximum demands at the higher network level divided by the sum of maximum demands at the lower network level. It captures the extent to which maximum demands at lower network levels occur at different times, so that the aggregate maximum demand at the lower network level is higher than the aggregate maximum demand at the higher network level. The coincidence factor is a number between 0 and 1 (unless the data are distorted by electrical losses). For clarity, an example is included below this table.
Circuit length	The length, typically measured in kilometres, of an electrical circuit. A three-phrase circuit is counted as one circuit. A double circuit, where circuits share infrastructure e.g. pylons, but can be switched separately, is counted as two circuits.
Configuration	This refers to one of the standard configurations for a hypothetical higher voltage transformation substation, or group of such substations providing support and security for each other. Configurations are the building blocks of the transformation network levels of the HIDAM model at higher voltages. Each network level has its own unique configurations e.g. configuration 1 for TR/EHV is unrelated to configuration 1 for EHV/HV.
Higher voltages	This refers to all parts of the network from primary substations upwards, i.e. anything that operates at, or transforms down from, a nominal voltage of 22kV or more.
HV/LV	This refers to all parts of the network below primary substations, i.e. where nominal voltages are less than 22kV.

HV/LV Configuration	This refers to one of the standard configurations for a hypothetical transformation substation from the high-voltage network (between 1 and 22kV) and the low-voltage network (below 1 kV). HV/LV Configurations are the building blocks of HIDAM at that network level.
In the HIDAM	The phrase "in the HIDAM" refers to hypothetical amounts (e.g. transformer numbers, installed capacities) in the hypothetical incremental distribution asset model (HIDAM).
In the licence area	The phrase "in the licence area" refers to amounts (e.g. transformer numbers, installed capacities) that actually exist, irrespective of any hypothetical asset model.
Modelled	The word "modelled" refers to hypothetical amounts (e.g. transformer numbers, installed capacities) in the hypothetical incremental distribution asset model (HIDAM).
Primary substation	A transformation substation in which the primary voltage is 22kV or more and the secondary voltage is less than 22kV.
Route length	The length, typically measured in kilometres, of the route alongside an electrical circuit or a group of electrical circuits that follow the same route. For example, for a route length of 3km where the route has a single circuit, the corresponding circuit length is 3km (irrespective of whether it is a single-phase or three-phase circuit, whether there is a neutral conductor, etc.). If a route has two circuits that could be switched separately, then 3 km of route length corresponds to 6km of circuit length.

Diversity and coincidence factors: example

17. The HIDAM uses coincidence factors. The following illustrative example shows what they are and how they relate to diversity allowances elsewhere in the CDCM.

18. Imagine that a higher network level has a single substation, which feeds two substations at the network level below. One of the two substations at the lower network level serves domestic loads and the other one serves industry.

19. Suppose the industrial consumption is a continuous 200MW during the business day and zero otherwise. Suppose that domestic consumption peaks on Christmas day at 350MW, and that it is always below 300MW during business hours, with 300MW being reached on one occasion, late in the afternoon on a winter business day.

20. Disregarding electrical losses, the maximum demand at the higher network level substation is 500MW (late afternoon on a winter business day).

21. The sum of maximum demands at the lower network level is 550MW: 200MW for the substation serving industry, and 350MW for the substation serving houses.

22. In this example:

(a) The relevant coincidence factor is 500/550 = 0.909.

(b) The relevant diversity factor is 550/500 = 1.100, and the relevant diversity allowance is 10 per cent.

Description of the input data tables

- **Assumptions sheet**

23. This section covers the input data tables that are found within the "Assumptions" worksheet.

24. It does not contain technical details about the sources of input data. For information on sources, or further information on the data required, refer to the HIDAM design document. The relevant HIDAM design document variable names are shown in the worksheet under the title of each data table.

25. The Blank version of the spreadsheet contains #values in every input cell. When populating the model, the user should replace all #values with meaningful data, including blanks where appropriate. If #values are left inside input data tables then the model may not compute as expected.

1700. Company, charging year, data version

26. The identifying information entered in this table is reproduced at the top of each sheet in the workbook. It does not affect the calculations.

1701. Modelled maximum demand at GSP level (MW)

27. This is the aggregate of maximum demand measured at grid supply points to which the model is to be fitted. The design document mandates a value of 500MW.

1702. Name and numbers of substation configurations in the HIDAM (higher voltage levels)

28. Table 1702 is used to adjust the number of substations within the HIDAM model. Before entering numbers here, it is suggested that users enter information in tables 1731–1736 and 1781–1782, which are needed to calculate modelled firm capacity, modelled maximum demand and average power factors.

29. For each transformation network level except HV/LV, and for each substation configuration, this is the number of substations in the HIDAM to meet the modelled maximum demand.

30. Users have the option to name the configurations for each network level using the blank column entitled "Configuration descriptions". These names will be copied to the other input tables which refer to the same configurations, such as 1731–1736 and 1750. It is not compulsory to enter names for each or any configurations and these columns can be blanked out if preferred.

31. For higher voltage transformation levels in the HIDAM, the modelled firm capacity must be greater than or equal to the ratio of modelled maximum demand to the average power factor, and less than 1.05 times that ratio. In order to meet this condition, the number of substations of each configuration can be adjusted. Integer numbers should be used if possible. Where the inequality cannot be achieved, fractions can be used for the less common substation types.

32. The graph below table 1702 presents the ratio of modelled firm capacity to modelled maximum demand over the average power factor for each network level in the table. This number should be between 1 and 1.05.

33. A message is displayed at the bottom of each bar on the graph. It provides details on whether the test has been met ("OK") or whether the user would need to reduce or increase modelled firm capacity (MFC) by altering the number of substations in order to meet the test. In the model, this test is not performed on network levels where both the modelled maximum demand and the modelled firm capacity are zero.

1703. Adjusted modelled maximum demands (MW)

34. This table can be used to adjust the modelled maximum demand numbers calculated in tables 5608 and 5611. Modelled maximum demand can be adjusted to reflect current practice and experience.

35. If a number is entered into a cell in this table for a transformation level it will be taken as the adjusted modelled maximum demand for that transformation level. Zero is a valid number for this purpose. If any text that is not a number or zero is entered in a cell then the corresponding modelled maximum demand is not adjusted.

36. Adjustments, if any, should be such that the following conditions are met:

    (a) The sum of adjusted modelled maximum demand for TR/EHV, adjusted modelled maximum demand for TR/132kV and adjusted modelled maximum demand for TR/HV must equal 500MW.

    (b) The sum of adjusted modelled maximum demand for 132kV/EHV and adjusted modelled maximum demand 132kV/HV must equal the adjusted combined modelled maximum demand at the 132kV/EHV and 132kV/HV transformation level (calculated in table 5609).

