USER MANUAL ACCOMPANYING THE SCOTTISH GOVERNMENT HEAT NETWORK TARIFF COMPARISON TOOL

V1.2

Contents

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1 Disclaimer

The guidance provided in this document is limited to technical operation of the tool only. The tool itself is intended to provide organisations with an indicative tariff value for each property connecting to a proposed heat network. This demonstrates the relative value of the total costs paid for heat for each property connecting to a heat network relative to an estimated counterfactual cost and relative to the share of heat drawn from a network.

Where the network has spare capacity, the tool could also be used to determine the added value of connecting additional properties to a heat network, although this feature should be treated with caution as the model is not built to flex technical considerations. Potential small loads which would not impact the sizing of main or auxiliary generators can be added to test whether the additional revenue would cover the additional costs.

All figures and data shown in this document should be taken as purely explicative.

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2 Tool structure and functionality

The model has been built in Microsoft Excel 365. Early in the model building process, we have checked with client whether this was acceptable. Please note that not all functions may be compatible with earlier versions of Excel.

2.1 Colour coding

Cells are colour coded for ease of use.

	Indicates a cell which requires a user input, either through entering data or by selecting from a drop-down list
	Indicates a cell which contains a formula and automatically populates. Note that these cells can be overwritten with other information
	Indicates a calculation cell which contains a formula and automatically populates. These cells are used for underlying calculations. Note that these cells can be overwritten with other information
	Constant - linked from input cell

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Sheets are colour coded depending on their function:

Sheet function	Colour
Output sheets	Blue
Input sheets	Pink
Calculation sheets	Gold
Information sheets	Grey

2.2 Acronyms

The following acronyms are used in the model:

Acronym	
CAPEX	Capital expenditure
CF	Cashflow
CHP	Combined Heat and Power
GDP	Gross Domestic Product
EfW	Energy from Waste
NPV	Net Present Value
OPEX	Operating expenditure
REPEX	Replacement expenditure

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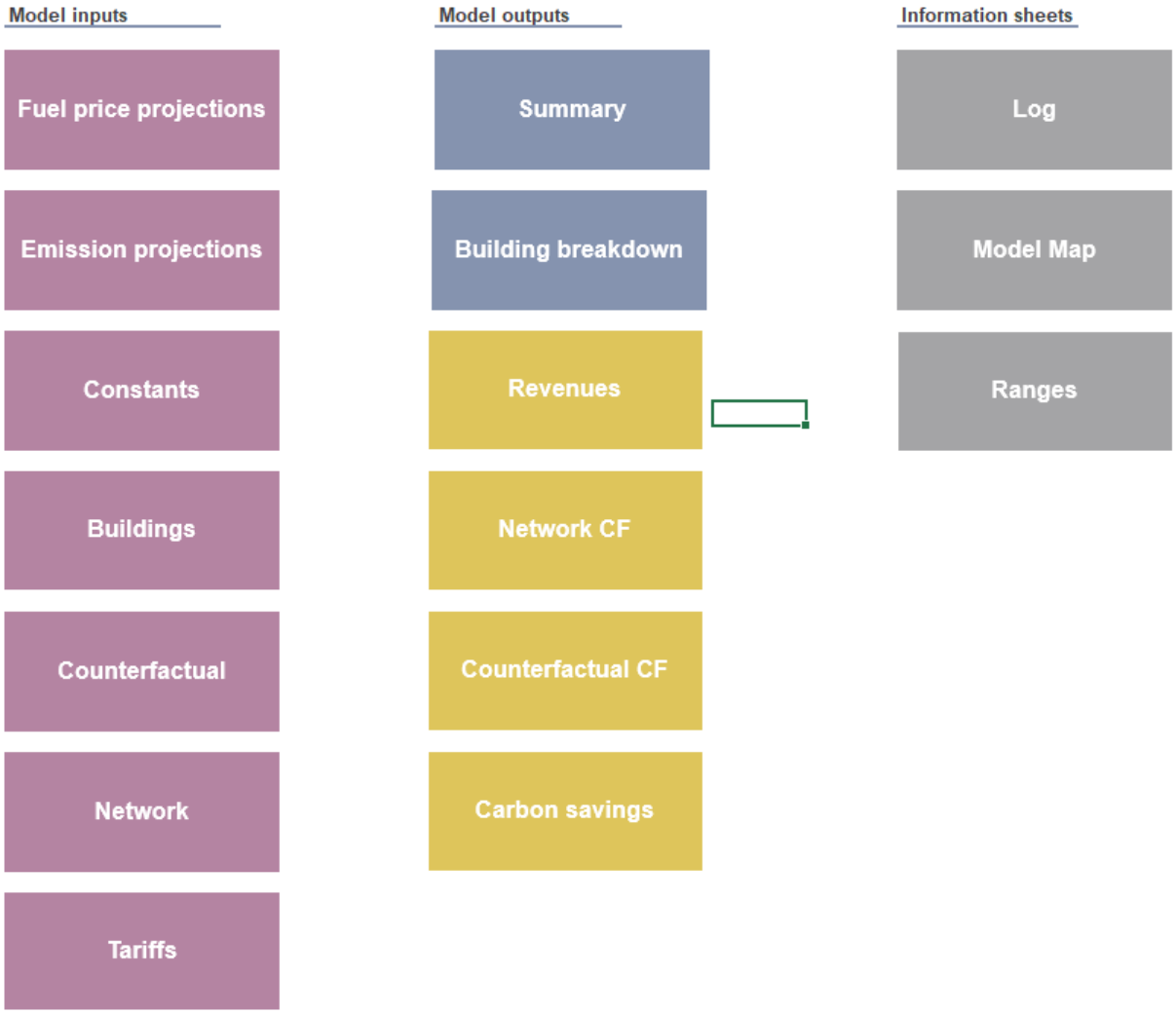
2.3 Worksheet description



The figure above illustrates the model map, with a breakdown of individual worksheets and their function in the Tool. This map is included the Tool on the Model Map worksheet. A brief description of each sheet can be found below.

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Worksheet name	Description
Log	This sheet provides a log of all major changes made to the model, including the modeller name. This sheet is used to ensure version control of the model.
Model Map	This sheet provides an illustration of all the worksheets in the model
Fuel price projections	This sheet includes the expected changes to fuel prices over time, and is used to index price changes for a price base
Emission projections	This sheet includes the long run marginal carbon dioxide equivalent emissions for fuel types captured in the model
Constants	This sheet contains all the core assumptions, including dates and property definitions used throughout the model
Buildings	This is an input sheet, used to fill in basic information on properties connected to the network and their annual heat demand
Counterfactual	This is an input sheet with details on the counterfactual heat technologies which would be used if the properties are not connected to the heat network
Network	This is an input sheet with technical information on the proposed heat network. This sheet is to be populated with information from the technical feasibility study
Network costs	This is an input sheet with financial information on the proposed heat network. This sheet should be populated with information from the financial feasibility study.
Tariffs	This is an input sheet which should include information on the proposed heat network tariff prices and counterfactual fuel prices.
Summary	Main outputs from the Tool. This provides the key comparison of the proposed network tariffs against the estimated counterfactual and corresponding lifetime network costs.
Building breakdown	Provides a summary of information per building for annual costs, variable and standing charges.
Revenues	This sheet provides the main calculations for revenues from the heat network.
Network CF	This sheet provides the network cashflow, with total overall costs of the network and incoming revenues
Counterfactual CF	This sheet provides the counterfactual cashflow, with total overall costs (revenues not included)
Carbon savings	Estimates of carbon footprint for the network and the counterfactual scenario
Ranges	This sheet provides an overview of all the options shown in drop-down menus throughout the model