37. To the right of table 1703, there is a table containing the original calculated modelled maximum demands in the HIDAM, and two additional columns designed to help the user ensure that the conditions above are met. These two columns should show a value of zero. Changes to adjusted modelled maximum demand for some network levels will affect the original calculated modelled maximum demands at other network levels.

1704–1705. Names and numbers of substations in the HIDAM (HV/LV level)

38. Tables 1704 and 1705 are used to adjust the number of substations within the HIDAM model. Before entering numbers here, it is suggested that users enter information in tables 1737 and 1738 which are needed to calculate modelled installed and firm capacity.

39. For the HV/LV transformation network level, for each substation configuration (see table 1737 for the definition of HV/LV substation configurations), this is the number of substations in the HIDAM to meet the modelled maximum demand. There are two tables, one for pole-mounted substations and one for ground-mounted substations.

40. Users have the option to name the configurations for each network level using the blank column entitled “Configuration descriptions”. These names will be copied to the other input tables which refer to the same configurations, such as 1737 and 1751. It is not compulsory to enter names for each or any configurations and these columns can be blanked out if preferred.

41. The ratio of HV/LV modelled installed capacity to modelled firm capacity must be between 1 and 1.01. In order to meet this condition, the number of substations of each configuration can be adjusted.

42. The graph below table 1705 presents the ratio of modelled installed capacity to modelled firm capacity.

43. A message is displayed at the bottom of the bar on the graph. It provides details on whether the test has been met (“OK”) or whether modelled installed capacity (“MIC”) would need to increase or decrease (by altering the number of substations) in order to meet the test.

1706–1709. Adjusted circuit length proportions by type

44. These four tables allow the user to adjust the proportions of circuit types for each network level modelled within the HIDAM. The adjustments can be made to reflect current practice. There is a separate table for each of the 132kV, EHV, HV and LV network levels.

45. The proportions for each type refer to the proportion of circuit length and not of route length.

46. If a number is entered into a cell in these tables it will be taken as an adjusted value. Zero is a valid number for this purpose. If any text that is not a number or zero is entered in a cell then the corresponding value is not adjusted.

47. For each network level, the proportions after adjustment must sum to one.

48. For reference, the existing proportions for each circuit type are displayed in the column to the right of each table. The title of each of these reference columns contains a link which will take the user to the calculation.

1710. Proportion of excavate and lay for HV and LV circuits

49. Users should enter the proportion of underground cable extension that is ‘excavate and lay’, as opposed to ‘lay only’. The difference between the two is whether excavation is undertaken by a DNO or by another party, such as a developer.

50. This table covers both the estimated proportion (eg. PROP_HVUGCEL) and modelled proportion (eg. MPROP_HVUGCEL) variables described in the design document. The proportions are used in the same way regardless of which number is entered and therefore users are only required to enter one number for HV and one for LV.

51. The design document suggests that DNOs can estimate the proportions separately for HV and LV based on recently installed circuits in the past five years (eg. PROP_HVUGCEL), although the proportions can also be adjusted to reflect current practice (eg. MPROP_HVUGCEL).

52. The column to the right of the table provides an area to enter text should a user wish. This could be useful if a user wanted to record for their own information any other values for the proportion variable that were considered.

- **Factual inputs sheet**

1731–1736. Transformer ratings at higher voltage levels (MVA)

53. There is a table for each transformation network level except HV/LV. The tables ask for information on the substation configurations that will be used in the HIDAM. The substation configurations should follow the same order as those referred to in table 1702. The configuration descriptions entered in table 1702 are copied into tables 1731–1736 to help the user.

54. The user should enter the enhanced forced and natural cooling ratings of each transformer in each configuration type. This may or may not be the name plate rating. There can be up to 11 transformers in each configuration.

55. Some configurations might refer to groups of substations being operated in parallel rather than to individual substations.

56. Users may enter a specific capacity limitation for each configuration if this would be the largest assumed capacity limitation associated with interconnecting circuits. A blank or zero value in this cell indicates that there is no largest assumed capacity limitation for the relevant group of substations.

57. The configurations used in these tables must be consistent with those used in table 1702.

58. The numbers in this table are used to derive modelled firm capacity in the HIDAM. For convenience, the table to the right of the data displays the current modelled firm capacity of each configuration given the information provided.

1737. Installed capacity of each HV/LV substation configuration (MVA)

59. This is the installed capacity of each pole mounted and ground mounted standard HV/LV substation configuration to be included in the HIDAM. The configuration descriptions entered in tables 1704 and 1705 are copied here to help the user.

60. Users can specify different substation configuration types for pole and ground mounted substations. There are separate columns for ground and pole mounted substation configurations to be included in the HIDAM.

61. The configurations used should be consistent with the configurations used in tables 1704 and 1705.

1738. Existing installed capacity of ground and pole mounted HV/LV substations (MVA)

62. This table should contain the total existing installed capacity of all ground- and pole-mounted HV/LV substations within the licence area. Existing installed capacity at a substation is equal to the sum of the natural cooling rating of the transformers at that substation.

63. There are two columns for total existing capacity, one for pole-mounted substations and one for ground-mounted substations.

1740. Existing circuit length at 132kV and EHV levels (km)

64. These figures relate to the existing DNO network.

65. The data should reflect the total existing circuit length within the licence area by different circuit types at the 132kV level and the EHV level separately.

66. There are three different circuit types considered within the HIDAM at the 132kV and EHV network levels:

(a) underground (underground cable);

(b) single overhead line (overhead wood pole line); and

(c) double overhead line (overhead tower line).

67. The sum of the existing circuit length for these three types of circuit should equal the total existing circuit length at the relevant circuit level.

68. In the case of a double overhead line, total circuit length is twice the route length.

1741. Existing circuit length for HV and LV levels (km)

69. These figures relate to the existing network in the licence area.

70. The data should reflect the total existing circuit length within the licence area by different circuit types at the HV and LV level separately.

71. There are two different circuit types considered within the HIDAM at the HV and LV network levels: underground and overhead.

72. The sum of the existing circuit length for these two types of circuit should equal the total existing circuit length at the relevant circuit level.

1742. HV switchgear data

73. This table asks for data split by different HV circuit types. Definitions of these circuit types can be found in Appendix 1 of the design document.

74. In the first column, 'Existing industry benchmark for the number of customers interrupted per fault on HV circuit type i', users should enter data on the existing industry benchmark for the number of customers interrupted per fault for each type of

HV circuit. This information is collated by Ofgem. Users must enter a positive number in this column for each HV circuit type, even if the licence area does not contain any HV circuits of that particular type.

75. The second column, ‘Average existing customers connected to type i HV circuits’, asks the user for the average number of customers connected to each HV circuit type on the existing network.