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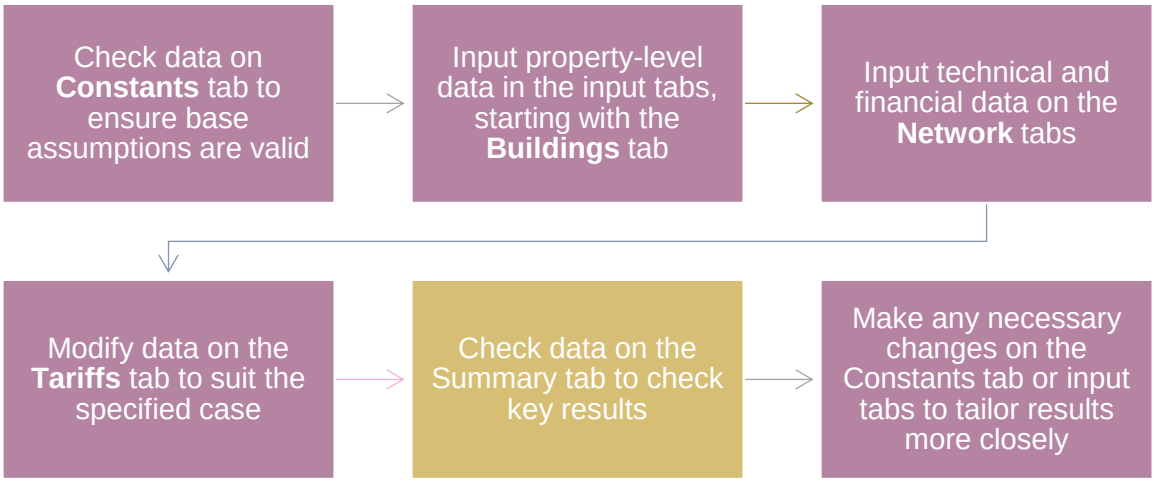
2.4 Tool flow



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3 Base assumption sheets

3.1 Log

This sheet is used to track all material changes made to the model, for example; if more data becomes available about network costs, it can be added to the Network Costs tab and a note made in the log. This allows changes in output to be tracked back specific modifications, increasing the transparency of the model and understanding of the conclusions that can be drawn from it.

Additionally, if multiple copies of the model end up in circulation, a comprehensive log sheet can aid in determining where the different versions of the model differ and the alterations that are needed to return to a single master copy.

The log sheet has been reset prior to issue of the model.

3.2 Model Map

This sheet is for information only and provides an overview of all the sheets contained in the model. It also includes an overview of cell colours and a brief description of each sheet.

3.3 Ranges

This sheet provides an overview of all the options included in the drop-down cells of the model.

This sheet should not be modified.

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4 Input Sheets

4.1 Fuel price projections

This sheet is found at the back end of the model. No user amendment is required.

Business cases for investment in energy efficiency and renewable energy projects can be very sensitive to assumptions about the future of energy costs, which are generally expected to increase over and above inflation. The model enables sensitivity testing on this key risk by allowing the user to compare energy price projections across low, central and high projections across three types of users; Domestic, Commercial/Public Sector and Industrial.

These price projections are taken from the government website on Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal.

These projections include the following assumptions:

- Central estimates of economic growth
- All agreed policies where decisions on policy design are sufficiently advanced to allow robust estimates of impact.
- Inclusion of all non-avoidable taxes and duties (VAT is not included, but CCL rates are included)
- Inflation adjusted, so only the 'real' change in prices is shown

Due to high levels of uncertainty on the movement of energy prices beyond 2031 will remain constant.

The graphs below show the price projections under each of the scenarios. In the model, we have calculated the percentage change between each of the year and applied them to the tariff input values on the Tariffs tab. This sheet should not be altered, except to update these projections with the latest information from the Department of Business, Energy and Industrial Strategy.

Note only the graphs for Commercial/Public Sector have been reproduced below.