76. The third column, ‘Existing number of HV circuits by circuit type’, requires data on the number of each circuit type within the existing network.

1743. Average capacity per pole mounted HV switch (MVA)

77. This is a locked cell.

78. The design document mandates a value of 1 MVA for this item.

1750. Allocated substation asset values for higher voltages (£)

79. This table should contain the asset values of each substation configuration for each transformation network level above EHV/HV and how they are allocated within the HIDAM model between the transformation level and the circuit level.

80. For the 132kV and EHV transformation levels, each substation configuration within the HIDAM can have its total asset value apportioned between the substation asset and the circuit assets. The asset value data should be entered for the correct level.

81. For example, 132kV/EHV - EHV refers to 132kV/EHV substation assets that have been allocated to the EHV circuit level.

82. All GSP asset values are allocated to a circuit level since the HIDAM does not include transmission transformation assets.

83. All asset values should be per substation included within the HIDAM.

84. The configurations used in this table must be consistent with those used in tables 1702 and 1731–1736.

1751. Allocated substation asset values for lower voltages (£)

85. This table contains, for the HV/LV transformation network level and for each substation configuration, the asset value attributed to each relevant network level.

86. The asset value of a substation configuration can be allocated to the transformation assets or the downstream circuit level.

87. There are separate columns for pole- and ground-mounted substation configurations contained within the HIDAM.

88. All asset values should be per substation included within the HIDAM.

89. The configurations used in this table must be consistent with those used in tables 1704–1705 and 1737.

1752. 132kV and EHV levels unit costs per km of route (£/route km)

90. This table contains an asset value in £/route km, for each different circuit type for 132kV and EHV circuits.

91. For double overhead line circuits, the cost should be per route length rather than circuit length. One km of double overhead line route length contains 2 km of circuit length.

1753. HV and LV network levels unit costs by circuit type (£/circuit km)

92. This table contains an asset value in £/circuit km, for each different circuit type for HV and LV circuits. (This cost is per circuit length rather than route length.)

1754. HV switchgear unit cost data (£ per unit)

93. This table asks for data by HV circuit type. Definitions of these circuit types can be found in Appendix 1 of the design document.

94. The first column, entitled ‘Unit cost of switchgear to meet IIS benchmark based on installations up to 5 years ago (£ per zone)’, requires unit cost data for items of switchgear needed to meet the IIS benchmark. The number entered here should be for the cost of items of switchgear per zone and based on installations in the last five years.

95. The second column is for the ‘Unit cost of additional HV switchgear to meet DNO standards (£ per circuit)’. This column allows the user to add additional asset costs to HV switchgear in the HIDAM that might arise from specific DNO specifications. It should be added as an additional cost for HV switchgear per circuit.

1755. Pole mounted switchgear unit costs (£ per unit)

96. This table covers the cost of pole-mounted switchgear on HV circuits. The cost should be per pole-mounted switchgear unit.

1756. Source circuit breaker unit costs (£ per unit)

97. This table covers the cost of source circuit breakers on HV circuits. The cost should be per source circuit breaker.

- **Sstn and Site sheets**

98. There is only one input data table in the “Site” worksheet.

99. There is only one input data table in the “Sstn” worksheet.

1781. Existing firm capacity, forecast maximum demand and reactive power at EHV substations and above

100. This table should contain data relating to forecast maximum demand and forecast reactive power at different substations for transformation levels above EHV for the charging year. It is organised by transformation level.

101. The first column can be used to enter the name of a substation if this helps the user in entering data. The use of this field is optional. It should be noted that there is no connection between a substation number and different transformational levels. So, for example, substation 1 at TR/EHV will not be linked to substation 1 at EHV/HV.

102. There is no need to start with substation 1 for each transformation level. This allows the user to enter each substation on a separate line and with a unique name should they wish.

103. For each existing substation in the charging area for which 'use-of-system' charges are being calculated and at the transformation levels listed, the user should enter the existing firm capacity (MVA), forecast maximum demand (MW) and the forecast reactive power (MVAR). In the case of a leading power factor, reactive power should be entered as a negative value.

104. In the HIDAM, we are interested in the aggregate of these numbers. If preferred, for any network level, the user can enter only one line of data covering the total amount of forecast maximum demand or forecast reactive power at that network level.

105. If entering aggregate information, it is important to ensure consistency with forecast maximum demand and forecast reactive power information entered in table 1782 regarding connected sites at the EHV and 132kV network levels.

106. The sum of the numbers entered in each column in table 1781 is displayed above the table for convenience.

1782. Import Capacity (MVA), forecast maximum demand (MW) and forecast reactive power (MVAr) at EHV and 132kV connected sites

107. The data to be entered into this table relate to connected sites at the EHV and 132kV levels. It should not refer to merchant generators; these are ignored in the HIDAM.

108. For each site connected at the EHV and 132kV network levels, the user should enter the maximum import capacity, the forecast maximum demand and the forecast reactive power of the site. The forecast maximum demand (MW) and forecast reactive power (MVAR) can be entered as described above in the instructions for table 1781. In the case of a leading power factor, reactive power should be entered as a negative value.

109. The maximum import capacity (MVA) for each site should also be added, remembering to ignore merchant generators.

110. The sum of the numbers entered in each column in table 1782 is displayed above the table for convenience.

Overview of the calculation sheets

111. This section provides an overview of the contents for each calculation sheet within the workbook.

112. The user does not need to interact with the calculation sheets in order to produce results from the HIDAM model. The cells of calculation tables are protected. This prevents users changing the contents of calculation cells without first removing the protection.

113. The structure of the workbook has been designed to make it easy for the user to follow the calculations. Each calculation table displays links to the tables that it relies on as well as a copy of the formulas that have been used within it. This allows the user to trace back very easily from a particular calculation sheet in order to understand what is going on. In addition, table names often provide a good indication of what is happening within a particular calculation table.

114. The purpose of this section is to provide an overview of what each calculation sheet in the workbook does. For a more detailed understanding of the HIDAM model, the user must refer to the HIDAM design document. In most cases, the variable names and equation numbers relevant to a calculation table will be written underneath the table name.

115. Two different methods are used to illustrate how the calculations are working within a sheet. For some of the more complicated sheets containing many different tables a flowchart is presented which gives an overview of the basic logic behind the calculations in each sheet. For sheets with less information, the manual provides a brief description of each table in the worksheet.

116. As well as detailing the logic of the calculations taking place, the manual also highlights tables that are needed for the functioning of the workbook but do not have an obvious interpretation at first glance. This is to help avoid confusion.

117. In the HIDAM, calculation sheets are organised along two different lines:

    (a) by section in the design document; and

    (b) by higher and lower voltage levels.

118. Calculation sheets covering higher voltage levels (TR/132kV, TR/EHV, TR/HV, 132kV/EHV, 132kV/HV, EHV/HV), are labelled EHV; those covering the HV and LV systems are labelled HVLV.

119. Each calculation sheet is described in turn below.

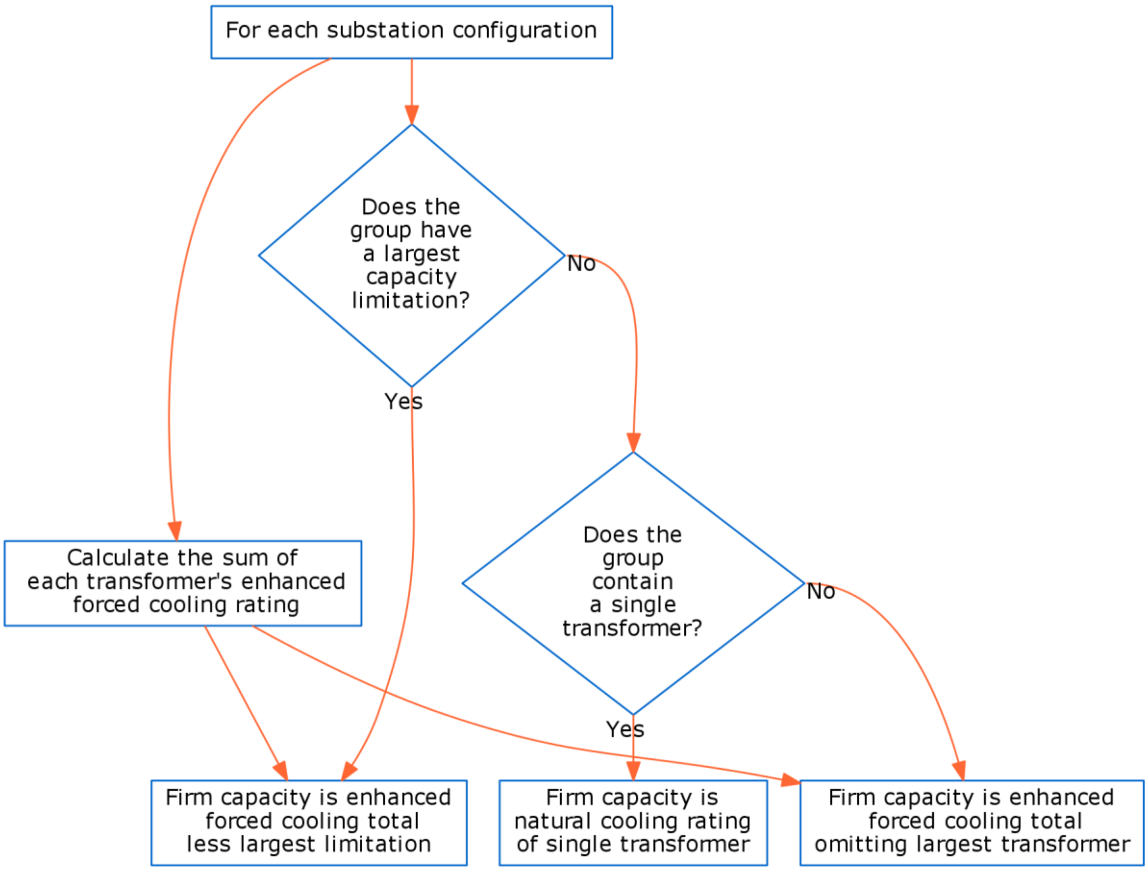
EHV-Sec5 – Calculating firm capacity for substation configurations

120. This sheet implements section 5 of the HIDAM design document. It only applies to higher voltage transformation levels.

121. EHV-S5 uses the input data from tables 1731 to 1736 to calculate the modelled firm capacity for each substation configuration at the different transformation levels.

122. Figure 2 provides an overview of the process involved in calculating firm capacity at the substation configuration level.

Figure 2 Calculating firm capacity for each higher voltage substation configuration



123. Table 3 provides a brief description of the tables in sheet EHV Sec5.

Table 3 Tables in EHV Sec5

Table name and number	**Brief description**
5501–5506. Enhanced forced cooling ratings (MVA)	This table is just a re-ordering of the enhanced forced cooling rating data entered into tables 1731–1736. The re-ordering is needed for structural purposes.
5507. Modelled installed capacity (MVA) at different transformation levels by HIDAM configuration	This is calculated as the sum of the different substation configuration enhanced forced cooling ratings. This is seen from the formula displayed and the links above the table.

5508. Enhanced forced cooling rating of the largest transformer in the group (MVA)	Calculated as the maximum enhanced forced cooling rating of a transformer within the group.
5509–5514. Natural cooling ratings (MVA)	This table is just a re-ordering of the natural cooling data entered into tables 1731–1736. The re-ordering is needed for structural purposes.
5515. Maximum natural cooling rating (MVA) of each HIDAM configuration at different transformation levels	Calculated as the maximum natural cooling rating of a transformer within each configuration.
5516. Number of transformers in each HIDAM substation configuration at different transformation levels	Calculated using a "COUNTIF" function, it is used to identify whether a substation configuration is a single transformer configuration or not.
5517. Modelled firm capacity (MVA) of each configuration type	This table uses an "IF" command to separate the different rules that apply to single and multi-transformer groups.

EHV-Sec6 – Calculating total modelled firm capacity

124. This calculation sheet follows the calculations done in section 6 of the HIDAM design document for higher voltage transformation levels.

125. The main output from this sheet is the calculation of the modelled firm capacity at the various transformation levels, subject to some constraints between modelled firm capacity, modelled maximum demand and average power factors.

126. The two constraints that must be met are that:

(a) Modelled firm capacity $\geq$ Modelled maximum demand / Average power factor

(b) Modelled firm capacity < 1.05* Modelled maximum demand / Average power factor

127. These constraints can be met by adjusting the number of substations in table 1702.

128. Figure 3 provides an overview of how modelled maximum demand is calculated for the various transformation levels within EHV-S6. Modelled maximum demand can be adjusted in order to reflect current practice and experience. To adjust modelled maximum demand, adjusted numbers can be entered into table 1703. If this is the case, calculated modelled maximum demand for a transformation level is replaced with the adjusted number.

129. Figure 4 looks at how modelled firm capacity is calculated for each transformation level within EHV-S6, including how the numbers of substations should be adjusted to ensure consistency with the constraints of the HIDAM.