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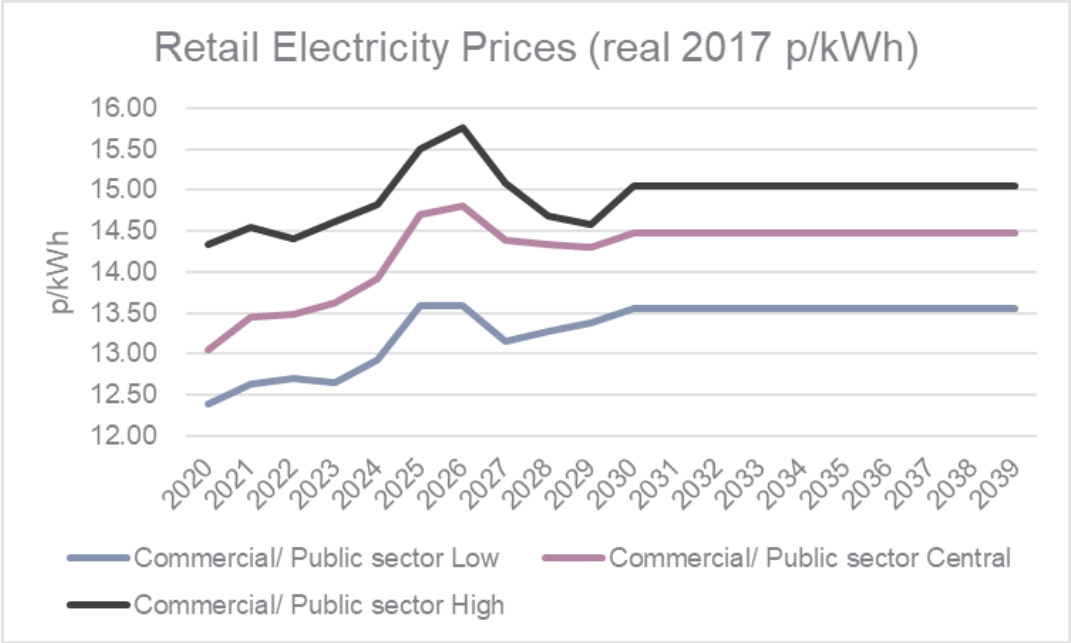

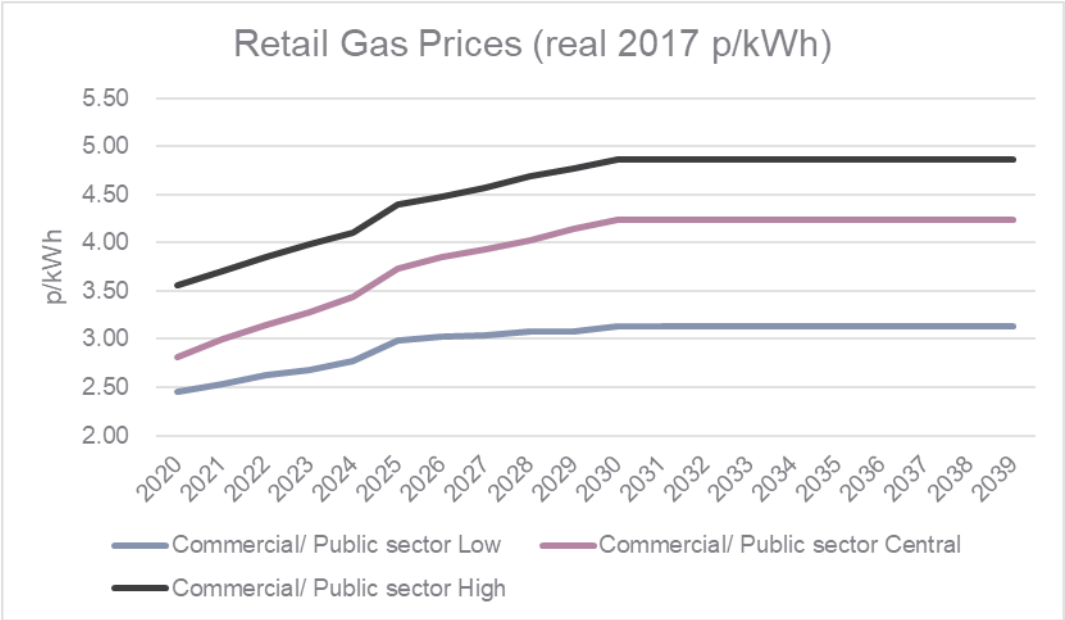

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4.2 Emissions projections

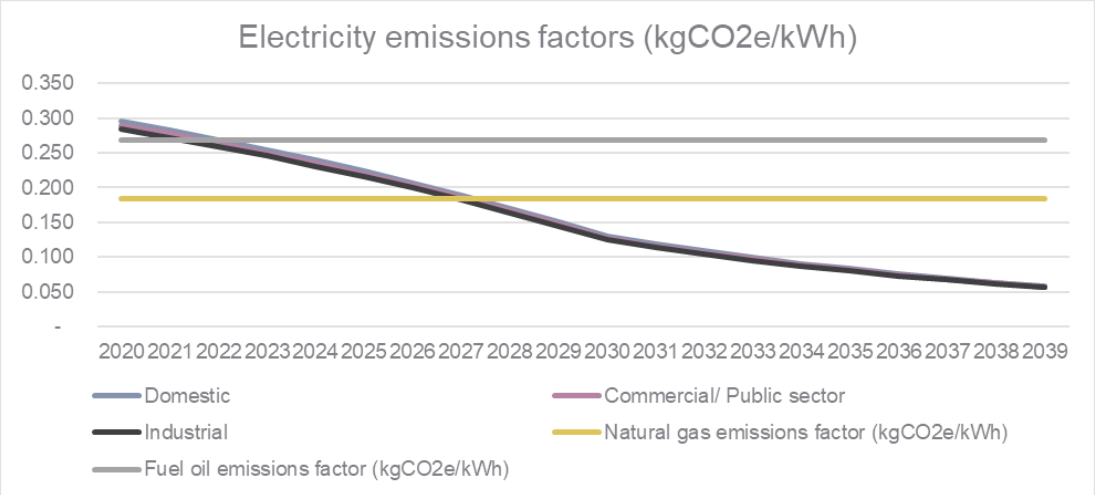
This sheet is also located near the back of the model. **User amendment is required where the main or secondary heat source is through a Heat supply agreement with a third party**. These values should be inputted in the identified row, as illustrated below.

Heat supply agreement emissions factor (kgCO2e/kWh)		
User input		

The carbon impact of electricity use will change over time as the grid decarbonises. Both for counterfactual technologies which will use electricity, and for heat network projects which propose to use electricity, this decarbonisation trend will impact the overall project carbon factor.

In line with recommendations from the government website on Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal, we have used the long-run marginal, consumption based emissions factors for electricity, natural gas and fuel oil (note there is no change in the carbon equivalent factors for natural gas and fuel oil over time).

Electricity emission factors are shown below (with natural gas and fuel emissions included for reference).



4.3 Constants

This sheet is critical for transparency, as it details the base assumptions used in the model. **This sheet is filled with placeholder information but should be amended by each user.**

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Technology assumptions for efficiencies, lifetimes and fuel sources are contained on this sheet. If there are site-specific assumptions for efficiencies that need to be modified, these can be changed on the Counterfactual tab.

Placeholder capital costs (Capex) and operating costs (Opex) assumptions for the counterfactual are contained on this sheet. **These costs must be modified before use.** These costs have implications for the lifetime costs of the counterfactual scenario, and through this on the comparison in prices paid by consumers for district heating or the most likely alternative.

Note that average costs per kW are used throughout the model.

4.4 Buildings

The Buildings tab contains the base energy demand information for each property. Up to 50 buildings can be added.

For each property, a Building name should be filled in, a long with a choice of building use. A property can consist of multiple buildings, potentially with a variety of building uses. Building uses can be selected from a drop-down menu which contains the following options:

- Public sector
- Residential
- Social Housing
- Vulnerable residential
- Commercial
- Mixed use
- Industrial

Building name	Building use	Tariff band	Annual heat demand	Connection year	Connection fee
	choice	automatic	kWh	input	input £000's
AAA	Social Housing	Low	2,000,000	2020	60
AAB	Public sector	Central	3,000,000	2023	

For buildings with multiple uses, it is recommended to either select Mixed use from the Building use categories or to split building use by category.