Figure 3 Calculating modelled maximum demand for higher voltages

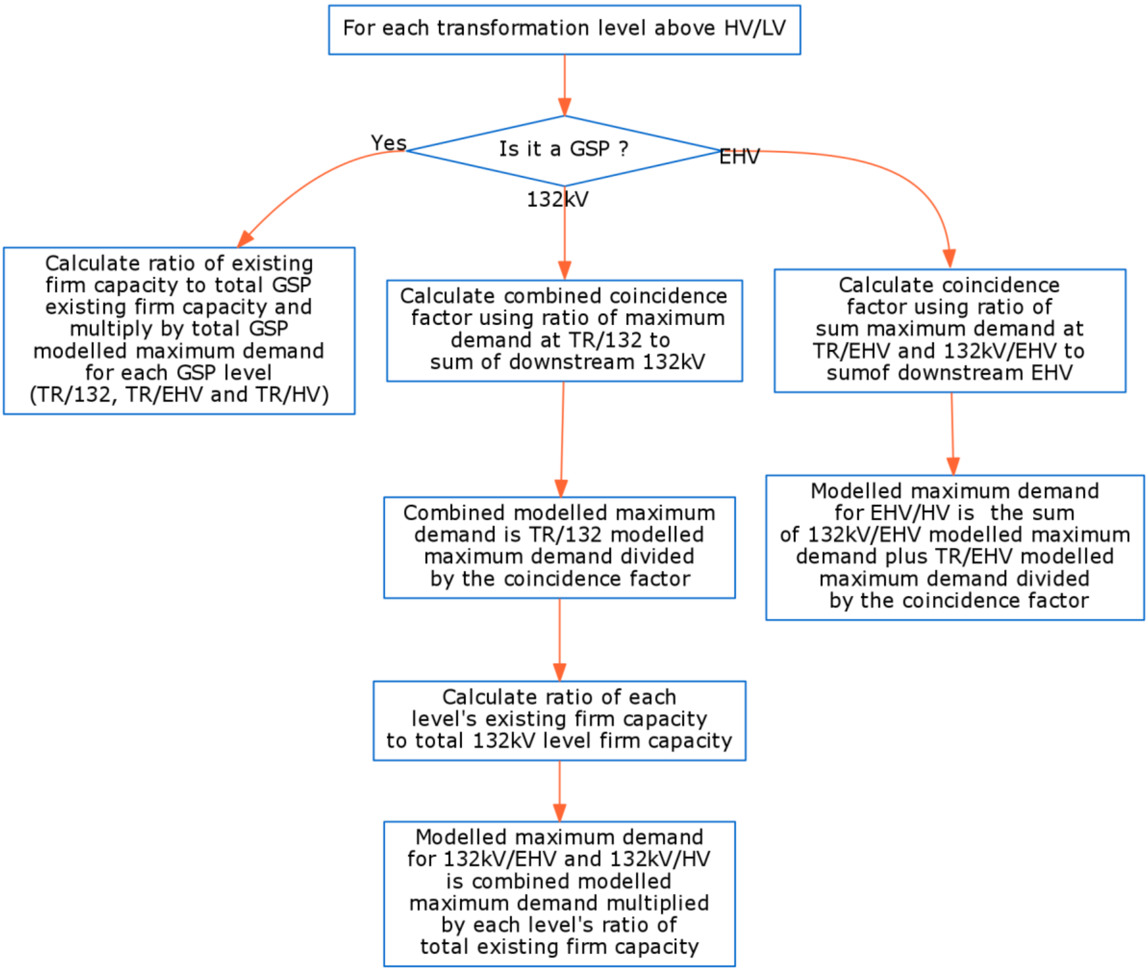
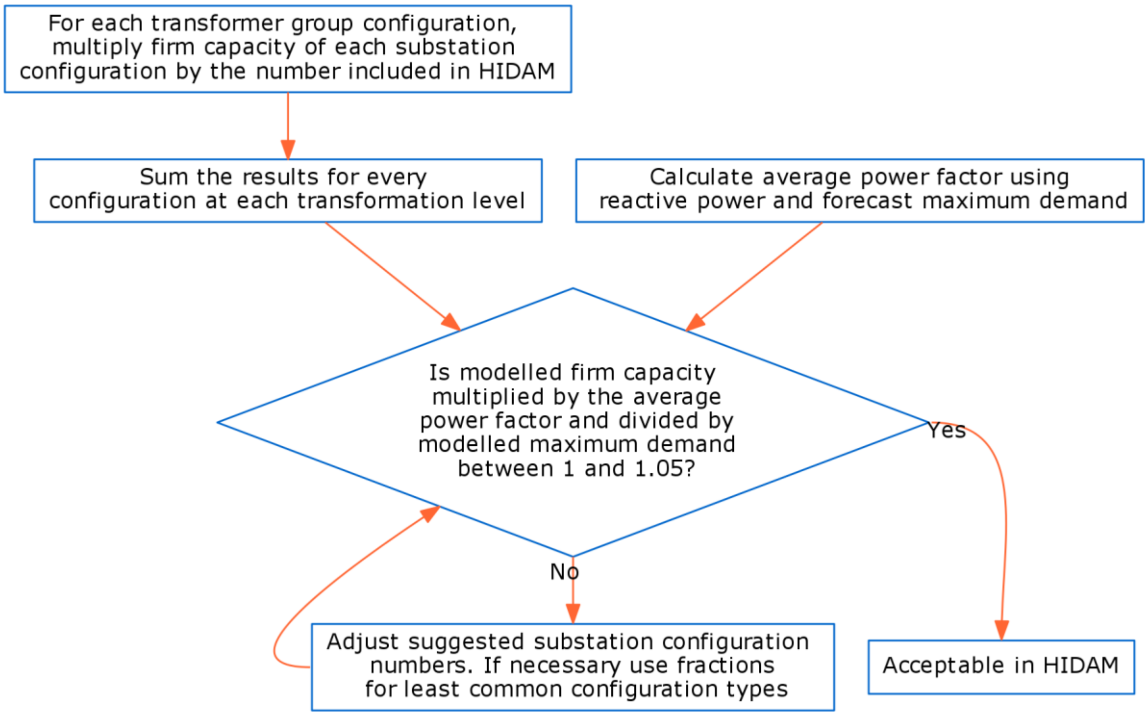


Figure 4 Calculating modelled firm capacity for higher voltages



130. The “Assumptions” sheet in the workbook provides a useful graph which shows how far off the user is from passing the test for each transformation level. There are a number of tables in EHV-Sec6 that are needed to help create these graphs. Table 4 provides a short description of each of these tables.

Table 4 Description of EHV-Sec6 graph tables

Table name and number	**Description**
5619. HIDAM sizing indicators (higher voltages) — only meaningful if the model is fully populated	This is the combination of the two inequalities that must be met in section 6.
5620. HIDAM sizing indicator test upper threshold (higher voltages)	This table displays the upper threshold for the test. It is currently 1.05.
5621. HIDAM sizing indicator outcome (higher voltages)	States the outcome of the test. The blank column is needed to produce the graph.
5622 and 5623 Ancillary tables for feedback graph	These two tables are ancillary tables needed to produce the threshold lines in the graph.