In addition to building use, annual heat demand, the proposed connection year to the district heating network and the Connection fee (if applicable) should be added. The blue cells for tariff band are automatically populated from the Constants tab but can be overwritten for any buildings which fall outside the norm. The actual tariffs for each band are inputted by the user on the Tariffs tab at a later stage.

Buildings with multiple properties of up to three different heat demand profiles can be aggregated using the “Annual heat demand calculator” at the top of the sheet.

Connection fees for potential extensions to new properties should be set to “0”. For other properties, revenues from connection fees will be used to offset the cost of connecting to the heat network in the year of connection. By setting connection fees to “0” for new properties, the cost of extending the network will not be offset by the

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buildings connecting to the network, which provides a proxy estimate of value of the additional heat demand relative to network extension costs.

4.5 Counterfactual

Most of the counterfactual tab is automatically populated, but it is necessary to select a main heat source and in some cases a secondary head source.

It is assumed that only a single heat source is used in the counterfactual scenario, from a selection of the below:

- Domestic gas boiler
- Commercial gas boiler
- Oil boiler
- Electric heating
- Biomass boiler
- Natural gas CHP
- Air source heat pump

The choice of counterfactual technology should reflect the most likely technology used if the building is not connected to the proposed heat network.

Efficiencies of the main heat source are automatically populated from the Constants tab but can be overwritten on a case by case basis. This will impact estimated fuel consumption for the system.

System status in 2020 should be selected from a drop-down list with three options; relatively new, in need of replacement or unsure. This determines the age of the main system in 2020, which is used to calculate the replacement costs necessary to maintain the counterfactual system, feeding into the calculations for lifetime costs.

Main heat source	%heating from main heat source	% heat efficiency of main heat source	System status in 2020	Age of main system in 2020
choice	estimate	estimate	choice	estimate (years)
Commercial gas boiler	100%	90%	in need of replacement	19
Electric heating	100%	100%	unsure	13
Domestic gas boiler	65%	90%	in need of replacement	11

It is automatically assumed that 100% of heating to the building will be supplied from the main counterfactual technology. However, this assumption can be overwritten, which will allow back-up heating fields to be filled in:

Back-up heating	% efficiency of back-up heating	Back-up system status in 2020	Age of back-up heating
choice	input	choice	estimate (years)
Electric heating	100%	unsure	13

4.6 Network

This tab is used for the main technical assumptions for the proposed heat network. These include the choice of heat source (from a drop-down list), fuel input type, heat capacity, proportion of heat met by the technology and heat generation efficiency.

The following heat sources are included as part of the drop down selection:

- Water source heat pump
- Ground source heat pump
- Biomass boiler
- Industrial heat recovery
- EfW recovery
- Natural gas CHP

Note that heat pumps (both Water source and Ground source) will likely be fuelled by Electricity, and Industrial heat recovery and EfW recovery are both considered forms of recovered waste heat arranged through a heat supply agreement. This has implications for fuel costs and for the carbon savings calculations.

Technology 1	choice	Water source heat pump
Fuel input type	choice	Electricity
Heat capacity	kW	1,000
Proportion of heat met by this technology	%	50%
Heat efficiency	%	350%
Technology 2	choice	
Fuel input type	choice	
Heat capacity	kW	
Proportion of heat met by this technology	%	
Heat efficiency	%	
Backup and peak technology type	choice	Gas boiler
Fuel input type	choice	Natural gas
Heat capacity	kW	2,000
Proportion of heat met by this technology	%	50%
Heat efficiency	%	90%

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In addition to the choice of technology, expected heat network distribution losses should be filled in. This is currently set to 12% but can range from 15-40% in practice.

4.7 Network costs

Network capital costs, lifetimes and operating costs should be added in this tab. Replacement costs and residual values (for equipment with an expected lifetime in excess of the 20 years modelled in this Tool) are automatically calculated.

Expected fuel prices should be added (2019 values). Currently, fuel prices to the heat network are expected to increase in line with Central values for Commercial/Public sector clients but this setting can be changed on the drop down menu.