EHV-Sec7 – Calculating modelled circuit length

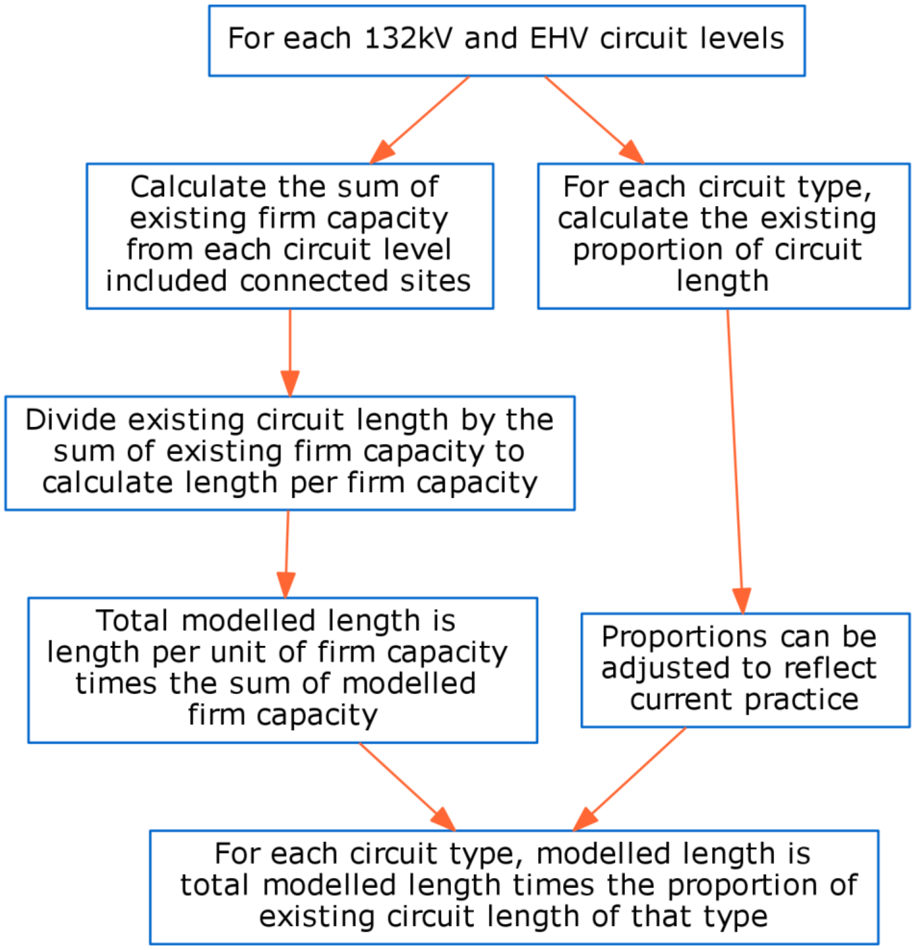
131. This calculation sheet covers the calculations in section 7 of the HIDAM design document covered for 132kV and EHV circuits.

132. It calculates the modelled length of the different circuit types for these circuits.

133. Modelled length is calculated by taking the existing length of circuit per MVA of fixed capacity and scaling it by modelled firm capacity from EHV-S6.

134. Figure 5 provides an illustration of how the calculations in EHV-S7 are formed.

Figure 5 Modelled length by circuit type for 132kV and EHV circuits



135. Figure 5 above provides an overview of how EHV-Sec7 is structured. There are a few tables within this section that are not easy to interpret from the name of the table or from the links to other tables. Table 5 provides a description of each of these tables to avoid confusion.

Table 5 Description of certain tables in EHV-Sec7

Table name and number	**Description**
5701. Number of circuits at higher voltage circuit levels	This is a table of constants that is needed to convert the route length data into circuit length data.
5708. Proportion of 132kV and EHV lines by type (%)	This table contains the proportion information used in the HIDAM, updating the proportions if adjusted numbers have been entered in the “Assumptions” sheet.
5710. Test of whether sum of proportion of line types used at higher voltages equals 100%	This table must show a pass for the model to be valid.

EHV-Sec8 – Calculating substation asset values

136. This sheet implements section 8 of the HIDAM design document for higher voltage transformation levels (primary substation and above).

137. It derives asset values for the substations in the model by combining unit cost data entered into table 1750 and the number of substations from table 1702. The asset values derived in this section are attributable to either the transformation level or the circuit level.

138. There are two tables in this section. Table 6 describes the contents of each of these.

Table 6 Table descriptions for EHV-Sec8

Table name and number	**Description**
5801. Modelled Asset Values at higher voltages (£)	Calculates the asset value allocated to a particular transformation level or circuit level from the specified transformation assets. Substations asset values can be allocated between the transformation level and the downstream circuit.
5802. Modelled Asset Values by substation level at higher voltages (£)	Calculates the total asset value associated with a transformation level, irrespective of the allocation between substation and circuit level.

EHV-Sec9 – Calculating circuit asset values

139. This sheet implements section 9 of the HIDAM design document for 132kV and EHV circuit levels.

140. It calculates the modelled asset values for each circuit type and then sums them to calculate the total modelled asset value for each circuit type. The calculations in this

sheet are relatively simple. The modelled asset value for a particular circuit type is calculated as the product of the modelled length of that circuit type, as calculated in EHV-S7, and the unit cost per km given in table 1752.

141. Table 7 provides a brief description of each table within this sheet.

Table 7 Table descriptions for EHV-Sec9

Table name and number	**Description**
5901. 132kV circuit asset values by type (£)	Calculates the modelled asset value for each of the three types of 132kV circuit included within the HIDAM.
5902. Total modelled asset value of 132kV circuits (£)	Calculates the modelled asset value for the 132kv circuit level as the sum of table 5901.
5903. EHV circuit asset values by type (£)	Calculates the modelled asset value for each of the three types of EHV circuit included within the HIDAM.
5904. Total modelled asset value of EHV circuits (£)	Calculates the modelled asset value for the EHV circuit level as the sum of table 5903.

HVLV-Sec6 - Calculating total modelled firm capacity

142. This calculation sheet follows the calculations done in section 6 of the HIDAM design document for the HV/LV transformation level. The main output from this sheet is to calculate modelled firm capacity and modelled installed capacity at the HV/LV transformation level, subject to a constraint on their relative size

143. The two constraints that must be met are that:

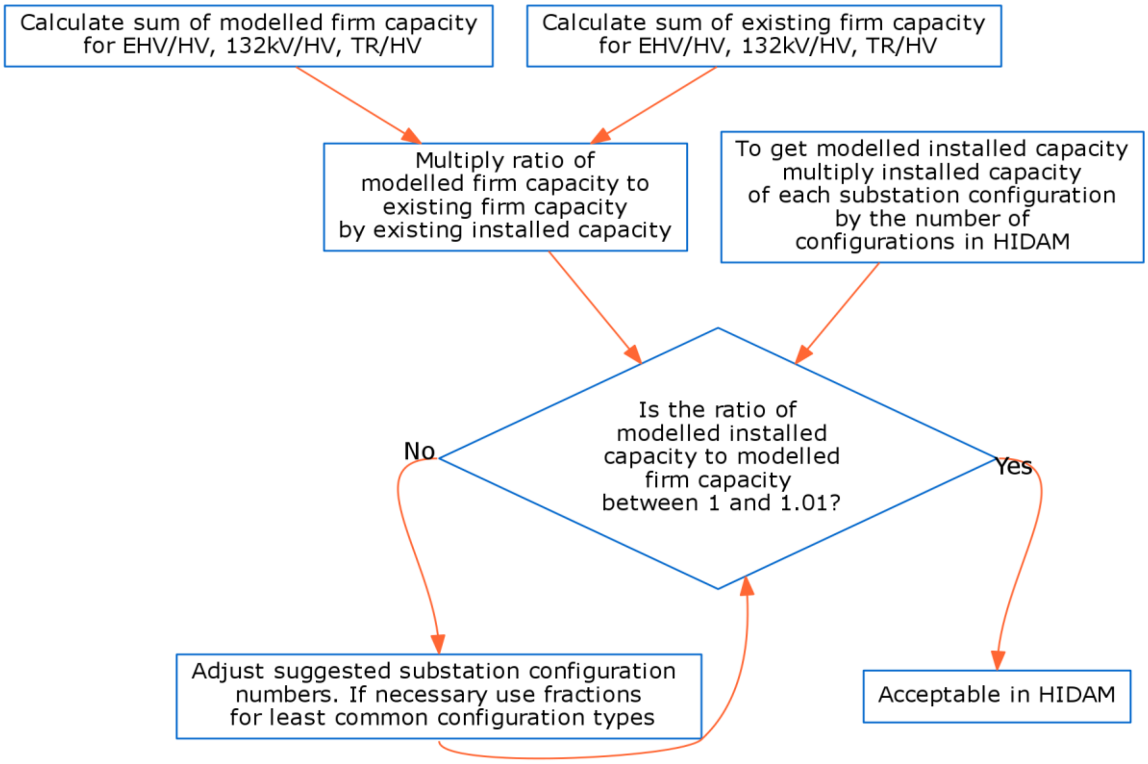
(a) Modelled firm capacity $\geq$ Modelled installed capacity

(b) Modelled firm capacity < 1.01 * Modelled installed capacity

144. These constraints can be met by adjusting the number of substations in table 1704 and 1705.

145. Figure 6 provides an overview of how modelled firm capacity and modelled installed capacity is calculated for the HV/LV level, including how the numbers of substations should be adjusted to ensure consistency with the constraints of the HIDAM.

Figure 6 HV/LV modelled firm capacity



146. The "Assumptions" sheet in the workbook provides a useful graph which shows how far off the user is from passing the test for each transformation level. There are a number of tables in HVLV-Sec6 that are needed to help create these graphs. Table 8 provides a short description of each of these tables.

Table 8 Description of HVLV-Sec6 graph tables

Table name and number	**Description**
6608. HIDAM sizing indicator (lower voltages) — only meaningful if the model is fully populated	This is the combination of the two inequalities that must be met in section 6.
6609. HIDAM sizing indicator threshold (lower voltages)	This table displays the upper threshold for the test. It is currently 1.01.
6610. HIDAM sizing indicator outcome (lower voltages)	States the outcome of the test. The blank column is needed to produce the graph.
6611-1612 Ancillary table for graph	These two tables are just ancillary tables needed in to produce the threshold lines in the graph.

HVLV-Sec7 - Calculating modelled circuit length

147. This calculation sheet covers the calculations in section 7 of the HIDAM design document covered for HV and LV circuits.

148. It calculates the modelled length of the different circuit types for these circuits. The calculations are similar to those used in EHV-S7 apart from differences in the types of circuit and that modelled installed capacity is used to scale modelled LV circuits rather than modelled firm capacity as used in section 7 for higher voltages.

149. There are a few tables within this section that are not easy to interpret from the name of the table or the links to other tables. Table 9 provides a description of each of these tables to avoid confusion.

Table 9 Description of certain tables in HVLV-Sec7

Table name and number	**Description**
6704. Test of whether sum of proportion of line types used at HV and LV equals 100%	Both cells in this table need to show a pass in order for the HIDAM to be valid.
6705. Relevant capacity at HV and LV (MVA)	This table contains the sum of existing firm capacity at TR/HV, 132kV/HV and EHV/HV and modelled installed capacity at the HV/LV level.
6710. HV and LV circuits overground/underground proportions after adjustment	This table shows the proportion of overground and underground circuits that will be modelled within the HIDAM for HV and LV networks. It will show the adjusted number if one has been entered into “Assumptions”.

HVLV-Sec8 - Calculating substation asset values

150. This sheet implements section 8 of the HIDAM design document for lower voltages (HV/LV).

151. The sheet calculates the total allocated asset values of the pole and ground mounted HV/LV substations included within the HIDAM. The calculations are similar to those undertaken in EHV-S8 for higher voltage transformation levels, apart from a separation between two different classes of substations at the HV/LV level and therefore the structure of the sheet is different from EHV-S8.

152. Table 10 gives a brief overview of each table contained within HVLV-S8.

Table 10 Overview of tables in HVLV-Sec8

Table name and number	Description
6801. Modelled Asset Value of HV/LV ground mounted substations allocated to HV/LV (£)	This table calculates the asset value allocated to the HV/LV transformation level in the HIDAM based on the number of ground mounted substations contained in the model. It is calculated as the sum of the product of the number of each configuration type in table 1705 and the unit cost of that configuration type in table 1751.
6802. Modelled Asset Value of HV/LV pole mounted substations allocated to HV/LV (£)	This table calculates the asset value allocated to the HV/LV transformation level in the HIDAM based on the number of pole mounted substations contained in the model. It is calculated as the sum of the product of the number of each configuration type in table 1704 and the unit cost of that configuration type in table 1751.
6803. Modelled Asset Value of HV/LV ground mounted substations allocated to LV (£)	This table calculates the asset value allocated to the LV circuit level in the HIDAM based on the number of ground mounted substations contained in the model. It is calculated as the sum of the product of the number of each configuration type in table 1705 and the unit cost of that configuration type in table 1751.
6804. Modelled Asset Value of HV/LV pole mounted substations allocated to LV (£)	This table calculates the asset value allocated to the LV circuit level in the HIDAM based on the number of pole mounted substations contained in the model. It is calculated as the sum of the product of the number of each configuration type in table 1704 and the unit cost of that configuration type in table 1751.
6805. Modelled Asset Values at lower voltages (£)	This table simply calculates the total allocated asset values from HV/LV substation assets for the HV/LV transformation level and the LV circuit level.
6806. Modelled Asset Values by substation level at lower voltages (£)	This table calculates the total asset value associated with HV/LV substation assets irrespective of any allocation issues between substation and circuit level.