Index set to	Central + Commercial/ Public sector
	Combined standing and variable charge
Natural gas	3.21
Fuel oil	
Recovered waste heat	
Biomass	
Electricity	14.50

As there are no separate price indexations for recovered waste heat or biomass, these have been set to the expected price changes for electricity and fuel oil, respectively. This is because recovered waste heat from e.g. Energy from Waste plants are closely linked to electricity production, and for industrial processes will be linked to electricity production or consumption onsite.

Linking biomass to fuel oil is based on the assumption that much biomass or fuel oil use would be in rural areas, off the gas grid. As the closest alternative, it is possible that price projections are likely to follow one another. Additionally, one of the main costs of biomass lies in the collection and transport of biomass as a commodity, which is typically oil-based (or diesel).

4.8 Tariffs

The tariff tab requires two sets of tariff input data. Sample data has been provided.

The first set of tariff data is for the Network. Tariff bands are chosen based on input data from the Constants tab.

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Occupancy	Tariff band	Standing charge p/kWh	Variable charge p/kWh	Total charge p/kWh
Public sector	Central	0.46	4.50	4.96
Residential	Central	0.91	4.50	5.41
Social Housing	Low	0.85	4.50	5.35
Vulnerable residential	Low	0.44	3.50	3.94
Commercial	Central	0.44	4.50	4.94
Mixed use	Central		4.50	4.50
Industrial	Low	0.17	4.50	4.67

The standing charge is based on calculations on the same tab, as below:

Standing charge conversion

Annual standing charge £ per year	Average Annual demand kWh per year
4,600.0	1,000,000
90.0	9,844
55.0	6,500
20.0	4,500
2,400.0	550,000
5,000.0	3,000,000

Similarly, variable and fixed tariffs should be inputted for each building type and tariff band for each of the five fuel types included in the model. A sample for electricity is shown below. Note that standing charges are modelled as p/kWh here, so will need to be converted to provide the corresponding value. The calculation for the network tariff can be used as a guideline.

Electricity

Building type	Tariff band constant	Standing charge p/kWh	Variable charge p/kWh	Total charge p/kWh	Fuel
Domestic	Low	0.50	12.40	12.90	Electricity
Commercial/ Public sector	Low	0.50	12.40	12.90	Electricity
Industrial	Low	0.50	12.40	12.90	Electricity
Domestic	Central	0.50	13.40	13.90	Electricity
Commercial/ Public sector	Central	0.50	13.40	13.90	Electricity
Industrial	Central	0.50	13.40	13.90	Electricity
Domestic	High	0.50	15.00	15.50	Electricity
Commercial/ Public sector	High	0.50	15.00	15.50	Electricity
Industrial	High	0.50	15.00	15.50	Electricity

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5 Calculation sheets

5.1 Summary

This sheet provides the key outputs of the analysis, focussing on the comparison of heating costs to each occupancy category for the heat network and counterfactual.

Outputs are provided as a per kWh cost, savings against the counterfactual, proportion of heating and a breakdown of lifetime costs of the network and counterfactual.

Note that the default heat supply from the network is three times greater than the default heat demand in the model, which results in a negative net present value calculation for the heat network.

5.2 Building breakdown

This sheet provides the annual cost per building connecting to the network alongside variable and standing charges (which are inputted on the Tariff tab).

5.3 Revenues

This sheet provides a summary of all network revenues per building. Note that the button Update list should be clicked when buildings are added/removed from the Buildings tab.

5.4 Network CF

The Network cashflow sheet provides costs and revenues to the network, with revenues captured from the previous tab. It also provides discounted costs and revenues and summarises these as a net present value (NPV) figure.

5.5 Counterfactual CF

The Counterfactual cashflow sheet provides a summary of all counterfactual costs (applicable operating costs, replacement costs and fuel costs). Similar to the Revenues tab, this sheet should be updated to capture any changes the Buildings tab.

5.6 Carbon savings

The Carbons savings sheet estimates the total carbon impact of the counterfactual for each building added. This allows for a comparison of net carbon output of the network and counterfactual on the Summary sheet.

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