HVLV-Sec9 – Calculating circuit asset values

153. This sheet implements section 9 of the HIDAM design document for HV and LV circuits. Its purpose is to calculate the modelled asset value attributable to HV and LV circuits within the HIDAM.

154. Broadly speaking, the calculations in this section are similar to those undertaken for higher voltage circuit levels in the EHV-S9 sheet. However, there are some differences. Most notably, the asset value of the HV circuit level includes an allowance for HV switchgear which is not included at any other circuit level.

155. A description of each table contained within this section is provided below.

6901. Analysis of HV circuit length and asset values

156. This table calculates the asset value associated with the three types of circuit at HV level:

(a) underground excavate and lay;

(b) underground lay only; and

(c) overhead.

157. The asset value of a specific circuit type is calculated by multiplying the modelled length of that circuit calculated in the HVLV-S7 sheet by the unit cost per km of circuit.

158. The table also displays total modelled length of each circuit type for convenience.

6902. Analysis of HV switchgear by circuit type

159. This table contains four separate columns relating to the analysis of costs of HV switchgear. Table 11 provides a description of each of these columns.

Table 11 Description of columns in table 6902

Column	**Description**
Modelled number of different types of HV circuits	This column contains the modelled number of HV circuits within the HIDAM. It takes the existing number of each circuit as entered in table 1742 and multiplies it by the total modelled firm capacity at the HV/LV level divided by the total existing installed capacity at the HV/LV level.

Column	Description
Total modelled number of control, automation and protection zones	This calculates the number of extra zones needed for HV circuit type. It is calculated by rounding up to the highest integer the ratio of customers on a circuit to the industry benchmark for customers interrupted and multiplying by the modelled number of HV circuits.
Modelled asset value of HV switchgear to meet IIS benchmark (£)	This calculates the asset value of the protection zones for each type of HV circuit. The calculation is made by multiplying the number of zones by the unit cost per zone from table 1754.
Asset value of additional HV switchgear to meet DNO design standards (£)	This column calculates the asset value relating to additional HV switchgear in the HIDAM. Additional HV switchgear is calculated as an uplift on the unit cost for each modelled HV circuit by type. The input data for this uplift is entered into table 1754.

6903. Modelled number of pole mounted switches on HV circuits

160. This table calculates the modelled number of pole mounted switches on HV circuits in the HIDAM. It is calculated as the modelled installed capacity at HV/LV circuits divided by 1 to approximate 1MW groups of demand. This number is taken from a locked cell in table 1743.

6904. Analysis of HV switchgear: totals

161. This table contains five separate columns relating to the asset value of total HV switchgear in the HIDAM. Table 12 provides a description of each of these columns.

Table 12 Description of columns in table 6904

Column	Description
Total modelled number of all types of HV circuits	This is the total number of modelled circuits at the HV circuit level. It is the sum of the first column in 6902.

Column	Description
Total asset value of HV switchgear to meet P2/6 for all HV circuits in the HIDAM (£)	This provides the asset value of HV switchgear to meet P2/6 for all HV circuits in the HIDAM. It is calculated as the sum of the asset values of the source circuit breakers and pole mounted switchgear. The asset value of source circuit breakers is given by the unit cost of the switchgear times the number of circuit breakers. Similarly, the asset value of pole mounted switchgear is given as the amount of switchgear multiplied by the unit cost.
Total asset value of additional HV Network Switchgear to meet IIS benchmark for HV circuit (£)	This is the sum of the third column of table 6902 and provides the total asset value relating to HV switchgear to meet the interruptions incentive scheme.
Total asset value of additional HV switchgear in the HIDAM to meet DNO design standards (£)	This is the sum of the fourth column of table 6902 and provides the total additional asset value in the HIDAM relating to HV circuits
Total asset value of HV switchgear in the HIDAM (£)	This is the sum of the total asset value relating to switchgear needed to meet P2/6, switchgear to meet IIS and additional HV switchgear

6905. Total asset values for HV circuits (£)

162. This table provides the total asset value relating to HV circuits in the HIDAM. The first column provides a value for the HV circuit level without adding asset values relating to HV switchgear. This value does not form part of the final HIDAM calculations and switchgear asset values are included in the HV level calculations.

6906. Analysis of LV circuit length and asset values

163. This table calculates the asset value associated with the three types of circuit at LV level:

(a) underground excavate and lay;

(b) underground lay only; and

(c) overhead.

164. The asset value of a specific circuit type is calculated by multiplying the modelled length of that circuit calculated in the HVLV-S7 sheet by the unit cost per km of circuit.

165. The table also displays total modelled length of each circuit type for convenience.

6907. Total asset value of LV circuits (£)

166. The total asset value of LV circuits modelled within the HIDAM.

Results – Calculating HIDAM gross asset values

167. This sheet provides the results of the HIDAM model as well as some summary data of the hypothetical network described in the model.

168. Table 13 provides a brief description of each table within the results sheet.

Table 13 Tables in the results sheet

Table name and number	**Brief description**
7001. Gross asset value of circuit and substation levels (£)	Provides the gross asset value allocated to each substation and circuit level within the HIDAM.
7002. Asset value data to populate CDCM and percentage of total asset values (£)	A transposed version of 7001 for easy copying into the CDCM and the percentage of each network and transformation levels gross asset value of the total HIDAM asset value.
7003. Total asset value (£)	The sum of each network and transformation level's gross asset value within the HIDAM.
7004. Summary of modelled installed capacity (MVA)	A summary table of the modelled installed capacity within the HIDAM at each transformation level.
7005. Summary of modelled 132kV circuit lengths	Provides a summary of modelled length and modelled proportion of each type of 132kV circuit within the HIDAM.
7006. Summary of modelled EHV circuit lengths	Provides a summary of modelled length and modelled proportion of each type of EHV circuit within the HIDAM.
7007. Summary of modelled HV circuit lengths	Provides a summary of modelled length and modelled proportion of each type of HV circuit within the HIDAM.
7008. Summary of modelled LV circuit lengths	Provides a summary of modelled length and modelled proportion of each type of LV circuit within the HIDAM.